	General Characteristics	
1	**Abstract of Model Capabilities**	PUFF-PLUME is a Gaussian atmospheric transport chemical/radionuclide diffusion model that includes wet and dry deposition, real-time input of meteorological observations and forecasts, dose estimates from inhalation and gamma shine, and puff or plume dispersion modes. It is the primary model for emergency response use for atmospheric releases at the Savannah River Site. It is one of a suite of codes for atmospheric releases and is used primarily for first-cut results in emergency situations. (Other codes containing more detailed mathematical and physical models are available for use when short response time is not the over-riding consideration.)
2	**Sponsor and/or Developing Organization**	DOE/Savannah River Operations/Westinghouse Savannah River Company
3	**Last Custodian/ Point of Contact**	Robert J. Kurzeja Savannah River Technology Center P.O. Box 616 Aiken, SC 29808 E-mail: Robert.Kurzeja@SRS.gov Charles H. Hunter Savannah River Technology Center P.O. Box 616 Aiken, SC 29808 E-mail: Chuck.Hunter@SRS.gov
4	**Life-Cycle**	PUFF-PLUME began as Gaussian puff-plume dispersion model developed by Larry Wendell at PNL in the early 1970s. It was modified for application at the Savannah River Site utilizing real-time meteorological tower measurements and providing radiological dose estimates. The code underwent a major revision in 1981 with the addition of dry and wet deposition modules. Improvements and revisions have been made to the code since its inception on an as-needed basis.
5	**Model Description Summary**	A Gaussian model for puff and plume dispersion is used for the basic model in PUFF-PLUME. Atmospheric diffusion parameters are calculated from formulations recommended by F. Pasquill for the horizontal dispersion and by G. Briggs for the vertical. These formulations for the dispersion coefficients can use turbulence data directly for the horizontal dispersion parameter, and by using Gifford's relation between Pasquill classes and turbulence intensity, the vertical turbulence intensity can also be utilized directly. Thus real-time turbulence and wind speed data are used in the model. In its operational implementation at SRS, the model accesses forecasted wind speed, direction, and turbulence data from statistical regression equations which are updated twice-daily. These forecasts are made so that the model is always able to produce twelve hour forecasts of transport and diffusion. The wet and dry deposition modules for particulates are based on simplifications of the particle size distribution expected from radionuclide releases that have undergone the sand filtering scheme used in production facilities at the SRS. The wet deposition model allows for light or heavy rainfall rates. The deposition module for tritium and tritium oxide is based on a resistance model for tritium and tritium oxide fluxes in the atmosphere, vegetation, and soil. Radioactive decay is considered in the dose modules and radionuclides are assumed to yield dose through gamma shine from a cloud and internal dose though inhalation. Chemical species are assumed to be non-buoyant and passive with respect to chemical reactivity, but molecular weight of the chemical is needed to compute parts per million by volume.
6	**Application Limitation**	Gaussian diffusion, time scales of several hours, distance scales out to 100 miles.
7	**Strengths/ Limitations**	**Strengths:** Speed and simplicity are the principal strengths. Other strengths include: incorporation of wind speed, direction and turbulence forecasts, and modeling of tritium and tritium oxide deposition. **Limitations:** Lack of the ability to accommodate a two or three dimensional wind field in the model is a major weakness. Also, the code is unable to model dense-gas dispersion.
8	**Model References**	! A.J. Garrett and C.E. Murphy, 1981: A PUFF/PLUME Atmospheric Deposition Model for use at SRP in Emergency Response Situations, DP-1595. ! J.C. Fast, 1991: A Comparison of the WIND System Atmospheric Models and Rascal, WSRC-RP-91-894. ! J.C. Fast, 1991: Evaluation of the WIND System Atmospheric Models: An Analytic Approach, WSRC-91-1208. ! J.C. Fast, 1991: A Comparison of the WIND System Atmospheric Models and MATS Data, WSRC-RP-91-1209.

9	**Input Data/Parameter Requirements**	Interactive input variables (choices): (Default values of all parameters below are assumed automatically in cases where the operator does not have the actual information available.) ! Input type (Long, Short) ! Hard copy (Yes, No) ! Job name (variable) ! Units (Metric, English) ! SRS location (Yes, No) (User-specified coordinates if No selected) ! Area tower winds (Yes, No) (SRS locations only) ! Release location (1-9) (SRS locations only) ! Stack height (meters, ft) ! Time and date of release (0-2400 EST or EDT, date) ! Time step (minutes) (Defines receptor distances based on wind speed) ! Type of winds (Latest, Canned, Manual, Automatic) ! Release type (Puff, Plume) ! Radioactive release (Yes, No) ! Isotope or chemical compound number (selected from menu) ! Release rate (Ci/sec, lbs/min) or release amount for puff (Ci, lbs) ! Length of release (minutes) (plume only) ! Initial horizontal cloud size (meters, ft) ! Initial vertical cloud size (meters, ft) ! Deposition (Yes, No) (Precipitation rate for wet deposition — none, light, heavy) ! Output resolution (in time step interval) Input format is by integer number, alphanumeric, fixed point or exponential.
10	**Output Summary**	Output variables include: ! Input data page (variable format depending on the user's choices) ! Meteorological data page (metric or English units, in hourly increments) variables include: time, wind speed, wind direction, std. dev. of azimuth and elevation, height of the inversion, stability class. ! Output summary table page (metric or English units, at selected time steps) variables include: distance, arrival time, plume width (2 sigma width) and height (2 sigma height), dose and concentration at centerline and 2 sigma-width, centerline deposition and percent removed. ! Summary page for SRS site boundary. ! Maps of puff or plume locations with selected data from summary table.
11	**Applications**	! C.H. Hunter, 1990: WSRC TM-90-14 WINDS Users Manual (U). ! C.H. Hunter, 1992: Weather Center Operating Procedures Manual, L15.15. May 8,1992.
12	**User-Friendliness**	Alphanumeric, command line interface. The code is extremely user friendly. Experience has shown that new users are normally able to operate the code with a few minutes training and practice.
13	**Hardware-Software Interface Constraints/ Requirements**	**Computer operating system:** VMS on Digital Equipment Computers; DOS on IBM-PC **Computer platform:** **Disk space requirements:** 300 K-bytes for the executable **Run execution time** (for a typical problem)**:** 2-3 minutes for typical problem **Programming language:** FORTRAN **Other computer peripheral information:** Extremely portable.
14	**Operational Parameters**	**Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:** Yes, several spread throughout the code.
15	**Surety Considerations**	**All quality assurance documentation:** 1. J.C. Fast, 1991: A Comparison of the WIND System Atmospheric Models and Rascal, WSRC-RP-91-894. 2.J.C. Fast, 1991: Evaluation of the WIND System Atmospheric Models: An Analytic Approach, WSRC-91-1208. **Benchmark runs:** **Validation calculations:** **Verification with field experiments that has been performed with respect to this code:** J.C. Fast, 1991: A comparison of the WIND System Atmospheric Models and MATS Data, WSRC-RP-91-1209.

16	**Runtime Characteristics**	1 or 2 minutes.

Specific Characteristics

Part A: Source Term Submodel Type		
A1	**Source Term Algorithm?**	__YES _✔_NO
Part B: Dispersion Submodel Type		
B1	**Gaussian**	**_✔_Straight-line plume _✔_Segmented plume _✔_ Statistical plume _✔_ Statistical puff**
Part C: Transport Submodel Type		
C1	**Prognostic**	Model utilizes forecast data.
C4	**Frame of Reference**	**___ Eulerian _✔_ Lagrangian __ Hybrid __ Eulerian-Lagrangian**
Part D: Fire Submodel Type (Not Applicable)		
Part E: Energetic Events Submodel Type (Not Applicable)		
Part F: Health Consequence Submodel Type		
F1	**For Chemical Consequence Assessment Models**	**Health effects: __ fatalities __ cancers __ latent cancers __ symptom onset** **Health criteria** **__ IDLH __ STEL __ TLV __ TWA** **__ ERPG __ TEEL __ AEGL __ WHO** **Zones with flammable limits: __ UFL __ LFL** **Blast overpressure regions:** **Fire radiant energy zones:** **Risk qualification:** **Concentration: _✔_ single value _✔_ time-history __ integrated dose** **Probits:**
Part G: Effects and Countermeasures Submodel Type (No Information Provided.)		
Part H: Physical Features of Model		
H2	**Release Elevation**	**_✔_ ground _✔_ roof**
H6	**Mixing Layer**	**__ trapping __ lofting _✔_ reflection __ penetration** **__ inversion breakup fumigation ___ temporal variability**
H7	**Cloud Buoyancy**	**_✔_ neutral [passive] __ dense [negative] ___ plume rise [positive]**
Part I: Model Input Requirements		
I1	**Radio(chemical) and Weapon Release Parameters**	**Release rate: _✔_ Continuous _✔_ Time dependent__ Instantaneous** **Release container characteristics: _✔_ vapor temperature** **__ tank diameter** **__ tank height __ tank temperature __ tank pressure __ nozzle diameter** **__ pipe length** **Jet release: __ initial size __ shape** **__ concentration profile at end of jet affected zone** **Release dimensions: _✔_ point _✔_ line _✔_ area** **Release elevation: _✔_ ground _✔_ roof _✔_ stack**

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** **See above. Currently cloud cover is used; however, a conversion to incoming solar radiation will be made in the near future.** **Four dimensional meteorological fields from prognostic model: See above.**
Part J: Model Output Capabilities		
J3	**Concentration Versus Time Plots**	Yes
Part K: Model Usage Considerations (See Items 5 - 7.)		