| General Characteristics | | |
|---|---|---|
| 1 | **Abstract of Model Capabilities** | HASCAL (Hazard Assessment System for Consequence AnaLysis) is a part of the Defense Special Weapons Agency's (DSWA's) Hazard Prediction and Assessment Capability (HPAC) software package, based on an enhanced adoption of NRC's RASCAL (Radiological Hazard Assessment System for Consequence AnaLysis) for nuclear accident assessments. HASCAL is a collateral effects assessment tool for hazardous material releases of nuclear, biological, or chemical (NBC) nature, and includes an atmospheric transport and dispersion effects assessment module known as the Second-order Closure Integrated PUFF (SCIPUFF). Although this review is limited to the SCIPUFF model, the packaging with HASCAL does not always allow for clean distinctions in user related review items.<br>Only a beta version of HASCAL/SCIPUFF was available during the CDCA Working Group review. When all planned features are fully implemented, the software is intended to support the Munitions Effects Assessment (MEA) capability of HPAC, which is an expert system for target attack planning associated with conventional weapons attacks on NBC facilities or the potential use of NBC weapons. HASCAL/SCIPUFF may also be run independent of HPAC to provide hazard assessment of NBC material releases from industrial accidents. |
| 2 | **Sponsor and/or Developing Organization** | **Sponsor:**<br>Defense Special Weapons Agency (DSWA)<br>(HPAC) 6801 Telegraph Road<br>Alexandria, VA 22310-3398<br>**Developer:**<br>Ian Sykes<br>(SCIPUFF) ARAP Group, Titan Research and Technology Division<br>50 Washington Road<br>P.O. Box 2229 Phone: 609 452-2950<br>Princeton, NJ 08543-2229 Fax: 609 452-2856 |
| 3 | **Last Custodian/ Point of Contact** | Douglas R. Wenzel<br>Lockheed Martin Idaho Technologies<br>P.O. Box 1625<br>Idaho Falls, ID 83415-5209<br>(208) 526-3463 (208) 526-3787 **Fax**<br>dxw@inel.gov **primary individual**<br>dxw@inel.gov **secondary individual** |
| 4 | **Life-Cycle** | Lt. Col. James Hodge, Phone: (703) 325-6106 (DSN 221-6106)<br>Maj. D. Myers, Maj. Tom Smith Fax: (703) 325-0398<br>HQ. DSWA/WEL e-mail: HYPERLINK mailto:jhodge@foxtrot.spwe.hq.dna.mil jhodge@foxtrot.spwe.hq.dna.mil<br>(Address given above) |
| 5 | **Model Description Summary** | The SCIPUFF model was originally developed in the mid 1980's under the sponsorship of the Electric Power Research Institute. It was commonly referred during this period as the ARAP model, named after the development group. The Defense Nuclear Agency later became interested in the code for defense non-proliferation applications. Although SCIPUFF was used for these applications in the early 1990s, the first operational release of an integrated Biological facility source-term capability associated with the DNA Counter Proliferation Program was packaged and released under the HASCAL (1.0a, with SCIPUFF 0.338) name in February of 1996. This release provided a tighter coupling between HASCAL and SCIPUFF. Subsequent software development and packaging was done under the Hazard Assessment and Consequence (HPAC) Analysis name. HPAC 1.0, released in May of 1996, included a complete set of SCIPUFF readable high-resolution maps and meteorological preprocessing software for defense weather data (AFGWC and AFDIS) conversion. A user's guide was released with version 1.3 of HPAC (HASCAL, Ver. 2.0) in November 1996. This release included enhancements to integrate historical climatology, algorithms for addressing precipitation and washout, and a coupled terrain gridded meteorology file. Although planned, the inclusion of dense gas physics within SCIPUFF was not ready with the HPAC 1.3 release. HPAC 3.0 was release in October 1997. Several new and enhanced features were added including: computation and enhanced display of hazard areas, a mass consistency wind solver, and improved computational efficiency for scenarios involving surface evaporation. |

| | | |
|---|---|---|
| 6 | **Application Limitation** | **Application Limitations**<br>It appears that HASCAL/SCIPUFF are designed to deal with large NBC material releases and to provide a rapid and gross assessment of hazard impact zone on a regional or continental scale. Although several options exist for customizing sources and materials released and meteorology, the design of these options around biological materials (in HPAC.0a) restricted its application to specific release conditions more typical to chemical accidents at industrial facilities. The model is not capable for handling near-source physics and thermodynamics associated with a pipeline break, storage tank leak, or cylinder rupture. SCIPUFF is not a prognostic model and therefore not designed to accept real-time meteorological data for emergency response applications.<br><br>**Limiting Model Assumptions**<br>Although data input files can be generated to include detailed wind and temperature profiles, as well as stability class, the user cannot specify parameters such as Pasquill-Gifford's stability class and ambient temperature outside of this detailed observational data set.<br>Can not deal with plume dispersion for atmospheric releases of lighter-than-air (buoyant) or dense gases. Can not deal with accidental releases of substances released within the building wake.<br>The Lagrangian modeling approach using a plume trajectory-following coordinate would not accept user-specified receptors as model input. Model output results can only be displayed graphically in contour plots on a monitor screen for instantaneous concentration, integrated dose and ground deposition. |
| 7 | **Strengths/ Limitations** | **Strengths:** The model is particularly suitable for assessing radiological impacts associated with nuclear reactor accidents.<br>The Lagrangian modeling approach and 3-D wind field generation are more appropriate for long-range atmospheric transport and diffusion studies.<br>Complex terrain modeling can be achieved through the use of a terrain-following coordinate in the model.<br>**Limitations:** Runs only on 32-bit Microsoft Windows operating system platform (including Windows NT and 95) and source codes are difficult to compile and run on other platforms without significant modifications. The so-called "operator friendly" model input interface is very awkward and user unfriendly. Does not use standard archived data formats of NCC's surface and upper air observations as meteorological data input. Does not use standard source release and meteorological input parameters found in most U.S. EPA endorsed atmospheric dispersion models (refer to Sec. 6b).<br>Can not generate model output results at special-interest receptors due to the lack of a user-controllable Eulerian computational grid. Does not provide any tabulated model output summary results for either screen display or hard-copy output. |
| 8 | **Model References** | ! "HASCAL/SCIPUFF User's Guide," draft, Defense Nuclear Agency, Alexandria, VA, February 1996.<br>! Sykes, R.I., et al., "PC-SCIPUFF Version 0.2 Technical Documentation," A.R.A.P. Report No. 712 (Draft), Titan Corporation, Princeton, NJ, April 1995.<br>! Athey, G.F., et al., "RASCAL Version 2.0 User's Guide," NUREG/CR-5247, U.S. Nuclear Regulatory Commission, Washington, DC, February 1993.<br>! Sykes R.I., and R.S. Gabruk, "A Second-Order Closure Model for the Effect of Averaging Time on Turbulent Plume Dispersion," manuscript submitted for publication, Titan Corporation, Princeton, NJ, 1995.<br>! Sykes, R.I., et al., "SCIPUFF - A Generalized Hazard Dispersion Model," manuscript submitted for publication, Titan Corporation, Princeton, NJ, 1995. |
| 9 | **Input Data/Parameter Requirements** | As a minimum, the following four basic input files are required to set up a simple HASCAL/SCIPUFF run:<br>! An input file containing information such as the time setup, puff grid parameters, and material setup;<br>! An input file containing the release scenario parameters;<br>! An input file containing the meteorology description;<br>! An input file created by HASCAL for restarting a project file.<br>! Other optional input files that may be required for modeling runs include:<br>! Material physical properties data file;<br>! Surface and upper air observations data files;<br>! Gridded terrain data file;<br>! Population data file;<br>! Mass-consistent wind field data file. |

| | | |
|---|---|---|
| 10 | **Output Summary** | Output summaries are presented graphically on a monitor screen, in the form of contour plots of instantaneous concentration, integrated dose and ground deposition which can be superimposed on a high-resolution, vector basemap. Animated displays of graphical output at a prespecified computational time interval can also be generated. However, no tabulated model output summary tables are available for screen display or printer output. |
| 11 | **Applications** | The HASCAL/SCIPUFF software, when fully implemented, is intended to support the Munitions Effects Assessment (MEA) capability of HPAC, which is an expert system for target attack planning and weaponeering associated with conventional attacks on NBC facilities or by NBC weapons. A few HPAC applications are summarized below:<br><br>! Summit of Eight – Contingency planning support.<br>! Global War Game – Support to senior military and policy decision makers.<br>! Ulchi Focus Lens – theater missle scenarios in Korea with chemical payloads<br>! Real-World Incident – accidental releases of CS tear gas and HC smoke into civilian sector during a training exercise.<br><br>The reviewers and the developers are not aware of any HPAC model applications to chemical hazard assessment associated with industrial accidents is questionable. |
| 12 | **User-Friendliness** | The HASCAL 1.0a release Windows-based user interface was not as user friendly as might be expected from current standards in PC-based GUI application software. The draft HASCAL/SCIPUFF user's manual, which provides little technical information or background about input parameters required for SCIPUFF, appears to represent a series of tutorial sessions teaching a novice user how to run the software under Microsoft Windows. The on-line help menus offer rather limited technical discussions of the input parameters in a very general sense. |
| 13 | **Hardware-Software Interface Constraints/ Requirements** | **Operating System:** HASCAL/SCIPUFF runs under 32-bit Microsoft Windows 3.1, Windows NT, or Windows 95 with a minimum of 16 MB random access memory (RAM) on Intel 486 (66 MHz or higher) and Pentium PCs. Future versions will also support the UNIX platform.<br>**Disk space required**: The minimum installation of HASCAL/SCIPUFF requires at least 30 MB hard disk space. Up to 550 MB disk space is required for full installation. Alternatively, HASCAL databases can reside on a CD-ROM for user access.<br>**Run execution time for typical problem (CPU or Real Time):** The software execution time varies with the complexity of release scenarios, time interval of puff releases, and meteorological data fields, as well as with the CPU speed of the Intel microprocessor (a math coprocessor is required). For a simple test run using a constant source release rate and a uniform wind field, such as those test scenarios developed for model evaluation by CDCA WG, the CPU execution time can vary from 5 minutes to over 30 minutes using a 75 MHz Intel Pentium microprocessor.<br>**Programming language:** The programming language is the 32-bit Microsoft FORTRAN for Windows NT. Source codes written for this FORTRAN version will compile and run under a 32-bit Microsoft Windows operating system on an Intel 486 or Pentium PC only.<br>e. Interface with other codes: HASCAL/SCIPUFF is a stand-alone, Microsoft Windows-based computer software, which can not be interfaced with other APAC codes.<br>**Portability:** The HASCAL/SCIPUFF source codes are written specifically for Microsoft Windows. Since it is not possible to recompile the source codes, without significant alternations, for other operating systems or hardware platforms, such as UNIX, VAX, VM, etc., the source codes are not portable. The developer (Doug Henn, No, 8, 1996) asserts that a de-coupled version of SCIPUFF can be provided to run as a stand alone under UNIX and Window NT. |
| 14 | **Operational Parameters** | **Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:**<br>A very brief error message will be displayed when an invalid or incorrect input parameter (or data file) is entered by the user. An error message will also be displayed if a SCIPUFF run can not proceed due to incomplete (or invalid) input data file setup by the user. As indicated by the model developer, the execution of SCIPUFF must utilize the Windows-based HASCAL user interface. Although it is feasible to run the model in batch mode, this practice is strongly discouraged. |
| 15 | **Surety Considerations** | **All quality assurance documentation:**<br>Quality assurance of HASCAL/SCIPUFF is implemented through the incremental beta releases. DNA is responsible for software quality assurance and control. In the draft "HASCAL/SCIPUFF User's Guide," a "Fax Back HASCAL Software Problem Form" is provided for users to report software bugs.<br>**Benchmark runs:** Benchmark comparisons are not mentioned in the documentation. Since the model is significantly different from other Tier I and II models chosen by the CDCA Working Group for evaluation, it would be difficult to benchmark against other models.<br>**Validation calculations:** |

| | | |
|---|---|---|
| 15 | **Surety Considerations (Cont.)** | **Verification with field experiments that has been performed with respect to this code:** SCIPUFF model performance evaluations have been conducted with field data collected the Kincaid, and ANATEX filed experiments, and the Fackrell and Robins Wind Tunnel experiment. A brief discussion of model comparisons with these and other field data is presented in a paper entitled "A Second-Order Closure Model for the Effect of Averaging Time on Turbulent Plume Dispersion," by R.I. Sykes and R.S. Gabruk (manuscript submitted for publication). Other papers and reports documenting SCIPUFF model evaluations are listed below.<br><br>Sykes, R.I., et al., 1993, Numerical Simulations of ANATEX Tracer Data Using a Turbulance Closure Model for Long-Range Dispersion, JAM, 32, pp 929-94.<br>Sykes, R.I., et al., 1988, A Hierarchy of Dynamic Plume Models for Incorporating Uncertainty, EPRI EA-6095.<br>Sykes, R.I., et al., 1984, A Turbulent-Transport Model for Concentration Fluctuactions and Fluxes, JFM, 139, pp 193-218. |
| 16 | **Runtime Characteristics** | Without detailed software documentation and some theoretical background in meteorology and atmospheric dispersion, it can be difficult for a novice user to understand some SCIPUFF terminology for model input parameters and to set up an initial SCIPUFF run. Once an initial run is successfully set up, subsequent runs of "similar" scenarios can be done rather quickly. |
| **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**<br>**Aerosol releases:**<br>**Particulate releases:**<br>__ **Chemistry** __ **Isotopic exchange** __ **Physical properties capability** |
| A4 | **For Weapons Consequence Assessment Models** | Biological agent source term capability. |
| **Part B: Dispersion Submodel Type** | | |
| B1 | **Gaussian** | **__Straight-line plume __Segmented plume __ Statistical plume _✔_ Statistical puff** |
| B9 | **Multiple Capabilities** | Turbulent diffusion is based on second-order turbulence closure theory. The turbulence diffusion is represented by a dynamic eddy diffusivity equation. |
| **Part C: Transport Submodel Type** | | |
| C3 | **Stochastic** | Yes |
| 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**<br><br>**Health criteria**<br>__ **IDLH** __ **STEL** __ **TLV** __ **TWA**<br>__ **ERPG** __ **TEEL** __ **AEGL** __ **WHO**<br>**Zones with flammable limits:** __ **UFL** __ **LFL**<br>**Blast overpressure regions:**<br>**Fire radiant energy zones:**<br>**Risk qualification:**<br>**Concentration:** _✔_ **single value** _✔_ **time-history** _✔_ **integrated dose**<br>**Probits:** |
| **Part G: Effects and Countermeasures Submodel Type** (No Information Provided.) | | |
| **Part H: Physical Features of Model** | | |
| H2 | **Release Elevation** | _✔_ **ground** _✔_ **roof** |

| | | |
|---|---|---|
| H4 | **Horizontal Plume Meander** | Controlled by the gridded 3-dimensional spatial and temporal wind fields generated within the model. |
| H5 | **Horizontal/Vertical Wind Shear** | Vertical shear is accounted for through vertical wind speed variability. |
| H8 | **Cloud Liquid Droplet Formulation/ Aerosolization** | Droplet evaporation equation used from input of saturation vapor pressure, aerosol density, etc. Droplets and vapor are tracked separately as droplet plume can settle but vapor plume does not. Evaporation rate changes with meteorology. |
| H10 | **Deposition** | **_✔_ gravitational setting _✔_ dry deposition _✔_ precipitation scavenging __ resistance theory deposition __ simple deposition velocity _✔_ liquid deposition __ plateout and re-evaporation** |
| H13 | **Temporally and Spatially Variant Mesoscale Processes** | **Urban heat island:**<br>**Canopies:**<br>**Complex terrain (land) effects: _✔_ mountain-valley wind reversals**<br>**__ anabatic winds __ katabaic winds**<br>**Complex terrain (land-water) effects: _✔_ seabreeze airflow trajectory reversals**<br>**__ Thermally Induced Boundary Layer definition __ seabreeze fumigation**<br>**__ landbreeze fumigation**<br>**Thunderstorm outflow:**<br>**Temporally variant winds:**<br>**High velocity wind phenomena: __ tornado __ hurricane __ supercane __ microburst** |
| **Part I: Model Input Requirements** | | |
| I1 | **Radio(chemical) and Weapon Release Parameters** | **Release rate: __ Continuous __ Time dependent __ Instantaneous**<br>**Release container characteristics: __ vapor temperature __ tank diameter**<br>**__ tank height __ tank temperature __ tank pressure __ nozzle diameter**<br>__ pipe length<br><br>**Jet release: __ initial size __ shape**<br>**__ concentration profile at end of jet affected zone**<br><br>**Release dimensions: _✔_ point _✔_ line _✔_ area**<br><br>**Release elevation: _✔_ ground _✔_ roof _✔_ stack** |
| I2 | **Meteorological Parameters** | **Wind speed and wind direction: __single point __ single tower/multiple point _✔_ multiple towers**<br><br>**Temperature: __ single point __ single tower/multiple point _✔_ multiple towers**<br><br>**Dew point temperature: __ single point __ single tower/multiple point __ multiple towers** |
| I2 | **Meteorological Parameters (Cont.)** | **Precipitation: __ single point __ single tower/multiple point__ multiple towers**<br>**See above.**<br>**Turbulence typing parameters: _✔_ temperature difference**<br>**_✔_ sigma theta**<br>**_✔_ sigma phi _✔_ Monin-Obukhov length _✔_ roughness length**<br>**_✔_ cloud cover _✔_ incoming solar radiation _✔_ user-specified**<br><br>**Four dimensional meteorological fields from prognostic model:** |
| **Part J: Model Output Capabilities** | | |
| J1 | **Hazard Zone** | **Yes** |
| J2 | **Graphic Contours and Resolution** | **Yes. Instantaneous concentration only.** |
| J3 | **Concentration Versus Time Plots** | **Line graph.** |
| **Part K: Model Usage Considerations** (See Items 5 - 7.) | | |