Appendix B: Systems Requirements Specification

Herbicide Exposure Assessment

Software Requirements Specification
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SRS.doc

Table of Contents

Revision History

Date	Revision	Description	Author
1/5/02	0.1	Created façade use cases based on initial elicitation	Andrew Stellman, Steven Stellman
1/13/02	0.2	Updated filled use cases based on second round of elicitation	Andrew Stellman, Steven Stellman
2/3/02	0.3	Updated focused use cases based on additional investigation and refinement. Added functional requirements.	Andrew Stellman, Steven Stellman
2/19/02	0.4	Refined focused use cases	Steven Stellman
3/18/02	0.5	Refined focused use cases, updated functional requirements	Steven Stellman
4/6/02	0.6	Added vision and scope, definitions, rationales. Updated use cases and functional requirements. Identified missing pieces.	Andrew Stellman
4/15/02	0.7	Filled in missing pieces identified in version 0.6	Steven Stellman
4/19/02	0.8	Incorporated all existing elements into one final document. Added Open Issues section.	Andrew Stellman
4/22/02	0.9	Proofread document and made various changes	Andrew Stellman
5/10/02	0.10	Substantial modifications to FR-AR8	Steven Stellman
5/27/02	0.11	Updated many sections	Andrew Stellman
6/8/02	0.12	Updated many sections, added diagrams, added nonfunctional requirements, created section for external files, created introduction section, created appendices for external file formats and examples.	Andrew Stellman
7/16/02	0.13	Updated based on 6/20 review and subsequent information	Andrew Stellman
10/19/02	0.14	Updated based on 10/19 review and subsequent meetings. Added statechart, as well as states to each use case. Split UC-ST4 into two use cases. Removed use of Excel subtotals. Added functionality to delete studies, analyses and datasets.	Andrew Stellman, Steven Stellman, Jennifer Greene
11/29/02	0.15	Minor editing changes to sections 1 and 2, added a comment to FR-AR2 and FR-AR8 to resolve potential conflict.	Steven Stellman, Andrew Stellman
11/30/02	0.16	Added functionality to copy (duplicate) an analysis or dataset from the current study (UC-ST4 and UC-ST4a alternative paths).	Andrew Stellman
12/3/02	0.17	Fixed numbering for UC-ST6. Added rename functionality to UC-DA3 and UC-AR5.	Andrew Stellman
12/13/02	0.18	FR-AR7: Removed the "Date" parameter, added day numbers to the Date-In and Date-Out parameters.	Andrew Stellman
12/15/02	0.19	FR-AR10: Added comment	Andrew Stellman
1/29/03	0.20	Updated as per 1/26 meeting with Steven Stellman and Jennifer Greene	Andrew Stellman

2/1/03	0.21	Updated statistics about execution (from 1/26 meeting, didn't make it into 0.20)	Andrew Stellman
3/16/03	0.22	Added DateIn_Intersect, DateOut_Intersect and Overlap flags to FR-AR2 and FR-AR8	Andrew Stellman
4/8/03	0.23	Updated UC-AR2 to add alternative path 4	Andrew Stellman, Steven Stellman

Introduction

Purpose

The purpose of this document is to serve as a guide to developers and testers who are responsible for engineering the Herbicide Exposure Assessment software. It should give the engineers all of the information necessary to design, develop and test the software.

Scope

This document contains a complete description of the functionality of the Herbicide Exposure Assessment project. It consists of use cases and functional requirements, which taken together form a complete description of the software.

System Overview

The primary function of the software is to transform date and location inputs into exposure opportunity score outputs. Each program feature is intended to facilitate this transformation process by assisting the user to refine imperfect real-world input data to a quality sufficient for further analysis.

The users of this system are researchers who will be conducting studies, in which the exposure for troops, locations or individuals are used as the basis for statistical analysis. For any one study, a researcher will generally want to find the exposure for a number of troops, locations or individuals who were in certain parts of Vietnam at certain dates. The researcher will collect the location data into one or more datasets and use the system to generate exposure values for the data, specifying certain analysis parameters set to specific levels chosen for that study in order to analyze the data for those parameters. A study may refer to several datasets and analyses, although any one analysis may only be run against a single dataset. When an analysis is run, the researcher will generally want to export the results of the analysis to a file, generally to be imported into a statistical analysis package. In addition, the researcher generally needs to keep records of all analyses performed while running a study. The system automatically creates documentation that the researcher can include in notes or in a report.

References

The procedures and data contained in this document are based on methods that were first developed and presented by the authors in 1980, and which have undergone considerable refinement since then.

The following papers have been published in peer-reviewed journals:

1. SD Stellman and JM Stellman. Estimation of exposure to Agent Orange and other defoliants among American troops in Vietnam. A methodological approach. Amer. J. Indust. Med., 9: 305-321, 1986.

2. SD Stellman, JM Stellman, and JF Sommer, Jr. Combat and herbicide exposure in Vietnam among American Legionnaires. Environ. Res., 47: 112-128, 1988.

3. SD Stellman, JM Stellman, T Weber, C Tomasallo, AB Stellman, and RJ Christian, Jr. A geographic information system for characterizing exposure to Agent Orange and other herbicides in Vietnam. Environ. Health Persp., (in press):, 2003.

An updated methodological paper is being prepared for submission to Journal of Exposure Analysis and Environmental Epidemiology:

4. SD Stellman and JM Stellman. Exposure opportunity models for Agent Orange, dioxin, and other military herbicides used in Vietnam, 1961-1971 (in preparation).

The methodology has also been presented at the following professional meetings:

5. SD Stellman and JM Stellman. Health Problems Among 535 Vietnam Veterans Potentially Exposed to Toxic Herbicides. SD Stellman, JM Stellman. Paper presented at Society for Epidemiologic Research, Minneapolis, June 15, 1980.

6. JM Stellman and SD Stellman. Exposure assessment methodology for Agent Orange and other herbicides used in Vietnam. Paper presented at American Public Health Association, Montreal, November, 1982.

7. JM Stellman and SD Stellman. Invited presentation before the Institute of Medicine Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides, National Academy of Sciences, Washington, DC, Sept. 9, 1992.

8. SD Stellman, JM Stellman, and R Christian, Jr. Modeling Veterans' Exposure Opportunity for Herbicides in Vietnam using Expanded and Cleaned HERBS Data Files. Presentation in Symposium on Assessing Military Exposures: Methods And Lessons Learned From the Vietnam and Gulf Wars, International Society for Exposure Assessment, Monterey, CA. October 20, 2000.

9. JM Stellman, SD Stellman, R Christian, Jr., and T Weber. A Comprehensive View of Herbicide Spray Projects in the Vietnam War. Presented at International Society of Exposure Analysis, Charleston, SC, November 5, 2001.

10. JM Stellman, SD Stellman, R Christian, C Tomasallo, and T Weber. Visualization of US Army military unit locations in relation to herbicide spraying during the Vietnam War. Presented at International Society of Exposure Analysis, Vancouver, BC, August, 2002.

Definitions

Glossary

A **study** is a collection of datasets and analyses that pertain to those datasets. The study is the basic object that is used by the system. Researchers are the main users of the software, and they think in terms of studies. A researcher is generally working on a research project, for which a study must be carried out.

A **dataset** is a collection of location history records for one or more entities. A dataset has a user-supplied name. It may be created manually by the user or imported from a file, after which it is stored internally. It may be viewed, edited, and exported to a file.

An **analysis** is the calculation by which exposure values are generated from one or more datasets. An analysis has parameters which, when run against a specified dataset, result in a collection of exposure history records. These records represent the results of the analysis, which the researcher will generally want to view and export to a file. The analysis results are the main product of this software.

An **entity** is an individual, military unit, or location for which an exposure assessment is to be carried out.

A **location history record** is an input record which describes a single location of one entity during one time interval. The time interval may be as short as one day or as long as many years. An entity may require several location history records to describe its movement over time. It consists of the following information:

- ID (text)
- Longitude (up to 5 decimal places)
- Latitude (up to 5 decimal places)
- Date-in
- Date-out

An **Exposure Opportunity Score** (or EOS) is a numerical score (scalar) which describes the exposure for an entity. It is one output field which is created by running the exposure calculation on one or more location history records. This software package is designed to compute up to five different scores, each representing a different exposure measure. All but one are "hit" counts (see definitions below). Hit counts apply only to "direct" exposures, and do not utilize gallonage or time. The remaining score, E4, includes both "direct" and "indirect" exposures and takes into account time, distance, and gallonage of herbicide sprayed.

Residence time. Time is an essential characteristic of exposure. Calculation of an Exposure Opportunity Score for an entity always requires a beginning date (date-in in the location history record) and an ending date (date-out). The date-in and date-out together define the residence time during which the entity is at risk of exposure.

Hit. A "hit" is an instance of a herbicide spray application falling within a prescribed distance of a location. By definition, a hit has an associated radius, so that we speak of hits within 0.5 km, 1 km, 2 km, etc., of a location, which for the GIS is the centerpoint of a grid.

Direct Hit. Researchers distinguish between direct and indirect modes of exposure. Direct exposure is any exposure which occurs between the date-in and the date-out. An individual receives direct exposure if he is present on the day when a spray occurs, and is exposed directly to the herbicide when it is sprayed.

Indirect Hit. Indirect exposure is exposure to the residue of a spray which occurred before an individual arrived at a location. It is based on the concept that herbicides (and their contaminants such as dioxin) do not disappear immediately, but decay slowly over time. This is the reason we allow the researcher to specify the herbicide half-life as an analysis parameter – the longer the half-life, the longer it takes for the herbicide to decay.

An **exposure history record** is an output record which contains the results of an exposure analysis for an entity. The main purpose of this software is to produce exposure history records, using location history records as input and the data in the input tables (below) as reference data. When an analysis is run, the results are always output in the form of a set of exposure history records, where the ID of each exposure history record in the output corresponds to the ID of a location history record used as input for the analysis. Besides the ID of an entity, each exposure history record contains one or more fields, where each field is a quantitative exposure variable. Depending on how the user chooses to group the analysis results, an exposure history record may describe the exposure for one or several locations occupied by the entity. The user may decide which of the output fields are to be included when setting up the analysis parameters. The exposure history record may contain the following data elements:

- ID: Text identifier, from the location history record for which this exposure score was generated (required)
- PointID: Grid point identification number (optional)

- Mission: HERBS file mission number (optional)
  At least one of the following:
- NT05: Total hits within 0.5 km
- NT1: Total hits within 1 km
- NT2: Total hits within 2 km
- NT5: Total hits within 5 km
- E4: Continuous exposure time- and distance-adjusted measure

Study Data Hierarchy

The following diagram describes the hierarchy for the data required for studies. Each study contains a set of datasets and a set of analyses. Each dataset contains a number of entities, where each entity consists of a set of location history records. Each analysis contains parameters and results. (Results could be computed on the fly rather than stored in a database, depending on the performance of the implementation.) When the analysis is run, the results are populated with data (in the form of exposure history records) and statistics about that data.

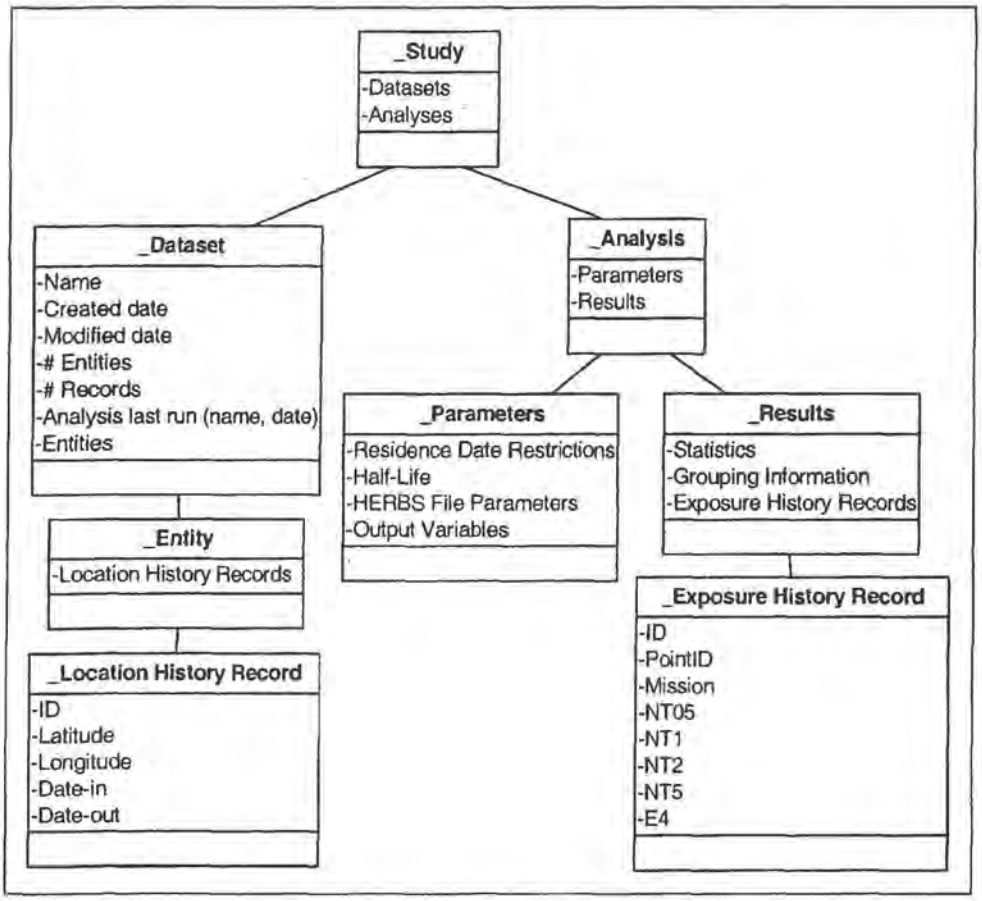


Figure 1: Study Data Hierarchy

Input Tables

All input data for the software is provided in a Microsoft Access database (HEA.mdb). This file contains the master exposure database, and is a required input file which will be provided as part of the software package. The database contains four tables: **HERBS, GridPoints, Exposure_Master** and **DATES**. This section describes the table layouts and descriptions of every column in the table. A complete overview of each table is provided.

These tables are used in three requirements: FR-SR2 ("HERBS File Analysis Parameters and Calculation"), FR-AR2 ("Analysis Results Grouping"), FR-AR8 ("Computation of Exposure Scores") and FR-AR9 ("Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life").

HERBS table

Description

This is the most up-to-date version of the HERBS file, which describes all known herbicide applications that were carried out by the US military during the Vietnam War. It is the database that contains all of the information on herbicide applications in Vietnam. It is at the heart of use case **UC-DA7** ("Analyze HERBS File").

The HERBS file is organized by mission, where a mission is defined as a sequence of records that describes a single application of a given quantity of a specific type of herbicide along a specified route on a single day. This version of the HERBS file includes data on herbicide spraying by the Air Force (Operation Ranch Hand) as well as other service branches. The great majority of missions were flown by the Air Force as part of Operation Ranch Hand. A Ranch Hand mission consisted of one or more aircraft (each known as a *sortie*) dispersing a specified amount of herbicide along a specified route on a specified day. The HERBS file also contains non-Ranch Hand data that are derived from the so-called "Services HERBS file," and includes missions that describe ground applications carried out by truck or backpack spraying. The same format is used for missions from both sources.

The HERBS file provides the actual flight paths taken by Ranch Hand aircraft as they carried out their spray missions. Alphanumeric indicators show the locations at which the aircraft switched directions or turned off and on their spray nozzles. The data are thus structured in a way that emphasizes the continuity of flight of the fixed-wing aircraft that carried out most of the Operation Ranch Hand missions. (Connectivity may not apply to ground perimeter spraying which generally went from guard post to guard post around the base camp). To convey this information, each mission within the HERBS file is organized as a sequence of "vertices" which were the starting, turning, and stopping points of spray aircraft as they carried out a mission. Figure 1 illustrates defoliation along a roadway. The flight path consists of four connected segments in which the plane begins spraying at point 1A and continues spraying until it reaches point 1E. Points 1B, 1C, and 1D are intermediate "turning" points at which the plane changes direction, while continuing to spray. The dotted line represents a 1 km envelope about the spray path. Planes frequently flew multiple paths in a single mission; additional vertices would be designated by 2A, 2B, 3A, 3B, etc. Spray nozzles would be turned off between ending one path and beginning another.

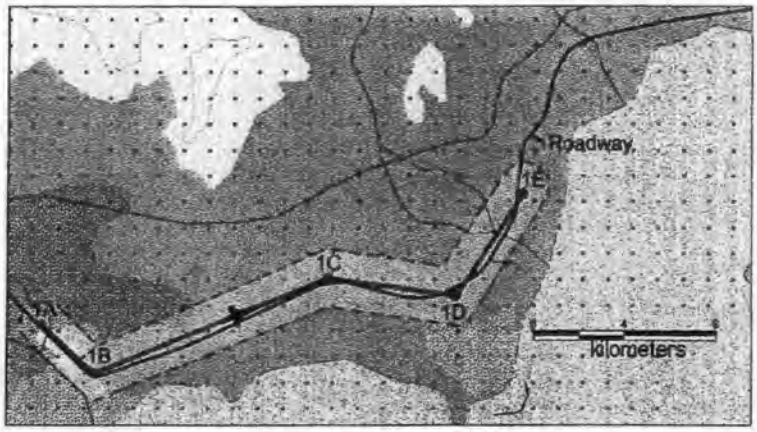


Figure 2: Typical Ranch Hand Flight Path (orange line) as represented in the HERBS file

Aircraft sprayed Agent Orange defoliant continuously along roadway from 1A → 1B → 1C → 1D → 1E. Dashed line is 1 km envelope around spray path. Dots are grid points spaced at 0.01° in longitude and latitude.

Table Layout

Column	Type	Description	Range (Permissible Values)
Date	Date/Time	Date on which the spraying occurred	8/10/1961 through 12/27/1971
Mission	Integer	Collection of records describing a spray application by one or more aircraft over a prescribed route on a specified date.	1 through 13027
Leg	Text (length=2)	Vertex denoting start, stop, or turning point	1A through 9B
CTZ	Integer	Corps Tactical Zone. One of four military regions into which the Republic of Vietnam was divided for military planning purposes.	1 (I Corps) = North to demilitarized zone 2 (II Corps) = North-Central 3 (III Corps) = South-Central including Saigon 4 (IV Corps) = South including Mekong Delta
Source	Text	Type of aircraft or other equipment used to carry out the mission	R = Ranch Hand (C-123 aircraft) S = Services

			A = Added by NAS contractor
Incident	Text	Indicator of unplanned incident	A = Mission/Aircraft aborted E = Aircraft with herbicide load crashed L = Herbicide leak R = Wrong target sprayed Z = Emergency herbicide dump
Method	Text		F, G, H, S, U
UTM	Text	Universal Transverse Mercator coordinates of the given leg; GGxxxyyy where GG is the grid, xxx is the x-coordinate, and yyy is the y-coordinate. The x and y coordinates have one decimal implied (i.e., xxx means xx.x km)	Any string of two letters followed by six numbers
Agent	Text	Herbicide Agent sprayed	B = Blue D = Dinoxol K = Pink O = Orange P = Purple T = Trinoxol U = Unknown W = White
Gallons	Integer	Number of gallons dispersed over the entire mission	Appears only for 1A record for any mission
FWAC	Text	Fixed-wing aircraft designator – 3 pairs of numeric digits as a single field; 030201 means 3 aircraft were assigned to the mission, two took off, and one was productive	Any six-digit number
Type	Text	Type or purpose of mission	P=perimeter spraying C=crop D=defoliation U=unknown
Province	Text	Province of the Republic of South Vietnam	01 – 93

References

- FR-SR2 ("HERBS File Analysis Parameters and Calculation"): The HERBS file analysis allows the user to set up a set of filters to extract and aggregate a subset of the HERBS file
- FR-AR7 ("Computation of Exposure Scores"): Most exposure score calculations will be carried out on a restricted set of missions, such as those which dispersed only Agent Orange. Those missions are selected by filtering one or more variables in this Table.

GridPoints table

Description

The GridPoints table is used to translate grid points into longitude and latitude and vice versa.

Vietnam has been broken into a series of grids to make it easier to calculate exposures. Exposure is always referred to the by the geographic center of a 0.01° by 0.01° grid. The center of every grid has coordinates (Longitude + 0.005°, Latitude + 0.005°) relative to the southwest corner of the grid.

The grid system plays a central role in the geographic information system. Vietnam (and parts of Laos) is partitioned into 0.01° x 0.01° "square" grids, as shown in Figure 2 (above). Each of the 176,060 grids which make up South Vietnam and the additional grids for the Island of Phu Quoc and for Laos (263,358 grids in total) has a unique integer called the PointID associated with it. The PointID is the geographical link between the exposure database (**Exposure_Master** table) and the location history records for military units or other entities for which exposure is to be determined.

Grid points and latitude/longitude are two equivalent coordinate systems, and each has its own use. Latitude and longitude are needed to describe a location in a universally accepted frame of reference, while grid point values were assigned to longitude/latitude pairs in a completely arbitrary manner. An exposure score such as NT05 or E4 always pertains to a specific grid point. This table provides the means to convert between them when needed. Grid points are used to link herbicide data with location data for entities, while latitude and longitude are used to perform distance calculations and to do mapping.

To convert a latitude and longitude value to a grid point, truncate the longitude and latitude value to two significant figures. It is critical that the value be truncated rather than rounded, because truncating the value will always yield the southwest corner of the

grid. There will be exactly one record in the table with any pair of longitude and latitude values, and the associated PointID value is used to look up records in the **Exposure_Master** table (below).

Table Layout

Name	Type	Duplicates Permitted	Description
PointID	Number	No	Integer between 1 and 263359 which uniquely identifies a 0.01° by 0.01° grid in South Vietnam and parts of Laos.
Longitude	Double	Yes	Longitude of the southwest corner of the grid. Two significant figures only.
Latitude	Double	Yes	Latitude of the southwest corner of the grid. Two significant figures only.

Additional Notes

This section describes the truncation operation used in Step 1 of **FR-AR8** ("Computation of Exposure Scores").

The Geographical Information System (GIS) is built around two interrelated concepts: (1) geographical partitioning of Vietnam into 0.01° x 0.01° "square" grids, and (2) association of each grid with counts of "hits" from the individual herbicide missions which occurred inside the grid or near it, as well as with estimates of exposure opportunity that are based upon more elaborate exposure models. There are 176,060 distinct grids that cover the land area of South Vietnam (plus additional grids for Phu Quoc Island and Laos for a total of 263,358 grids).

We have adopted the following convention. A grid is defined as the area bounded by a pseudo-square whose sides extend eastward and northward by exactly 0.01° from a point that defines its southwest corner. (The grid is described as a pseudo-square because it has the appearance of a square but is really a curved area on the earth's surface and its sides are not necessarily of equal length.) The southwest corner has been chosen as the local origin because in Southeast Asia longitudes increase eastwards and latitudes increase northwards. The southwest corner of every grid has longitude and latitude coordinates that are multiples of 0.01°. For example, (108.79°, 11.74°) is a valid origin for a grid. The entire grid is then defined by a pseudo-square whose corners have the following coordinates:

a = 108.79°, 11.74°
b = 108.79°, 11.75°
c = 108.80°, 11.74°
d = 108.80°, 11.75°

Each grid is identified by a unique integer, the variable PointID. The Table GridPoints is used to convert the variable GridPt to a longitude-latitude pair and vice versa. The following table is an extract from the Table GridPoints.

GridPoint		
PointID	Longitude	Latitude
74998	108.77	11.74
74999	108.78	11.74
75000	108.79	11.74
75001	108.8	11.74
75002	108.81	11.74

According to this table, the grid in our example whose southwest corner is (108.79°, 11.74°) has PointID = 75000.

The variable PointID is used as a linkage key in many calculations that require geographical data from several different tables. In many tables, the coordinates of important entities, such as locations of military units or herbicide spray applications, are expressed to as many as five significant figures. A frequent programming task is to determine the grid in which such an entity falls. This is done in two steps:

Step 1. Truncate the longitude and latitude to two significant figures.

Step 2. Use the truncated longitude and latitude as lookup entries in GridPoints table to find the corresponding PointID.

Example. The Location History Record for a military unit gives its coordinates on a particular day as (108.78312°, 11.74791°). Find its grid.

Step 1. Truncate the longitude and latitude to two significant figures:

108.78312° → 108.78°
11.74791° → 11.74°

Step 2. Use the values 108.78 and 11.74 as a lookup in the GridPoints table. The lookup will return PointID = 74999.

Caution: Use truncation rather than rounding. Rounding 11.74791° in the example will produce 11.75°. Looking up (108.78°, 11.75°) in the GridPoints table will return PointID = 75336 which is not correct.

Note that the southwest corner of the grid is chosen as the local origin for numerical convenience. However, exposure calculations are referred to the center of the grid and not the corner. In other words, if (G, L) are the coordinates of the southwest corner of a grid, exposures for that grid are calculated with respect to the point (G+0.005°, L+0.005°).

References

- FR-AR8: Computation of Exposure Scores

Exposure_Master table

Description

This is the fundamental table which facilitates the transformation of inputs (locations expressed as grid points) into outputs (exposure scores expressed as hit counts or E4). **Exposure_Master** contains pre-calculated exposure scores for every grid point which was within 5 km of any herbicide spray.

Many grids were exposed to herbicide from more than one mission. Each record in this Table contains exposure values for a single, unique grid-mission combination. The design of this Table makes it possible to report separately each exposure which occurred at a specific grid from individual spray missions, or to report the total exposure at a specific grid from all contributing missions, simply by grouping by PointID and summing exposures within each group. Each record in this Table also contains a complete set of variables which describe characteristics of the mission associated with that record. This information makes it possible to restrict exposure calculations to missions that meet specific criteria, such as herbicidal Agent.

"Poof" factor: A "poof" factor is also included in every record. It is an E4 adjustment factor for direct hits. It is equal to an E4 score calculated at the given grid point, but using a residence interval of three days beginning with the date of spraying, and using a half-life of one year. See **FR-AR8** ("Computation of Exposure Scores") for information on how the "poof" value is used.

Table Layout

Name	Type	Description
Mission	Integer	Identifies a specific mission which was the source of exposure
Day	Integer	Day number on which the mission took place (a)
PointID	Integer	Identifies the grid for which the exposure scores were calculated
E4_total_30	Double	Continuous E4 exposure score, based on a 30-day half-life (b)
poof	Double	"poof" factor using 3 days' residence time and 1 year half-life: to be used in calculating continuous E4 exposure score for direct hits
hits05km	Integer	Number of mission legs which fell within 0.5 km of this grid point
hits1km	Integer	Number of mission legs which fell within 1 km of this grid point
hits2km	Integer	Number of mission legs which fell within 2 km of this grid point
hits5km	Integer	Number of mission legs which fell within 5 km of this grid point
TZero_30day	Integer	TZero for a 30-day half-life which may be used to evaluate exposure for a different residence time
Date	Date/Time	Date on which the spraying occurred
CTZ	Integer	Corps Tactical Zone. One of four military regions into which the Republic of Vietnam was divided for military planning purposes.
Source	Text	Type of aircraft or other equipment used to carry out the mission
Incident	Text	Indicator of unplanned incident
Method	Text	Aircraft or vehicle type
UTMGrid	Text	First two characters of 8-character Universal Transverse Mercator coordinate of first (1A) vertex of mission
Agent	Text	Herbicide Agent sprayed
Gallons	Integer	Number of gallons dispersed over the entire mission
FWAC	Text	Fixed-wing aircraft designator – 3 pairs of numeric digits as a single field; 030201 means 3 aircraft were assigned to the

		mission, two took off, and one was productive
Type	Text	Type or purpose of mission

Additional Notes

The **Exposure_Master** table is derived from a table which only contained the first ten variables in the above table layout (Mission through TZero_30day). The remaining ten variables (Date through Type) included in the **Exposure_Master** table are copies of the HERBS file records that correspond to the given mission. (See **HERBS table** [above] for the valid ranges for each of these variables.)

The ten additional variables were copied from the HERBS table into Exposure_Master by running the following Make Table Query (**Add_HERBS_data_to_Master**):

```
SELECT exposure_master.*, HERBS.Date, HERBS.CTZ, HERBS.Source, HERBS.Incident, HERBS.Method,
Left([UTM],2) AS UTMGrid, HERBS.Agent, HERBS.Gallons, HERBS.FWAC, HERBS.Type INTO
Add_HERBS_data_to_Master
FROM exposure_master INNER JOIN HERBS ON exposure_master.Mission = HERBS.Mission
WHERE (((HERBS.Leg)="1A"));
```

The resulting table was renamed to **Exposure_Master** after first deleting the original table **Exposure_Master**. The reason for doing this is to eliminate an extra step in the calculation of exposure values. Every exposure calculation requires that the value in **Exposure_Master** be joined to the corresponding row in **HERBS** on the Mission column, where Leg = '1A'. By adding the additional columns directly to **Exposure_Master**, this extra step is avoided and the calculation is simplified.

References

- FR-AR8: Computation of Exposure Scores
- FR-AR9: Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life

DATES table

Every day of the Vietnam War period is assigned a number beginning with 1 (January 1, 1961) and ending with 4,017 (December 31, 1971), the last day of the final year of herbicide use. Dates and day numbers may be converted back and forth using the **DATES** table. Day numbers are found in the **Exposure_Master** table.

The **DATES** table is used to convert between day number and calendar date. This table is needed because most queries will have residence dates connected with them. The user supplies the residence dates in calendar format (e.g., 5/27/74) but calculations of E4 use

day numbers. To convert calendar dates to Day values that can be used with the **Exposure_Master** table, retrieve the row where the Date column matches the date in question. Day values can be converted back to dates by looking up the row with the Day value in question. This table can convert Week values as well.

Name	Type	Description
Date	Date/Time	Calendar date. Every day between 1/1/61 and 3/31/73 is represented
Day	Integer	Day number. Every day is numbered consecutively from 1/1/61 = 1 through 3/31/73 = 4473
Week	Integer	Week number. Consecutive from 1 through 639
Month	Integer	Month number. Consecutive from 1 through 147
Year	Integer	Year number. Consecutive from 1 through 13

Use Cases

Use Case Overview

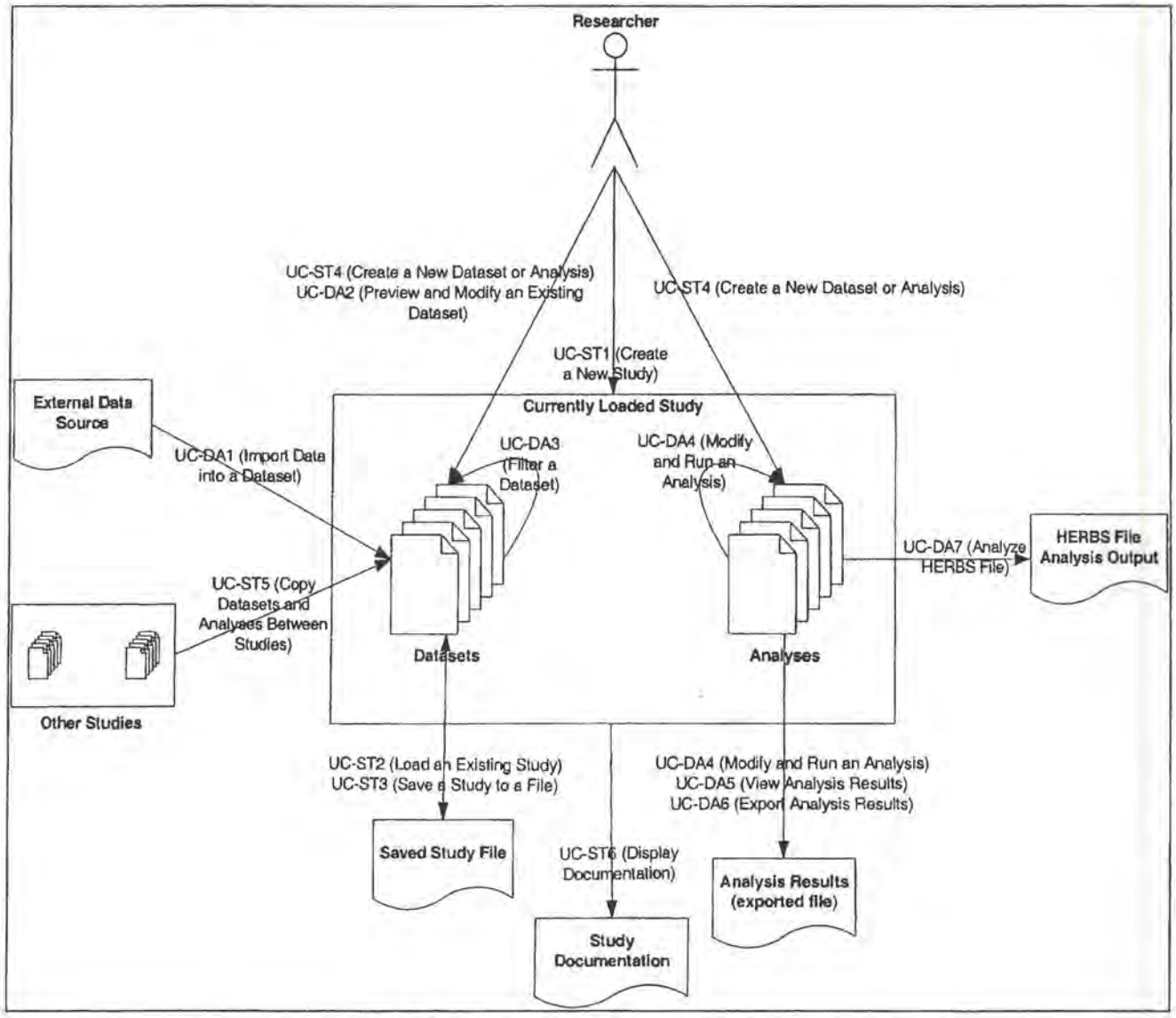


Figure 3: Use Case Overview

The use cases are divided into four sections: System Context Use Case, which contains one use case which describes the basic use of the system; Study Use Cases, which describe how the user interacts with studies; and Dataset Use Cases, which describe how the user interacts with datasets; and Analysis Use Cases, which describe how the user interacts with analyses.

Study Use Cases

- UC-ST1: Create a New Study
- UC-ST2: Load an Existing Study
- UC-ST3: Create Backup of Study
- UC-ST4: Copy Datasets Between Studies
- UC-ST4: Copy Analyses Between Studies
- UC-ST5: Display Documentation
- UC-ST6: Delete an Existing Study

Dataset Use Cases

- UC-DA1: Import Data into a Dataset
- UC-DA2: Preview and Modify an Existing Dataset
- UC-DA3: Delete or Rename an Existing Dataset
- UC-DA4: Create a New Dataset

Analysis Use Cases

- UC-AR1: Modify and Run an Analysis
- UC-AR2: View Analysis Results
- UC-AR3: Export Analysis Results
- UC-AR4: Analyze HERBS File
- UC-AR5: Delete or Rename an Existing Analysis

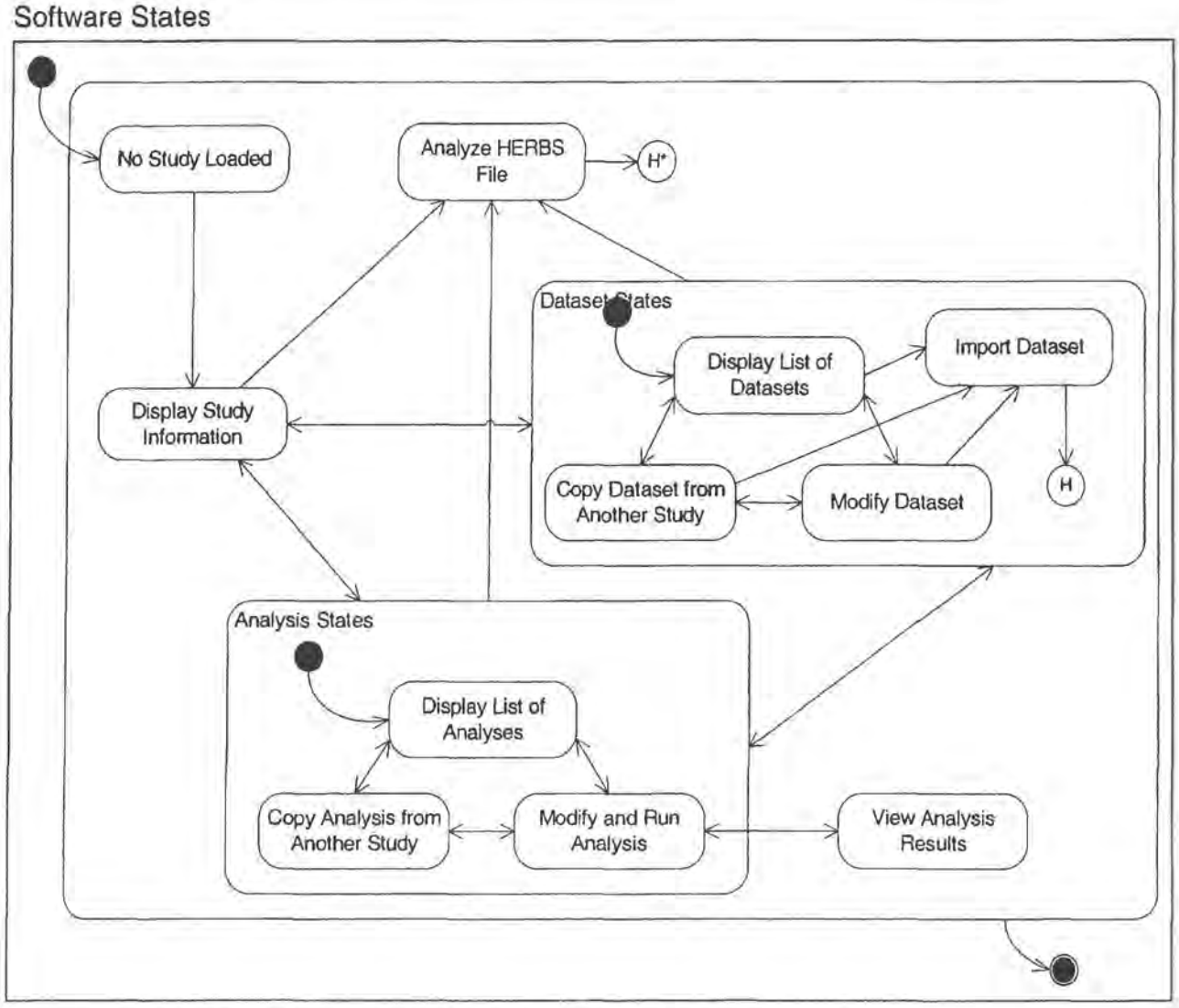


Figure 4 – Statechart depicting states of the software

The state transitions for the above diagram are documented within the Basic Course of Events section of each use case (in *italics*). For many of the use cases, the system must be in a certain state before the use case may begin. The user may cause use navigation functions to manually switch the state of the software.

System Context Use Case

Name	UC-SC1: Carry out Exposure Assessment
Summary	System Context Use Case. A researcher uses the Herbicide Exposure Assessment system to assess the exposure for an individual, group, or location. The researcher imports location history records for analysis, specifies exposure parameters, runs the analysis, and exports the data.
Rationale	The System Context Use Case represents the typical use of the system. It is a step-by-step path through the system that touches on all of the most important features. In this case, it shows the most basic way a researcher will use the software to analyze specific data. The software must always present its options in terms that the researcher identifies with, so by laying out System Context Use Case using language that the user will recognize and understand we lay down a foundation to build the software in a manner that will be intuitive to its main users. Many of the steps in the System Context Use Case are explained in more detail in later use cases. In these cases, the use case number is added in ***bold italics*** after the step.
Basic Course of Events	1. The researcher starts the software. *(State: No Study Loaded)* 2. A researcher requests that a study be loaded. ***(UC-ST2)*** 3. The system responds by displaying a list of studies (or an empty list if no studies exist yet) and requests the researcher to either select one or create a new study. 4. The researcher responds by selecting an existing study. 5. The system responds by loading the study. *(new state: Display Study Information)* 6. The researcher imports data into new dataset. ***(UC-DA1)*** 7. The system responds by displaying statistics about the new dataset and a map preview of the dataset. *(new state: Display List of Datasets)* 8. The researcher selects an analysis to be opened. ***(UC-AR1)*** 9. The system responds by opening the analysis for modification. It displays the herbicide application parameters, output variables, E4 half-life, residence time restrictions and the datasets available for analysis. *(new state: Modify and Run Analysis)* 10. The researcher modifies the analysis, specifying herbicide application parameters, output variables, E4 half-life, residence time restrictions and the

	dataset to be analyzed. 11. The system responds by running the analysis and displaying the results of the analysis. ***(UC-AR2)*** *(new state: View Analysis Results)* 12. The researcher indicates that the results are to be exported and specifies a format and location for the export. ***(UC-AR3)*** 13. The system responds by exporting the results of the analysis to the file and in the format specified by the researcher. 14. The researcher dismisses the analysis results. 15. The system responds by returning to the list of analyses. *(new state: Modify and Run Analysis)* 16. The researcher requests documentation for the analysis. ***(UC-ST5)*** 17. The system responds by displaying the documentation in a text editor. 18. The researcher exits the software.
Alternative Paths	1. Instead of steps 2 to 5, the researcher may create a new study. ***(UC-ST1)*** 2. One extremely important use of the system which is not reflected above is the stand-alone analysis of the HERBS file, in which the researcher carries out basic a statistical analysis of the spray data without reference to any particular entity *(state: Analyze HERBS File)*. ***(UC-AR4)***
Exceptions	None
Trigger	None
Assumptions	None
Preconditions	Initial State
Postconditions	Final State
Functional Requirements	None
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 2/19/02: Focused (Steven Stellman) 3/18/02: Focused (Steven Stellman) 4/6/02: Updated (Andrew Stellman) 4/22/02: Updated (Andrew Stellman) 5/06/02: Updated (Steven Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Study Use Cases

Name	UC-ST1: Create a New Study
Summary	The researcher creates a new, empty study to begin work.
Rationale	Before a researcher can analyze data, a study must be created and datasets and analyses must be added to that study. This allows the researcher to group useful data together in a convenient package. The system maintains the list of studies in its own internal folders and files. The user should not have to specify locations of studies; rather, the system will always display a list of previously created studies. The user provides a name for the study when it is created. Furthermore, the user shouldn't be bothered with having to think about saving changes to a file – the system should do that automatically. The user should simply be make changes, which the system remembers automatically.
Basic Course of Events	1. This use case begins when the researcher indicates that a new study is to be created. *(state: any state)* 2. The researcher indicates the name of the study. 3. The system creates the study and displays empty lists of datasets and analyses. *(new state: Display Study Information)*
Alternative Paths	None
Exceptions	After step 2: If the system finds that a study with that name already exists, it prompts the researcher for a new name. The researcher either specifies a new name, after which the system resumes step 3, or cancels the operation, after which the system returns to the precondition state.
Trigger	There are two possible triggers for this use case: a. The researcher indicates that a new study is to be created. b. While loading an existing study (**UC-ST2**), the user indicates that a new study should be created.
Assumptions	None
Preconditions	None *(state: Any State)*
Postconditions	The system has created the new study. *(state: Display Study Information)*
Functional Requirements	None
Revision History	2/2/02: Focused (Andrew Stellman, Steven Stellman) 2/19/02: Focused (Steven Stellman) 4/6/02: Updated (Andrew Stellman)

	4/22/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman)

Name	**UC-ST2: Load an Existing Study**
Summary	The researcher loads an existing study.
Rationale	The system must store a set of studies so that the researcher may recall any of them. Normally, the system will simply maintain a list of studies that were previously created and the user should not have to think about files or folders. When the user wants to load a study, the system should simply display the list of studies. However, sometimes users will want to save a study to an external file in order to email or back it up. To support this, the user must be able to specify that a study is to be loaded from an external file (alternative path 1).
Basic Course of Events	1. This use case begins when the researcher indicates that an existing study is to be loaded *(state: any state)* 2. The system responds by displaying a list of studies that may be loaded. 3. The researcher indicates which study is to be loaded. 4. The system responds by loading the study and displaying information about it. *(new state: Display Study Information)*
Alternative Paths	1. After step 3, the researcher may indicate that a previously backed up study is to be restored. The researcher must specify the location of the backup file. The system responds by reading the study data (including datasets and analyses) from the backup file, adding it to the system and loading it. 2. During step 2, when the list of studies that are already in the system is being displayed, the researcher may select one and rename it. The system responds by checking for an existing study with the new name. If none exists, the study is renamed and the system returns to step 2. If the name is already used, the system generates a unique name by appending "(2)" to the name (or another number if appending "(2)" does not make it unique), and prompts the user to decide whether to use that as the name or select a different name. 3. During step 2, the researcher is given the option to create a new study even if other studies already exist. If the researcher chooses to do this, this use case ends and the use case **UC-ST1** (Create a New Study) is triggered.
Exceptions	If no studies exist yet, the researcher is given the option to either start a new

	study, which triggers the use case **UC-ST1** (Create a New Study), or load an external one, which triggers the alternative path 1 above.
Trigger	The researcher indicates that an existing study is to be loaded. This may take place at one of two times: a. When the software has just loaded, and no study has been loaded yet b. When a study has been loaded, but no other operations are taking place
Assumptions	None
Preconditions	None *(state: any state)*
Postconditions	The system has loaded the specified study *(state: Display Study Information).*
Functional Requirements	None
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-ST3: Create Backup of Study**
Summary	The researcher saves the current study to a file as a backup.
Rationale	Normally the system will not require the user to explicitly save a study. Rather, any changes the user makes (for example, datasets are added or deleted, analyses are modified, etc.) are automatically saved and the user is shielded from having to deal with files and folders. However, sometimes a user will want to save a study to a file in order to back it up (or e-mail it to someone else, or copy it to another machine). This use case presents the user with that option.
Basic Course of Events	1. This use case begins when the system has loaded a study. *(state: Display Study Information)* 2. The researcher indicates that the current study is to be saved to an external file. The researcher specifies a filename. 3. The system responds by creating the external file specified by the researcher and copying all of the datasets and analyses into it.
Alternative Paths	None
Exceptions	None
Trigger	When a study has been loaded, the researcher indicates that the study is to be saved to a file.

Assumptions	None
Preconditions	The system has loaded a study. *(state: Display Study Information)*
Postconditions	The study has been saved to a file. *(state: Display Study Information)*
Nonfunctional Requirements	NF-SR1: Study File Constraints
Revision History	2/3/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman)

Name	**UC-ST4: Copy Datasets Between Studies**
Summary	The researcher copies datasets to the open study from a different study.
Rationale	The researcher will generally have several consecutive research projects in the same area of research. Once a set of data is collected, a researcher will generally conduct several studies on it. In order to make it easy to create new studies for each new project that they are working on, it is necessary to allow them to easily copy datasets between studies.
Basic Course of Events	1. This use case begins when the system has loaded a study and is displaying the list of datasets. *(state: any dataset state)* 2. The researcher indicates that a dataset is to be copied from another study. 3. The system responds by displaying a list of studies from which datasets may be copied. *(new state: Copy Dataset from Another Study)* 4. The researcher indicates which study contains the dataset to be copied. 5. The system responds by displaying the list of datasets in the study indicated by the researcher. 6. The researcher indicates one or more datasets to be copied. 7. The system responds by copying the datasets to the current study. *(new state: Display List of Datasets)*
Exceptions	The user may abort this operation after any step.
Alternative Paths	After step 4: If the researcher specifies the current study, any the system duplicates any selected datasets in the current study rather than copying them from another study. The new datasets are given a unique by appending "(2)" to the name (or another number if appending "(2)" does not make it unique) and using the unique name when duplicating the datasets.

	During step 7: For any dataset being copied has the same name as a dataset already in the study, the system generates a unique name by appending "(2)" to the name (or another number if appending "(2)" does not make it unique) and uses the unique name when copying the dataset to the study.
Trigger	The researcher indicates that datasets are to be copied from another study.
Assumptions	None
Preconditions	The system has loaded a study. *(state: any dataset state)*
Postconditions	The loaded study contains one or more new datasets copied from another study. *(state: Display List of Datasets)*
Functional Requirements	None
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 4/22/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 11/30/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-ST4a: Copy Analyses Between Studies**
Summary	The researcher copies analyses to the open study from a different study.
Rationale	This use case is very similar to **UC-ST4** ("Copy Datasets Between Studies"), except that it copies analyses instead of datasets.
Basic Course of Events	1. This use case begins when the system has loaded a study and is displaying the list of analyses. *(state: any analysis state)* 2. The researcher indicates that an analysis is to be copied from another study. 3. The system responds by displaying a list of studies from which analyses may be copied. *(new state: Copy Analysis from Another Study)* 4. The researcher indicates which study contains the analysis to be copied. 5. The system responds by displaying the list of analyses in the study indicated by the researcher.

	6. The researcher indicates one or more analyses to be copied. 7. The system responds by copying the analyses to the current study. *(new state: Display List of Analyses)*
Alternative Paths	After step 4: If the researcher specifies the current study, any the system duplicates any selected analyses in the current study rather than copying them from another study. The new analyses are given a unique by appending "(2)" to the name (or another number if appending "(2)" does not make it unique) and using the unique name when duplicating the analyses. During step 7: For any analysis being copied that has the same name as an analysis already in the study, the system generates a unique name by appending "(2)" to the name (or another number if appending "(2)" does not make it unique) and uses the unique name when copying the analysis to the study.
Exceptions	The user may abort this operation after any step.
Trigger	The researcher indicates that analyses are to be copied from another study.
Assumptions	None
Preconditions	The system has loaded a study. *(state: any analysis state)*
Postconditions	The loaded study contains one or more new analyses copied from another study. *(state: Display List of Analyses)*
Functional Requirements	None
Revision History	11/2/02: Created (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 11/30/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-ST5: Display Documentation**
Summary	The researcher displays the documentation for the analysis.
Rationale	All research studies require sufficient documentation to permit reconstruction of the results by an independent researcher. This documentation feature is analogous to the "Notes" window of SPSS. Documentation consists of a complete set of values of key variables that is required to fully specify an analysis.
Basic Course of Events	1. This use case begins when the system has loaded a study. *(state: any analysis state)* 2. The researcher indicates that the documentation for the analysis is to be

	displayed. 3. The system responds by generating all documentation for the analysis and the specified datasets and analyses, writing it to a temporary file and bringing it up in the text viewer window.
Alternative Paths	None
Exceptions	None
Trigger	The researcher indicates that documentation is to be generated.
Assumptions	None
Preconditions	The system has loaded a study. *(state: any analysis state)*
Postconditions	The documentation is written to a temporary file and displayed to the user in the text viewer window.
Functional Requirements	FR-SR1: Documentation Requirements FR-SR3: Text Viewer Window
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman)

Name	**UC-ST6: Delete an Existing Study**
Summary	The researcher deletes a study from the system.
Rationale	If a study is no longer useful, the researcher may want to remove it from the system.
Basic Course of Events	1. This use case begins when the system has loaded a study. *(state: Display Study Information)* 2. The researcher indicates that the current study is to be deleted. 3. The system requests confirmation. 4. The researcher confirms the study is to be deleted. 5. The system deletes the current study from the system, including all datasets and analyses contained in the study. *(new state: No Study Loaded)*
Alternative Paths	Path 1: If after step 3 the researcher aborts the operation, the system takes no action and returns to the state Display Study Information.
Exceptions	None
Trigger	The researcher indicates that the current study is to be deleted.
Assumptions	None

Preconditions	The system has loaded a study. *(state: Display Study Information)*
Postconditions	No study is loaded. *(state: No Study Loaded)*
Functional Requirements	None
Revision History	11/19/02: Created (Andrew Stellman) 12/3/02: Updated (Andrew Stellman)

Dataset Use Cases

Name	**UC-DA1: Import Data into a Dataset**
Summary	A researcher specifies an external data source of data for entities (location history records for specific units, individuals, or geographical locations). The system imports the data from this source for analysis.
Rationale	Usually researchers will already have a set of data for which they have collected other information and want to generate exposure data for comparison. This feature allows the researcher to import this external data, provided that it is in a readable format.
Basic Course of Events	1. This use case begins when the system has loaded a study. *(state: any dataset state)* 2. The researcher indicates that a dataset is to be imported. 3. The system responds by prompting the user for information about the dataset. *(new state: Import Dataset)* 4. The researcher specifies the location and format of data to be imported, and a name for the new dataset to be created. 5. The system responds by reading the dataset and displaying a preview of the data superimposed on a map of Vietnam. 6. The user indicates that the file is to be imported and specifies a name for the new dataset. 7. The system responds by creating the new dataset and reading the data from the external data source. *(new state: Display List of Datasets)*
Alternative Paths	After step 5, the user may change the import options, in which case the use case returns to step 2 (if the user specifies a different source) or step 4 (if the user specifies different information about the dataset). After step 6, if the name provided by the user already exists in the study, then the system prompts the user to overwrite the dataset. If the user does not want to overwrite it, then the system returns to step 6.
Exceptions	None

Trigger	The researcher indicates that a dataset is to be imported.
Assumptions	None
Preconditions	The system has loaded a study. *(state: any dataset state)*
Postconditions	The study contains a new dataset containing imported data. *(state: Display List of Datasets)*
Functional Requirements	FR-DR1: Dataset Contents FR-DR2: Entity and Location Data FR-DR5: Supported Dataset Import Formats FR-DR6: Dataset Import and Hand Entry Error Handling FR-DR8: Residence Date Input Verification
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 2/19/02: Focused (Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-DA2: Preview and Modify an Existing Dataset**
Summary	The researcher opens an existing study, opens a dataset within the study and adds and removes data.
Rationale	Sometimes the researcher will create or edit a dataset by hand. This feature gives the user the ability to add, edit or delete data from a dataset. While modifying the dataset, the system will display a preview of the data superimposed on a map of Vietnam in order to give the researcher a qualitative idea of the data being modified.
Basic Course of Events	1. This use case begins when the system has loaded a study. *(state: any dataset state)* 2. The researcher opens a dataset for modification. *(state: Modify Dataset)* 3. The system responds by displaying the data in a hierarchical format (entities and locations per entity), along with a map preview of the data in the dataset. 4. The researcher selects an entity or location and makes changes to it, adding and/or deleting locations and/or entities. 5. The system updates the dataset to reflect the modification and updates

	the map preview. 6. The researcher indicates that the changes are complete. 7. The system asks the researcher whether or not to save the changes. 8. The researcher indicates that the changes are to be saved. 9. The system responds by updating the dataset in the study. *(state: Display List of Datasets)*
Alternative Paths	After step 7, the researcher may decide not to save the changes, at which point steps 8 and 9 are skipped and the changes are abandoned.
Exceptions	None
Trigger	When a study is loaded, the researcher indicates that a dataset is to be previewed.
Assumptions	None
Preconditions	The system has loaded a study. *(state: any dataset state)*
Postconditions	The study contains an updated dataset. *(state: Display List of Datasets)*
Functional Requirements	FR-DR2: Entity and Location Data FR-DR3: Hand Entry of Data UI FR-DR4: Map Preview of a Dataset FR-DR8: Residence Date Input Verification
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 2/26/02: Focused (Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-DA3: Delete or Rename an Existing Dataset**
Summary	The researcher deletes a dataset from the current study.
Rationale	If a dataset is no longer useful, the researcher may want to remove it from the system.
Basic Course of Events	1. This use case begins when the system is displaying the list of datasets in a study. *(state: Display List of Datasets)* 2. The researcher selects a dataset and indicates that it is to be deleted. 3. The system requests confirmation. 4. The researcher confirms the dataset is to be deleted. 5. The system deletes the selected dataset from the study, including

	removing references to it from all analyses which reference it.
Alternative Paths	Path 1: If after step 3 the researcher aborts the operation, the system takes no action and returns to the list of datasets. Path 2: In step 2, the user may indicate that the selected dataset is to be renamed rather than deleted. In this case, in steps 4 and 5 and in the postcondition, the dataset is renamed instead of deleted. If the name is already used, the system generates a unique name by appending "(2)" to the name (or another number if appending "(2)" does not make it unique) and the unique name is used.
Exceptions	None
Trigger	The researcher indicates that an analysis is to be deleted.
Assumptions	None
Preconditions	The system is displaying the list of analyses in a study. *(state: Display List of Analyses)*
Postconditions	A dataset has been deleted from the study. *(state: Display List of Analyses)*
Functional Requirements	None
Revision History	11/19/02: Created (Andrew Stellman) 12/3/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-DA4: Create a New Dataset**
Summary	The researcher creates a new dataset.
Rationale	Each study contains datasets, but they have to get into the system somehow. This use case shows how the user creates a new dataset or analysis once a study is loaded.
Basic Course of Events	1. This use case begins when the system has loaded a study. *(state: any dataset state)* 2. The researcher indicates that a new dataset is to be created, along with the name for that new dataset. 3. The system responds by creating an empty dataset and adding it to the list of datasets in the study. *(new state: Display List of Datasets)*
Alternative Paths	None
Exceptions	None
Trigger	When a study has been loaded, the researcher indicates that a new dataset is to be created.
Assumptions	None

Preconditions	The system has loaded a study. *(state: any dataset state)*
Postconditions	The study contains a new dataset. *(state: Display List of Datasets)*
Functional Requirements	None
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/5/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman)

Analysis Use Cases

Name	**UC-AR1: Modify and Run an Analysis**
Summary	The researcher modifies an analysis in a study and views the results.
Rationale	***Note: This is the most important use case in the system.*** The most important feature of the system is the ability to run an analysis. Running an analysis consists of specifying parameters and limits for the exposure calculation and generating the exposure data for the input. The output of that analysis will generally be exported to an external file for further statistical analysis using external statistical software.
Basic Course of Events	1. This use case begins when the system has loaded a study and is displaying information about the analyses. *(state: any analysis state)* 2. The researcher opens an analysis for modification. *(new state: Modify and Run Analysis)* 3. The system responds by displaying the dataset to be analyzed, the herbicide application parameters and the E4 half-life. 4. The researcher modifies the analysis parameters and executes the analysis. 5. The system responds by running the analysis and displaying a preview of the results. (This triggers use case **UC-AR2**, "View Analysis Results") 6. The user indicates that the changes to the analysis are complete. 7. The system responds by returning to the list of analyses. *(state: Display List of Analyses)*
Alternative Paths	1. During step 6, the researcher may wish to modify the analysis, in which

	case the system returns to step 3.
Exceptions	If the analysis does not reference a dataset, the system does not execute the analysis (step 5 and alternative path 4 are skipped). It only allows the user to modify the study and save it.
Trigger	After the system has loaded a study, the researcher indicates that an analysis is to be modified.
Assumptions	None
Preconditions	The system has loaded a study and is displaying information about the analyses. *(state: any analysis state)*
Postconditions	The list of analyses is displayed. *(state: Display List of Analyses)*
Functional Requirements	FR-AR1: Analysis Parameters FR-AR7: Default Analysis Parameters
Nonfunctional Requirements	NF-SR2: Run Analysis Performance Constraints
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/2/02: Focused (Andrew Stellman, Steven Stellman) 3/16/02: Updated (Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**UC-AR2: View Analysis Results**
Summary	The researcher has finished running an analysis and views the results.
Rationale	The researcher will generally want to view the results of an analysis once it has been executed.
Basic Course of Events	1. This use case begins after the researcher has modified and run an analysis. *(state: Modify and Run Analysis)* 2. The system displays a preview of the analysis results. *(new state: View Analysis Results)* 3. The researcher specifies the grouping for the analysis results. 4. The system responds by updating the results of the analysis in an appropriate format using the specified grouping. 5. The researcher dismisses the results, and the system responds by

	returning to the analysis modification (**UC-AR1**, "Modify and Run an Analysis", step 6). *(new state: Modify and Run Analysis)*
Alternative Paths	1. While viewing the results, the researcher may select either one parameter of an entity or a location, or a set of entities and locations, and copy them into the Windows copy/paste buffer. 2. At any time during this use case, the researcher indicates that the results are to be exported to a file, triggering the use case **UC-AR3** (Export Analysis Results). 3. After step 2, the researcher may skip steps 4 and 5, by dismissing the results without changing the grouping. The system responds by returning to the analysis modification (**UC-AR1**, "Modify and Run an Analysis", step 6). 4. After step 3, if the user specifies any grouping options other than "Ungrouped Results," **and** if any Intersect or Overlap flag is true for any record, the system issues the following message: "Warning: Grouping results for data containing date-in or date-out intersections may result in overestimation of exposure scores. Proceed anyway?" The user is given a choice of two buttons: Yes and No. If Yes is selected, the grouping is completed as requested. If No is selected, the "Ungrouped Results" grouping is displayed.
Exceptions	None
Trigger	After running an analysis (**UC-AR1**, "Modify and Run an Analysis"), the system displays the results.
Assumptions	None
Preconditions	The system has just run an analysis. *(state: Modify and Run Analysis)*
Postconditions	The system displays the analysis for further modification. *(state: View Analysis Results)*
Functional Requirements	FR-AR2: Analysis Results Grouping
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman) 4/8/03: Updated (Andrew Stellman, Steven Stellman)

Name	UC-AR3: Export Analysis Results
Summary	The researcher opens an analysis and specifies a file format and location for the results. The system exports the results of the analysis.
Rationale	The researcher will generally export the results of an analysis after it has been run. However, the researcher will always want to preview the results before exporting, which is why this feature can only be triggered from within the "view results" use case.
Basic Course of Events	1. This use case begins when the system is displaying the results of an analysis. *(state: View Analysis Results)* 2. The researcher specifies the location and format of the file to be created. 3. The system responds by exporting the data in the specified format. 4. The system returns to step 3 of use case UC-AR2 ("View Analysis Results").
Alternative Paths	None
Exceptions	If the specified file already exists, the user is given the option to either overwrite the file or specify another filename. The user may abort this operation at any time, at which point the system returns to the precondition state *(state: View Analysis Results)*.
Trigger	The researcher indicates that analysis results are to be exported in **UC-AR2** (View Analysis Results), alternative path 3.
Assumptions	None
Preconditions	The system is displaying the results of an analysis. *(state: View Analysis Results)*
Postconditions	Use case UC-AR2 ("View Analysis Results"), step 3. *(state: View Analysis Results)*
Functional Requirements	FR-AR2: Analysis Results Grouping FR-AR5: Analysis Results Export Format
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 4/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman)

	1/29/03: Updated (Andrew Stellman)

Name	**UC-AR4: Analyze HERBS file**
Summary	The researcher carries out a statistical analysis of the HERBS file
Rationale	***Note: This is the second most important use case in the system, after UC-AR1 "Modify and Run an Analysis"*** The researcher often wishes to analyze the HERBS file without reference to any specific entity. The researcher typically wishes to know how many gallons of a certain herbicide were sprayed or how many missions of a certain type were run during a given period of time. The output may be either a summary of the data requested or a list of all HERBS file records which meet the request. - Example 1. How many gallons of Agent Orange were sprayed by Ranch Hand aircraft in June, 1969, and in how many missions? Display a list of all such missions. - Example 2. How many missions were flown by Ranch Hand aircraft in January, 1968, within UTM grid XT? - Example 3. Display a list of all grid points which fell within 1 km of mission no. 513. - Example 4. Display a list of all grid points which fell within 1 km of any Agent Orange mission between June 1, 1969, and June 30, 1969. The HERBS file analysis can be run at any time. It doesn't affect any of the other parts of the software, and runs almost as if it were a standalone application. While its output can be saved, individual HERBS file analyses cannot. This is due to the fact that there are few parameters, and saving them would make the program more complex without gaining anything for the user.
Basic Course of Events	1. This use case begins when the researcher indicates that a HERBS file analysis is to be run. *(state: any state)* 2. The system responds by displaying a researcher interface to allow the researcher to enter parameters (search and aggregation criteria) *(new state: Analyze HERBS File)* 3. The researcher selects search and aggregation criteria 4. The system runs the specified analysis and displays information about

	the results 5. The researcher specifies a filename to save the results 6. The system saves the results to a file 7. The system returns to the state it was in before step 1.
Alternative Paths	1. After step 4, the researcher may elect to alter the parameters, in which case the system returns to step 3. 2. After step 4, the researcher may elect not to save the results, in which case the system skips steps 5 and 6 and returns to the state it was in before step 1.
Exceptions	None
Trigger	The researcher may indicate at any time that a HERBS file may be run.
Assumptions	None
Preconditions	None
Postconditions	The system returns to the same state it was in before the HERBS file analysis feature was invoked.
Functional Requirements	FR-SR2: HERBS File Analysis Parameters and Calculation
Revision History	1/5/02: Façade (Andrew Stellman, Steven Stellman) 1/13/02: Filled (Andrew Stellman, Steven Stellman) 2/3/02: Focused (Andrew Stellman, Steven Stellman) 2/12/02: Focused (Steven Stellman) 3/16/02: Updated (Steven Stellman) 4/6/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman)

Name	**UC-AR5: Delete or Rename an Existing Analysis**
Summary	The researcher deletes an analysis from the current study.
Rationale	If an analysis is no longer useful, the researcher may want to remove it from the system.
Basic Course of Events	1. This use case begins when the system is displaying the list of analyses in a study. *(state: Display List of Analyses)* 2. The researcher selects an analysis and indicates that it is to be deleted. 3. The system requests confirmation. 4. The researcher confirms the analysis is to be deleted. 5. The system deletes the selected analysis from the study.
Alternative Paths	If after step 3 the researcher aborts the operation, the system takes no action and

	returns to the list of analyses. Path 2: In step 2, the user may indicate that the selected analysis is to be renamed rather than deleted. In this case, in steps 4 and 5 and in the postcondition, the analysis is renamed instead of deleted. If the name is already used, the system generates a unique name by appending "(2)" to the name (or another number if appending "(2)" does not make it unique) and the unique name is used.
Exceptions	None
Trigger	The researcher indicates that an analysis is to be deleted.
Assumptions	None
Preconditions	The system is displaying the list of analyses in a study. *(state: Display List of Analyses)*
Postconditions	An analysis has been deleted from the study. *(state: Display List of Analyses)*
Functional Requirements	None
Revision History	11/19/02: Created (Andrew Stellman) 12/3/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Requirements

This section contains the functional and nonfunctional requirements. Each requirement contains a reference to one or more use cases. The functional requirements contain the functionality details required to implement each use case. The nonfunctional requirements contain constraints on the implementation.

Requirements are broken down into four categories. The first three contain functional requirements, the last contains nonfunctional requirements:

Study Requirements

- FR-SR1: Documentation Requirements
- FR-SR2: HERBS File Analysis
- FR-SR3: Text Viewer Window

Dataset Requirements

- FR-DR1: Dataset Description
- FR-DR2: Entity and Location Data
- FR-DR3: Hand Entry of Data UI
- FR-DR4: Map Preview of a Dataset
- FR-DR5: Supported Dataset Import Formats
- FR-DR6: Dataset Import and Hand Entry Error Handling
- FR-DR7: *Removed*
- FR-DR8: Residence Date Input Verification
- FR-DR9: *Removed*

Analysis Requirements

- FR-AR1: Analysis Parameters
- FR-AR2: Analysis Results Grouping
- FR-AR3: *Removed*
- FR-AR4: *Removed*
- FR-AR5: Analysis Results Export Format
- FR-AR6: *Removed*
- FR-AR7: Default Analysis Parameters
- FR-AR8: Computation of Exposure Scores

- FR-AR9: Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life
- FR-AR10: Date Overlap Handling in the Exposure Calculation

Nonfunctional Requirements

- NF-SR1: Backup File Constraints
- NF-SR2: Run Analysis Performance Constraints
- NF-SR3: Installer Constraints

Study Requirements

Name	**FR-SR1: Documentation Requirements**
Summary	Documentation can be automatically generated for a study.
Rationale	All research studies require sufficient documentation to permit reconstruction of the results by an independent researcher. Documentation consists of a complete set of values of key variables that is required to fully specify an analysis.
Requirements	When the user indicates that the documentation for an analysis is to be displayed, the system displays or saves information about the dataset and other parameters associated with the analysis. The following information is displayed for each dataset associated with the analysis: - Dataset name - The date the dataset was created - The date the dataset was last modified - The number of rows in the dataset The following information is displayed about analysis parameters is displayed: - Date restrictions, if any *(Example: 01/31/64 <= date <= 12/31/68)* - Half-life *(Example: Half-life = 30 days)* - Selections other than default *(Example: Herbicide = O, Gallons >=1000, Type=D)* - Grouping *(Example: Group by ID)* When the documentation is displayed, the system writes it to a temporary file and displays it in the text viewer window.

References	UC-ST5: Display Documentation FR-SR1: Documentation Requirements FR-SR3: Text Viewer Window FR-DR6: Dataset Import and Hand Entry Error Handling
Revision History	3/16/02: Updated (Steven Stellman) 4/22/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 11/13/02: Updated (Steven Stellman, Andrew Stellman)

Name	**FR-SR2: HERBS File Analysis Parameters and Calculation**
Summary	This specification governs the analyses of the HERBS file that may be requested
Rationale	The user needs to know what variables exist in the HERBS file and what choices are available for specifying analyses. The HERBS file analysis allows the user to set up a set of filters to extract and aggregate a subset of the HERBS file.
Requirements	The following table shows the parameters which the user can specify to restrict an analysis, their available values, and the selection options. The default for every parameter is "All records." The user must specify one or more of the following operations: - Selection based on one or more of the available variables (listed in the Variable column of the table below) - Selections may be specific values or ranges (listed for each variable in the Range column in the table below) - Aggregate over one or more of the available variables - Count records which satisfy the selection criteria (listed for each variable in the Restrictions column in the table below) The system responds by running the specified analysis (as per **UC-AR4**, "Analyze HERBS File"). The system selects all rows in the **HERBS** table which fit the specified operations, grouping by any specified aggregation variables. The results will be a subset of the **HERBS** table, optionally aggregated by one or more variables.

Variable	Range	Restrictions
FWAC – two rightmost characters of	01 to 12, blank	The user must specify either blank, a single value, or a range (between a low value

FWAC field		or a high value)
Agent	B, D, K, O, P, T, U, W, blank	The user may specify either blank or any combination
Gallons	1 - 12000, blank	The user must specify a range (between a low value and a high value)
Type	C, D, E, F, O, P, S, U, W, blank	The user may specify either blank or any combination
UTM Grid - first 2 characters of UTM field	AA to ZZ	The user must specify either all grids or a single grid
Source	A, R, S, blank	The user may specify either blank or any combination
Incident	A, E, L, R, Z, blank	The user may specify either blank or any combination
Method	F, G, H, S, U, blank	The user may specify either blank or any combination
Date	1/1/61 to 12/31/71	The user must specify a range (between a low value and a high value)
Longitude	8.10 to 20.50	The user must specify a range (between a low value and a high value)
Latitude	102.84 110.02	The user must specify a range (between a low value and a high value)

If no rows are returned, the user must be notified that no HERBS file data match the specified criteria.

If rows are returned, the system must display the number of rows returned.

If the user chooses to save the results, the system must prompt the user for a filename. If the user enters a filename, the system must write the results to a comma-delimited (.CSV) text file. The columns of the file must correspond to the columns

	of the **HERBS** table.
Examples	The following are examples of typical HERBS file analyses that may be run: - Generate a list of the total gallonage of Agents White and Blue that were carried out in June, 1969, by Method (Ranch Hand, Perimeter) - Generate counts of the number of Agent Orange, Agent White, and Agent Blue Missions in 1966
References	UC-AR4: Analyze HERBS File
Revision History	3/16/02: Updated (Steven Stellman) 4/22/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**FR-SR3: Text Viewer Window**
Summary	Describes the functionality of the text viewer used to display messages or errors
Rationale	The user sometimes needs to see status messages or errors. It's not sufficient to simply bring up these messages in Notepad due to poor user interface interactions – when the Notepad window pops up, it's not clear to the user what to do. This requirement specifies a viewer interface to display messages to the user. This requirement contains some user interface and design constraints.
Requirements	Analysis documentation and import error messages must be displayed to the user in a modal text viewer window. This window must allow the user to perform the following functions: - Scroll to view the entire text of the message. - Select part or all of the message and copy it to the copy/paste buffer. - Write the message to a text file specified by the user. If the specified file exists, the software must the user to overwrite it.
References	FR-SR1: Documentation Requirements
Revision History	1/29/03: Created (Andrew Stellman

Dataset Requirements

Name	**FR-DR1: Dataset Description**
Summary	Describes the contents of a dataset: what data is stored, the format for the data elements, other elements of the dataset (name, statistics, etc.)

Rationale	The user needs basic information about an existing dataset in order to decide whether to use it in a new analysis.
Requirement	When the dataset is displayed in the list of datasets in a study, the following information must be displayed: - Name - Date of creation - Date last modified - Number of entities it contains - Number of records it contains - Name and date of analysis most recently run on the dataset
References	UC-DA4: Create a New Dataset UC-DA1: Import Data into a Dataset
Revision History	7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman)

Name	**FR-DR2: Entity and Location Data**
Summary	The format of the entity and location data that the user may display and edit
Rationale	Since it is the user's responsibility to provide location history records for a given analysis, he or she needs to know what variables are needed and the format in which to provide them.
Requirements	When the user edits entities and location history records by hand, the following data elements may be added, deleted or updated: - ID – numeric, long integer - Longitude – numeric, single or double precision - Latitude – numeric, single or double precision - In-date – first date that the entity occupied the given location - Out-date – last date that the entity occupied the given location The in-date and out-date within an input record must conform to specification FR-AR8
References	UC-DA1: Import Data into a Dataset UC-DA2: Preview and Modify an Existing Dataset FR-AR8: Computation of Exposure Scores
Revision history	Updated 05/06/02: (Steven Stellman) Updated: 6/8/02 (Andrew Stellman) 7/16/02: Updated (Andrew Stellman)

Name	FR-DR3: Hand Entry of Data UI
Summary	Specific design constraints for the hand entry of data, including supporting hierarchical location/entity data and editing date ranges
Rationale	For those situations in which the user elects to provide location history records for a given analysis, he or she needs to know what variables are needed and the format in which to provide them.
Requirements	The user may enter one or more location history records. Each location history record must specify the following variables: - ID (text) - Longitude - Latitude - Date Range (specified by date-in and date-out)
Constraints	This requirement applies only to location history records. A user may enter location history data manually instead of importing location history records from an external file. The ID number may not be left blank. To save time, the user may indicate that by skipping the ID field the ID of the previously entered record is to be used.
References	UC-DA2: Preview and Modify an Existing Dataset
Revision History	Updated: 5/6/02 (Andrew Stellman) 7/16/02: Updated (Andrew Stellman)

Name	FR-DR4: Map Preview of a Dataset
Summary	Details about how a dataset is to be previewed on a map.
Rationale	It will often be helpful for the user to visualize the locations in Vietnam of the entities for which exposure will be calculated.
Requirements	During UC-DA2 (Preview and Modify an Existing Dataset), the system displays a dataset preview superimposed on a map of Vietnam. A simple x-y plot will be shown, on which the outline of Vietnam is superimposed. The plot will be capable of being copied to the Windows clipboard as an object for pasting into another application. Plotted points will be represented by the symbol **x**.
References	UC-DA2: Preview and Modify an Existing Dataset
Revision History	6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman)

Name	FR-DR5: Supported Dataset Import Formats
Summary	The system will permit importation of data from Excel, Access and CSV files
Rationale	When the user wishes to import location history data from an external source, that source must be a Microsoft Excel file, a Microsoft Access database or a comma-delimited (.CSV) text file. The user may specify which columns correspond to the values that are to be imported.
Requirements	When importing data into a dataset, the user must specify the following: - The filename of one of the following files: o The filename of an MS Excel file compatible with Office XP, along with the name of the worksheet of the file. The worksheet must contain location history records for a set of entities, with one location history record per row. Entities are identified by an ID column. o The filename of an MS Access file compatible with Office XP, along with the name of the table to be read. The table must contain location history records for a set of entities, with one location history record per row. Entities are identified by an ID column. o The filename of a comma-delimited (.CSV) text file. The file must contain location history records for a set of entities, with one location history record per row. Entities are identified by an ID column. - Which fields in that table contain the ID, longitude, latitude, date-in and date-out values The software will verify that those fields are in the correct format in every line to be imported. Any non-compliant lines will be displayed to the user after the import is complete.
Revision History	5/6/02: Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	FR-DR6: Dataset Import and Hand Entry Error Handling
Summary	How to deal with data problems and date overlaps during data import, including

	when and how to alert the user of errors.
Rationale	When the user imports or enters data into the system, that data may contain errors. This requirement dictates how those errors are to be treated. There are two sorts of errors that the system checks for: date overlap errors and range errors. Date overlaps for a given entity are prohibited except in certain limited cases. The user needs to know the rules governing when overlaps are permitted and how exposure will be calculated in those instances. To keep the handling of date overlaps simple, only the most common case of overlaps is handled. This is the case where an entity has dates that only overlap in pairs, meaning that if a pair of date-in/date-out ranges overlaps, then each range does not overlap with any other date for that entity. In the few cases where three or more date-in/date-out ranges overlap, the software considers that data to be too inaccurate for processing and will not allow that data to be imported or entered. This is necessary because the calculation for handling date overlaps only handles that simple case (see **FR-AR8**, "Computation of Exposure Scores").
Requirements	**Data Error Conditions** *Date Overlap Errors* If the user attempts to manually enter (**UC-DA2**, "Preview and Modify an Existing Dataset") or import (**UC-DA1**, "Import Data into a Dataset") an entity in which three or more locations overlap then the system must not accept that input and instead display an error message. *Range and Format Errors* When importing data for an entity, each location history record imported must fall within the following ranges: - Longitude must be a single-precision number within the range 102.00, 111.00 - Latitude must be a single-precision number within the range 8.0, 21.0 - Date-in must be a date value within the range 1/1/61 through 5/7/75 - Date-out must be a date value within the range 1/1/61 through 5/7/75

	Any entity which violates these rules must be treated as an error. In addition, the system must adhere to rules for verifying residence date input, specified in **FR-DR8** ("Residence Date Input Verification"). **Error Handling for Imports** When the user imports data that contains entities with errors, those entities must be skipped and an error log must be displayed after the rest of the dataset is imported. The error log must contain a list of the entities with details about the specific errors that were skipped. The log must be displayed in the text viewer window. **Error Handling for Hand-Entered Data** When the user manually enters a location history record that contains an error, the system must inform the user of the error. The user must then be given the option to either fix the error and save the location history record or abort the input.
References	UC-DA1: Import Data into a Dataset UC-DA2: Preview and Modify an Existing Dataset FR-DR8: Residence Date Input Verification FR-AR8: Computation of Exposure Scores
Revision History	7/16/02: Updated (Andrew Stellman)

Name	**FR-DR7: *Removed***
Summary	*This requirement was removed*
Rationale	*At the 11/1 inspection, we decided that the system does not need to support filtering. This requirement is left in the document as a placeholder.*
Requirements	*None*
References	*None*
Revision history	3/18/02 Created (Steven Stellman) 4/19/02 Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman)

	7/16/02: Updated (Andrew Stellman) 11/2/02: Removed (Andrew Stellman)

Name	**FR-DR8: Residence Date Input Verification**
Summary	The system must verify a residence date that was either inputted by the user or imported from a file.
Rationale	A rigid and consistent set of rules is required which governs flagging and handling of potential date conflicts in individual location history records and between location history records for a given entity.
Requirements	When location data is inputted by the user or imported from a file, the following rules must be verified: 1. Every input record must have an in-date and an out-date. 2. The in-date can never be later than the out-date. 3. The out-date cannot exceed the current date. 4. Every date must include a month and a year. When user input violates these rules, the record the user is inputting may not be saved until the problem is resolved or the operation is cancelled. When data being imported violates these rules, the offending records are to be skipped and displayed to the user after the import is finished.
References	FR-DR2: Entity and Location Data UC-DA1: Import Data into a Dataset UC-DA2: Preview and Modify an Existing Dataset
Revision history	3/18/02 Created (Steven Stellman) 4/19/02 Updated (Andrew Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 11/19/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**FR-DR9: *Removed***
Summary	*This requirement was removed*
Rationale	*At the 1/26 meeting the find functionality was removed. This requirement is left in the document as a placeholder.*
Requirements	*None*

References	*None*
Revision history	6/8/02: Created (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Removed (Andrew Stellman)

Analysis Requirements

Name	**FR-AR1: Analysis Parameters**
Summary	The parameters associated with an analysis, including herbicide application parameters, E4 half-life (including range), residence time restrictions, output variables.
Rationale	The user may wish to restrict an analysis to include only exposure from certain herbicides, residence intervals, methods of application, or a particular half-life.
Requirements	When an analysis is defined or modified in **UC-AR1** ("Modify and Run an Analysis"), the user may select a dataset to be analyzed, the herbicide application parameters and the E4 half-life. The user must specify a dataset to be analyzed. Only one dataset may be specified per analysis. If the user has not specified a dataset, then the analysis cannot be run and results cannot be viewed. Attributes of the entity which may be specified by the user for a specific analysis: - Residence date restrictions: the user may restrict the residence dates of all of the location history records in the analysis by specifying a start date and an end date (the range is any valid date) Herbicide application parameters which may be specified by the user for a specific analysis: - Agent - Mission - CTZ - FWAC - Gallons - Type - UTM (2-character grid) - Date

	The software must allow the user to enter a range for the above parameters that matches the range in the **HERBS** table definition (section 5.1). Additional parameter which may be specified by the user for a specific analysis: - Half-life, specified in days (the range is any positive integer) The software must restrict the input to permissible ranges, which can be found in the description of the **HERBS** table (section 5.1). The default values for these parameters are specified in **FR-AR7** ("Default Analysis Parameters").
References	UC-AR1: Modify and Run an Analysis FR-AR7: Default Analysis Parameters
Revision History	3/16/02: Updated (Steven Stellman) 5/06/02: Updated (Steven Stellman) 6/8/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**FR-AR2: Analysis Results Grouping**
Summary	Definition of grouping for display of analysis results
Rationale	An entity is often exposed during a given time period to herbicides from many different missions. These exposures may occur at any of the locations which the entity occupied. The user may wish to know only the total exposure from all sources combined or the exposure from individual missions. If the entity was in several different locations, the user may wish to know only a summary exposure score for all locations, or may wish to know the exposure received at every location. This will generally be useful for generating data to be displayed on maps.
Requirements	During **UC-AR2** ("View Analysis Results") and **UC-AR3** ("Export Analysis Results"), when the user selects a grouping for the results of an analysis, the system provides the following options: - Ungrouped Results. The result set contains ungrouped output. There is one output row per location history record in the dataset, with the exception of overlapping

	location history records, in which case there is one row per overlapping pair of records. - Total Exposure for Each ID. The result set is grouped by ID. It contains one output row per unique ID in the dataset. The output variables (NT05, NT1, NT2, NT5 and E4) are summed over each ID. - Total Exposure per Location for Each ID. The result set is grouped by ID and PointID. It contains one output row per pair of ID and PointID values in the dataset. The result set does not return PointID, rather it uses the GridPoints table to translate PointID into Longitude and Latitude. The output variables are summed over each ID/PointID pair. - Total Exposure Restricted to Missions Within 0.5km (or 1km, 2km or 5km) The result set is grouped by ID, and the results are in an identical format as the Total Exposure for Each ID grouping. The difference is that only the records where NT05 > 0 contribute to the sums of the output variables. (For 1km, 2km or 5km, the sum uses the NT1, NT2 or NT5 variables respectively.) When the system displays or exports the results of an analysis, the results are grouped based on which of the above options the user selected. For the "Ungrouped Results" grouping, the flags are determined as per **FR-AR8** ("Computation of Exposure Scores"). For all of the other groupings, each of three flags (DateIn_Intersect, DateOut_Intersect and Overlap) is calculated for each grouped output row as follows: the flag in each output row is true only if the flag is true for one of the input rows that contributed to it. If the flag is not true in any of the input rows, then that flag is not true in the output row.
References	UC-AR2: View Analysis Results UC-AR3: Export Analysis Results FR-AR8: Computation of Exposure Scores FR-AR10: Date Overlap Handling in the Exposure Calculation
Revision History	5/06/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman)

	11/14/02: Updated (Steven Stellman, Andrew Stellman) 11/30/02: Updated (Steven Stellman, Andrew Stellman) 1/29/03: Updated (Andrew Stellman) 3/16/03: Updated (Andrew Stellman)

Name	**FR-AR3: *Removed***
Summary	*This requirement was removed*
Rationale	*At the 1/26 meeting we determined that after the analysis is run the results should be displayed immediately and statistics about the results should not be shown on the Modify/Run Analysis form. This requirement is left in the document as a placeholder.*
Requirements	*None*
References	*None*
Revision History	3/16/02: Created (Steven Stellman) 4/19/02: Updated (Andrew Stellman) 5/06/02: Updated (Steven Stellman) 2/1/03: Updated (Steven Stellman

Name	**FR-AR4: *Removed***
Summary	*This requirement was removed*
Rationale	*At the 1/26 meeting the find residence time override functionality was removed. This requirement is left in the document as a placeholder.*
Requirements	*None*
References	*None*
Revision History	5/06/02: Updated (Steven Stellman) 6/8/02: Updated (Andrew Stellman) 1/29/03: Removed (Andrew Stellman)

Name	**FR-AR5: Analysis Results Export Format**
Summary	Specify the format for results of an analysis to be exported.
Rationale	The user needs the ability to export the results in a format that can be used as input for a subsequent statistical analysis using a package such as SPSS.
Requirements	Any analysis results being saved to a file must be written to a comma-delimited (.CSV) text file. The user must specify the filename and location of this file. The first row of the file must contain the column names, and the remaining rows must contain the data. The columns and data correspond to the analysis results.

References	UC-AR3: Export Analysis Results FR-AR2: Analysis Results Grouping
Revision History	03/16/02: Updated (Steven Stellman) 05/06/02: Updated (Andrew Stellman) 7/16/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**FR-AR6: *Removed***
Summary	*This requirement was removed*
Rationale	*At the 1/26 meeting the find functionality was removed. This requirement is left in the document as a placeholder.*
Requirements	*None*
References	*None*
Revision history	6/8/02: Created (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Removed (Andrew Stellman)

Name	**FR-AR7: Default Analysis Parameters**
Summary	The default parameters for new analyses created by the user
Rationale	Any new analysis that is created must have default values. These defaults are drawn from the list of possible analysis parameters specified in **FR-AR1** ("Analysis Parameters"). The system needs to provide the most common analysis that the researcher may use, so that if data is imported an analysis can be run immediately.
Requirements	When the user creates a new analysis, the following default values are displayed:

Parameter	Default Value
Half-life	30 days
In-date	January 1, 1961 (day 1 in the DATES table)
Out-date	May 7, 1975 (day 5240 in the DATES table)
Mission	All missions
CTZ	All CTZs
FWAC	All FWAC
Agent	O (Orange) and P (Purple)
Gallons	All values
Type	All types

	UTM	All values	
	Output Variables	ID, date-in, date-out, NT05, NT1, NT2, NT5, E4	
References	FR-AR1: Analysis Parameters		
Revision History	7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)		

Name	**FR-AR8: Computation of Exposure Scores**
Summary	This section provides technical details for calculating exposure scores.
Rationale	Computing exposures is the primary function of this software package. This functional requirement describes the method for computing exposures. With this method, location-residence data for an entity are transformed into exposure history records. The goal of an exposure analysis is to assign a set of exposure scores to each entity. A simple set of operations takes a location history record, uses database lookups and some simple calculations, and returns an exposure history record. The exposure history record may contain any or all of the following: E4, NT05, NT1, NT2 and NT4. In general, one exposure history record is generated as output for each location history record in the dataset. The only exception is that when if an entity contains two location history records with overlapping dates, a single output exposure history record is generated for both input location history records. (If more than two location history records overlap within an entity, the system will have already excluded them from the dataset during creation or import.)
Requirements	After the user has loaded and modified an analysis in **UC-AR1** (Modify and Run an Analysis), the system runs the analysis to produce analysis results. This requirement describes the algorithm by which the results are produced. The input to the algorithm is the analysis. The analysis is run on a dataset comprised of entities, with one or more location history records for each entity. The output will contain one or more rows for each location history record in each entity in the dataset contained in the analysis. For each location history record, the system proceeds with the following steps to produce one or more output rows:

	• **Input:** a) One location history record, which contains a location (longitude, latitude) and date range (date-in, date-out) b) Half-life from the analysis c) Date range restrictions from the analysis (begin-date, end-date) d) HERBS file parameters from the analysis: CTZ, Source, Incident, Method, UTMGrid, Agent, Gallons, FWAC and Type restrictions • **Step 1: Truncate the latitude and longitude.** (See section 2.3 for an explanation of truncation.) Look up the truncated latitude and longitude in the **GridPoints** table to obtain PointID. • **Step 2: Restrict date-in and date-out based on the date range restrictions in the analysis parameters.** If begin-date is after date-in, then replace date-in with begin-date for the remainder of this algorithm. If end-date is earlier than date-out, then replace date-out with end-date for the remainder of this algorithm. • **Step 3: Look up records in the Exposure_Master table.** Retrieve from the master exposure table **Exposure_Master** records that match the PointID value obtained in step 1, filtering out any records where the CTZ, Source, Incident, Method, UTMGrid, Agent, Gallons, FWAC and Type columns do not match the analysis parameters. (The analysis parameters are described in **FR-AR1,** "Analysis Parameters".) • **Step 4: Compute NT05, NT1, NT2 and NT5.** For each record found in step 3 where Date is between the Date-In and Date-Out values from step 2, compute the following sums: NT05 is the sum of all hits05km values, NT1 is the sum of all hits1km values, NT2 is the sum of all hits2km values and NT5 is the sum of all hits5km values. NT05, NT1, NT2 and NT5 are written to the exposure history record output. • **Step 5: Compute the E4 exposure score.** For each record found in step 3, adjust the E4 value using the algorithm in **FR-AR9** ("Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life"). The inputs to this algorithm are the Day, E4_total_30, poof and TZero_30day columns from the **Exposure_Master** row, Date-In and Date-Out values from the location history record, and the half-life from the analysis. The sum of all of the adjusted E4 values

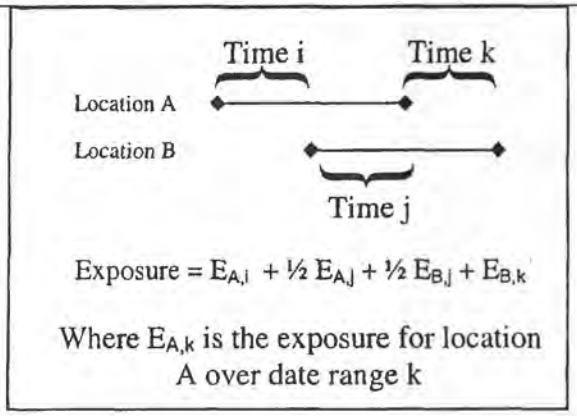
	is written to the exposure history record output. • **Output:** The algorithm produces the an exposure history record: NT05 = # of hits within 0.5km NT1 = # of hits within 1km NT2 = # of hits within 2km NT5 = # of hits within 5km E4 exposure score. DateIn_Intersect flag DateOut_Intersect flag Overlap flag Each of these is written to the row of the output file (depending on the "output variables" parameter of the analysis – any variables excluded by this parameter must be omitted from the output file). • **Handle date overlaps.** In the final set of output rows generated by applying steps 1 through 5 to all of the location history records, if any entity has two locations whose dates overlap, the calculation must be adjusted as per **FR-AR10** ("Date Overlap Handling in the Exposure Calculation"). A single output record is generated for these two location history records, where Date-In is taken from the record with the earlier Date-In and Date-Out is taken from the record with the later Date-Out. This step is always performed **before** any aggregation of records over different missions. • **Determine flags.** There are three flags that are attached to every output record. The DateIn_Intersect flag is true only if the date-in of the input record is the same as the date-out of another record with the same ID and location. The DateOut_Intersect flag is true only if the date-out of the input record is the same as the date-in of another record with the same ID and location. (These two cases are not treated as overlaps – see **FR-AR2**, "Date Overlap Handling in the Exposure Calculation".) The Overlap flag is true if the output record was calculated from two input records using the date overlap handling adjustment in **FR-AR10** ("Date Overlap Handling in the Exposure Calculation").
References	UC-AR1: Modify and Run an Analysis FR-DR2: Entity and Location Data FR-DR6: Dataset Import and Hand Entry Error Handling FR-AR1: Analysis Parameters

	FR-AR2: Analysis Results Grouping FR-AR9: Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life FR-AR10: Date Overlap Handling in the Exposure Calculation
Revision History	3/16/02: Created (Steven Stellman) 4/19/02: Updated (Andrew Stellman) 5/10/02: Updated (Steven Stellman) 5/14/02: Updated (Steven Stellman) 7/16/02: Updated (Andrew Stellman) 11/16/02: Updated (Andrew Stellman) 3/16/03: Updated (Andrew Stellman)

Name	**FR-AR9: Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life**
Summary	Calculation details for transformation of existing E4 values in the Exposure.dat file to a residence interval and/or different half-life that are different from their tabled values
Rationale	The master exposure table **Exposure_Master** contains pre-calculated values of E4 which assume a residence time from the beginning of the War (1/1/61) through the end of the War (12/31/71), and a half-life of 30 days. The researcher nearly always wishes to use a different residence interval. The researcher may also want to change the half-life of the herbicide. This calculation will allow the researcher to produce updated exposure values using a given date-in/date-out and half-life.
Requirements	This requirement describes the calculation by which the E4 value is produced. • **Input:** This calculation requires the following input: E4_total_30, poof, TZero_30day, DateIn, DateOut, Day and HalfLife. • **Step 1:** If the Day value is provided in days, it must be converted to a date using the **DATES** table (see section 5.4). • **Step 2:** λ_1 must be computed: $$\lambda_1 = \frac{\ln_e(2)}{HalfLife}$$ • **Step 3:** E4 must be computed. Case 1: If DateIn ≤ Day ≤ DateOut then the input values represent a direct hit and the following calculation must be performed:

	$$T_1 = \frac{1}{\lambda_1}[1 - \exp(-\lambda_1 \cdot (DateOut - Day))]$$ $$E4 = E4\_total\_30 \cdot \frac{T_1}{TZero\_30day} + 120 \cdot poof$$ Case 2: If Day < DateIn then the input values represent an indirect hit and the following calculation must be performed: $$T_1 = \frac{1}{\lambda_1}[\exp(-\lambda_1 \cdot (DateIn - Day)) - \exp(-\lambda_1 \cdot (DateOut - Day))]$$ $$E4 = E4\_total\_30 \cdot \frac{T_1}{TZero\_30day}$$ Case 3: If Day > DateOut then the hit is irrelevant because the exposure happened after the entity left the area, so E4 = 0.
References	FR-AR8: Computation of Exposure Scores
Revision History	7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman) 1/29/03: Updated (Andrew Stellman)

Name	**FR-AR10: Date Overlap Handling in the Exposure Calculation**
Summary	Calculation details for handling locations within an entity whose dates overlap
Rationale	This requirement contains information on how to handle the situation in which an entity shares two locations whose date-in/date-out ranges overlap. To keep the handling of date overlaps simple, only the most common case of overlaps is handled. This is the case where an entity has dates that only overlap in pairs, meaning that if a pair of date-in/date-out ranges overlaps, then each range does not overlap with any other date for that entity. This exposure calculation should not encounter any cases where three or more date-in/date-out ranges overlap, because the software considers that data to be too inaccurate for processing and will prevent that data to be imported or entered into the system in the first place. (See also **FR-DR6**, "Dataset Import and Hand Entry Error Handling")
Requirements	When computing exposure scores, date overlaps must be handled using the following formula:



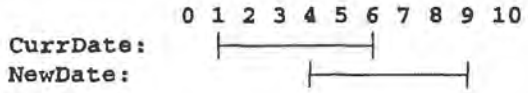
For an entity residing in locations A and B with date overlaps between the locations such that the entity was in location A during time periods i and j and location B during time periods j and k (j is the entity's date overlap for locations A and B), the total exposure for the two locations should be the exposure for location A over date range i, plus half the exposure for location A and half the exposure for location B over date range j, plus the exposure for location B over date range k.

To compute the exposure for a location over a date range, see **FR-AR9**, "Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life".

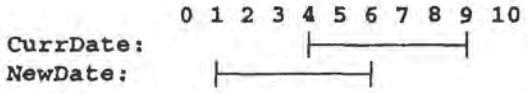
Comments

There are three types of overlaps. Given pairs of current and new datein/dateout values (CurrDate with DateIn/DateOut and NewDate with NewDateIn/NewDateOut), then the following types of overlaps could occur when comparing the two location history records for overlaps:

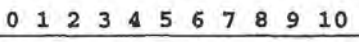
1. Date—in overlap: DateIn < NewDateIn < DateOut

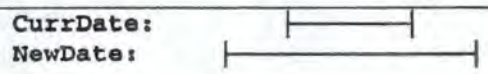
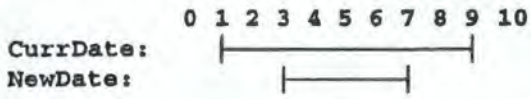


2. Date—out overlap: DateIn < NewDateOut < DateOut



3. Complete containment: DateIn > NewDateIn and DateOut < NewDateOut



	 4. Complete overlap: DateIn < NewDateIn and DateOut > NewDateOut  NOTE: The complete overlap is also detected by the tests for Date-in overlap and Date-out overlap, so the software doesn't need to explicitly test for it. It is common for a series of location history records to overlap the first and last day for each consecutive record. For example, the first record could range from day 491 to day 504, the next 504-549, and the next 549-601. The system must not register this as an overlap, even though the second record shares day 504 with the first and day 549 with the third. For this reason, the above tests use < and > instead of <= and >=.
References	FR-DR6: Dataset Import and Hand Entry Error Handling FR-AR8: Computation of Exposure Scores FR-AR9: Steps to Transform E4 to a Different Residence Interval and/or a Different Half-Life
Revision History	7/16/02: Updated (Andrew Stellman) 11/2/02: Updated (Andrew Stellman)

Nonfunctional Requirements

Name	**NF-SR1: Backup File Constraints**
Summary	Constraints on the backup file to which a study is saved
Rationale	The user needs a mental picture of a study that corresponds to how research is done. A computer file which contains all the data and the tools to analyze those data is a useful metaphor.
Constraint	A study must be one unit (such as a file or a directory) that the user can copy and back up easily.
References	UC-ST3: Create Backup of Study
Revision History	Updated: 6/8/02 (Andrew Stellman) Updated: 1/29/03 (Andrew Stellman)

Name	**NF-SR2: Run Analysis Performance Constraints**
Summary	The user should not face unreasonable delays while running an analysis.
Rationale	Running the analysis may be a time-consuming task. If it is, it may be

	necessary to have the user explicitly run the analysis and store the results on the hard drive. However, if the analysis can be performed quickly, then it may be sufficient to run it every time the user wishes to view the results.
Constraint	When the researcher runs generates the results of an analysis, it must not take more than 10 seconds on a current computer running Windows XP Professional.
References	UC-AR1: Modify and Run an Analysis
Revision History	Updated: 6/8/02 (Andrew Stellman) Updated: 11/2/02 (Andrew Stellman)

Name	**NF-SR3: Installer Constraints**
Summary	Constraints on the installation program which installs the software on the user's machine
Rationale	The software must ship with a user-friendly installation procedure.
Constraint	The installer must ensure that the files copied on the user's hard drive are copied with read-write permissions.
References	None
Revision History	Created: 1/29/03 (Andrew Stellman)