General Characteristics		
1	**Abstract of Model Capabilities**	HOTSPOT uses the well-established Gaussian Plume Model, widely used for an initial emergency assessment or safety analysis planning of a radionuclide release. Virtual source terms are used to model the initial 3D distribution of material associated with an explosive release, fire release, resuspension, or user-input geometry. The HOTSPOT documentation describes the HOTSPOT algorithms in detail. The dosimetric methods of ICRP Publication 30 were used throughout the HOTSPOT programs. Individual doses (unweighted) are produced, along with the 50-year committed effective dose equivalent (CEDE). HOTSPOT supports both CLASSIC units such as rem, rad, curie, and SI units. The HOTSPOT dose values are due solely to the inhalation of released material during the passage of the plume. In the specific case of noble gases, e.g., Kr-85, the submersion dose is output. The specific dose conversion factors for all of the radionuclides in the HOTSPOT Library can be viewed in the "HOTSPOT Library" program. The ground shine dose is not included because the effective dose equivalent (per hour of stay time in the contaminated area), due to ground shine is typically several orders of magnitude less than the CEDE due to plume passage. For alpha-emitting radionuclides e.g., Pu-239, Am-241, the hourly groundshine component is at least 7 orders of magnitude less than the inhalation component. Emergency preparedness requires a fast and adequate means of generating an initial assessment of an actual or scheduled atmospheric release. Just as important, is the need for consistency in the assessment methodology, e.g., well documented, consistent output for a particular set of input assumptions, etc. Actual source terms ,the substances involved, meteorological conditions, etc., are seldom accurately known. Overly sophisticated and data intensive models seldom provide useful and timely information in emergencies involving the release or potential release of radioactive material into the atmosphere. In the specific case of emergency planning and response, we are usually interested in worst-case scenarios, i.e., if the plume of radioactive material does reach a target community, what are the projected committed effective dose equivalent values. Unless specific accident scenarios are accurately detailed and proven to be reliable, large modeling errors are possible. Such errors render the use of large, complex, and time consuming models no more accurate than using a simple Gaussian model. The Gaussian model should be recognized as a starting place for analyses and in many cases the only necessary tool due to the large uncertainty associated with the release scenario.
2	**Sponsor and/or Developing Organization**	Steven G. Homann / Steven G. Homann / LLNL
3	**Last Custodian/ Point of Contact**	Steven G. Homann Lawrence Livermore National Laboratory 7000 East Avenue L-380 Livermore, CA 94551 Voice: (510) 490-6379 Internet: shomann@llnl.gov
4	**Life-Cycle**	1985 HOTSPOT 1.0 Hewlett Packard HP-41 system 1990 -1994 HOTSPOT 2.0 - HOTSPOT 7.0 (IBM PC or compatible) 1995 HOTSPOT 8.0 (Urban terrain, wet deposition, user's custom library, 50-nuclide mixture, GIS interface)
5	**Model Description Summary**	The HOTSPOT Health Physics codes were created to provide Health Physics personnel with a fast, field-portable calculation tool for evaluating accidents involving radioactive materials. HOTSPOT codes are a first-order approximation of the radiation effects associated with the atmospheric release of radioactive materials. HOTSPOT programs are reasonably accurate for a timely initial assessment. More importantly, HOTSPOT codes produce a consistent output for the same input assumptions, and minimize the probability of errors associated with reading a graph incorrectly or scaling a universal nomogram during an emergency. Four general programs, Plume, Explosion, Fire, and Resuspension, calculate a downwind assessment following the release of radioactive material resulting from a continuous or puff release, explosive release, fuel fire, or an area contamination event. Other programs deal with the release of plutonium, uranium, and tritium to expedite an initial assessment of accidents involving nuclear weapons. Additional programs estimate the dose commitment from inhalation of any one of the radionuclides listed in the database of radionuclides, calibrate a radiation survey instrument for ground survey measurements, and screening of plutonium uptake in the Lung.
6	**Application Limitation**	HOTSPOT is not intended to be used in situations of complex terrain.

7	**Strengths/ Limitations**	**Strengths:** The HOTSPOT code has a well-deserved reputation for ease-of-use in emergency situations. It is used extensively by government agencies in the United States and in Western and Eastern European countries. The code uses a Gaussian model formulation so the atmospheric physics are only first-order approximations, nevertheless, HOTSPOT has proven to be extremely valuable in providing reasonable and reliable guidance for a diversity of applications. The salient features of this code are contained in its source term modules which are extensive and well-formulated. For example, provisions are made for plutonium, uranium, and general fires and explosions, tritium releases, nuclear explosions, general plumes, and resuspension. **Limitations:** Use in applications where more complex physical modeling is important, e.g., building wakes, complex terrain, shearing winds, etc., the code would not be appropriate to use. Some U.S. government agencies are stressing the need to provide estimates of groundshine dose, HOTSPOT does not yet contain this capability.
8	**Model References**	! Homann, S.G., 1994, “HOTSPOT Health Physics Codes for the PC”, Hazards Control Department and the Emergency Preparedness and Response Program, Nonproliferation, Arms Control, and International Security Directorate, UCRL-MA-106315, Lawrence Livermore National Laboratory, University of California, Livermore, California, 94551.
9	**Input Data/Parameter Requirements**	**Name of Radionuclide or Mixture** (Mix can contain up to 50 individual radionuclides) **Source Term**, Curies and/or kg of plutonium or uranium **Release Fraction** .The fraction of the total quantity of material involved in the fire, explosion, etc., that is respirable and available for dispersion into the atmosphere. This respirable fraction is defined as the fraction of the released material associated with an Activity Median Aerodynamic Diameter (AMAD), of 1 micrometer. **Explosive Release Modules: High Explosive** (pounds TNT equivalent). **Fuel Fire Module: Volume of Fuel** (gallons), **burn duration** (minutes), **heat emission rate** (calories/second). **Radius of Fire zone** (meter), if fire option selected. **Wind Speed** (m/s) at a height of 2 meters or 10 meters. Wind speed at effective release height is determined using a standard power function. **Stability Class (A-G)** **Release Height** (meters). **Receptor Height** (meters). **Inversion Layer Height** (meters) **Deposition Velocity** (meters/second), for plume depletion and ground deposition. **Washout Coefficient** (1/second), for washout plume depletion and ground deposition. **ICRP-30 Dose conversion database or User’s custom database**
10	**Output Summary**	Users can direct tabular output to the computer screen, printer, or disc file. Graphics (50-yr CEDE and ground contamination as a function downwind centerline distance, and 50-yr CEDE and ground contamination contours can be directed to the computer screen, printer disc file, or as coordinates for GIS mapping systems. Users can query specific locations, e.g., data at coordinate (x,y).

11	**Applications**	HOTSPOT is currently used at a number of DOE sites for Emergency Response and Planning. The codes are also distributed by the U.S. Army Space and Strategic Defense Command in Huntsville Alabama. The command is working with the Office of the Joint Chiefs of Staff and the Office of the Under Secretary of Defense for Policy, Emergency Planning Directorate, to conduct the Partnership for Peace (PfP) project. The project's purpose within the Civil Defense arena is to actively facilitate better communications with joint planning between neighboring PfP countries; increase the level of technology in the PfP countries to permit improved planning and response to major emergencies; and improve the capability of PfP nations to provide more timely notifications and requests to their neighbors, Western nations, and international agencies during times of disasters. To date, the countries using HOTSPOT via this program include Belarus, Latvia, Lithuania, Russia, Ukraine, Kazakhstan, and Poland.
12	**User-Friendliness**	HOTSPOT is noted for being easy to use based on its well-designed user interface. The user fills in an input data template and the output results appear almost instantaneously.
13	**Hardware-Software Interface Constraints/ Requirements**	All PCs and HP 100 Palmtop, Apple computers with DOS emulator, e.g., Soft PC.
14	**Operational Parameters**	HOTSPOT Codes are written in Borland's Turbo Pascal 7.0. HOTSPOT will run on an IBM PC, XT, AT, or compatible, with a minimum of 512 kilobytes of RAM and a single floppy disk drive. However, the programs run more efficiently when they reside on a hard disk. The software supports either monochrome or color monitors (CGA, EGA, VGA). The only operating system required is MS-DOS version 3.0 or later. HOTSPOT also supports high-resolution (300 dpi) output to printers, and also to graphics files (.PCX and .BMP Files). The latter allow incorporation of HOTSPOT graphics into word processing files. HOTSPOT also supports GIS mapping applications via ASCII Plume contour files.
15	**Surety Considerations**	Validation identified in HOTSPOT PC Health Physics Codes," S.G. Homann, March, 1994, UCRL-MA-106315, with test problems included in documentation.
16	**Runtime Characteristics**	HOTSPOT is noted for being easy to use based on its well-designed user interface. The user fills in an input data template and the output results appear almost instantaneously.

Specific Characteristics

Part A: Source Term Submodel Type

A1	**Source Term Algorithm?**	_✔_ YES __NO
A3	**For Radiological Consequence Assessment Models**	**Gaseous releases:** _✔_ **noble gases** _✔_ **iodines** __ **other non-reactive gases** **Aerosol releases:** **Particulate releases:** __ **Chemistry** __ **Isotopic exchange** ___ **Physical properties capability**

Part B: Dispersion Submodel Type

B1	**Gaussian**	_✔_ **Straight-line plume** __**Segmented plume** __ **Statistical plume** __ **Statistical puff**

Part C: Transport Submodel Type

C4	**Frame of Reference**	_✔_ **Eulerian** __ **Lagrangian** __ **Hybrid** __ **Eulerian-Lagrangian**

Part D: Fire Submodel Type

D1	**Radiant Energy**	Radioactive fuel fire.

Part E: Energetic Events Submodel Type

E4	**Detonations**	Yes
E8	**High Explosives**	Yes

Part F: Health Consequence Submodel Type		
F2	**For Radiological Consequence Assessment Models**	**Cloudshine:** __ finite cloud ✔ semi-infinite cloud __ other **Groundshine:** __ short-term __ long-term **Inhalation:** __ short-term __ long-term ✔ Total effective dose equivalent __ Uptake of respirable fraction of particle spectra **Resuspension:** __ short-term __ long-term ✔ Anspaugh **Food/Water Ingestion:** __ dynamic _ static **Skin dose:** ✔ absorption _ other (tritium only) **Dose assessment:** __ ICRP-60 criteria ✔ organs ✔ pathways **Health effects:** __ early _ latent
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 (explosions only) __ inversion breakup fumigation __ temporal variability
H7	**Cloud Buoyancy**	✔ neutral [passive] __ dense [negative] ✔ plume rise [positive]
H10	**Deposition**	___ gravitational setting ✔ dry deposition ✔ precipitation scavenging __ resistance theory deposition __ simple deposition velocity __ liquid deposition __ plateout and re-evaporation
H11	**Resuspension**	Anspaugh
H12	**Radionuclide Ingrowth Decay**	Decay with no ingrowth.
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		
J4	**Tabular at Fixed Downwind Locations**	Default centerline values (0.1 to 50 km) at specific location.
Part K: Model Usage Considerations (See Items 5 - 7.)		