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CONSEQUENCES OF TRITIUM RELEASE TO WATER PATHWAYS FROM POSTULATED ACCIDENTS IN A DOE PRODUCTION REACTOR (U)

by

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CONSEQUENCES OF TRITIUM RELEASE TO WATER PATHWAYS FROM POSTULATED ACCIDENTS IN A DOE PRODUCTION REACTOR (U)*

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ABSTRACT

A full-scale PRA of a DOE production reactor has been completed that considers full release of tritium as part of the severe accident source term. Two classes of postulated reactor accidents, a loss-of-moderator pumping accident and a loss-of-coolant accident, are used to bound the expected dose consequence from liquid pathway release. Population doses from the radiological release associated with the two accidents are compared for aqueous discharge and atmospheric release modes. The expectation values of the distribution of possible values for the societal effective dose equivalent to the general public, given a tritium release to the atmosphere, is 2.8 person-Sv/PBq (9.9 x 10^{-3} person-rem/Ci). The general public drinking water dose to downstream water consumers is 6.5 x 10^{-2} person-Sv/PBq (2.4 x 10^{-4} person-rem/Ci) for aqueous releases to the surface streams eventually reaching the Savannah River. Negligible doses are calculated for freshwater fish and saltwater invertebrate consumption, irrigation, and recreational use of the river, given that an aqueous release is assumed to occur. Relative to the balance of fission products released in a hypothetical severe accident, the tritium-related dose is small. This study suggests that application of regional models (1610 km radius) will indicate larger dose consequences from short-term tritium releases to the atmosphere than from comparable tritium source terms to water pathways. However, the water pathways assessment is clearly site-specific, and the overall aqueous dose will be dependent on downstream receptor populations and uses of the river.

INTRODUCTION

A Probabilistic Risk Assessment (PRA) of reactor operation at the U. S. Department of Energy's Savannah River Site (SRS) has been completed. The PRA is a key element in the overall safety assessment of the current production reactors. It documents quantification of the risks posed to the general public and to SRS workers. Through a formalized set of logic structures and engineering analyses, the PRA systematically: (1) identifies initiating events and respective frequency of occurrence, then groups initiating events leading to similar states of reactor core damage; (2) predicts the response of the reactor plant to these damage states, then develops groups or bins of radiological source terms to the environment; (3) quantifies the consequences of these postulated releases, i.e. calculates the population dose and subsequent health effects from the postulated source term groups and (4) sums the product of the source term consequence distribution by the frequency of source term occurrence to determine the overall integrated risk. Both internal and external initiators are considered and measures of risk include population dose, health effects, and area interdicted.

SRS reactors are heavy-water moderated, and are operated to produce radioactive isotopes for the Department of Energy. Secondary-side cooling is provided by light water, drawn from the Savannah River. The SRS reactors are operated principally as tritium production facilities, thus a full evaluation of the radiological source term involves determination of the effects of release of the tritium inventory. Potential tritium release modes may range from early, short-duration releases to the atmosphere of the total tritium inventory to late, long-duration releases to water pathways of a fraction of the available tritium. However, SRS PRA analyses do not explicitly model the in-plant behavior of tritium during postulated severe reactor accidents. Instead, the entire tritium inventory is assumed to transport identically to the noble gas fission product group. Thus, in the context of the PRA radiological source term, the tritium release is full-inventory, atmospheric and occurs early in the scenario. Once the tritium component is assumed to enter the environment, the transport species is considered to be tritiated water vapor solely. This paper discusses determination of water pathway population doses due to tritium release from postulated severe accidents at SRS, and compares the population dose level to the atmospheric release mode considered in the PRA. Two accident types with tritium-only source terms are the basis for the comparison.

SRS REACTOR SYSTEMS AND TRITIUM RELEASE MODES

SRS reactors contrast commercial light water reactor in the U. S. from both a primary/secondary system side as well as a confinement vs. a containment operation. The primary, or process water system (PWS), is a low-temperature, low-pressure system that allows venting from the reactor into a large building volume directly above the reactor, a "process room". The evaporation of minimal amounts of heavy water moderator into the process room is not a serious occupational dose concern because of two factors: (1) personnel are prohibited from access into the process room during operation; and (2) high volumetric air flow of the airborne activity confinement system continuously purges the air in the process room. Thus, the second point prohibits the build-up of large tritium concentrations.

Releases of tritium and other radionuclides in the reactor building enter the high volumetric air flow system operating during both normal and accident conditions. Radiologically Controlled Areas (RCAs) in the building are at negative pressure with respect to "clean" areas and the environment. Air purging the reactor building flows from clean areas into RCAs, then is filtered and stacked into the environment. The system is termed a confinement system, rather than a containment system typically configured as part of the fission product barrier system in commercial U. S. reactor plants. The confinement system will retain most of the halogens and particulates released during an accidental discharge of radioactivity into the reactor building. However, tritium and noble gases are not filtered and are released with exhaust air from the stack.

Tritium in a SRS reactor is produced in lithium-bearing aluminum alloys used as fuel, target, and control elements. The predominant production reaction is from thermal neutron capture in ^{6}Li due to (n, ∂) reactions. Incidental tritium production also occurs in the heavy water moderator through capture reactions in the deuterium. A third, small contributing mode is that of ternary fission.

Environmental impact studies performed for the Department of Energy have used a 2.6 x 10^{18} Bq (70 MCi) basis for the global quantity present in a production reactor as the tritium source term.[1,2] The quantity of tritium in this case is an estimate for tritium produced in fuel, target, and control components as well as that formed in the moderator. The moderator tritium level is a function of integrated power level, or reactor exposure. As an upper bound, a basis value of 1.85 x 10^{17} Bq (5 MCi) is assumed for this and other reactor safety analyses. Both the global and moderator values of tritium are for safety assessment purposes and do not result from power or exposure steady-state conditions under the current or past reactor configuration.

In the event of an accidental aqueous release to surface streams from the SRS reactor area, tritium contained in the discharge would be introduced into the Savannah River at Steel Creek, a mixing zone approximately 14.5 km (nine miles) south of the reactor, (Figure 1). Despite this proximity, the mean travel time of accidental effluent to the Savannah River at the mouth of Steel Creek is 3.5 days.[3]

Attached.

Figure 1. Stream Flow Into Savannah River Following Hypothetical Release

METHODOLOGY

Computer codes for this study have been developed for the U. S. NRC and U. S. Department of Energy for severe accident, PRA, and NRC Regulatory Guide 1.109 applications.[4] A schematic shown in Figure 2 indicates the origins, sponsors, and evolution of the codes for this analysis. The required codes and primary function(s) in these analyses are : (1) MACCS - Calculates atmospheric release population dose from tritium and ingestion of tritium from potable water bodies; (2) FUSCRAC3 - Calculates the food ingestion dose accounting for the incorporation of tritium in the foodstuffs, and indicates the relative impact of chronic to acute dose response; and (3) LADTAP II - Calculates liquid pathways dose to specific populations downstream of SRS from a postulated radiological release to the Savannah River. The first two codes are similar in the treatment of the variability of final dose and consequence estimate due to the meteorological effects at the time of the release. Both codes sample possible meteorological conditions from a year's worth of site-specific data using a Latin Hypercube Sampling algorithm. Given the same magnitude source term and downstream population centers, the dose assessment performed by the LADTAP II code is principally a function of volumetric flow of the river.

MACCS 1.5

A methodology to calculate the short-term (acute) and long-term (chronic) consequences based on probabilistic sampling of site-specific meteorological conditions was developed originally for the WASH-1400 assessment of reactor operation risk.[5] U. S. Nuclear Regulatory-sponsored work in this area has been principally focussed at Sandia National Laboratories with the CRAC-CRAC2-MACCS evolution of codes.

MACCS (MELCOR Accident Consequence Code System) Version 1.5 methodology models the dispersal of radioactive material away from the reactor building source, accounts for the disposition of radionuclides released, and then estimates the population dose, health effects and economics effects that could occur[6-8]. Doses and measures of consequence from a source term are calculated by MACCS and FUSCRAC3 codes in a conditional complementary cumulative

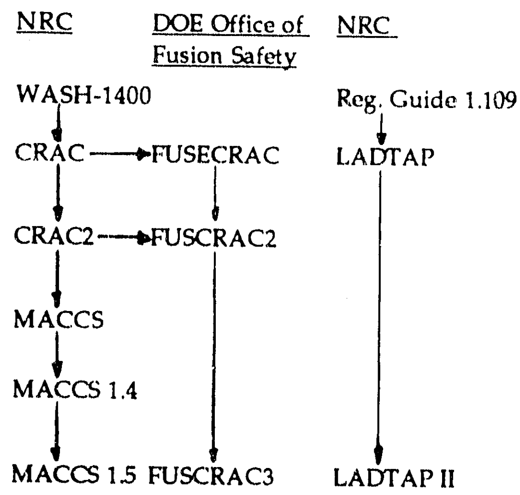

Figure 2. Code Evolution For Tritium Release Analysis

distribution function (conditional CCDF) output format. The conditional CCDF for a given consequence indicates the probability that a corresponding level of consequence is equalled or exceeded. Once the source term is weighted by a frequency of occurrence, CCDFs result. These plots indicate an annual exceedance frequency (per reactor-year) that a corresponding level of consequence is equalled or exceeded.

For the SRS PRA, MACCS 1.5 calculations were based on two release segments, each of variable duration, radionuclide composition, and direction. Dispersion in the cross-wind direction is improved from the "top-hat" distribution to a multi-step distribution. A Gaussian plume model is used in MACCS with Pasquill-Gifford dispersion parameters for six stability categories. The dispersion model for transport of radioactivity away from the reactor can treat wind shift between plume segments. Also, the meteorological binning procedure is expanded to allow greater attention to potentially consequence-dominant releases affected by rainfall. A resuspension model is available for both early and late periods following the radiological release.

Dose pathways MACCS have been expanded to include: (1) skin deposition; (2) inhalation of resuspended material; and (3) ingestion of contaminated water. There is considerable user flexibility allowed in the input of parameters for health effects models. Sample input to early (acute fatalities and injuries) and latent (cancer fatalities and injuries) health effect models are developed from the second edition of NUREG/CR-4214 (1989).[9] Although various emergency response models are available in MACCS 1.5, the total societal dose consequence (to a radius of 1610 km) is not affected by changes in close-in population dose mitigation. The code has been subject to a quality assurance and verification review by Idaho National Engineering Laboratory.[10]

Water-ingested tritium is included in the MACCS 1.5 analysis by modeling the contamination of surface water via direct deposition, and indirect contamination, through run-off. Although consumption of water supplies impacted by the atmospheric release is considered, no food pathway model for tritium is currently supported in MACCS. Long-term uptake of source term tritium from the food chain at levels somewhat above background by large and possibly, distant (>100 miles) populations has been recognized as a major component of dose and latent effects in consequence analysis. A separate methodology, FUSCRAC3, is used to calculate collective dose and health effects due to ingestion of tritium in the food chain and to determine the relative dose incurred during plume passage.

FUSCRAC3

FUSCRAC3 is a fusion-based code for calculation of reactor accident consequences, that has the capability to handle a tritium source term and to provide a probabilistic treatment of site-specific meteorology.[11,12] It was originally developed as an upgrade to CRAC in 1982 by Piet[13] by adding fusion activation isotopes as well as ^{14}C and ^{3}H. Upgrades by Idaho National Engineering Laboratory to FUSCRAC3 were based on CRAC2. The current effort is supported by the Department of Energy's Office of Fusion Safety and is conducted at the Idaho National Engineering Laboratory.

FUSCRAC3 currently considers exposure pathways including inhalation, cloudshine, groundshine, and ingestion of foodstuffs. Special purpose models are available for ^{14}C and tritium. Tritium is modeled as tritiated water vapor. The ingestion model accounts for food chain pathway isotopes that are of metabolic importance. Both acute and chronic exposure doses are evaluated as well as subsequent early and latent health effects.

LADTAP II

The LADTAP II (Liquid Annual Doses To All Persons) code was developed by Oak Ridge National Laboratory.[14] It implements the dose models recommended in NRC Regulatory Guide 1.109 and calculates radiation exposures due to liquid effluent pathways. Although the code estimates maximum individual and general population doses, the application in a severe accident context as summarized here will be limited to population dose levels.

The code has been made site- and region-specific by the Environmental Technology Section at the Savannah River Site.[15] The exposure pathways included are drinking water, recreational use (swimming, boating, fishing), and ingestion of freshwater fish and saltwater invertebrates. There is no irrigation use of the Savannah River for agricultural production downstream of the Savannah River Site. LADTAP II models drinking water doses incurred by users from two municipal systems, Port Wentworth and Beaufort-Jasper, approximately 181 and 165 river kilometers, respectively, from the mixing point.

Dose conversion factors for MACCS 1.5 and FUSCRAC3 are based on ICRP 30 and work by Kocher.[16,17] LADTAP II is based on DOE publication EH-71[18].

POTENTIAL ACCIDENTS LEADING TO TRITIUM DISCHARGE

Two hypothetical severe accidents are selected to illustrate potential tritium release modes. The accidents involve release of tritium as: (1) airborne discharge through evaporative losses of tritium from uncontained, or spilled heavy-water moderator; and, (2) waterborne or aqueous discharge through the accidental release of tritiated heavy water directly to secondary side water, or to surface effluent streams in the reactor area. The tritium release associated with each accident shall be described. An alternative treatment is provided from the Probabilistic Risk Assessment severe accident perspective. Both airborne and aqueous release mechanisms are discussed.

The first accident is a classical Loss-of-Coolant Accident, or LOCA. Although for this class of accidents, a spectrum of pipe and expansion joint break sizes may be postulated, this treatment will consider large-break, high-flooding rate LOCAs. The large-break assessment is illustrative, rather than representative and best-estimate. The LOCA will release process water inventory to the reactor building floor. For the expansion joint and other large breaks, heavy water initially flows to reactor building sumps. Sump pumps automatically start and pump water to an underground tank with sufficient capacity to contain the entire moderator inventory. Emergency core cooling system (ECCS) flow into the core will maintain core coverage; however depending on the break location, light water from the ECCS and heavy water from the process system will flow into the building. As the large tank fills, additional water will then flow to a large tank located outside the building. Both the underground tank and the large tank are vented back to the reactor building's confinement system. In latter stages of the accident, sufficient water may be pumped out to fill both tanks, and overflow will be accommodated by a large lined and covered basin.

Heavy water from the LOCA event will remain in the reactor building in the event of sump pump failure, and will remain until the light water addition is sufficient to fill the building. Diluted heavy water then will flow through the drain system to the large tank until that tank overflows to the basin indicated above.

As long as the heavy water is maintained in the reactor building or in the system of overflow tanks and basins during the LOCA, tritium release is only through evaporation to the confinement system and therefore a long-term stack release (~62 m elevation). In the event of seismically-induced LOCA, some and perhaps most of the release will be as liquid effluent to groundwater or to surface streams.

In the severe accident LOCA scenarios considered for the PRA, mechanistic calculations and Accident Progression Event Tree (APET) analysis are based on more worst-case assumptions regarding active and passive safety systems. Under these conditions, fuel damage occurs. Early in this class of accidents, it is assumed that most of the noble gases and tritium will be completely released from the reactor fuel, moderator, and other components to the confinement system. The confinement system does not have the capability to remove these components from the building air flow, so that Kr, Xe, and tritium are released to the environment at the stack level.

The other class of accident identified as having a large tritium release potential is the postulated loss-of-pumping accident (LOPA). LOPAs are flooding accidents that initiate upon breaks in the secondary, or cooling water system. The largest LOPA flooding rates are calculated from postulated heat exchanger inlet or outlet header breaks. If cooling water (light-water) leaks are not isolated before flooding of key motors powering process water pumps occurs, active flow of process water will terminate. Fuel damage with associated release of non-tritium fission products may occur depending on additional, low-probability failures assumed to occur during the LOPA. However, only tritium release implications will be considered in this analysis.

If the leak is isolated before motor flooding, ECCS may not be required to assure core cooling. However, if the leak is not isolated before motors are flooded, operation of the ECCS may be necessary. With the operation of this system, moderator and light-water from the ECCS will be forced through the reactor. As flow is maintained, a mixture of moderator and ECCS water will be forced out of process water system into the process room. Some of the spilled moderator water and ECCS water will flow by gravity directly to the large tank described earlier in the LOCA scenario. The remainder of the water will flow to lower elevations in the reactor building and be pumped out to the same network of water storage facilities discussed under the LOCA section. These facilities are purged by the confinement system air flow, so that tritium release is limited to evaporation of a fraction of the moderator once it has escaped the process water system. If bypass of the water storage system is assumed under continued ECCS flow, some moderator could be released to surface effluent streams.

In the severe accident LOPA scenarios considered for the PRA, worst-case assumptions regarding active and passive safety systems considerably worsen the fission product release potential. Fuel damage and melting occur in addition to subsequent phenomena. In this class of accidents, it is assumed that noble gases and tritium will be completely released from the reactor fuel, moderator, and other components to the confinement system. The released Kr, Xe, and tritium are released to the environment at the stack level as in the case of the severe accident LOCA.

EVALUATED POPULATION DOSES

Atmospheric Release

Both loss-of-coolant and loss-of-pumping accidents release the full inventory of tritium when these accidents are considered in a severe accident context. The release and transport in the SRS reactor building is not modeled explicitly, rather, the modeling of the tritium transport group is based on noble gas behavior. Once released atmospherically, tritium is modeled as a release species with the transport properties of tritiated water vapor. Table 1 lists transport and other modeling parameters used in the airborne release analysis.

FUSCRAC3 calculations using weighted importance sampling of meteorological conditions occurring in the SRS vicinity were used to predict the whole-body population dose from a tritium-only release of 2.6×10^{18} Bq. The dose includes acute and chronic effects but is dominated by long-term pathways. In the acute phase, tritium dose is composed of inhalation and skin absorption components. In the chronic phase, inhalation of resuspended tritium, and food ingestion dominate the dose.

Table 1. Atmospheric Release of Tritium - Modeling Parameters

Species Identity	Tritiated Water Vapor
Impact Region	Southeastern U.S. (centered at SRS)
Extent of Coverage	1610 km (1000 miles)
Release Elevation	0 m - 60 m
Wet Deposition	$f_w = 1 - \exp(C\,R\,t_i)$
f_w, fraction removed over interval i	
R, rainfall occurring over interval i, (mm)	
C, 1.0E-03 mm-sec-1 unstable/neutral cond.	
, 1.0E-04 mm-sec-1 stable conditions	
t_i, traversal time of plume over i	
Dry Deposition	$f_d = [v_d\, t_i]/h_{eff}$
h_{eff}, effective plume height	
v_d, deposition velocity, (2.0-3.0)E-03 m/s	
Absolute Humidity	0.011 kg/m^3
(Direct Uptake Via Crops & Grasses)	
Soil Moisture	20 v/o
(Indirect Uptake Via Soil)	

Figure 3 shows the Complementary Cumulative Distribution Function (CCDF) for the modeled tritium release. The CCDF curve is the locus of probabilities for corresponding levels of dose consequence to be equaled or exceeded. The variability in the dose response is based on site-specific annual frequency of meteorological conditions. In this case, the level of consequence changes

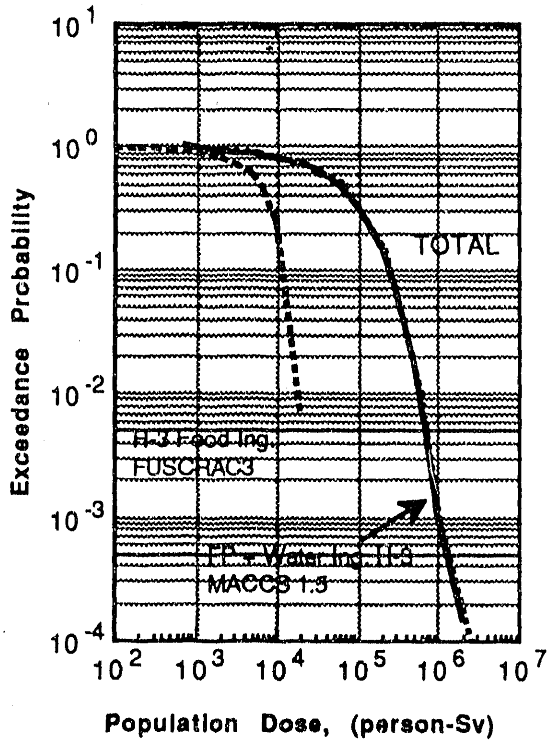

Figure 3. Atmospheric Release Comparison Tritium and Fission Product Components

due to the effectiveness of meteorology at the time of the release to introduce tritium in the plume into acute and chronic dose pathways. The expectation value of the distribution is 6.9×10^3 person-Sv. Negligible shift in the CCDF occurs if the release height is varied from 0 m to the full stack height.

The PRA assessed over 60 postulated release partitions, or bins of similar source terms. If the aggregate population EDE CCDF is computed for release of fission products other than tritium is divided by the total core melt frequency, then the exceedance probability for non-tritium fission products results (also shown in Figure 3). This CCDF, labeled "FP + Water Ing. H-3", has an expectation value of the non-tritium population dose is 9.7×10^4 person-Sv. Thus, the tritium-only mean dose is ~7 % of the full fission product release, given that a hypothetical full core melt has occurred. The MACCS full fission product CCDF does include water ingestion dose of tritium via deposition from the plume. The FUSCRAC3 calculation does not account for this dose pathway.

The overall EDE dose from the atmospherically-released source terms is shown in Figure 3 as "TOTAL". To generate this CCDF, the total non-tritium CCDF dose and the tritium-only CCDF dose have been added at the same conditional probability level. The resulting CCDF is virtually indistinguishable from the non-tritium CCDF. It is concluded tritium is a negligible contributor to societal EDE population dose (~1610 km radius) from a comparison of CCDFs related to postulated severe accidents.

Figure 4 indicates the relative importance of wet and dry deposition mechanisms over the same long-range grid, specifically EDE population dose to a 1610 km radius. The CCDFs and expectation values for population dose are calculated with FUSCRAC3 for four sets of assumptions: (1) Case 1 is an inert gas behavior assumption whereby neither dry nor wet deposition is modeled; (2) Case 2 neglects dry deposition but models washout; (3) Case 3 neglects washout but allows dry deposition; and (4) the PRA base case that realistically accounts for both wet and dry deposition. Within the limits of the FUSCRAC3 models and user assumptions, population dose is a function primarily of washout at the low-to-mid level of consequence, while dry deposition is limiting for the mid-to-high level of consequence. Assuming the most realistic case where wet and dry deposition are modeled, the dose per unit activity released is 2.8 person-Sv/PBq (9.9×10^{-3} person-rem/Ci).

Water Pathways

The LOCA and LOPA aqueous releases discussed earlier may result in differing quantities of tritiated moderator released over long periods to surface streams. The tritiated water is assumed to ultimately reach the Savannah River and lea[illegible] to population dose through drinking water consumption. Although it was observed that the loss-of-pumping may constitute a higher aqueous discharge hazard relative to the loss-of-coolant accident, for purposes of this analysis, 1.85×10^{17} Bq (5 MCi) is released.

Doses are computed with LADTAP II for drinking water consumption, marine life consumption, and recreational activity doses. In a best-estimate case, all of these dose pathways are avoidable much more readily than from atmospheric releases. For example, use of the Savannah River downstream of SRS may be temporarily interrupted until the bulk of the tritium released into the river has been sufficiently diluted or moves past intake points for the municipal water supplies discussed earlier. Sufficient time exists even in high flow-rate conditions to warn downstream populations to limit or to prevent entirely use of the water. Despite these likely post-event conditions, the aqueous release dose will be computed ignoring interdiction activities to mitigate population dose.

A basis LADTAP II calculation indicates that for the postulated release from the SRS into the Savannah River, the overall population dose is predominantly through drinking water consumption. The population dose to downstream consumers has the following components: 0% recreational use, 0% irrigated crop uptake, 0.0004% - saltwater invertebrate consumption, 0.4% - freshwater fish consumption, and 99.6% drinking water. On the basis of this outcome and the remainder of this treatment, only the drinking water dose shall be referenced. Input parameters are summarized in Table 2. In contrast to dose incurred from atmospheric releases, the controlling parameters for long-term aqueous releases are limited. Important determinants of the liquid pathways population dose are volumetric flow rate of the river and the receptor population. If the basis downstream population is held constant, then the calculated dose for any of the months over the ten-year period, 1981-1990, is inversely proportional to the monthly Savannah River flow rate. Assembly of a drinking water CCDF is based on procedures discussed earlier with the 120 monthly doses computed in this manner.

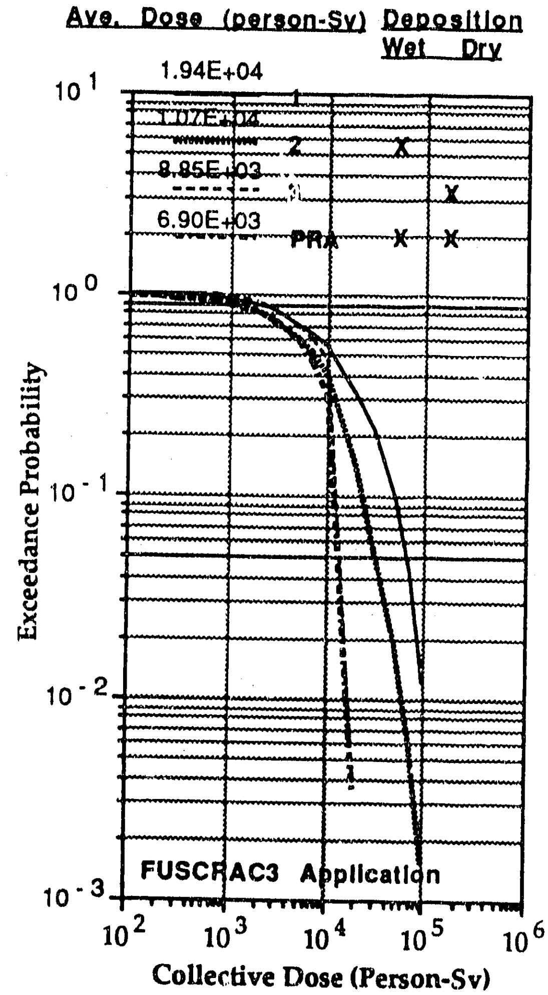

Figure 4. Collective Dose Components From Atmospheric Release of Tritium

Table 2. Aqueous Release of Tritium - Basis Model Parameters

Species Identity	Tritiated water diluted by Savannah River
Activity Released	1.85×10^{17} Bq
Impacted Region	225 km downstream of SRS
River Flow Rate	283 m^3/s, (10,000 ft^3/s)
Regulatory Guidance:	Reg. Guide 1.109
Downstream Use:	
-Drinking Water	71,000 consumers
-Agriculture	0 irrigation applications
-Recreational	
-Marine life consumption	

Figure 5 is the drinking water population dose exceedance probability, given the aqueous release assumed. The mean value of downstream dose for the ten-year period considered is 12.02 person-Sv (1202 person-rem), or 6.5×10^{-2} person-Sv/PBq (2.4×10^{-4} person-rem/Ci). This is a factor of >40 less dose per unit activity than determined for atmospheric release, and is dependent on the population at-risk.

Comparison to NCRP Model

Global, hydrological models such as the seven-compartment model discussed in NCRP No. 62 estimate tritium concentrations with aqueous releases to streams and ocean surface compared to atmospheric releases.[19] The human compartment dose is based on source of drinking water, i.e. assumed mix of streams, surface lakes and deep groundwater. Consequently, human compartment derives its concentration from transfer rates and compartment volumes. The integral concentration to the the human compartment from a one (1) MCi release is 11.8/3.7/0.38 pCi-year per liter from release to streams / atmosphere / ocean surface, respectively. These values consider compartmental volumes limited to the Northern Hemisphere. This order of importance is different from the site-specific ranking discussed above for hypothetical SRS acute releases.

One source of the margin of difference is commitment of all tritium activity to the impacted region in the MACCS model for atmospheric release. Tritium in the plume for most sequences is removed after several hundred kilometers; any remaining activity at 800 km radius is subject to a washout boundary condition so that all tritium activity can be introduced into a dose pathway. A similar boundary condition is not employed in the aqueous release model. Tritium immediately enter fish but the dose to humans relative to drinking water is insignificant.

Secondly, to the degree that the postulated discharge into Savannah River reaches the ocean before partitioning

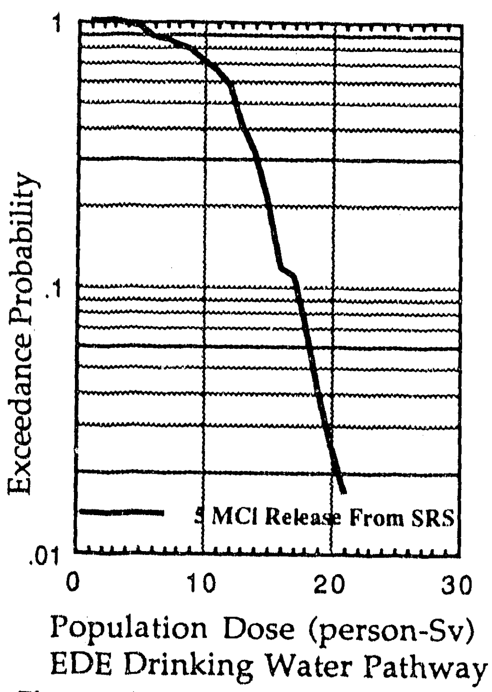

Figure 5. Exceedance Probability of Aqueous Release Population Dose

significantly to dose pathways, the river release relative to the NCRP No. 62 model is better modeled as a release to the ocean surface. Larger dilution by ocean compartment volumes lessens the long-term tritium concentration eventually appearing in the human compartment pool. The integral concentration ratio of atmospheric-to-ocean surface releases based on the NCRP model is $3.7/0.38 \approx 10$ or much closer to the calculated value of 43, using the site-specific models discussed in this paper.

CONCLUSIONS

A comparison of population doses from site-specific models for hypothetical tritium releases from the Savannah River Site has been completed. The following observations may be made in light of this analysis:

1. Higher EDE population doses specific to populations in the environs of SRS are observed per unit tritium activity released atmospherically relative to aqueous discharge to the river.

2. The PRA population doses achieved by modeling the tritium source term as a gaseous plume release yields higher population doses than if detailed liquid pathways modeling was performed at SRS, because of the more limited downstream population at-risk.

3. At the mean level of EDE consequence, the tritium-related dose is ~7% of the dose from the balance of fission products in the source term. On a CCDF comparison basis, the tritium component to EDE population dose is insignificant.

4. Wet deposition (washout) from atmospheric releases is important for higher-probability low-to-mid levels of consequence. Dry deposition becomes dominant for mid-to-high levels of dose consequence. Contributions at the higher dose levels are generally from food ingestion pathways.

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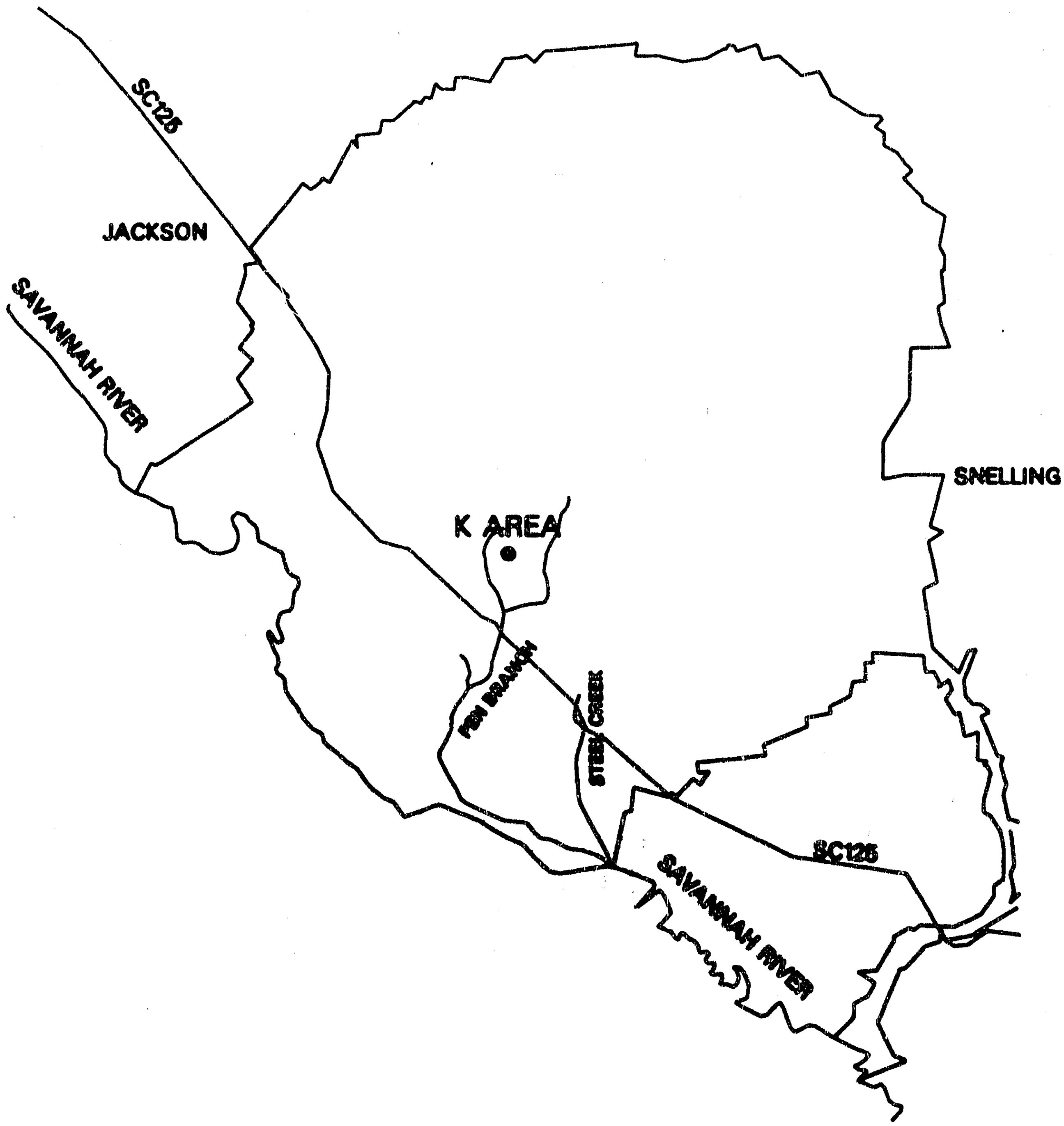
FIGURE 1.
SURFACE STREAM FLOW TO SAVANNAH RIVER FOLLOWING HYPOTHETICAL AQUEOUS DISCHARGE



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