

RAMP ATMOSPHERIC CODES OVERVIEW



The screenshot shows the U.S. NRC RAMP website. The header features the RAMP logo on the left and the text "United States Nuclear Regulatory Commission Radiation Protection Computer Code Analysis and Maintenance Program" on the right. Below the header is a navigation menu with buttons for Home, RASCAL, SNAP/RADTRAD, HABIT, VARSKIN, GALE, Radiological Toolbox, PIMAL, DandD, GENII, MILDOS, and Atmospheric Codes. The Atmospheric Codes dropdown menu is open, showing three options: XOQDOQ, PAVAN, and ARCON96. A red circle highlights this dropdown menu. On the left side of the page, there is a "RAMP Navigation" section with links to Contact RAMP Administrators, RAMP Member Registration, RAMP Forum, FAQs, and RAMP Information Policy Paper. The main content area includes a welcome message: "Welcome to the U.S. NRC RAMP Website" and "Fall RAMP Users' Meeting October 17th - 21st, 2016 - Washington D.C. Metro Area". A blue button labeled "Register for Users' Meeting" is positioned below the meeting information.

**United States Nuclear Regulatory Commission
Radiation Protection Computer Code
Analysis and Maintenance Program**

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XOQDOQ
PAVAN
ARCON96

RAMP Navigation

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Welcome to the U.S. NRC RAMP Website

Fall RAMP Users' Meeting October 17th - 21st, 2016 - Washington D.C. Metro Area

Register for Users' Meeting

ARCON96

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ARCON96 Overview

ARCON96 is a:

- Gaussian plume model
- Diffusion coefficients account for enhanced dispersion under low wind speed conditions and in building wakes
- χ/Q values are estimated for various time-averaged periods
- 0-2 hrs, 2-8 hrs, 8-24 hrs, 1-4 days, 4-30 days
- Meteorological input consists of hourly values of wind speed, wind direction, and atmospheric stability class
- Hourly meteorological data are used to calculate hourly χ/Q values
- Hourly χ/Q values are then combined to estimate concentrations ranging in duration from 2 hours to 30 days
- Cumulative frequency distributions are prepared from the average χ/Q values
- χ/Q values that are exceeded no more than 5 percent of the time for each averaging period are selected

ARCON96 Navigation

- [Registration for the ARCON96 Code](#)
- [Download the ARCON96 Code](#)
- [Download the ARCON96 User Guide](#)
- [Download the ARCON96 Technical Documents](#)

RAMP Navigation

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RAMP Users' Meeting

ARCON96: OVERVIEW

- ARCON96 is a Gaussian dispersion model for calculating short-term relative concentrations (χ/Q 's) at nuclear power plant control room air intakes that would be exceeded no more than 5% of the time.
- Dispersion is near-field, in the vicinity of buildings.
- ARCON96 includes enhanced diffusion coefficients for low wind speed conditions and building wake.

ARCON96: USE

- Used by the NRC for New Reactor Safety Reviews for design-basis accidents
- 10 CFR Part 50, Appendix A, General Design Criterion 19 (GDC 19), Control Room
 - 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 (0.05 Sv) whole body, or its equivalent to any part of the body, for the duration of the accident

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PAVAN Overview

The information on PAVAN code is following:

- The larger of the following two calculated χ/Q values is selected to represent the χ/Q value for the 0–2 hour time interval:
 - 0.5-percent maximum sector value
 - 5-percent overall site value
- These calculated χ/Q values are based on 1-hour averaged data but are conservatively assumed to apply for 2 hours
- This procedure is repeated two times:
 - Once for the EAB
 - Once for the LPZ
- 0.5-percent Maximum Sector χ/Q Value:
 - For each of the 16 downwind direction sectors (N, NNE, NE, ENE, etc.), χ/Q values are calculated for each combination of wind speed and atmospheric stability at the appropriate downwind distance
 - The χ/Q values calculated for each sector are then placed in order from the greatest to the smallest, and an associated cumulative frequency distribution is derived based on the frequency distribution of wind speed and stabilities for each sector.
 - An upper envelope curve is determined for each sector, based on the derived data (plotted as χ/Q versus probability of being exceeded), so that no plotted point is above the curve
 - From this upper envelope, the χ/Q value, which is equaled or exceeded 0.5 percent of the total time (44 hrs) is obtained
 - The maximum 0.5 percent χ/Q value from the 16 sectors becomes the 0–2 hour “0.5-percent maximum sector χ/Q value”
- 5-percent Overall Site χ/Q Value:
 - Using the same approach, all χ/Q values independent of wind direction are combined into one cumulative frequency



PAVAN: OVERVIEW

- PAVAN is a Gaussian dispersion model for calculating short-term relative concentrations (χ/Q 's) at offsite locations, including the:
 - Exclusion Area Boundary (EAB)
 - Low Population Zone (LPZ)
- PAVAN uses Pasquill-Gifford (PG) diffusion coefficients with simple modifications to account for low wind speed conditions and building wake for ground-level releases.

PAVAN: USE

- Used by the NRC for New Reactor Environmental Impact Statements and Safety Reviews for design-basis accidents
- 10 CFR 52.79(a)(1)(vi), Contents of applications; technical information in final safety analysis report
 - Perform an assessment assuming a fission product release from the core into the containment
 - An individual located at any point on the boundary of the EAB for any 2-hour period would not receive a dose in excess of 25 rem (0.25 Sv) TEDE
 - An individual located at any point on the outer boundary of the LPZ would not receive a dose in excess of 25 rem (0.25 Sv) TEDE during the entire period of the passage of the radioactive cloud

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- Download the XOQDOQ User Guide
- Download the XOQDOQ Technical Documents

RAMP Navigation

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RAMP Users' Meeting

XOQDOQ Overview

XOQDOQ is a:

- Gaussian plume model:
 - Plume horizontal distribution is assumed to be evenly distributed within the 22.5 deg downwind sector (sector-averaging)
 - For ground-level releases, plume vertical diffusion coefficient modified to account for building wake
- Meteorological input consists of a JFD of hourly values of:
 - Wind speed (calms defined as 1/2 sensor threshold)
 - Wind direction (16 directions, 22.5 deg sectors, centered on true north)
 - Atmospheric stability class (preferably based on delta-T)
- Building wake impacts on release height:
 - Release points below adjacent solid structures → ground-level releases
 - Release points higher than but less than 2 times higher than adjacent solid structures → mixed-mode (part-time ground, part-time elevated) releases
 - Function of the ratio of plume vertical exit velocity to horizontal wind speed
 - Release points higher than 2 times adjacent solid structures → elevated releases
 - Calculates effective plume height
- Allows adjustment of χ/Q and D/Q values to account for the effects of local air recirculation or stagnation using default or



XOQDOQ: OVERVIEW

- XOQDOQ is a Gaussian dispersion model for calculating long-term relative concentrations (χ/Q 's) and deposition (D/Q 's) at user-specified locations and standard radial distances/segments out to 50 miles
- XOQDOQ plume horizontal distribution is assumed to be evenly distributed within the 22.5 degree downwind sector (sector-averaging)
 - For ground-level releases, plume vertical diffusion coefficient modified to account for building wake

XOQDOQ: USE

- Used by the NRC for New Reactor Environmental Impact Statements and Safety Reviews to assess impacts from routine releases
- 10 CFR Part 20, Subpart D, Radiation Dose Limits for Individual Members of the Public
 - The annual average concentrations of radioactive material released in gaseous effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to Part 20
 - Intended to result in doses below 0.05 rem (0.5 mSv)
- Appendix I of 10 CFR Part 50, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet ALARA Criterion for Radioactive Material in Reactor Effluents
 - Section II.B: Unrestricted annual air dose < 10 mrad (0.1 mGy) gamma or 20 mrad (0.2 mGy) beta
 - Section II.C: Unrestricted annual individual organ dose from all pathways of exposure < 15 mrem (0.15 mSv)
 - Section II.D: radwaste system cost-benefit analysis based on population dose out to 50 miles

- *Jeremy Rishel*

- *Mr. Rishel support the RAMP Atmospheric Codes, including ARCON96, PAVAN, and XOQDOQ. In addition, Mr. Rishel supports the development of the NRC's RASCAL emergency response code.*
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