	General Characteristics	
1	**Abstract of Model Capabilities**	ARCON96 is a model for calculating concentrations in the vicinity of buildings. It is used by the U.S. Nuclear Regulatory Commission (NRC) to assess nuclear power plant control room habitability under accident conditions. ARCON96 uses hourly averaged meteorological data and recently developed methods for estimating dispersion in the vicinity of buildings to calculate relative concentrations (X/Q) at control room air intakes that would be exceeded no more than 5% of the time. Relative concentrations are calculated for averaging periods ranging from 1 hour to 30 days duration to support control room habitability dose calculations to ensure that General Design Criterion 19 is not exceeded.
2	**Sponsor and/or Developing Organization**	US Nuclear Regulatory Commission/Pacific Northwest National Laboratory (PNNL) Washington, DC 20555 Richland, WA 99352 (509) 372-6316 j_ramsdell@pnl.gov **developing organization**
3	**Last Custodian/ Point of Contact**	Ms. Leta A. Brown US Nuclear Regulatory Commission Mail Stop O-10 D4 Washington, DC 20555 (301) 415-1232 LAB2@nrc.gov **primary individual**
4	**Life-Cycle**	ARCON96 is an improved version of the ARCON95 computer code. Recent modifications now permit users to simulate releases from area sources as well as point sources. In addition, the method of averaging concentrations for periods longer than 2 hours has also been revised. Centerline concentrations are now used for the first 8 hours in each time period longer than 8 hours duration. Sector-average concentrations are used for the remaining hours.
5	**Model Description Summary**	Refer to the abstract of model capabilities that was presented in part 1.
6	**Application Limitation**	ARCON96 employs a straight-line Gaussian diffusion model which does not allow for temporal and spatial variations in the wind field. ARCON96 assumes a constant release rate for the entire 30-day period of release, not allowing for variations in accident release rates. The ARCON96 source-receptor distance cannot exceed 10,000 meters, while the intake height cannot exceed 100 meters.
7	**Strengths/ Limitations**	**Strengths:** Several improvements over the commonly-used 1974 Murphy and Campe control room habitability assessment procedure. **Limitations:** See Application Limitations in Item 6 above.
8	**Model References**	Ramsdell, J.V., Jr. 1988 Atmospheric Diffusion for Control Room Air Habitability Assessment, NUREG/CR-5055, U.S. Nuclear Regulatory Commission, Washington, D.C. Ramsdell, J.V. Jr. 1990 Diffusion in Building Wakes for Ground-Level Releases, Atmospheric Environment Vol. 24B, pp.377-388. Ramsdell, J.V., Jr., and C.J. Fosmire 1995 Atmospheric Dispersion Estimates in the Vicinity of Buildings. PNL-10286 Pacific Northwest Laboratory, Richland, Washington Ramsdell, J.V., Jr., 1991 EXTRAN: A Computer Code for Estimating Concentrations of Toxic Susbstances at Control Room Air Intakes NUREG/CR-5656, U.S. Nuclear Regulatory Commission, Washington, D.C. ASME 1986 Quality Assurance Program Requirements for Nuclear Facilities, ANSI/ASME NQA1, American Society of Mechanical Engineers
9	**Input Data/Parameter Requirements**	Meteorological input: Number of data files; upper- and lower-level measurement heights; wind speed. Source input: Release type (i.e., ground, vent, stack); release height; building area; stack flow, vertical velocity and stack radius. Receptor input: Distance to receptor (e.g., control room intake); intake height; source-receptor elevation difference; direction from receptor to source.
10	**Output Summary**	Relative concentration (X/Q) values at 95th percentile for each time period. Hourly value range (maximum and minimum) of centerline and sector-average X/Q values. Table of cumulative frequency distributions of X/Q values.
11	**Applications**	Applied by the U.S. NRC for assessments of nuclear power plant licensee submittals concerning control room habitability to assure compliance with General Design Criterion 19 of 10 CFR Part 50, Appendix A that states that “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 ...”

12	**User-Friendliness**	Graphical User Interface (GUI) screens prompt for input values. Help screen. Error warning for missing needed input values.
13	**Hardware-Software Interface Constraints/ Requirements**	**Computer operating system:** IBM DOS **Computer platform:** IBM compatible PC using 80386 and more recent 32-bit processor with a 32-bit math coprocessor. High density floppy disk drive (3.5 inch or 5.25 inch disks), a hard disk drive, VGA color monitor, and a mouse. Can be run from a Visual Basic shell with Windows 3.1 or higher. **Disk space requirements:**640 kilobytes of memory **Run execution time** (for a typical problem)**:** 1 minute **Programming language:** ANSI FORTRAN-77 & Visual Basic **Other computer peripheral information:** None
14	**Operational Parameters**	**Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:** NA **Set up time for: Typical times are:** ***first-time user:*** .5 h ***experienced user:*** 15 min
15	**Surety Considerations**	**All quality assurance documentation:** Code was developed and tested in accordance with the requirements of ANSI/ASME NQA-1, 1986 edition (ASME 1986), Quality Assurance Program Requirements for Nuclear Facilities. **Benchmark runs:** See referenced NUREG documents. **Validation calculations:** See referenced NUREG documents. **Verification with field experiments that has been performed with respect to this code:** Equations contain information gleaned from applicable field studies and wind tunnel studies.
16	**Runtime Characteristics**	½ minute to 1 minute depending on speed of installed PC processor.

Specific Characteristics

Part A: Source Term Submodel Type (Not Applicable)

Part B: Dispersion Submodel Type (No Information Provided.)

Part C: Transport Submodel Type (No Information Provided.)

Part D: Fire Submodel Type (Not Applicable)

Part E: Energetic Events Submodel Type (Not Applicable)

Part F: Health Consequence Submodel Type (Not Applicable)

Part G: Effects and Countermeasures Submodel Type (Not Applicable)

Part H: Physical Features of Model

H1	**Stability Classification Turbulence Typing**	**Pasquill-Gilfford-Turner:** Pasquill-Gilfford-Turner: Subroutine NSIGMA1 calculates the initial diffusion coefficients using algorithms for approximating the Pasquill-Gifford-Turner diffusion coefficient curves described by Martin and Tikvart (1968) and Tadmor and Gur (1969). Given a source-receptor distance and stability class as input, the subroutine returns both a horizontal diffusion coefficient and a vertical diffusion coefficient. Correspondingly, if initial values are entered for the diffusion coefficient, the subroutine will determine associated virtual distances. **Monin-Obukhov length (L):** Function INVMOL2 converts the stability class to the reciprocal of the Monin-Obukhov scaling length used in the diabatic wind profiles. This procedure is based on Figure 5 in a technical paper by Golder (1972).
H4	**Horizontal Plume Meander**	Subroutine CURVEFIX calculates low-wind speed corrections to the diffusion coefficients. These corrections are functions only of distance and wind speed. Ramsdell and Fosmire (1995) present a detailed derivation and evaluation of the equations used to calculate the correction factors. Subroutine WAKECOR calculates the building-wake corrections to the diffusion coefficients calculated by Subroutine NSIGMA1. These corrections are functions of the building cross-sectional area, wind speed, and distance from the release point to the receptor.
H5	**Horizontal/Vertical Wind Shear:**	Subroutine INIT calculates wind speed adjustment factors based on the diabatic wind profiles (Panofsky and Dutton) are functions of the wind speed measurement heights, the stability class, and the surface roughness at the site.

H13	**Temporally and Spatially Variant Mesoscale Processes**	**Urban heat island:** **Canopies:** **Complex terrain (land) effects: __ mountain-valley wind reversals** **__ anabatic winds __ katabaic winds** **Complex terrain (land-water) effects: __ seabreeze airflow trajectory reversals** **__ Thermally Induced Boundary Layer definition __ seabreeze fumigation** **__ landbreeze fumigation** **Thunderstorm outflow:** **Temporally variant winds:** Model uses hourly wind data for periods up to 30 days. **High velocity wind phenomena: __ tornado __ hurricane __ supercane __ microburst**
Part I: Model Input Requirements		
I2	**Meteorological Parameters**	**Wind speed and wind direction: _single point ___ single tower/multiple point _ multiple towers** **Temperature: __ single point __ single tower/multiple point __ multiple towers** See above. **Dew point temperature: __ single point __ single tower/multiple point __ multiple towers** See above. The actual measurement is of humidity from which the dew point can be calculated. **Precipitation: __ single point __ single tower/multiple point __ multiple towers** See above. **Turbulence typing parameters: __ temperature difference __ sigma theta** **__ sigma phi ___ Monin-Obukhov length ___ roughness length** **__ cloud cover __ incoming solar radiation __ user-specified** **Four dimensional meteorological fields from prognostic model:**
Part J: Model Output Capabilities		
J4	**Tabular at Fixed Downwind Locations**	Relative concentration (X/Q) values at 95th percentile for each time averaging interval at the receptor location. Hourly value range (maximum and minimum) of centerline and sector-average X/Q values. Table of cumulative frequency distributions of X/Q values at the receptor for each time averaging interval.
Part K: Model Usage Considerations (No Information Provided.)		