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ATMOSPHERIC RELATIVE CONCENTRATIONS FOR CONTROL ROOM RADIOLOGICAL HABITABILITY ASSESSMENTS AT NUCLEAR POWER PLANTS

A. INTRODUCTION

This guide is being developed to provide guidance on determining atmospheric relative concentration (χ/Q) values in support of design basis control room radiological habitability assessments at nuclear power plants. This guide describes methods acceptable to the NRC staff for determining χ/Q values that will be used in control room radiological habitability assessments performed in support of applications for licenses[1] and license amendment requests.

In 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” Section 50.34, “Contents of Applications; Technical Information," requires that each applicant for a construction permit or operating license provide an analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from the operation of the facility. Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50 establishes minimum requirements for the principal design criteria for water-cooled nuclear power plants. General Design Criterion 19 (GDC-19), “Control Room,” of Appendix A establishes minimum requirements for the facility control room. Included is the requirement that adequate radiation protection be provided to permit access and occupancy of the control room for the duration of accident conditions. Similar criteria are provided in 10 CFR Part 50.67(b)(2)(iii) for those plants using alternative source terms. Atmospheric relative concentrations are significant inputs in assessments performed to demonstrate compliance with these regulations.

Many of the regulatory positions presented in this guide represent substantial changes from procedures previously used to determine atmospheric relative concentrations for assessing the potential control room radiological consequences for a range of postulated accidental releases of

[1] This guide will be useful to applicants for construction permits or operating licenses under Part 50, applicants for design certifications under Part 52, and applicants for combined licenses under Part 52 who do not reference a standard design certification. See the Implementation section of this guide.

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received complete staff review or approval and does not represent an official NRC staff position.

Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted electronically or downloaded through the NRC’s interactive web site at <WWW.NRC.GOV> through Rulemaking. Copies of comments received may be examined at the NRC Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by **March 15, 2002**.

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radioactive material to the atmosphere. These revised procedures are largely based on the NRC-sponsored computer code, ARCON96 (Ref. 1). This code implements an improved building wake dispersion algorithm; assessment of ground level, building vent, elevated, and diffuse source release modes; use of hour-by-hour meteorological observations; sector averaging; and directional dependence of dispersion conditions. This guide also provides procedures for addressing some aspects of control room χ/Q determinations not currently implemented in the ARCON96 code.

The ARCON96 code used in conjunction with the guidance herein will provide an improved basis for determining site-specific control room χ/Q values. Although holders of operating licenses may continue to use χ/Q values determined with methodologies previously approved by the NRC staff, the methodology described in this guide should be used in determining new or revised χ/Q values to be used in evaluations performed to demonstrate compliance with GDC-19 or 10 CFR Part 50.67(b)(2)(iii), as applicable.

Regulatory guides are issued to describe to the public methods acceptable to the NRC staff for implementing specific parts of the NRC's regulations, to explain techniques used by the staff in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with regulatory guides is not required. Regulatory guides are issued in draft form for public comment to involve the public in developing the regulatory positions. Draft regulatory guides have not received complete staff review; they therefore do not represent official NRC staff positions.

The information collections contained in this draft regulatory guide are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget, approval number 3150-0011. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

B. DISCUSSION

In licensing proceedings for currently operating nuclear power plants, the applicants and the NRC staff have used various models for determining atmospheric relative concentration values (χ/Q) for control room habitability evaluation. The primary NRC models were those documented in the control room habitability assessment procedure developed by Murphy and Campe (Ref. 2). The Murphy-Campe procedure provided models addressing three different ground-level source-receptor geometries. Elevated releases were not addressed. The first model was a straight-line Gaussian model for the case of a point source and point receptor geometry with a difference in elevation less than 30 percent of the containment building height. This model included a fixed-value building wake correction. The second model was a straight-line Gaussian model appropriate for three geometries: a point source and point receptor with a difference in elevation greater than

30 percent of the containment building height, a diffuse source and point receptor, and a point source and a volume receptor. The third Murphy-Campe model was used for point or diffuse sources when there were alternative receptors. Section 6.4, “Control Room

Habitability System," of the Standard Review Plan (Ref. 3) references the Murphy-Campe models.

In the 1980s, the NRC sponsored studies to evaluate the existing (e.g., Murphy-Campe) models against experimental testing in the environment and in wind tunnels and to develop alternative approaches. The results of these studies were published in 1988 in NUREG/CR-5055, "Atmospheric Diffusion for Control Room Habitability Assessments" (Ref. 4). These results indicated that the existing dispersion models did not reliably predict concentrations in the vicinity of buildings. NUREG/CR-5055 presented a statistical model that made significantly more reliable predictions in building wakes. Developmental work continued (Ref. 5, 6, 7). A formal peer review was conducted by the NRC in 1994 and the earlier model was revised in response to this peer review and was included in the ARCON95 code. Slight modifications were made to the code and it was re-issued as ARCON96. The code is documented in Revision 1 of NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes" (Ref. 1).

ARCON96 is a general code for assessing atmospheric relative concentrations in building wakes under a wide range of situations. As such, the ARCON96 code provides some user options that are not considered appropriate for use in design basis evaluations for control room habitability assessments. Although the model implemented in ARCON96 was structured to address short-term atmospheric dispersion in typical reactor site building complexes, there may be atmospheric dispersion scenarios and source-receptor geometries for which the model would be inappropriate, e.g., extremely short duration releases, receptor distances shorter than about 10 meters, or control room outside air intakes[2] located close to the base of tall elevated stacks.

This guide provides guidance on the use of ARCON96 for determining atmospheric relative concentrations to be used in design basis evaluations of control room radiological habitability and provides alternative methods for situations not adequately addressed by ARCON96. NUREG/CR-6331 (Ref. 1) is a contractor report that provides a user's guide to the ARCON96 code and provides several illustrative examples to facilitate user understanding. Analysts are cautioned that the information in NUREG/CR-6331 does not constitute a regulatory position and may not be acceptable in a particular licensing proceeding.

Analysts should not assume that the use of the ARCON96 code is acceptable for purposes other than control room radiological habitability assessments. In particular, regulatory positions on atmospheric relative concentrations for toxic gas dispersion are provided in Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release" (Ref. 8). Regulatory positions on atmospheric relative concentrations for offsite accident radiological consequence assessments are provided in Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants" (Ref. 9). Regulatory positions on atmospheric relative concentrations for routine effluent release assessments are provided in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors" (Ref. 10). Although this

[2] Unless otherwise stated, in this regulatory guide *control room intake* includes ventilation system intakes and other locations of significant infiltration through the control room envelope boundary.

guide does not address toxic gas dispersion, analysts may find that such considerations need to be reflected in the design and operation of control room outside air intakes.

C. REGULATORY POSITION

1. GENERAL CONSIDERATIONS

The May 9, 1997, version of the ARCON96 code as described in Revision 1 of NUREG/CR-6331 (Ref. 1) is an acceptable methodology for assessing control room χ/Q values for use in design basis accident (DBA) radiological analyses, subject to the positions in this draft guide, unless unusual siting, building arrangement, release characterization, source-receptor configuration, meteorological regimes, or terrain conditions indicate otherwise. These latter situations need to be addressed on a case-by-case basis.

Although the ARCON96 code, when used as described in this guide, can provide an improved basis for determining site-specific χ/Q values, holders of operating licenses may continue to use χ/Q values determined with methodologies previously approved by the NRC staff and documented in the facility's final safety analysis report (FSAR) to the extent that these values are appropriate for the application in which they are being used.[3] Licensees may also continue to use the licensing basis methodology for determining χ/Q values for newly identified source-receptor combinations or re-generating the approved χ/Q values using more recently collected meteorological data sets. The ARCON96 code and the other models addressed in this guide may be used voluntarily, subject to the guidance herein, as a replacement for the existing licensing basis methodology for determining χ/Q values for design basis control room radiological habitability. Since the existing licensing basis methodology remains valid, a licensee may use the ARCON96 code and the other models addressed in this guide on a selective basis, that is, it is not necessary that all existing χ/Q values be updated at the same time. The NRC staff does expect that the methodologies will be applied consistently in any particular accident assessment.

For each of the source-to-receptor combinations, the χ/Q value that is not exceeded more than 5.0 percent of the total hours in the meteorological data set (e.g., 95-percentile χ/Q) should be determined. Values for parameters used as input to the χ/Q assessment should be selected consistent with achieving this confidence level. Selection of conservative, bounding source-to-receptor combinations and less detailed site parameters for the χ/Q evaluation may be sufficient to establish compliance with regulatory guidelines.

The period of the most adverse release of radioactive materials to the environment should be assumed to occur coincident with the period of most unfavorable atmospheric dispersion. Control room χ/Q values are generally determined for each of the following averaging periods: 0-8 hours (or 0-2 hours and 2-8 hours), 8-24 hours, 24-96 hours, 96-

[3] If (1) the previously approved values are based on a misapplication of a methodology, (2) calculational errors are identified in the values, or (3) changes are deemed necessary to ensure adequate protection of the health and safety of the public, the NRC staff will pursue necessary corrections with the applicant.

720 hours. If the 0-2 hour χ/Q is calculated, this value should be used coincident with the limiting portion of the release to the environment. The 2-8 hour χ/Q value is used for the remaining 6 hours of the first 8-hour time period even if part of this 6-hour interval occurs before or after the limiting 2-hour period. The 8-24, 24-96, and 96-720 hour χ/Q values should similarly be used for the remainder of the release duration. For facilities using the traditional TID-14844 (Ref. 11) source term, this 2-hour period will generally start at the start of the event. For facilities with design basis analyses that include an alternative source term, this period is often the onset of the in-vessel release phase.

2. CALCULATION OF χ/Q USING ARCON96

This section addresses the use of the ARCON96 code for calculating χ/Q values for design basis control room radiological habitability assessments. The ARCON96 code should be obtained and maintained under an appropriate software quality assurance program that complies with the applicable criteria of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 and applicable industry consensus standards to which the licensee has committed.

2.1 Meteorological Data Input

The meteorological data needed for χ/Q calculations include wind speed, wind direction, and a measure of atmospheric stability. These data should be obtained from an onsite meteorological measurement program based on the guidance of Regulatory Guide 1.23, "Onsite Meteorological Programs" (Ref. 12), that includes quality assurance provisions consistent with Appendix B to 10 CFR Part 50. The meteorological data set used in these assessments should represent hourly averages as defined in Regulatory Guide 1.23. Data should be representative of the overall site conditions and be free from local effects such as building and cooling tower wakes, brush and vegetation, or terrain. Collected data should be reviewed to identify instrumentation problems and missing or anomalous observations (see Ref. 13). The size of the data set used in the χ/Q assessments should be sufficiently large that it is representative of long-term meteorological trends at the site. The NRC staff considers 5 years of hourly observations to be representative of long-term trends at most sites. With sufficient justification of its representativeness, the minimum meteorological data set is one complete year (including all four seasons) of hourly observations.

Wind direction should be expressed as the direction from which the wind is blowing (i.e., the upwind direction from the center of the site) referenced from true north.

Atmospheric stability should be determined by the vertical temperature difference (ΔT) measured over the difference in height appropriate for the projected release height (including plume rise as applicable). Acceptable stability classes are given in Regulatory Guide 1.23 (Ref. 12). If other well-documented methodologies are used to estimate atmospheric stability (with appropriate justification), the models described in this guide may require modification. A well-documented methodology is one that is substantiated by diffusion data for conditions similar to those at the nuclear power plant site involved.

The meteorological data set is input to the ARCON96 code as one or more data files composed of a series of records, each of which contains the data for one hourly observation. These data should be input to ARCON96 in chronological order. ARCON96 can accept up to 10 separate meteorological data files in a single run. Each individual file may contain the data for one year, a fraction of a year, or multiple years. ARCON96 will process the data in blocks of 10,000 records, spanning files as necessary, until all data are processed. The file is a formatted, ASCII text data file. The format of each record is shown in Table 1.

ARCON96 analysts need to ensure that the measurement unit used to represent wind speed in the data set corresponds to the measurement unit selected within ARCON96 for the particular code run. Data should be reviewed to ensure that parameter conversion or normalizations have been made properly.

2.2 Determination of Release Point (Source) Characteristics

A 95th-percentile χ/Q value should be determined for each identified source-receptor combination. However, it may be possible to identify bounding combinations in order to reduce the needed calculational effort. In determining the bounding combinations it will be necessary to consider the distance, direction, release mode, and height of the various release points to the environment in relation to the various control room intakes. Additional parameters, such as those used in establishing plume rise, may need to be considered in determining the bounding combination.

The characterization of the release points will need to consider changes in associated parameters that could occur as a result of differences between normal operation and accident conditions, differences between accidents, differences that occur over the duration of the accident, single failure considerations, and considerations of loss of offsite power.

The ARCON96 code provides options that allow an analyst to model ground-level, elevated stack, and vent-point source releases. In addition, the analyst can model diffuse area sources as a sub mode of the ground-level release type. These modes and limitations on their use are discussed in the positions that follow.

2.2.1 Ground-Level Releases

The ground-level release mode is appropriate for the majority of control room χ/Q assessments. If the release type is ground level, ARCON96 ignores all user inputs related to release velocity and radius. Release height is used to establish the plume slant path.[4]

2.2.2 Elevated (Stack) Releases

The stack release mode is appropriate for releases from an isolated, free-standing, uncapped stack, the top of which is at least 2-1/2 times the height of adjacent solid structures. To be considered as an elevated release, stacks must be uncapped. Plume rise from buoyancy or mechanical jet effects are not calculated by ARCON96. The analyst may determine plume rise and add the amount of rise to the physical height of the stack to

[4] The slant path is the shortest line-of-sight distance from the release point (at the plume height) to the intake, based on the difference of elevation and the intervening distance. ARCON96 bases its source-to-receptor distance on the slant path calculated from the analyst's input of elevations and horizontal distance.

Table 1
ARCON96 Meteorological Data File Format

Field	Parameter	Discussion
1X	Blank space	
A4	Identifier	Any four character string to identify file. Can be used for any purpose, site name, etc.
I4	Calendar year	Four digit calendar year.
I3	Julian date of observation	1-365 or 1-366 (leap year) as an integer.
I2	Hour of day of observation	Military time, 0-23, with midnight = 0 as an integer.
2X	Blank spaces	
I3	Lower-level wind direction	In degrees from which wind is blowing. A wind from the north is entered as 360° and a wind from the south is entered as 180° as an integer.
I4	Lower-level wind speed	In mph, meters/second, or knots, entered to the nearest tenth of the reporting unit[1] with the decimal point assumed. For example, 5.3 meters/second is entered as 53, 5 meters/second as 50, etc.
1X	Blank space	
I2	Stability class	As an integer, A=1, G=7.
2X	Blank space	
I3	Upper-level wind direction	In degrees from which wind is blowing. A wind from the north is entered as 360° and a wind from the south entered as 180° as an integer.
I4	Upper-level wind speed	In mph, meters/second, or knots, entered to the nearest tenth of the reporting unit with the decimal point assumed. For example, 5.3 meters/second is entered as 53, 5 meters/second as 50, etc.

Notes: (1) The analyst selects the reporting unit on an ARCON96 dialog form during the code run.
(2) Invalid data should be represented by the field completely filled with 9s. For example, "999" for a I3 field, "9999" for a I4 field.

obtain an effective plume height as described in Regulatory Position 4 of this guide.[5] Although ARCON96 does not determine plume rise, the input values of stack flow, radius, and vertical velocity are used by ARCON96 to assess downwash and to estimate a maximum χ/Q value.

If the control room intake is located close to the base of a tall stack, the elevated release model in ARCON96 generates negligibly low χ/Q values. Although perhaps numerically correct, these model results may not be sufficiently conservative for a design basis assessment since the model doesn't adequately address meteorological conditions that could result in higher χ/Q values. Although the staff has previously suggested that licensees model fumigation as a mechanism to address this situation, the fumigation model did not appear to adequately estimate the effluent concentrations at the bases of industrial stacks. Concentrations greater than those predicted by ARCON96 could result from diurnal wind direction changes, meander, or stagnation. Therefore, the following

[5] The plume rise may not be added to the physical height of the stack for the purpose of meeting the 2-1/2 times height criterion.

procedure should be used to assess the χ/Q values for a control room intake located close to the base of a tall stack.

In addition to running ARCON96 to determine the elevated stack χ/Q values for the control room assessment, the analyst should calculate the maximum elevated stack χ/Q value using the methodology of Regulatory Guide 1.145 (Ref. 9) to determine the maximum χ/Q value at ground level for the 0-2 hour interval and for the 24-96 and 96-720 hour intervals. The NRC-sponsored code, PAVAN (Ref. 14), is acceptable to the staff for this assessment. For this assessment, the input parameters should be adjusted such that the effective release height is measured from the elevation of the control room outside air intake rather than plant grade. The same release point characterization and meteorological data sets used in ARCON96 should be used to determine the χ/Q values for several distances in each wind direction sector with the objective of identifying the maximum χ/Q value. Figure A.4 of Reference 15 may be useful in this regard. The maximum χ/Q value obtained for the 0-2 hour interval should be compared to the corresponding χ/Q value generated by ARCON96 and the higher value used in habitability assessments. The χ/Q values generated by ARCON96 for the 2-8 and the 8-24 hour intervals may be used without adjustment. The χ/Q values for the 24-96 and 96-720 hour intervals should be the averages of the χ/Q determined with ARCON96 and the maximum χ/Q value at ground level for each of the respective periods, weighted on the basis of 1 hour of the maximum χ/Q value for each day in the interval (e.g., 3 hours and 26 hours).

2.2.3 Vent Releases

The ARCON96 calculation of vent releases includes an algorithm to model mixed-mode releases as described in Regulatory Guide 1.111 (Ref. 10), which addresses χ/Q values used in the assessment of routine effluent releases. The development of this algorithm was based in part on limited field experiments. Given the limited experiment set, the results obtained with this algorithm may be insufficiently conservative for accident evaluations. For this reason, the vent release mode should not be used in design basis assessments. This position is consistent with the guidance of Regulatory Guide 1.145 (Ref. 9) for offsite χ/Q values.

2.2.4 Diffuse Area Sources

The diffusion models in ARCON96 are based on point-source formulations. However, some release sources may be better characterized as area sources. Examples of possible area sources are postulated releases from the surface of a reactor or a secondary containment building. Typical assessments for loss-of-coolant accidents (LOCAs) have conservatively assumed that the containment structure could leak anywhere on the exposed surface. As such, these assessments typically used the shortest distance between the building surface and the control room intake and have treated the building as a point source. This approach may be unnecessarily conservative. A more reasonable approach, while still maintaining adequate conservatism, would be to model the building surface as a vertical planar area source to facilitate using a virtual point source approximation. This approach is not intended to address dispersion resulting from building-induced turbulence. Treatment of a release as a diffuse source will be acceptable for design basis calculations if the guidance herein is followed. The staff may consider deviations from this guidance on a case-by-case basis.

2.2.4.1. Diffuse source modeling should be used only for those situations in which the activity being released is homogenously distributed throughout the building and when the assumed release rate from the building surface would be reasonably constant over the surface of the building. For example, steam releases within a turbine building with roof ventilators or louvered walls would generally not be suitable for modeling as a diffuse source. (See Regulatory Positions 2.2.4.7 and 2.2.4.8.)

2.2.4.2. Since leakage is more likely to occur at a penetration, analysts must consider the potential impact of building penetrations exposed to the environment[6] within this modeled area. If the penetration release would be more limiting, the diffuse area source model should not be used. Releases from personnel air locks and equipment hatches exposed to the environment, or containment purge releases prior to containment isolation, may need to be treated differently. It may be necessary to consider several cases to ensure that the χ/Q value for the most limiting location is identified.

2.2.4.3. The total release rate (e.g., Ci/sec) from the building atmosphere is to be used in conjunction with the diffuse area source χ/Q in assessments. This release rate is assumed to be equally distributed over the entire diffuse source area from which the radioactivity release can enter the environment. For freestanding containments, this would be the entire circumferential surface area above grade or above a building that surrounds the lower elevations of the containment. When a licensee can justify assuming collection of a portion of the release from the containment within the surrounding building, the total release from the containment may be apportioned between the exposed and enclosed building surfaces. Similarly, if the building atmosphere release is modeled through more than one simultaneous pathway (e.g., drywell leakage and main steam safety valve leakage in a BWR), only that portion of the total release released through the building surface should be used with the diffuse area χ/Q. The release rate should not be averaged or otherwise apportioned over the surface area of the building. For example, reducing the release rate by 50 percent because only 50 percent of the surface faces the control room intake would be inappropriate.

2.2.4.4. ARCON96 reduces an area source to a virtual point source approximation using two initial diffusion coefficients entered by the code user. There are insufficient field measurements to mechanistically model these initial diffusion coefficients. The following deterministic equations should be used in the absence of site-specific empirical data.[7]

$$\sigma_{Y_o} = \frac{\text{Width}_{\text{area source}}}{6} \qquad (1)$$

$$\sigma_{Z_o} = \frac{\text{Height}_{\text{area source}}}{6} \qquad (2)$$

2.2.4.5. The height and width of the area source (e.g., the building surface) are taken as the maximum vertical and horizontal dimensions of the above-grade building cross-sectional area perpendicular to the line of sight from the building center to the control room intake (see Figure 1). The horizontal distance from the building surface to the control room intake, along this line of sight, is used as the source-to-receptor distance.

[6] Penetrations that are enclosed within safety-related structures need not be considered in this evaluation if the release would be captured and released via a plant ventilation system, as ventilation system releases should have already been addressed as a separate release point.

[7] See Regulatory Position 5 regarding the use of site-specific empirical measurements.

The release height is set at the point on the surface of the area source that will result in the shortest slant path to the control room intake.

2.2.4.6. Intentional releases from a secondary containment, e.g., standby gas treatment systems (SGTS) at BWR reactors, or annulus ventilation systems in dual containment structures should be treated as a ground-level release or an elevated stack release, as appropriate. The diffuse area source model may be appropriate if the ventilation system is not capable of maintaining the requisite negative pressure differential specified in technical specifications or in the FSAR. Secondary containment bypass leakage (i.e., leakage from the primary containment that bypasses the secondary containment and is not collected by the SGTS) should be treated as a ground-level release or an elevated stack release, as appropriate.

2.2.4.7. A second possible application of the diffuse area source model is determining a χ/Q value for multiple (i.e., 3 or more) roof vents. This treatment would be appropriate for configurations in which (1) the vents are in a close arrangement, (2) no individual vent is significantly[8] closer to the control room intake than the center of the area source, (3) the release rate from each vent is approximately the same, and (4) no credit is taken for plume rise. The distance to the receptor is measured from the closest point on the perimeter of the assumed area source. For assumed areas that are not circular, the area width is measured perpendicular to the line of sight from the center of the assumed source to the control room intake. The initial diffusion coefficients are found by:

$$\sigma_{Y_o} = \frac{\text{Diameter or Width}_{\text{area source}}}{6} \tag{3}$$

$$\sigma_{Z_o} = 0.0 \tag{4}$$

2.2.4.8. A third possible application of the diffuse area source model is determining a χ/Q value for large louvered panels or large openings (e.g., railway doors on BWR Mark I plants) on vertical walls. This treatment would be appropriate when (1) a louvered panel or opening for which the line of sight to the control room intake subtends an angle no less than 45 degrees with reference to the surface of the panel or opening, (2) the release rate from the building interior is essentially equally dispersed over the entire surface of the panel or opening, and (3) assumptions of mixing, dilution, and transport within the building necessary to support condition 2 are supported by the interior building arrangement. The staff has traditionally not allowed credit for mixing and holdup in turbine buildings because
of the buoyant nature of steam releases and the typical presence of high volume roof exhaust ventilators. The distance to the receptor and the release height is measured from the center of the louvered panel or opening. Initial diffusion coefficients are found using Equations 1 and 2 assuming the width and height is that of the panel or opening rather than that of the building.

2.3 Determination of Control Room Intakes (Receptors)[2]

[8] The degree of significance will depend on the radius or width of the assumed area and the proximity of the vent cluster to the control room intake. As the radius decreases or the distance from the cluster to the control room intake increases, the less significance the position of any one vent has.

Radioactive materials released during an accident can enter the control room envelope via several potential pathways. These pathways may be intentional (e.g., ventilation system outside air intakes) and unintentional infiltration paths (e.g., doorways, envelope penetrations, leakage in ventilation system components). The applicable pathways will vary from site to site depending on the arrangement of the control room envelope in relation to other site buildings, the pressure differentials between these buildings and the control room, the configuration of control room ventilation systems, and the classification of the control room dose control (e.g., zone isolation with filtered pressurization, zone isolation with no pressurization). It may be necessary to determine χ/Q values for each potential pathway. However, the selection of one or more bounding intakes for the χ/Q evaluation may be sufficient to establish compliance with regulatory guidelines.

2.3.1 Ventilation System Outside Air Intakes

All control room ventilation systems draw makeup air from the environment during normal operations and many draw air from the environment for the purpose of supplying filtered pressurization air. The configuration of these systems may change between normal and emergency modes. In some configurations, normal ventilation outside air intakes isolate and different intakes open to supply pressurization air. Some intake dampers may have failure modes related to loss of AC power or single failures. These considerations will need to be evaluated in identifying the control room outside air intakes for which χ/Q values should be calculated.

2.3.2 Dual Ventilation Outside Air Intakes

This section applies to control room ventilation system configurations that have two outside air intakes, each of which meets applicable design criteria of an engineered safeguards feature (ESF), including single-failure criterion, missile protection, seismic criteria, and operability under loss-of-offsite AC power conditions. The outside air intakes should be located with the intent of providing a low contamination intake regardless of wind direction. The assurance of a low contamination outside air intake depends on release point configuration, building wake effects, terrain, and the possibility of wind stagnation or wind direction reversals. The two intakes should not be within the same wind direction window, which is 45 degrees on either side of the line of signt between the release point and the intake when ARCON96 is used, or as specified in Table 3. For example, of the locations illustrated in Figure 2, only locations b, c, and d would be acceptable. Location a is unacceptable because both inlets are within the same wind direction window and would be simultaneously contaminated. The methods of this regulatory position do not relieve the analyst of the need to consider χ/Q values for infiltration pathways as discussed in Regulatory Position 2.3.3.

The methods of this regulatory position involve identification of the limiting and favorable intake with regard to their χ/Q value. Because of the interplay of building wake, plume rise, wind direction frequency, intake flow rate, and other parameters, it may not be possible to identify the limiting or favorable intake by observation. In these situations, χ/Q values should be calculated for each release point-intake combination and the limiting and favorable intakes identifed on the basis of these values.

2.3.2.1. If the location of the dual intakes is such that it is not reasonable to assume that one intake would be uncontaminated (for example, if both are in the same wind direction window), or if the release is elevated, the χ/Q values for the limiting outside air intake should be calculated for each time interval using ARCON96 as described in other sections of this guide. No adjustment should be made for intake dilution.

2.3.2.2. If the dual outside air intakes are not in the same wind direction window and cannot be isolated by design, the χ/Q values for the limiting outside air intake should be calculated for each time interval as described elsewhere in this guide. The time interval values may be reduced[9] by a factor of 2 to account for intake dilution if the flow rates through the dual intakes are the same. If the flow rates are not equal, the individual χ/Q values for the two intakes are combined mathematically to obtain the effective χ/Q value using the following formula.

$$\overline{\chi / Q} = \frac{(\chi / Q)_1 \cdot F_1 + (\chi / Q)_2 \cdot F_2}{F_1 + F_2} \tag{5}$$

Where:

$\overline{\chi / Q}$ = Effective χ/Q, sec/m^3

$(\chi/Q)_1, (\chi/Q)_2$ = χ/Q value for outside air intakes 1 and 2, sec/m^3

F_1, F_2 = Flow rate for outside air intakes 1 and 2, cfm

2.3.2.3. If the ventilation system design allows the operator to manually select the least contaminated outside air intake as a source of outside air makeup and close the other intake, the χ/ Q values for each of the outside air intakes should be calculated for each time interval as described elsewhere in this guide. The χ/Q value for the limiting intake should be used for the time interval prior to intake isolation. This χ/Q value may be reduced by a factor of 2 to account for dilution by the flow from the other intake. The χ/Q values for the favorable intake are used for the subsequent time intervals. The χ/Q values for the favorable intake may be reduced by a factor of 4 to account for the dual inlet and the expectation that the operator will make the proper intake selection. This protocol is acceptable only if the dual intakes are in different wind direction windows and if there are redundant, ESF-grade radiation monitors within each intake, with control room indication and alarm, to monitor the intakes. The requisite steps to select the least contaminated outside air intake, and provisions for monitoring to ensure the least contaminated intake is in use throughout the event, should be addressed in procedures and in operator training.

A conservative delay time should be assumed for the operator to complete the necessary actions. This delay period should consider: (1) the time for the operator to recognize the radiation monitor alarm and determine its validity (e.g., channel check), (2) delays associated with other accident response actions competing for the operator's attention, (3) the time needed to complete the actions, and (4) diesel generator sequencing time. If actions are required outside the control room, delays associated with transit to the local control stations (including those delays caused by worker radiological protection controls associated with accident dose rates), and the availability of personnel need to be considered.

2.3.2.4. If the ventilation system design provides for automatic selection of the least contaminated outside air intake, the χ/Q values for the favorable intake should be

[9] The adjustment protocol and the numeric factors of this section are deterministic in nature and are expected to be conservative for most sites. Different factors may be considered on a case-by-case basis with sufficient justification.

calculated for each time interval as described elsewhere in this guide. The χ/Q values may be reduced by a factor of 10 to account for the ability to automatically select a "clean" intake. This protocol is acceptable only if the dual intakes are in different wind direction windows, there are redundant ESF-grade radiation monitors within each intake, and an ESF-grade control logic and actuation circuitry is provided for the automatic selection of a clean intake throughout the event.

2.3.3 Infiltration Pathways

Infiltration of contaminated air to a control room can be minimized by proper design and maintenance of the control room envelope (CRE). However, infiltration is always a possibility and the location and significance of these leakage pathways may warrant determination of χ/Q values. An unfiltered inleakage path of 100 cfm can admit the same quantity of radioactive material as a pressurization air intake having a flow of 2000 cfm through a 95 percent efficient filter. The situation can be further compounded if the χ/Q for the unfiltered pathway is more limiting than that for the control room outside air intake.

The following are some typical infiltration pathways that may need to be considered in establishing control room intakes for which χ/Q values are to be determined. This list is not intended to be all encompassing and not all paths may apply to a particular facility. The infiltration paths actually applicable to a particular facility will be identified via inleakage testing or CRE boundary inspections and surveillances.

- CRE doorway seals
- Personnel movement through CRE doors
- CRE outside air intake and exhaust isolation dampers
- Damper actuator or fan shaft penetrations in ductwork located outside of the CRE and subject to negative pressure (e.g., fan suctions)
- Cable tray, conduit, and piping penetrations in CRE
- Ductwork that traverses the CRE and contains contaminated air
- Floor drains

2.3.3.1. If the total amount of infiltration is such that the following mathematical identity cannot be met, 95th-percentile χ/Q values for each of the infiltration paths need to be determined.[10]

[10] This position presumes that the difference in the χ/Q values for the infiltration locations and the outside air intakes are minimal. If the site configuration is such that this presumption would not be reasonably met, χ/Q values should be determined for the specific infiltration locations.

$$F_1 \leq 0.1 \cdot F_2 \cdot \left[1 - \frac{eff}{100}\right] \tag{6}$$

Where:

F_1 = Total amount of unfiltered inleakage, cfm
F_2 = Control room outside air intake flow rate, cfm, used for pressurization
Eff = Filter efficiency, in percent

2.3.3.2. The selection of one or more bounding inleakage paths for the χ/Q evaluation may be sufficient to establish compliance with regulatory guidelines. If there is sufficient margin available, it may be possible to calculate a χ/Q value assuming the shortest distance between the release point and any point on the outside of the CRE.

2.4 Determination of Source-Receptor Distances and Directions

When the combinations of release points and intakes have been identified, the direction and distance between the release point and the intake need to be determined. Wind direction data are recorded as the direction from which the wind blows (e.g., a wind blowing out of the west is recorded with a direction of 270 degrees). The direction input to ARCON96 is the wind direction that would carry the plume from the release point to the intake.[11] For example, imagine you are standing at the intake facing the release point. If you are facing west, enter 270 degrees; if you are facing north, enter 360 degrees, etc.

The source-to-receptor distance is the shortest horizontal distance between the release point and the intake. For an area source such as building surface, the shortest horizontal distance from the building surface to the control room intake is used as the source-to-receptor distance. For releases within building complexes, the shortest horizontal distance between the release point and the intake could be through intervening buildings. In these cases, it is acceptable to take the length of the shortest path (e.g., “string length”) around or over the intervening building as the source-to-receptor distance. If the distance to the receptor is less than about 10 meters, the ARCON96 code and the procedures in Regulatory Position 3 should not be used to assess χ/Q values. These situations will need to be addressed on a case-by-case basis.

3. ALTERNATIVE PROCEDURES FOR GROUND-LEVEL RELEASES

This regulatory position addresses alternative methods for determining χ/Q values for control room radiological habitability assessments. The methods in Regulatory Positions 3.1 to 3.3 are based on Murphy-Campe (Ref. 2) and the Standard Review Plan Chapter 6.4 (Ref. 3).

3.1 Point Source-Point Receptor

[11] The site meteorological tower wind direction sensors are generally calibrated with reference to true north (360 degrees). Analysts should use caution in measuring directions on site engineering drawings since these drawings typically incorporate a plant grid and a plant “north” that may not align with true north. The source-to-receptor directions input to ARCON96 must use the same north reference as the wind direction observations.

The 0-8 hour 95th-percentile[12] χ/Q value for a single point source on the surface of the containment or other building, and a single point receptor with a difference in elevation less than 30 percent of the building height may be estimated using Equation 7.

$$\frac{\chi}{Q} = \frac{1}{3\pi U \sigma_y \sigma_z} \qquad (7)$$

Where:

χ/Q = Relative concentration at plume centerline for time interval 0-8 hours, sec/m^3

3 = Wake factor

U = Wind speed at 10 meters, m/sec

σ_y, σ_z = Standard deviation, in meters, of the gas concentration in the horizontal and vertical cross wind directions evaluated at distance x and by stability class

3.2 Diffuse Source-Point Receptor

Equation 8 may be used when the activity is assumed to leak from many points on the surface of a building such as the containment in conjunction with a single point receptor. This equation is also appropriate for point source-point receptors where the difference in elevation between the source and the receptor is greater than 30 percent of the height of the upwind building, typically the containment, that creates the most significant building wake impact. The equation is also applicable to a point source and volume receptor (e.g., an isolated control room with infiltration occurring at many locations).

$$\frac{\chi}{Q} = \left[U\left(\pi\sigma_y\sigma_z + \frac{A}{K+2}\right)\right]^{-1} \qquad (8)$$

Where:

χ/Q = Relative concentration at plume centerline for time interval 0-8 hours, sec/m^3

U = Wind speed at 10 meters, m/sec

σ_y, σ_z = Standard deviation, in meters, of the gas concentration in the horizontal and vertical cross wind directions evaluated at distance x and by stability class

K = $\frac{3}{(s/d)^{1.4}}$

s = Shortest distance between building surface and receptor location, m

d = Diameter or width of building, m

A = Cross-section area of building, m^2

The parameters σ_y, σ_z and U are determined on the basis of the site meteorological data. These data should be statistically analyzed to determine the combination of σ_y, σ_z and U that is representative of the 95th-percentile χ/Q. Some early analyses may have

[12] Defined as the χ/Q value that is not exceeded more than 5.0 percent of the total hours in the meteorological data set. The Murphy-Campe document identified this as the 5th-percentile χ/Q value.

been based on fixed meteorology conditions (e.g., F stability with wind speeds of 1.0 m/s). If these early analyses are to be updated, the staff recommends that the ARCON96 code be used. If the ARCON96 code is not used, site-specific hourly meteorological data should be used to determine the 95th-percentile χ/Q value. Figures 3 and 4 provide sigma values by stability category for distances greater than 10 meters. The data on these graphs should not be extrapolated for distances less than 10 meters.

3.3 Point or Diffuse Source with Two Alternative Receptors

Equations 7 and 8 of this guide may be used in conjunction with the procedures in Regulatory Position 2.3.2 to determine χ/Q values for control room designs having two or more control room outside air intakes, each of which meets the requirements of an engineered safety feature (ESF) including, as applicable, single-failure criteria for active components, seismic criteria, and missile criteria. If Equation 8 of this guide is used, the parameter K should be set to 0.0. In a change from previous practice, the staff no longer finds Equation 7 of Reference 2 to be acceptable for use in new applications.

3.4 Determination of χ/Q Values for Other Time Intervals

Equations 7 and 8 are used to determine χ/Q values for the first time interval of 0-8 hours. χ/ Q values for other time intervals are obtained by adjusting for long-term meteorological averaging of wind speed and wind direction.[13] This is accomplished by multiplying the 0-8 hour time interval χ/Q value by a wind speed correction factor and a wind direction factor.

3.4.1 Wind Speed Correction

This correction is defined as the ratio of the wind speed used to determine the 0-8 hour χ/Q value to the wind speed appropriate for each of the other time intervals. Column 2 of Table 2 tabulates the wind speed percentiles that correspond to each of these intervals. The hourly data should be arranged in order of increasing wind speed and the wind speed percentiles determined (i.e., the lowest wind speeds associated with the lowest percentiles). Include only the wind directions from sectors that result in receptor contamination. Table 3 tabulates the size of the minimum wind direction window to be used. From this ranking, identify the wind speed value for each interval that is not exceeded more than the stated percentage of the time. Divide this wind speed value into the 5th-percentile wind speed used to determine the 0-8 hour χ/Q to obtain the wind speed correction factor. The values shown in Column 1 of Table 2 are representative correction factors that may be used if hourly observation meteorological data are not available.

[13] Previous guidance also provided for including a factor to account for personnel occupancy factors. Since typical radiological analysis codes provide the capability to enter these factors separately, the staff recommends that the factors not be included in the χ/Q value to avoid inadvertent double crediting.

Table 2
Wind Speed Correction

Time Interval	Column 1 Representative Wind Speed Factors	Column 2 Corresponding Wind Speed Percentile
0-8 hours	1.0	5
8-24 hours	0.67	10
1-4 days	0.50	20
4-30 days	0.33	40

Table 3
Wind Direction Sectors

s/d Ratio	Minimum Window[14]
>2.5	68°
1.25 - 2.5	90°
0.8 - 1.25	113°
0.6 - 0.8	135°
0.5 – 0.6	158°
0.35 – 0.5	180°
<0.35	225°

The s/d ratio is based on the site building having the greatest impact on building wake (usually the containment) and is defined as:

$$\frac{s}{d} = \frac{\text{Shortest distance between building surface and receptor location, m}}{\text{Diameter or Width of building, m}} \qquad (9)$$

3.4.2 Wind Direction Correction

The average wind direction frequency F is obtained by summing the annual average wind direction frequencies within the minimum window. Table 3 tabulates the size of the minimum wind direction window to be used. Column 2 of Table 4 is used to determine the wind direction correction for each time interval. Column 1 is used when F has not been determined.

[14] Centered on the source-to-receptor direction.

Table 4
Wind Direction Correction

Time Interval	Column 1 Representative Wind Direction Factors	Column 2 Equations for Wind Direction Factors
0-8 hours	1.0	1.0
8-24 hours	0.88	0.75 + F/4
1-4 days	0.75	0.50 + F/2
4-30 days	0.5	F

3.5 Instantaneous Puff Releases

The method in this section may be used to model the release to the environment as an instantaneous puff release. To qualify as a puff release, 100 percent of the radioactivity must be released directly to the environment over a period no longer than about 1 minute and the center of the puff must pass over the control room outside air intake. Releases to enclosed buildings, intermittent releases that occur over a period longer than about 1 minute (e.g., releases from relief valves, atmospheric dumps), and releases that occur over a period longer than about 1 minute should be treated as continuous point source releases (without plume rise) as addressed elsewhere in this guide. The diffusion equation for an instantaneous puff ground level release is:

$$\chi(x) = \frac{2Q}{(2\pi)^{3/2}(\sigma_x^2+\sigma_I^2)(\sigma_z^2+\sigma_I^2)^{1/2}} \exp\left[-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2+\sigma_I^2}\right)+\left(\frac{z^2}{\sigma_z^2+\sigma_I^2}\right)\right] \qquad (10)$$

Where:

$\chi(x)$ = Concentration, Ci/m^3, at downwind distance x

Q = Puff release quantity, Ci

σ_x = Standard deviation, in meters, of the puff in the horizontal along wind direction. Use Figure 3 with the distance D to determine σ_x; assuming that $\sigma_x = \sigma_y$ and stability class is F.

σ_z = Standard deviation, in meters, of the puff in the vertical crosswind direction. Use Figure 4 and the difference between the release height and the intake height as the distance to determine σ_z. Assume stability class is F.

σ_I = Initial standard deviation, in meters

$$= \left[\frac{2Q}{(2\pi)^{3/2}\lambda N \rho_o}\right]^{1/3}$$

λN = Specific activity, Ci/g

ρ_o = Density of the puff at standard conditions, g/m^3

x = From Equation 11, meters

z = Difference in elevation between the physical release point and the control room intake, meters

Wind speed does not enter into the unit concentration per se, but does affect the time-integrated concentration since it determines puff passage time. The variation of unit concentration at a specific stationary receptor location is determined by evaluating x in the exponential term in Equation 10.

$$x = D - ut \qquad (11)$$

Where:

D = Release point-to-receptor distance, m

u = Windspeed, m/sec, assume 1.0 m/s

t = Time from the start of the release, s

Equation 10 provides the concentration at the control room intake at a single point in time for a single radionuclide. Equation 10 must be integrated over time from the start of the release until the trailing edge of the puff has passed the control room intake. Changes in control room intake flow rate and filtration alignment that occur during the puff transit must be included in this integration. This integration may be performed by solving Equation 10 reiteratively for the release activity that is injected into the control room volume during individual one-second time steps.

4. PLUME RISE

An applicant or licensee may propose adjustments to the release height for plume rise that are due to buoyancy or mechanical jet on a case-by-case basis. In order to credit these adjustments, the applicant or licensee must be able to demonstrate that the assumed buoyancy or vertical velocity of the effluent plumes will be maintained throughout the time intervals that plume rise is credited. Such justifications need to consider the availability of AC power, failure modes of dampers and ductwork, time-dependent release stream temperatures and pressures, and 95th-percentile wind speeds and ambient temperatures.[15] Plume rise may be considered for isolated, freestanding stacks and for vents located on plant buildings. However, plume rise may not be used in demonstrating that a particular stack meets the 2-1/2 times the adjacent structure height criterion in Regulatory Position 2.2.2. A mixed-mode release model, such as that in Regulatory Guide 1.111 (Ref. 10), should not be used for design basis assessments.

The plume rise may be determined through the use of the following set of equations (Ref. 16). The plume rise for plant vents is determined using Equation 12. The distance x is entered as the horizontal distance between the vent and the control room outside air intake.

The plume rise for isolated, free-standing stacks is calculated using Equations 12, 13, and 14. The distance x in Equation 12 should be based on the downwind location

[15] As used here, 95th-percentile wind speed is that wind speed that is not exceeded more than 5 percent of the time. A 95th-percentile ambient temperature is that temperature that is not exceeded more than 5 percent of the time.

corresponding to the maximum χ/Q value. See Regulatory Position 2.2.2. The plume rises calculated using Equations 13 and 14 should be compared and the larger plume rise identified. The result of this comparison is then compared to the plume rise determined using Equation 12 and the smaller plume rise selected for use.

$$\Delta h = \left[\frac{3}{\beta_1^2} \cdot \frac{F_m}{U^2} \cdot x + \frac{3}{2\beta_1^2} \cdot \frac{F_b}{U^3} \cdot x^2 \right]^{1/3} \qquad (12)$$

$$\Delta h = 2.6 \left(\frac{F_b}{Us} \right)^{1/3} \qquad (13)$$

$$\Delta h = 2.44 \left(\frac{F_m}{s} \right)^{1/4} \qquad (14)$$

Where:

Δh = Plume rise, m
F_m = Momentum flux parameter, $m^4 \cdot s^{-2}$
= $\frac{\rho_o V_o w_o}{\pi \rho_a}$
β_1 = Dimensionless entrainment constant for momentum = 0.6
U = Wind speed at release height, $m \cdot s^{-1}$
x = Distance from release point to receptor, m (see text)
F_b = Buoyancy flux parameter, $m^4 \cdot s^{-3}$
= $\frac{g(\rho_a - \rho_o)V_o}{\pi \rho_a}$
w_o = Effluent exit velocity, $m \cdot s^{-1}$
V_o = Volumetric release rate, $m^3 \cdot s^{-1}$
ρ_o = Effluent density after expansion to atmospheric pressure, $kg \cdot m^3$
ρ_a = Density of air, $kg \cdot m^3$
s = 0.0001 for A,B,C, and D stability; 0.00049 s^{-2} for E stability; 0.0013 s^{-2} for F stability; 0.002 s^{-2} for G stability
g = Gravitational acceleration, 9.8 $m \cdot s^{-2}$

Although ARCON96 processes ambient meteorological conditions on an hour-by-hour basis, the code cannot vary the other parameters that enter into a plume rise determination. For example, wind speed and stability class are varied hour-by-hour, but the density of air, the density of the effluent stream, and the vertical velocity are not varied hour-by-hour. As such, the analyst must ensure that these parameters are bounding for the entire period of the χ/Q assessment or use individual time intervals to model the time-variant parameters. An alternative approach would be to calculate the plume rise for each hour outside of ARCON96 and to select a plume rise not exceeded more than 5 percent of the time. This is then added to the stack height as input to ARCON96.

In lieu of mechanistically addressing the amount of buoyant plume rise associated with energetic releases from steam relief valves or atmospheric dump valves, the ground level χ/Q value calculated with ARCON96 (on the basis of the physical height of the release point) may be reduced[16] by a factor of 5. This reduction may be taken only if (1) the release point is uncapped and vertically oriented and (2) the time-dependent vertical velocity exceeds the 95th-percentile wind speed[15] (at the release point height) by a factor of 5.

5. USE OF SITE-SPECIFIC EXPERIMENTAL DATA

The methods and parameters provided in this guide are acceptable for use for design basis control room habitability radiological assessments provided that all stated prerequisites and conditions are met. The staff believes that use of the guidance in this guide will result in χ/Q values that are acceptably conservative. However, there may be circumstances in which these methods and parameters may not be advantageous for a particular plant configuration and site meteorological regimes and may lead to results that are deemed to be unnecessarily conservative. Licensees may opt to propose alternative methods and parameters that are based in part on data obtained from site-specific experimental field measurements. These proposed alternatives will be considered by the staff on a case-by-case basis.

The staff recommends that licensees considering an experimental program request a meeting with the staff in advance of starting the program. The intent of this recommendation is to allow the licensee and staff to discuss the proposed program, prior to resource expenditure, and for the staff to provide a preliminary assessment of the proposal. The staff's approval of the proposed alternative methods and parameters will not be made until the licensee completes the experimental program and dockets the proposal with supporting analyses and data for formal staff review.

An acceptable experimental program will incorporate the following standards:

5.1 The experimental program should be appropriately structured so as to provide data of appropriate quantity and quality to support data analysis and conclusions drawn from that data. The program should be developed by personnel having educational and work experience credentials in air pollution dispersion meteorology and modeling.

5.2 The experimental program needs to encompass a sufficient range of meteorological conditions applicable to the particular site so as to ensure that the data obtained address the site-specific meteorological regimes and the site-specific release point/receptor configurations that impact the control room χ/Q values. Meteorological conditions observed at the particular site with a frequency of 5 percent or greater in a year should be addressed. Parameters derived from statistical analyses on the experimental data should represent the 95 percent confidence level.

5.3 The experimental program, including data reduction and analysis, should incorporate applicable quality control criteria of Appendix B to 10 CFR Part 50. The products of the experimental program should be verified and validated.

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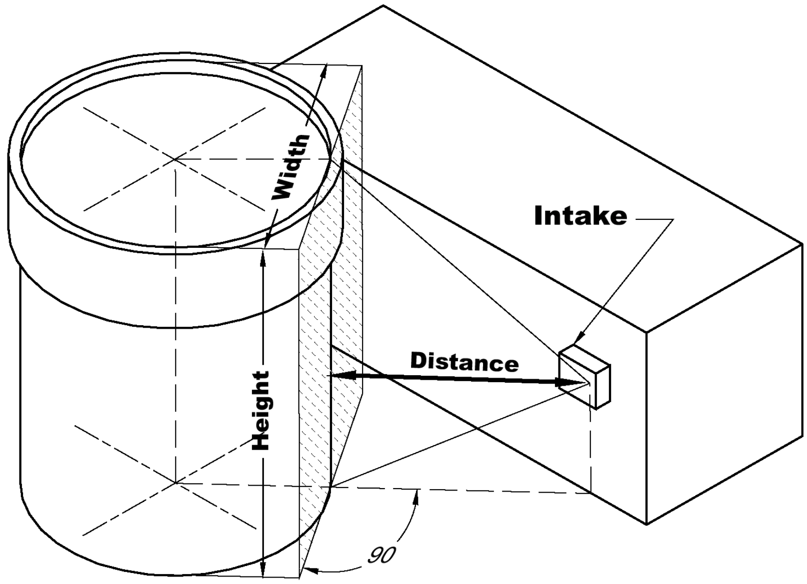
[16] This adjustment factor and the associated velocity ratio criterion are deterministic in nature and their selection was based on sensitivity analyses performed for typical steam release points at LWRs. The adjustment factor should not be ratioed for different vertical velocity ratios.

D. IMPLEMENTATION

The purpose of this section is to provide information to licensees and applicants regarding the NRC staff's plans for using this regulatory guide.

This draft regulatory guide has been released to encourage public participation in its development. Except in those cases in which a licensee or applicant proposes an acceptable alternative method for complying with specified portions of the NRC's regulations, the methods to be described in the final guide reflecting public comments will be used in the evaluation of (1) license amendments at operating reactors, (2) combined operating license applications, (3) construction permit applications, (4) operating license applications, and (5) design certification applications.

Figure 1
ARCON96 DIFFUSE SOURCE MODELING



This figure applies only to the modeling of a diffuse source in ARCON96. Only that part of the structure above grade or an *enclosing* building should be included in the building height. However, the height need not be reduced for an *adjacent* building if the assumed building surface release can be reasonably transported around or over the building to the intake.

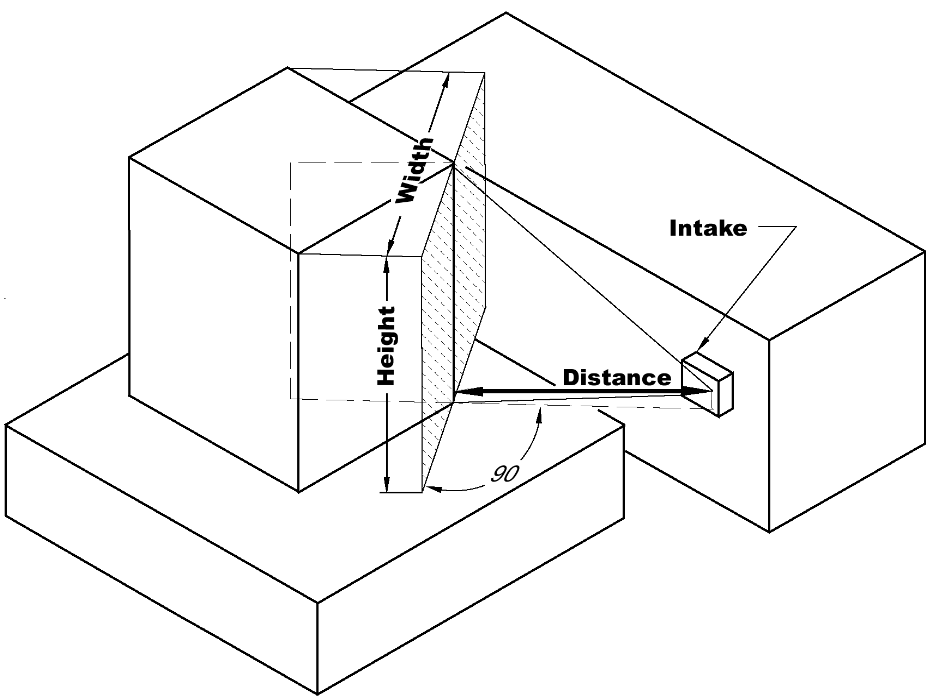
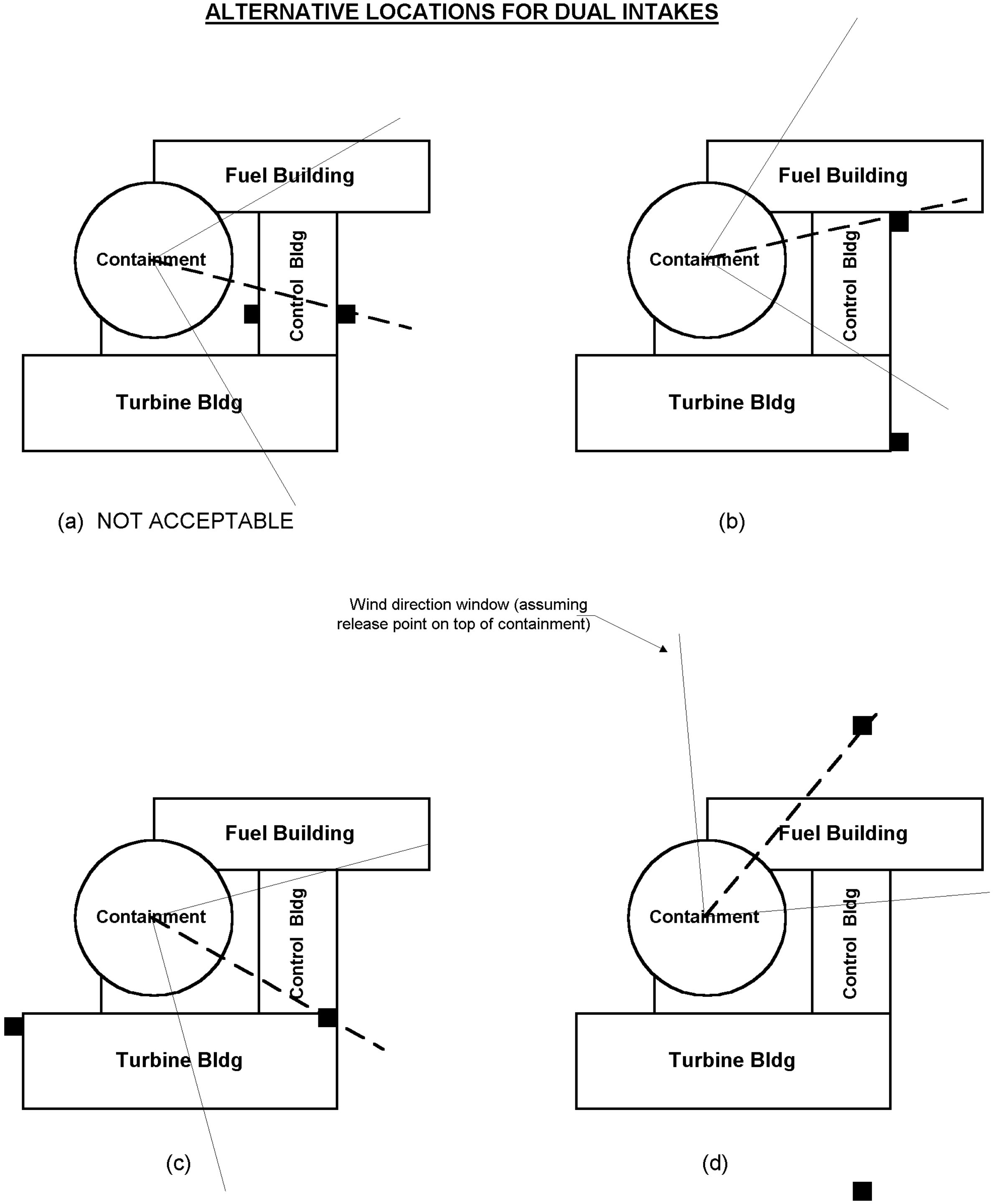


Figure 2
ALTERNATIVE LOCATIONS FOR DUAL INTAKES



These figures apply when using the methodology described in Regulatory Position 2.3.2

Figure 3

Lateral Dispersion Coefficient vs Distance and Stability Class

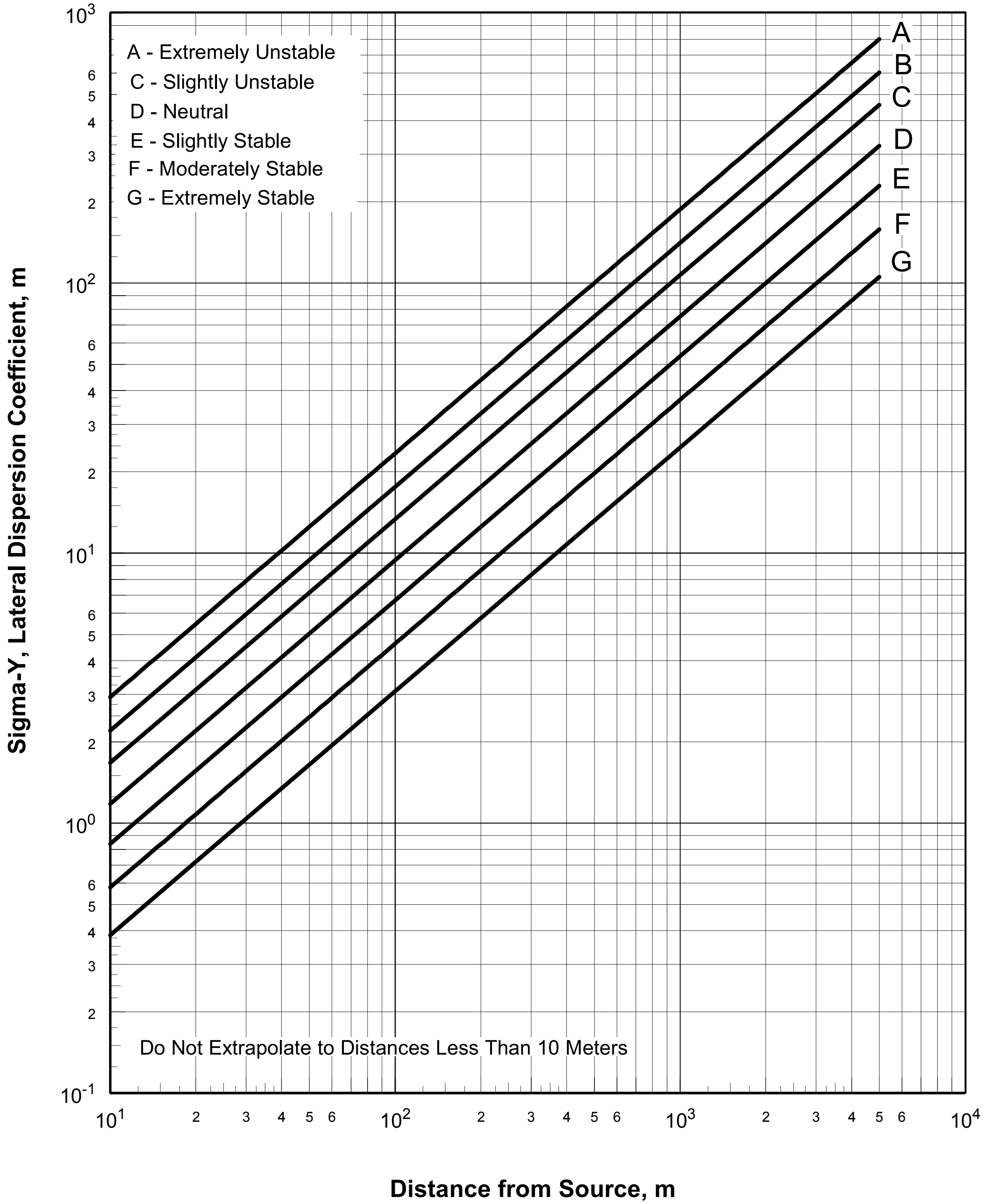
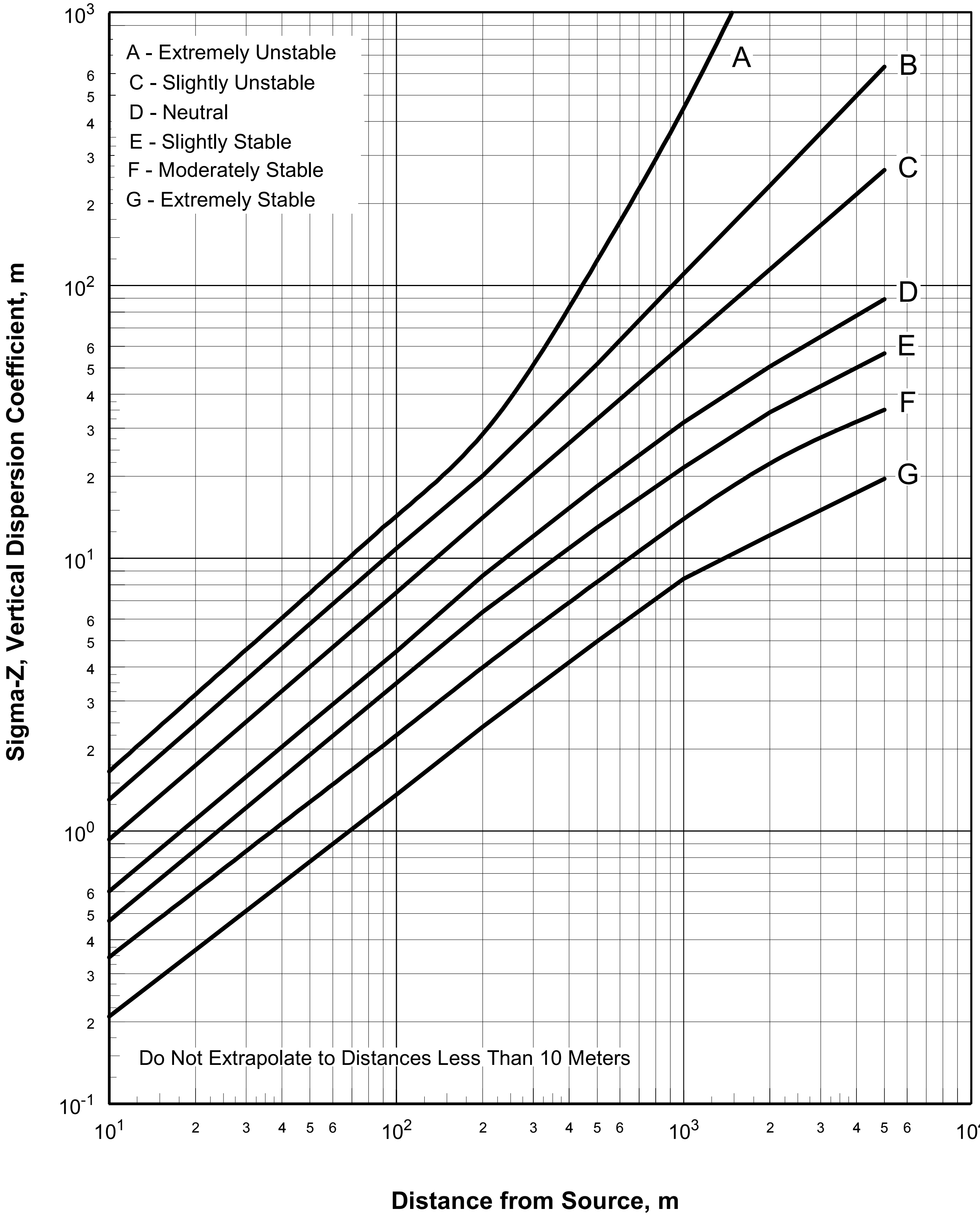


Figure 4

Vertical Dispersion Coefficient vs Distance and Stability Class



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[1] Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161; <http://www.ntis.gov/ordernow>; telephone (703)487-4650. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email is PDR@NRC.GOV.

[2] Single copies of regulatory guides, both active and draft, may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (703)487-4650; online <http://www.ntis.gov/ordernow>. Copies of active and draft guides are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email <PDR@NRC.GOV>.

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Table A-1
ARCON96 INPUT PARAMETERS FOR DESIGN BASIS ASSESSMENTS

Parameter	Discussion	Acceptable Input
Lower Measurement Height, meters	The value of this parameter is used by ARCON96 to adjust wind speeds for differences between the heights of the instrumentation and the release.	Use the actual instrumentation height when known. Otherwise, assume 10 meters.
Upper Measurement Height, meters	The value of this parameter is used by ARCON96 to adjust wind speeds for differences between the heights of the instrumentation and the release.	Use the actual instrumentation height when known. Otherwise, use the height of the containment or the stack height, as appropriate. If wind speed measurements are available at more than two elevations, the instrumentation at the height closest to the release height should be used.
Wind Speed Units	ARCON96 requires that wind speed be entered as miles per hour, meters per second, or knots.	Use the wind speed units that correspond to the units of the wind speeds in the meteorological data file.
Release Height, meters	The value of the release height is used for three purposes in ARCON96: (1) to adjust wind speeds for differences between the heights of the instrumentation and the release, (2) to determine slant path for ground level releases, (3) to correct off-centerline data for elevated releases.	Use the actual release heights whenever available. Plume rise from buoyancy and mechanical jet effects may be considered in establishing the release height if the analyst can demonstrate with reasonable assurance that the vertical velocity of the release will be maintained during the course of the accident. If actual release height is not available, set release height equal to intake height.
Building Area, m^2	ARCON96 uses the value of the building area in the high speed wind speed adjustment for ground-level and vent release models.	Use the actual building vertical cross-sectional area perpendicular to the wind direction. Use default of 2000 m^2 if the area is not readily available. Do not enter zero. Use 0.01 m^2 if a zero entry is desired. *Note: This building area is for the building(s) that has the largest impact on the building wake within the wind direction window. This is usually, but need not always be, the reactor containment. With regard to the diffuse area source option, the building area entered here may be different from that used to establish the diffuse source.*
Vertical Velocity, m/s	In ARCON96, the value of the vertical velocity is used only in vent and stack release models. It is used for the downwash calculation. In the vent release model the velocity is used in the mixed-mode calculation.	*Note: the vent release model should not be used for DBA accident calculations.* For stack release calculations only, use the actual vertical velocity if the licensee can demonstrate with reasonable assurance that

Parameter	Discussion	Acceptable Input
	If the vertical velocity is set to zero, the maximum downwash will be calculated and the release height will be reduced by an amount equal to six times the stack radius.	the value will be maintained during the course of the accident (e.g., addressed by technical specifications), otherwise, enter zero. If the vertical velocity is set to zero, ARCON96 will reduce the stack height by 6 times the stack radius for all wind speeds. If this reduction is not desired, the stack radius should also be set to zero.
Stack Flow, m^3/s	ARCON96 uses the value of the stack flow in χ/Q calculations for all 3 release types to ensure that the near field concentrations are no greater than the concentration at the release point. The impact diminishes with increasing distance.	Use actual flow if it can be demonstrated with reasonable assurance that the value will be maintained during the course of the accident (e.g., addressed by technical specifications). Otherwise, enter zero. The flow is used in both elevated and ground-level release modes to establish a maximum χ/Q value. This value is significant only if the flow is large and the distance from the release point to the receptor is small.
Stack Radius, meters	ARCON96 uses the value of the stack radius in downwash calculations in the vent and stack release modes.	Use the actual stack internal radius when both the stack radius and vertical velocity are available. If the stack flow is zero, the radius should be set to zero.
Distance to Receptor, meters	The value of horizontal distance to the receptor from the release point is used in ARCON96 for calculating the slant range for ground level releases and the off-centerline correction factors for stack release models.	Use the actual straight line horizontal distance between the release point and the control room intake. For ground-level releases, it may be appropriate to consider flow around an intervening building if the building is sufficiently tall that it is unrealistic to expect flow from the release point to go over the building. *Note: If the distance to receptor is less than about 10 meters, ARCON96 should not be used to assess relative concentrations.*
Intake Height, meters	The value of the intake height is used in ARCON96 for calculating the slant range for ground level releases and the off-centerline correction factors for stack release models.	Use the actual intake height. If the intake height is not available for ground level releases, assume the intake height is equal to the release height. For elevated releases, assume the height of the tallest site building.

Parameter	Discussion	Acceptable Input
Elevation Difference, meters	The value of this parameter is used by ARCON96 to normalize the release heights and the intake heights when the two heights are specified as "above grade" with different grades for the release point and intake height, or when one measurement is referenced to "above grade" and the other "above sea level."	Use zero unless it is known that the release heights are reported relative to different grades or reference datum.
Direction to Source, degrees	ARCON96 uses the value of this parameter and the Wind Direction Window to establish which range of wind directions should be included in the assessment of the χ/Q.	Use the direction FROM the intake back TO the release point. (Wind directions are reported as the direction from which the wind is blowing. Thus, if the direction from the intake to the release point is north, a north wind will carry the plume from the release point to the intake.) *Note: some facilities have a "plant north" shown on site arrangement drawings that is different from "true north." The direction entered must have the same point of reference as the wind directions reported in the meteorological data.* For ground level releases, if the plume is assumed to flow around a building rather than over it, the direction may need to be modified to account for the redirected flow. In this case, the χ/Q should be calculated assuming flow around and flow over (through) the building and the higher of the two χ/Q s should be used.
Surface Roughness Length, m	ARCON96 uses the value of this parameter in adjusting wind speeds to account for differences in meteorological instrumentation height and release height.	Use a value of 0.2 in lieu of the default value of 0.1 for most sites. (Reasonable values range from 0.1 for sites with low surface vegetation to 0.5 for forest covered sites.)
Wind Direction Window, degrees Code Default	ARCON96 uses the value of this parameter and the Direction to Source to establish which range of wind directions should be included in the assessment of the χ/Q.	Use the default window of 90 degrees (45 degrees on either side of line of sight from the source to the receptor).
Minimum Wind Speed, m/s Code Default	ARCON96 uses the value of this parameter to identify calm conditions.	Use the default wind speed of 0.5 m/s (regardless of the wind speed units entered earlier), unless there is some indication that the anemometer threshold is greater than 0.6 m/s.
Averaging Sector Width Constant	ARCON96 uses the value of this parameter to prevent inconsistency between the centerline and sector	Although the default value is 4, a value of 4.3 is preferred.

Parameter	Discussion	Acceptable Input
Code Default	average χ/Qs for wide plumes. Has largest effect on ground level plumes.	
Initial Diffusion Coefficients, meters	ARCON96 uses these parameters in modeling a diffuse source.	These values will normally be set to zero. If the diffuse source option is being used, see Regulatory Position 2.2.4.
Hours in Averages Code Default	The values of this parameter were selected to provide results for desired periods and to provide a smooth χ/Q curve.	Use the default values.
Minimum Number of Hours Code Default	The default values of this parameter will allow processing with up to 10% missing data.	Use the default values.

REGULATORY ANALYSIS

I. Statement of Problem

The NRC staff is proposing to develop and issue a proposed new regulatory guide, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants." This new guide is being proposed as a means to provide guidance to applicants for licenses and for license amendments that, in whole or part, seek to modify the licensing basis methodology for determining atmospheric relative concentrations (χ/Q) values in support of control room radiological habitability assessments. The staff proposes to issue a draft guide for public review and comment, and upon resolution of public comments, to finalize and implement the guide.

The staff has not issued a regulatory guide on the matter of control room χ/Q determination in support of radiological assessments, relying instead on a 1974 staff paper presented at the 13th AEC Air Cleaning Conference (Ref. 1).

In the 1980s, the NRC sponsored studies to evaluate the existing (e.g., Murphy-Campe) models against experimental testing in the environment and in wind tunnels and to develop alternative approaches. The results of these studies were published in 1988 in NUREG/CR-5055, "Atmospheric Diffusion for Control Room Habitability Assessments" (Ref. 2). These results indicated that the existing dispersion models did not reliably predict concentrations in the vicinity of buildings. NUREG/CR-5055 presented a statistical model that made significantly more reliable predictions in building wakes. Developmental work continued. A formal peer review was conducted by the NRC in 1994 and the earlier model was revised in response to this peer review and was included in the ARCON95 code. Slight modifications were made to the code and it was re-issued as ARCON96 (Ref. 3). This code implements an improved building wake dispersion algorithm; assessment of ground level, building vent, elevated, and area source release modes; processing of hour-by-hour meteorological observations; sector averaging; and directional dependence of dispersion conditions. Reference 3 documents the ARCON96 code and provides some user instruction, but does not provide regulatory guidance on the application of the code to actual plant analysis situations nor on the selection of inputs and user code options. Although the staff has not issued a generic communication related to the availability of the ARCON96 code, an increasing number of licensees have started to use the code in design basis assessments performed in support of various licensing actions. Staff experience in reviewing proposed license amendments involving changes in control room dispersion assessments has shown the need to provide or strengthen the guidance in this area. Some of the problems identified in those reviews include the following:

- Some licensees have proposed χ/Q values determined using the ARCON96 code with user-selectable options that the staff does not find acceptable in design basis calculations, such as the mixed-mode release used in routine release assessments.

- Some licensees have proposed χ/Q values determined using the ARCON96 code with data and assumptions taken from illustrative examples in the ARCON96 code documentation. Some of these illustrative examples incorporate data and assumptions that are either not acceptable to the staff for design basis calculations or are not adequately representative of any particular site.

- The ARCON96 code can generate non-conservative χ/Q values for certain plant configurations in which the control room outside air intakes are located in close proximity to the base of a tall stack. The staff has developed a protocol for addressing these cases that needs to be made available to licensees and others.

- The ARCON96 code provides a capability to model diffuse-source geometry. The staff has not previously accepted such geometries. However, the staff believes that such a model could be used for design basis assessments subject to certain conditions that need to be outlined in regulatory guidance.

- ARCON96 considers a single source-receptor pair with no explicit provision for multiple intake control rooms. The staff has determined that the protocol of SRP Chapter 6.4 (Ref. 4) would be acceptable with some revision.

- The staff has traditionally not accepted χ/Q assessments that involved buoyant or mechanically forced plume rise and no provision is made in the current version of ARCON96 to address this phenomenon. While there remains uncertainty for many plume rise situations, the staff believes that χ/Q values calculated for steam pressure relief valve releases are unduly conservative and that guidance on assessing these release points should be issued.

- The staff has identified deficiencies in the quality of the measured meteorological observation data input to the assessment. Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants" (Ref. 6), provides some of this information as it applies for offsite assessments, but there is no similar guidance for control room assessments.

- There are a large number of user-input fields for the ARCON96 code. Some of these are self-explanatory; others are not. Although the code documentation describes the mechanics of changing an entry field, the documentation is generally silent regarding the selection of data to be entered.

The staff is currently pursuing the task of addressing deficiencies in the habitability systems at currently licensed plants. This task, which has a long history, has received more attention of late because of recent industry experience in performing tracer gas measurements of unfiltered inleakage. The industry is preparing an industry report on control room habitability. In meetings related to that report, industry representatives expressed a strong desire to use the ARCON96 code in performing assessments and requested the staff provide guidance on its use. The staff is preparing a generic letter and regulatory guides that will provide guidance on demonstrating compliance with GDC-19. Since control room χ/Q values are an integral part of any analysis of control room habitability, the staff expects increased use of the ARCON96 code and re-assessment of χ/Q values, providing further impetus for the issuance of staff guidance on acceptable methods of assessing control room χ/Qs.

The NRC has received expressions of interest regarding future new plant licensing. Additionally, the President's recent National Energy Policy has called for increased use of nuclear power to meet future energy needs. The proposed guide is supportive of future licensing activities.

II. Existing Regulatory Framework

In 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Section 50.34, "Contents of Applications; Technical Information," requires that each applicant for a construction permit or operating license provide an analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from the operation of the facility. Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50 establishes minimum requirements for the principal design criteria for water-cooled nuclear power plants. General Design Criterion 19 (GDC-19), “Control Room,” establishes minimum requirements for the facility control room, including:

> Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident.[1]

Subsequent to plant licensing, licensees perform an analysis of control room habitability in support of plant modifications, pursuant to either 10 CFR 50.59, ”Changes, Tests, and Experiments,” or 10 CFR 50.92, “Issuance of Amendment.” The atmospheric relative concentrations are significant inputs in assessments performed to demonstrate compliance with GDC-19.

The staff has not previously issued a regulatory guide on the matter of control room χ/Q determination for radiological assessments. In 1974, a staff paper by K.G. Murphy and Dr. K.M. Campe, “Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19” (Ref. 1), was presented at the 13th AEC Air Cleaning Conference and was published as part of the conference proceedings. A section of this paper presented meteorological dispersion models acceptable to the staff. Section 6.4, “Control Room Habitability System,” of the Standard Review Plan (Ref. 4) cross-references this paper. Item III.D.3.4, “Control Room Habitability Requirements,” of NUREG-0737, “Clarification of TMI Action Plan Requirements” (Ref. 5), identifies this paper as a source of guidance. The Murphy-Campe methodology is part of the existing licensing basis at many of the operating plants.

III. Objective of the Regulatory Action

The objective of this proposed regulatory guide is to provide guidance on the assessment of control room χ/Q values using the ARCON96 code. The guide also provides guidance on the use of the Murphy-Campe methods, puff releases, and on plume rise determination. This guidance will describe and make available to our stakeholders such information as inputs, assumptions, and methods acceptable to the staff for performing assessments of control room χ/Q values used in evaluations that are to demonstrate compliance with GDC-19.

The staff has determined that holders of operating licenses may continue to use χ/Q values determined with methodologies that were previously approved by the NRC. The staff expects that licensees would utilize the information in the guide if they voluntarily decide to replace the facility χ/Q values and methodology described in the plant’s licensing basis with values determined using ARCON96 code.[2]

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[1] For licensees who have implemented an alternative source term pursuant to 10 CFR 50.67, GDC-19 and 10 CFR 50.67(b)(2)(iii) restate the numeric criterion as 5 rem TEDE.

[2] The guide notes that if (1) the previously approved values are based on a misapplication of a methodology, (2) calculational errors are identified, or (3) changes are necessary to ensure adequate protection of the health and safety of the public, the staff will pursue necessary corrections with the applicant.

Although the target audience for this regulatory guidance is primarily holders of operating licenses for power reactors, the guidance is expected to be applicable to future applicants for construction permits or operating licenses under Part 50, to applicants for design certifications under Part 52, and to applicants for combined licenses under Part 52 who do not reference a standard design.

IV. Alternative Approaches

1. Alternative 1 – Do Not Provide Guidance

Under this alternative, the staff would not issue regulatory guidance on the assessment of control room χ/Q values using the ARCON96 code or the Murphy-Campe methodology. This is the no action alternative. Not providing the needed guidance will result in increased unnecessary burden for the licensee and the staff in the form of preparation and response to requests for additional information (RAIs), re-analyses and supplementation of license amendment applications. This option is not supportive of any of the four nuclear reactor safety performance goals.

2. Alternative 2 – Endorse an Industry Initiative Addressing Control Room Habitability

Under this alternative, the staff would not develop its own regulatory guidance, but instead would endorse an acceptable industry document. The Nuclear Energy Institute (NEI) has prepared an industry guideline, NEI-99-03, "Control Room Habitability Assessment Guidance." This document was first submitted in August 1999 and was found to not adequately address the staff's concerns. This document was restructured and re-submitted in October 2000. An appendix to the NEI document addressed control room meteorology. This appendix was based, in part, on a preliminary staff talking paper on the use of ARCON96. There were still areas of disagreement between the staff and industry regarding the overall document. Because of this, the staff and NEI agreed that the staff should prepare formal guidance and resolve these issues in the public comment process. The proposed regulatory guidance on control room χ/Q assessments is part of this formal guidance. As such, this alternative is no longer viable.

3. Alternative 3 – Endorse a National Consensus Standard

The staff was not able to identify any national consensus standard that addresses the use of the ARCON96 code, or other comparable methodology, for performing χ/Q assessments for control rooms in support of habitability analyses. As such, this alternative is not viable.

4. Alternative 4 – Revise Regulatory Guide 1.145 To Address Control Room Meteorology

Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants" (Ref. 6), addresses the determination of χ/Q values for the exclusion area boundary and the low population zone. This guide is currently 14 pages in length. Only a small portion of the guide was deemed to overlap the information projected to be included in the proposed draft regulatory guide. The assessment methods and guidance for the offsite and control room χ/Q assessments are dissimilar. While this alternative would be supportive of the goals of public safety, reduction of unnecessary regulatory burden, and public confidence, the staff does not believe that this approach would be more effective and efficient. As such, the staff has concluded that there would by negligible benefit to revising Regulatory Guide 1.145 to address control room χ/Q assessments.

5. Alternative 5 – Issue New Regulatory Guide

This alternative would have the staff prepare a new regulatory guide addressing control room χ/Q assessments using the ARCON96 code or Muprhy-Campe methodology. This alternative is supportive of all four performance goals. Issuing a new regulatory guide would (1) maintain public safety by ensuring that safety analyses use appropriate analysis assumptions and methods, (2) reduce unnecessary regulatory burden, (3) improve efficiency and effectiveness as the guide would provide licensees with the staff position, thereby minimizing RAIs and resubmittals, and (4) maintain public confidence by providing guidance that ensures that safety analyses are adequate. The staff has determined that this alternative—issuing a new draft regulatory guide—is the most advantageous approach to addressing the need for additional regulatory guidance on performing assessments of control room atmospheric dispersion.

IV. Evaluation of Values and Impacts

Since the proposed action is a new regulatory guide, compliance with its regulatory positions is voluntary for currently licensed operating reactors. As with all regulatory guides, an applicant may propose alternative approaches to demonstrating compliance with the NRC's regulations. For operating reactors, it is assumed the licensees will revise their current control room χ/Q values and methods only if they perceive it to be in their interest to do so.[2] Because of the voluntary nature of this guide, the NRC has not performed a quantitative value-impact analysis. A qualitative analysis follows.

- Completion of the proposed action is estimated to require from 0.5 to 1.0 FTE. Associated costs include publication costs. The preparation of the draft and finalization of the proposed guide will be performed internally. A technical review of the draft and final guide may be performed under an existing task order contract. This technical review is projected to involve less than 10 professional staff days.

- Regulatory efficiency would be improved by reducing uncertainty as to what is acceptable and by encouraging consistency in the assessment of control room χ/Q values. The benefit to the industry and the NRC will be to the extent this occurs. The availability of this guidance should benefit licensees and applicants by reducing the likelihood for follow-up questions and possible revisions in licensees' analyses and plant modifications. NRC reviews would be facilitated because license applications should be more predictable and consistent analytically.

- A new regulatory guide on performing control room χ/Q assessments would result in cost savings to both the NRC and industry. The NRC will incur one-time incremental costs to develop the draft regulatory guide for comment and to finalize the regulatory guide. However, the NRC should also recognize cost savings associated with the review of licensee submittals. The staff believes that the continuous and on-going cost savings associated with these reviews should offset the one-time development costs.

- It is also expected that the industry would realize a net savings, as their one-time incremental cost to review and comment on a new regulatory guide would be compensated for by the efficiencies to be gained in minimizing follow-up questions and revisions associated with each licensee submittal.

- Control room χ/Q values are used in the assessment of the habitability of the control room during and after certain postulated accidents. Habitability requirements are established in the interest of providing an environment in which control room personnel can take actions to mitigate the consequences of these accidents, thereby assuring the health and safety of the public. Although the acceptance criteria for radiological habitability are comparable to the routine occupational exposure limits, the primary concern of control room habitability is protection of the public, rather than occupational radiation exposure. The use of the ARCON96 code and the guidance in the proposed regulatory guide may reduce the magnitude of the χ/Q values used in these evaluations, reducing the projected dose and increasing the apparent margin to the acceptance criterion. Licensees may propose modifications to the control room habitability envelope and systems that utilize a portion of this increased margin. The guidance to be provided in the proposed regulatory guide is expected to ensure that the χ/Q values have been calculated appropriately and that sufficient margins will continue to be present.

- The control room χ/Q values are used to assess the ability of the control room habitability envelope and systems to maintain an acceptable environment after an accident has occurred. Thus, the possible changes in χ/Q values cannot, of themselves, affect the actual accident sequence or progression or the core damage frequency (CDF) and large early release frequency (LERF). While changes to the envelope or systems enabled by the reduced χ/Q values could increase the radiation exposure of control room personnel following an accident, the potential impact on CDF and LERF is likely to be negligible. The staff bases this conclusion on (1) radiation doses that could impact the ability of the operator to take necessary actions are substantially greater than the habitability acceptance criteria, (2) the existence of elevated doses of this magnitude are associated with core damage and containment releases that are on-going, and (3) given an event that has progressed to core damage, the ability of the operator to take effective actions is reduced.

- With the possible exception of applicant agencies, such as TVA or municipal licensees, no other governmental agencies are affected by the proposed regulatory guide. Pursuant to the categorical exclusion in 10 CFR 51.22(a)(16), the issuance of the proposed regulatory guide does not require an environmental review. Under the provisions of the National Technology Transfer Act of 1995, Pub. L. 104-113, no voluntary consensus standard has been identified that could be used instead of the proposed regulatory guide (government-unique standard).

No conflicts have been identified between existing regulations and regulatory guidance and the proposed regulatory guide. Regulatory Guide 1.78, “Assumptions Used for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release” (Ref. 7), addresses control room habitability with regard to toxic gases. The proposed regulatory guide will contain language limiting the applicability of the guide to radiological habitability assessments. Section 6.4, “Control Room Habitability System,” of the SRP (Ref. 4) provides that estimates of dispersion of airborne contamination will be made in conjunction with an assigned meteorologist. No specific assessment methodology is described in Section 6.4. There is, however, a citation to the earlier Murphy-Campe report. The proposed regulatory guide would allow a licensee to voluntarily replace the earlier Murphy-Campe method with the use of the ARCON96 code and would provide needed guidance on the use of the Murphy-Campe methodology. There is no short-term need to revise Section 6.4.

V. CONCLUSION

Experience with licensee amendment reviews has demonstrated the need for guidance in performing χ/Q assessments in support of radiological analyses of control room habitability. Recent expressions of interest related to future licensing of new reactors also indicate a need for updated regulatory guidance. Based on this regulatory analysis, it is recommended that the NRC prepare a new regulatory guide on performing χ/Q assessments using ARCON96 or the Murphy-Campe methodology, issue the draft regulatory guide for public comment, and upon resolution of public comments, finalize the regulatory guide.

REFERENCES FOR REGULATORY ANALYSIS

1. K.G. Murphy and K.W. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19," published in *Proceedings of 13th AEC Air Cleaning Conference*, San Francisco, CONF 740807, U.S. Atomic Energy Commission (now USNRC), August 1974.

2. J.V. Ramsdell, "Atmospheric Diffusion for Control Room Habitability Assessments," NUREG/CR-5055, USNRC, May 1988.[1]

3. J.V. Ramsdell and C.A. Simonen, "Atmospheric Relative Concentration in Building Wakes," NUREG/CR-6332, Revision 1, USNRC, May 1997.[1]

4. USNRC, "Standard Review Plan For the Review of Safety Analysis Reports for Nuclear Power Plants," Chapter 6.4, "Control Room Habitability System," NUREG-0800, USNRC, 1987.

5. USNRC, "Clarification of TMI Action Plan Requirements," NUREG-0737, November 1980.[1]

6. USNRC, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Regulatory Guide 1.145, Revision 1, November 1982.[2]

7. USNRC, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Regulatory Guide 1.78, June 1974. (Proposed Revision 1, DG-1087, was issued for public comment, February 2001.)[2]

[1] Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161; (telephone (703)487-4650; <http://www.ntis.gov/ordernow>. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email is PDR@NRC.GOV.

[2] Single copies of regulatory guides, both active and draft, may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (703)487-4650; online <http://www.ntis.gov/ordernow>. Copies of active and draft guides are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email <PDR@NRC.GOV>.

BACKFIT ANALYSIS

The proposed regulatory guide does not require a backfit analysis as described in 10 CFR 50.109(c) because it does not impose a new or amended provision in the NRC's regulations nor does it impose a regulatory staff position interpreting the NRC's regulations different from a previous applicable staff position. Although the guidance in the proposed regulatory guide is a significant departure from earlier staff guidance, this guide does not require the modification or addition to systems, structures, components, or design of a facility, or the procedures or organization required to design, construct, or operate a facility. A licensee or applicant can select a preferred method of achieving compliance with a license condition, the rules, or orders of the Commission as described in 10 CFR 50.109(a)(7). This regulatory guide provides an opportunity to use an updated method for determining control room χ/Q values for use in radiological assessments, if that is the method the licensee or applicant prefers.