General Characteristics		
1	**Abstract of Model Capabilities**	The computer program UFOTRI has been developed for assessing the consequences of accidental tritium releases from nuclear installations. It considers tritium releases into the atmosphere of the two chemical forms tritiated gas (HT) and tritated water vapour (HTO). UFOTRI can be applied for deterministic (one weather sequence) and probabilistic assessment (up to 144 weather sequences). Endpoints are time dependent concentrations n six feed-and foodstuffs (deterministic) and individual and collective doses (deterministic and probabilistic). Additionally, an indication of food banning is provided. UFOTRI can be coupled with the code system COSYMA a package for accident consequence assessment (radionuclide except tritium).
2	**Sponsor and/or Developing Organization**	Forschungszentrum Karlsruhe Postfach 3640, 76021 Karlsruhe Germany (49) 7247 82 0 (49)7247 82 5508 **Fax** **sponsoring organization** **developing organization**
3	**Last Custodian/ Point of Contact**	Wolfgang Roaskob FZK, Abt. INR, Postfach 3640, 76021 Karlsruhe, Germay (49) 7247 82 2480 (49)7241 82 5508 **Fax** wolfgang.raskob@inr.fzk.dee **primary individual** **secondary individual**
4	**Life-Cycle**	UFOTRI has first been published and distributed 1991. Beginning of 1994, the actual version 4.0 was distributed. Major changes included that in this newest version all the exchange processes (atmosphere-soil; atmospher-plant) are based on resistance approaches and will we re-evaluated dependent on the prevailing environmental conditions. Additionally, a simple photosynthetic submodule, which calculates the actual transfer rate of HTO in plant water into organically bound tritium, improved the results for the ingestion pathways. Father modification will improve the modeling of tritium in soil and the photosynthetic submodel.
5	**Model Description Summary**	The computer program UFOTRI for assessing the consequences of accidental tritium releases considers processes such as the conversion of tritium gas (HT) into tritiated water (HTO) in the soil, reemission after deposition and the conversion of HTO into organically bound tritium (OBT). For atmospheric dispersion and deposition calculations (dry and wet) a trajectory model is implemented in UFOTRI. During the time period of the first few days, all the relevant transfer processes between the compartments of the biosphere (atmosphere, soil, plants, animals) are described dynamically. A first order compartment model calculates the longer term pathways of tritium in the foodchains. In its newest version all the exchange processes (atmosphere-soil; atmosphere -plant) are based on resistance approaches and will be re-evaluated dependent on the prevailing environmental conditions. A simple photosynthetic submodule, which calculatesthe actual transfer rate of HTO in plant water into organically bound tritium, is included. UFOTRI can be applied for deterministic and probabilistic assessments. Endpoints are concentrations (deterministic) and doses (probabilistic).
6	**Application Limitation**	Limited amount of feed-and foodstuffs no ‘long’ term releases (weeks to month), as only 15 release phases of a defined length (default 1 hr) are available to describe a time dependent source term.
7	**Strengths/ Limitations**	**Strengths:** Behaviour of tritium is described dynamically in atmospher, soil and plants (time step of one hour). **Limitations:** Improvements of the soil submodel as it seems to be too conservation at present (higher reemission rate).

8	**Model References**	! Raskob W. UROTRI: Program for Assessing the Off-Site Consequences from Accidental Tritium Releases. Report KfK-4605, Kernforschungszentrum Karlsruhe, 1990 ! W. Raskob, Modeling of the Tritium Behaviour in the Environment in: Proceedings of the '4th Topical Meeting on Tritium Technology in Fission, Fusion, and Isotopic Applications. Albuquerque 29.9.91 - 4.10.91, Fusion Technology, 21, 2, pp. 636-645 (1992) ! W. Raskob, Description of the New Version 4.0 of the Tritium Code UFOTRI.Including User Guide. Report KfK-5194 Kernforschungszentrum Karlsruhe, August 1993 ! D. Galeriu, P. Davis, S. Chouhan and w. Raskob: Uncertainly and Sensitivity Analysis for the Enviornmental Tritium Code UFOTRI. In: Proceedings of the Firth Topical Meeting on Tritium Technology in Fission, fusion and Isotopic Applications, Belgirate, 28. May - 3 June 1995 Fusion Technology, Vol. 28, Nr. 3, pp. 853-858, October 1995 ! W. Raskob and P. Barry: Importance and Variability in Processes Relevant to Environmental Tritium Ingestion Dose Models, in: Special Issue Environmental Tritium, Journal of Environmental Radioactivity, Vol. 36, No. 2-3, pp. 237-252, 1997
9	**Input Data/Parameter Requirements**	For one location hourly values of: wind speed, rain intensity, air temperature, solar insolation, relative humidity Optional: water content in soil layer 1,2, and 3; if not available a constant value can be used. Various parameters describing soil and vegetation, dispersion and deposition as well as inhalation and ingestion rates.
10	**Output Summary**	Spatially distributed doses of: inhalation after plume passage, with reemission and ingestion. Time dependent concentrations at one location for: atmosphere, soil layer 1-3, grass, potatoes, wheat, leafy vegetables
11	**Applications**	UFOTRI has been applied successfully in the frame of the SEAFP (Safety and Environmental Aspects of Fusion Power) study and is the reference code for tritium releases in the frame of ITER (International Thermonuclear Experimental Reactor). UFOTRI is distributed among others to CANADA, USA, Romania and Japan
12	**User-Friendliness**	UFOTRI is a research code and not user friendly. The input has to be changed via a normal text editor.
13	**Hardware-Software Interface Constraints/ Requirements**	**Computer operating system:** MS-DOS, 5.0 or higher, UNIX **Computer platform:** PC, workstation (8 MB of RAM) **Disk space requirements:** at least 10 MB of disk space for the model and data **Run execution time** (for a typical problem)**:** 1 minute for dterministic run, about 2 hours for probabilistic run **Programming language:** FORTAN **Other computer peripheral information:**
14	**Operational Parameters**	**Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:** Yes, but very limited **Set up time for:**. **Typical times are:** ***first-time user:*** preparation of input data in particular the meteorological file needs time (up to several days) ***experienced user:*** Changing of parameters only some minutes
15	**Surety Considerations**	**All quality assurance documentation:** **Benchmark runs:** **Validation calculations:** Tested in the frame of BIOMOVS (BIOlogical MOdel Validation Study phase II) **Verification with field experiments that has been performed with respect to this code:** Only parts: Exposure to wheat plants at FZF, Karlsruhe
16	**Runtime Characteristics**	For a standard deterministic run on a Pentium 133 PC about one minute CPU time. Probabilistic runs about 2 hours (Lahey FORTRAN compiler)

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** A Gaussian trajectory model calculates the dispersion of the primary plume. In the second step, the reemission of tritium from soil and vegatation is considered by an area sourse submodel. The area source is approximated by a single source point in the center of the area with a given initial widening of the plume. The plume dispersion parameters are power functions of the distance from the source. Dry deposition and reemission is calculated via a resistance approach which depends on the prevailing atmospheric and environmental (plant properties) conditions. Wet deposition is considered as washout from the whole plume (power function of considered as a function of the release characteristics. The possible effects of the power plant building on the plume behaviour are modelled in a simple manor
B1	**Gaussian (Cont.)**	according to a proposal from Briggs. The final result of the atmospheric dispersion are distance dependent, hourly time-integrated tritium concentrations in air near ground, in vegatation and on ground surface in a variable system of polar coordinates.
Part C: Transport Submodel Type		
C2	**Deterministic**	A weather sequence is defined as the starting hour in the atmospheric data set. Hourly values were used until the plume has left the area under investigation.
C3	**Stochastic**	Better probabilistic: A sampling scheme can be used to characterise the meteorological conditions of a certain period with respect to travel time, rainfall and wind direction (144 different classes). All possible weather sequences of this period will be sorted into these classes and one of each class will be selected randomly for the calculations (144 individual runs). These 144 weather sequences together with the probability of occurrence should represent the weather over the selected period.
Part D: Fire Submodel Type (Not Applicable)		
Part E: Energetic Events Submodel Type (Not Applicable)		
Part F: Health Consequence Submodel Type		
F2	**For Radiological Consequence Assessment Models**	**Cloudshine: __ finite cloud ___ semi-finite cloud ___ other** Not necessary for tritium **Groundshine: ___ short-term ___ long-term** Not necessary for tritium **Inhalation: _✔_ short-term _✔_ long-term** **_✔_ Total effective dose equivalent** **___ Uptake of respirable fraction of particle spectra** Uptake of tritiated water vapour via the skin into the body is added to the inhalation dose. **Resuspension: _✔_ short-term _✔_ long-term __ Anspaugh** Special reemission model (time dependent in the first days) **Food/Water Ingestion: _✔__ dynamic __ static** **Skin dose: ___ absorption __ other** Not necessary for tritium **Dose assessment: _✔_ ICRP-60 criteria _ organs__ pathways** Tritium is distributed uniformly in the body (ICRP 56) **Health effects: __ early _ latent**
Part G: Effects and Countermeasures Submodel Type		
G2	**Radiological Consequence Assessment Models**	**Land contamination:** As tritium sends out beta radiation with low energy (Emax=18.6 keV, E(av) = 5.6 keV) no external exposure has to be considered. **Economic costs: __ decontamination __ interdiction** **__ foodstuff losses __ denial of facility access __ victim treatment** **Evacuation:** not necessary **Sheltering:** Not necessary **Interdiction:** only foodbans depending on a concentration criteria **Decontamination:** not possible
Part H: Physical Features of Model		

H1	**Stability Classification Turbulence Typing**	**Pasquill-Gifford-Turner:** Classification according to Pasquill-Gillfford (6 classes) is an input parameter of the model (A=very unstable.....F=very stable) **STAR:** **Irwin:** **Sigma theta:** **Richardson number:** **Monin-Obukhov length:** **TKE-driven:** **Split sigma:**
H2	**Release Elevation**	**_✔_ ground __ roof** Release from a stack is considered
H3	**Aerodynamic Effects from Buildings and Obstacles**	**_✔_ building wake __ cavity __ K-factors __ flow separation**
H4	**Horizontal Plume Meander**	Included in the dispersion parameter set.
H6	**Mixing Layer**	**__ trapping __ lofting _✔_ reflection __ penetration** **__ inversion breakup fumigation __ temporal variability**
H7	**Cloud Buoyancy**	**_✔_ neutral [passive] __ dense [negative] __ plume rise [positive]**
H9	**(Radio)chemical Transformation and In-Cloud Conversion Processes**	No only conversion of HT into HTO in soil
H10	**Deposition**	**__ gravitational setting _✔_ dry deposition _✔_ precipitation scavenging** **_✔_ resistance theory deposition __ simple deposition velocity __ liquid deposition** **_✔_ plateout and re-evaporation**
H11	**Resuspension**	HTO reemission from soil and vegetation
H12	**Radionuclide Ingrowth and Decay**	Decay
H13	**Temporally and Spatially Variant Mesoscale Processes**	**Urban heat island:** No **Canopies:** vegetation canopies were considered for calulating the dry deposition and reemission. Distribution of vegetation is assumed to be uniform over the area under investigation; only fraction of area can be changed. **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:** No **Temporally variant winds:** No **High velocity wind phenomena: __ tornado __ hurricane __ supercane __ microburst** no
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** **Dew point temperature: _✔_ single point __ single tower/multiple point ___ multiple towers** **Precipitation: _✔_ single point __ single tower/multiple point ___ multiple towers** **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:** no
Part J: Model Output Capabilities		
J4	**Tabular at Fixed Downwind Locations**	Yes
J6	**Number of People Affected, Calculated at What Resolution?**	**__ block _✔_ block group __ country**
J7	**Graphic Contours of Probability of Exceeding Concentration**	No
J8	**F-N Probability Distribution Curves**	With additional software possible when UFOTRI is running in its probabilistic mode.
J9	**Commerical Off-the-Shelf (COTS) Geographic Informaiton System (GIS) Used**	No
Part K: Model Usage Considerations		
K1	**Ease of Model Use**	**Training required to run the model: __ background (years of education)** Basic radioecological (years of background) _1 month_ **training time needed on the model to be able to exercise all model capabilities** **Training required to continue development of the model:** **__ background (years of education)** Advanced radioecological and meteorological background, programming in FORTRAN _Several months_ **training time needed on the model to be able to exercise all model capabilities**
K2	**Time to Process From Notification of Release (including data acquisition) to Production of Product Listed in #K1, Listed for Platforms for Which the Program is Already Compiled**	Model is mainly used for risk assessments and recalculation of certain situation, but is not a predictive tool. Data acquisition and preparation may last for a longer period as there is no gap allowed in the hourly meteorological data set (at least one vegetation season for probabilistic calculation). If the basic parameters for one site are fixed - as it should be the case after the implementation of the code at the site -, the set up of the source term will last only some minutes-if not too complicated.
K3	**Ease of Use of Output, Evaluated as the Time Needed to Train a College Graduate in the Use of the Output**	One hour as the output is rather limited and stored in ASCII files.