Containment Sprays (SPR) Package
Users' Guide

The MELCOR containment spray package models the heat and mass transfer between spray water droplets and the containment building atmosphere.

This Users' Guide describes the input to the SPR package, including a brief description of the models employed, the input format, sample input, discussion of the output, sensitivity coefficients, plot variables, and control variables. Details on the models can be found in the SPR Package Reference Manual.

Contents

1. Introduction

The MELCOR Containment Spray (SPR) package models the heat and mass transfer between spray water droplets and the containment building atmosphere. The modeling in the SPR package is taken virtually intact from the HECTR 1.5 code. The model assumes, among other things, that spray droplets are spherical and isothermal and that they fall through containment at their terminal velocity and that there is no horizontal velocity component. In a special application, the spray model is used to treat condensation from the Heat Structures (HS) package's film-tracking model that "rains" from inverted surfaces into the containment atmosphere.

An arbitrary number of spray sources may be placed in any containment control volume. The source of water (reservoir) for each spray may be identified with the pool of any CVH control volume, or it may be left unidentified. If a CVH pool is designated as the spray source reservoir, then the spray will operate only if the pool has sufficient water. The user provides input in the form of pool heights in the reservoir to determine whether there is sufficient water for spray operation. The user may set a flag to stop the calculation if the water level in any reservoir falls below the specified minimum requirement. Radionuclides dissolved in the reservoir water will not be transported along with the water to the spray source (i.e., it is assumed that there is a perfect filter for all radionuclides between the reservoir and the spray).

For each spray source, except for sources associated with "rain" from the HS film-tracking model, the user must specify an initial droplet temperature and flow rate, each of which may be controlled by a control function. The user may turn the sprays on and off with a separate control function for each spray source. A droplet size distribution may also be input for each spray source. In other words, the spray droplets for each source may be divided into a number of different size bins, with individual drops representing the average droplet size being tracked during their fall through the control volume; the total heat and mass transfer for the spray source is obtained by summing the heat and mass transfers calculated for all sizes.

For spray sources associated with "rain" from the HS film-tracking model, the user must define an "out" transfer process in the MELCOR Transfer Process (TP) package that retrieves the "rain" from an associated "in" transfer process that is accessed by the HS film-tracking model. In this special application of the spray package model, the user should not specify control functions for the droplet temperature or flow rate or a CVH pool as the source reservoir. Refer to Section 5.4 of the Heat Structures Package Users' Guide for an example of Spray package and Transfer Process package input for the special HS film-tracking "rain" application. Note that radionuclides associated with the condensate film in the HS package currently are not transferred with the "rain" to the Spray package; they stay with the remaining film on the structure.

For each droplet type, the following computation is done in each control volume in the spray train. Spray droplet heatup and cooldown in a steam environment are modeled using a correlation for forced convection heat transfer coefficients. Similarly, evaporation and condensation are modeled using a correlation for mass transfer coefficients. The heat and mass transfer correlations have been formulated specifically for high temperature atmospheres, such as might be encountered during a hydrogen burn.

These coefficients are used to compute heat and mass transfer rates, which are integrated by a Runge-Kutta method over the fall height of the spray droplet to obtain the final droplet mass and temperature. By comparing the droplet mass and temperature at the bottom of the compartment to the inlet conditions, the heat transfer and mass transfer to a given droplet are computed. Total heat and mass transfer rates are calculated by multiplying the rates for one droplet by the total number of droplets of that size and summing over all droplet sizes. It is assumed that this total heat and mass transfer rate is constant over a given timestep, and it is also assumed that the containment atmosphere conditions do not change significantly during the fall time of the drop.

The user can describe how droplets falling from one control volume are to be carried over to lower control volumes. The user may designate that specified fractions of those droplets be transferred to one or more additional control volumes for continued heat and mass transfer to the atmosphere. (These droplets are currently treated independently of other spray trains involving those control volumes.) Alternatively, a separate control volume may be designated as the containment spray sump. Droplets reaching the bottom of a control volume and not carried over to other volumes will be placed in the pool of the sump control volume. Otherwise, droplets reaching the bottom of a control volume and not carried over to other volumes nor placed in a separate sump are put into the pool of that control volume.

It should be noted that the SPR package does not model interactions between spray droplets and other structures (nor does any other MELCOR package). Thus, it is not possible to model either core sprays or steam generator auxiliary feed water sprays properly using the SPR package.

WARNING

The SPR Package is coupled to the MELCOR Radionuclide (RN) package for the calculation of aerosol washout and atmosphere decontamination by the sprays. Current limitations of this interface require some restrictions on the input to the SPR package to avoid nonphysical results associated with multiple calculations in the same control volume. When the SPR and RN packages are both active, the user should limit the spray input so that <u>only one spray train passes through each control volume and only a single drop size</u> is used in this spray train.

2. User Input

2.1 MELGEN Input

2.1.1 Spray Source Data

The user must define the control volumes in which the spray sources are located. The user may optionally define the elevations of the spray sources if the sources are not at the top of the control volumes. The user may optionally input the numbers of the control functions determining whether the spray sources are on or off. Also, for each source the user must define the droplet initial temperature, the spray flow rate, and the droplet size distribution.

SPRSRnn00 – Spray Source Name, Control Volume, Control Function

01 ≤ nn ≤ 99, nn is the user-defined spray source number (may be any value—contiguous numbers are not necessary).

Required

This record allows the user to define a spray source name, the number of the control volume containing the spray source, and the elevation of the source in that control volume. The user can define an optional control function determining whether the spray source is on or off, a control volume containing the water reservoir, a flag to stop the calculation if the reservoir becomes dry, the pool elevation below which the reservoir is declared to be "dry" and the pool elevation that must be reached before spray operation can resume following "dryout."

(1) SPNAME - Character string defining a name for spray source.
(type = character*16, default = none)

(2) IVOL - Number of control volume containing the spray source.
(type = integer, default = none)

(3) FALLHS - Elevation of the spray source in control volume IVOL source. If this number is not input, the top elevation of control volume IVOL will be used. The value of FALLHS must be between the bottom and top elevations of control volume IVOL.
(type = real, default = top elevation of control volume IVOL, units = m)

(4) ISPCON - Number of logical control function to be used in determining whether spray source is on or off. If the control function value is .TRUE., the spray source is on, if the value is .FALSE., the spray

source is off. If no number is input, or if the number is not greater than zero, the spray source is assumed to be always on.
(type = integer, default = -1)

(5) IVOLRS - Number of control volume containing reservoir (pool) for spray source. If no number is input, then the spray source is unidentified.
(type = integer, default = no entry)

(6) IFDRY - Reservoir "dryout" option flag: enter 0 to inactivate spray upon reservoir "dryout", enter 1 to stop calculation upon reservoir "dryout."
(type = integer, default = 0)

(7) ELDRY - Reservoir pool elevation at "dryout."
(type = real, default = CVBOT + 0.01*(CVTOP – CVBOT))

(8) ELWET - Reservoir pool elevation to resume spray after "dryout"
(type = real, default = ELDRY + 0.04*(CVTOP – CVBOT))

SPRSRnn01 – Spray Droplet Temperature and Flow Rate
$01 \leq nn \leq 99$, nn is the user-defined spray source.
Required

This record allows the user to define the initial spray droplet temperature and flow rate for the spray source. These values may be defined either as constants or by control functions. The optional fifth field is only used in conjunction with the Heat Structures (HS) package film-tracking "rain" model.

(1) TDROPO - Initial temperature of all droplets from this source. Used if control function ITMPCF is not input. The value of TDROPO must be between 273.15 and 647.245 even if the value will not be used because ITMPCF is input.
(type = real, default = none, units = K)

(2) SPFLO - Total spray volumetric flow rate from this source. Used if control function IFLOCF is not input. The value of SPFLO must be greater than or equal to zero even if the value will not be used because IFLOCF is input.
(type = real, default = none, units = m^3/s)

(3) ITMPCF - Number of real-valued control function whose value is the initial temperature (K) of all droplets from this source. The value of the control function must be between 273.15 and 647.245. This field

is optional. If it is positive, the control function ITMPCF will be used for the droplet temperature and TDROPO is not used.
(type = integer, default = 0)

(4) IFLOCF - Number of a real-valued control function whose value is the total spray flow rate (m^3/s) for this source. The value of the control function must be greater than or equal to zero. This field is optional. If it is positive, the control function IFLOCF will be used for the flow rate and SPFLO is not used.
(type = integer, default = -1)

(5) IHSTP - "Out" transfer process number associated with the "in" transfer process that the Heat Structures package uses to transfer "rain" from the film-tracking model to the Spray package. If IHSTP is input, the specifications of temperature (TDROPO or ITMPCF) and flow (SPFLO or IFLOCF) will not be used.
(type = integer, default = "not used")

SPRSRnnmm – Spray Droplet Size Distribution
01 ≤ nn ≤ 99, nn is the user-defined spray source.
02 ≤ mm ≤ 99, mm is used for ordering the input.
Required

This record allows the user to define the initial spray droplet diameter and relative frequency for a droplet type in the spray source. One record per droplet type, maximum number of droplet types per source is 5.

Note: When the RadioNuclide package is active, radionuclide washout by sprays is automatically calculated. However, the radionuclide washout calculations used with caution when multiple spray droplet sizes and/or spray trains are present in the same control volume. For this reason, the user is strongly urged to avoid multiple droplet sizes and multiple spray trains in any control volumes where radionuclide washout calculations are to be performed.

(1) DIAMO - Initial diameter for this droplet type from this source. The value of DIAMO must be greater than zero.
(type = real, default = none, units = m)

(2) DRFREQ - Relative frequency in source for this droplet type. The value of each frequency must be between 0.0 and 1.0 and the frequencies of all droplets from a source must sum to 1.
(type = integer, default = none, units = none)

2.1.2 Spray Junction Data

Spray droplets reaching the bottom of a control volume may be carried over to other control volumes. The fraction of these droplets entering each subsequent control volume is specified by the user. If the sum of the specified fractions for a given 'from' volume is CAROVR, then CAROVR must be no greater than one. If CAROVR is less than one, and the "from" control volume is not in the list of control volumes emptying into the sump (see Section 2.1.3), then a fraction (1 – CAROVR) of the droplets is placed into the pool of the "from" volume. Spray droplets from a given spray source may pass through no more than 20 spray junctions.

SPRJUNmm – Spray Junction Volumes, Transmission Factors

01 ≤ mm ≤ 99, mm is the user-defined spray junction number (may be any value—contgiuous numbers are not necessary).
Optional

(1) KCVFM - "From" control volume number for this junction
(type = integer, default = none)

(2) KCVTO - "To" control volume number for this junction
(type = integer, default = none)

(3) FRSPTI - Fraction of spray droplets reaching bottom of "from" volume that are to be transported into "to" volume. Must be between 0 and 1.
(type = real, default = none, units = none)

2.1.3 Spray Sump Data

The user may optionally define the control volume that contains the sump. The sump is a pool into which spray droplets will be deposited if the droplets reach the bottom of user-selected control volumes and are not carried over into other control volumes. The user may define a list of control volumes from which droplets will enter the sump. If the sum of the transmission factors for a volume in that list is CAROVR, then a fraction (1 – CAROVR) of the droplets reaching the bottom of the volume is placed into the sump. At present, no more than one sump may be defined.

SPRSUMP0 – Spray Sump Control Volume

Optional

(1) MCVSUM - Number of the control volume containing the sump.
(type = integer, default = none)

SPRSUMPn – Control Volumes which Empty Sprays into Sump
$1 \leq n \leq 9$, n is used for ordering input.
Optional

These records are required if any spray droplets are to fall into the sump.

(1) ICVISM - Number of a control volume through which spray droplets may fall into sump. Up to 10 control volumes may be entered on a record. These control volume numbers must have already been input on either spray source or spray junction records.
(type = integer, default = none)

2.2 MELCOR Input

There is at present no MELCOR input to the containment sprays package.

3. Sensitivity Coefficients

The *sensitivity coefficient* feature in MELCOR is a powerful feature that gives the user the ability to change selected parameters the physics models that would otherwise require modification of the Fortran source code. Their use is described in Section 7 of the MELCOR EXEC Users' Guide.

3.1 SPR Sensitivity Coefficients

The sensitivity coefficients for the containment sprays package have identifier numbers from 3000 through 3099.

3000 – Correlation Coefficients for Terminal Droplet Velocity and Reynolds Number

This correlation is used for velocity and Reynolds number calculations. Three correlations are considered to take into account different expressions for the drag coefficient based on the Reynolds number.

$$
\begin{aligned}
C_d &= C3000(1)\mathrm{Re}^{C3000(2)} && \text{for} && \mathrm{Re} < C3000(4) \\
&= C3000(5)\mathrm{Re}^{C3000(6)} && \text{for } C3000(4) < && \mathrm{Re} < C3000(8) \\
&= C3000(9) && \text{for C3000(8)} < && \mathrm{Re}
\end{aligned}
$$

The elements of sensitivity coefficient array 3000 are not independent. The following relationships should be observed:

$$C3000(3) = 2.0 + C3000(2)$$

$$C3000(7) = 2.0 + C3000(6)$$

$$C3000(4) = [C3000(1) / C3000(5)] ** \{1 / [C3000(6) - C3000(2)]\}$$

$$C3000(8) = [C3000(5) / C3000(9)] ** \{-1 / C3000(6)\}$$

(1) - Multiplier for low Reynolds number
(default = 27.0, units = none, equiv = DIVVEL)

(2) - Exponent for low Reynolds number
(default = -0.84, units = none, equiv = EXDVVL)

(3) - 2 + C3000(2)
(default = 1.16, units = none, equiv = INEXVL)

(4) - Breakpoint between low and medium Reynolds correlations
(default = 77.737154, units = none, equiv = FRBKRY)

(5) - Multiplier for medium Reynolds number
(default = 0.271, units = none, equiv = DVVEL2)

(6) - Exponent for medium Reynolds number
(default = 0.217, units = none, equiv = EDVVL2)

(7) - 2 + C3000(6)
(default = 2.217, units = none, equiv = IEXVL2)

(8) - Breakpoint between medium and high Reynolds correlations
(default = 10006.443, units = none, equiv = SCBKRY)

(9) - Drag coefficient at high Reynolds numbers
(default = 2.00, units = none, equiv = DVVEL3)

3001 – Correlation Coefficients for Mass Transfer

This correlation is used to calculate the mass derivative. It uses the mass transfer correlation described in the SPR Package Reference Manual.

$$F(\mathrm{Re}, Sc) = C3001(3) + C3001(4)\mathrm{Re}^{C3001(5)}\, Sc^{C3001(6)}$$

C3001(1) is the leading multiplier in the correlation and must be negative, and C3001(2) should not be changed.

(1) - Leading multiplier for derivative of mass with respect to time equation
(default = -2.0, units = none, equiv = MLDMDT)

(2) - Additive factor in log expression
(default = 1.0, units = none, equiv = LGDMDT)

(3) - Additive factor in Reynolds-Schmidt number combination
(default = 1.0, units = none, equiv = ADRYSC)

(4) - Multiplicative factor in Reynolds-Schmidt number combination
(default = 0.25, units = none, equiv = MLRYSC)

(5) - Exponent for Reynolds number
(default = 0.5, units = none, equiv = EXREYN)

(6) - Exponent for Schmidt number
(default = 0.3333, units = none, equiv = EXSCHM)

4. Plot Variables and Control Function Arguments

The Containment Sprays package's variables that may be used for plot variables and control function arguments are described below. The control function arguments are denoted by a 'c.' The plot variable arguments are denoted by a 'p.' The 'c' or 'p' characters are inside slashes '/' following the variable name.

SPR-TP.n	/cp/	Temperature of spray droplets from source n (units = K)
SPR-FL.n	/cp/	Flow rate of spray droplets from source n (units = m^3/s)
SPR-HTTRAN.j	/cp/	Rate of heat transfer from sprays to steam in control volume j (units = W)
SPR-MSTRAN.j	/cp/	Rate of mass transfer from sprays to steam in volume j (units = kg/s)
SPR-SUMPHT.j	/cp/	Rate of heat transfer from sprays to pool in sump control volume j (units = W)
SPR-SUMPMS.j	/cp/	Rate of mass transfer from sprays to pool in sump control volume j (units = kg/s)

5. Example Input

5.1 Sample Problem Description

Containment is nodalized into 5 control volumes, numbered 100, 110, 120, 130, and 140. Two spray sources with different characteristics are defined. Source 2, in volume 100, has three droplet sizes and source 6, in volume 110, has two droplet sizes. Seventy percent of the droplets leaving volume 100 fall into volume 120, with the rest falling into volume 110. All droplets leaving volumes 110 and 120 fall into volume 130. Volume 140 is designated as the sump and all droplets leaving volume 130 are to enter the sump volume.

5.2 Sample Problem MELGEN User Input

```
*
*    MELGEN INPUT
*
*    ************************************************
*    *                                      |SRC. 2*
*    *                                      |______*
*    *                  100                        *
*    *                                             *
*    ************************************************
*    * SRC. 6|     *                               *
*    *_______|     *                               *
*    *             *                               *
*    *    110      *           120                 *
*    *             *                               *
*    *             *                               *
*    ************************************************
*    *                                             *
*    *                                             *
*    *                  130                        *
*    *                                             *
*    ************************************************
*    *                                             *
*    *                  140                        *
*    *                  SUMP                       *
*    *                                             *
*    ************************************************
*
* CONTAINMENT SPRAY INPUT
*
* TWO SPRAY SOURCES WITH SEVERAL DROP SIZES, JUNCTIONS
*    WITH DROPLETS FALLING INTO A SUMP
*
```

```
*         SUMP INFO
*
*         SUMP CONTROL VOLUME
SPRSUMP0            140
*         CONTROL VOLUME OVER SUMP
SPRSUMP1       130
*
*         SPRAY JUNCTION DATA
*
*         FROM VOL  TO VOL    TRAN FAC
SPRJUN05    100       110       0.3
SPRJUN15    100       120       0.7
SPRJUN25    110       130       1.0
SPRJUN35    120       130       1.0
*
*         SPRAY SOURCE DATA
*
*                        SOURCE 2
*         NAME           VOL  ELEV      ON/OFF CF
SPRSR0200 MAINSPRAY      10   10.0      -1
*
*              TEMP  FLOW  TEMPERATURE CF    FLOW CF
SPRSR0201      300.   2.5  -1                -1
*
*         THREE DROPLET SIZES
*          DIAM      REL. FREQ.
SPRSR0202  1.0E-3        0.6
SPRSR0203  .5E-3         0.3
SPRSR0204  .25E-3        0.1
*
*                        SOURCE 6
*          NAME          VOL       ELEV      ON/OFF CF
SPRSR0600  BACKUPSPRAY   110       10.0      -1
*
*          TEMP     FLOW   TEMPERATURE CF    FLOW CF
SPRSR0601  320.     1.3    -1                -1
*
*                   TWO DROPLET SIZES
*                   DIAM      REL. FREQ.
SPRSR0602           0.75E-3        0.75
SPRSR0603           0.66E-3        0.25
*
```

5.3 Inventory-Limited Spray Sample Input

It is often necessary to simulate situations where the inventory of spray source water is limited. For example, if the spray source water is taken from a tank, the sprays must be shut off when the tank runs dry. The following control functions simulate this situation. They assume that control function 100 has already been formulated to represent the demanded spray volumetric flow rate. The remaining input integrates the spray flow rate and shuts off the sprays when the total spray flow reaches 1000.0 m^3.

```
*
* CF 100 (NOT SHOWN) IS DEMANDED SPRAY VOLUMETRIC FLOW RATE
*
* THIS CONTROL FUNCTION INTEGRATES THE DEMANDED FLOW RATE
*
CF10100   TOTAL     INTEG     2    1.0  0.0
CF10101   0.0
CF10110   1.0       0.0       CFVALU.100
CF10111   1.0       0.0       TIME
*
* THIS CONTROL FUNCTION GIVES ( 1000 M**3 - INTEGRAL FLOW ), SO
* IT IS NEGATIVE IF MORE THAN 1000 M**3 HAS BEEN DEMANDED.  THEN
* IT TAKES THE 'SIGN' FUNCTION OF THE DIFFERENCE, GIVING A VALUE
* +1 IF INTEGRAL IS LESS THAN 1000 M**3, AND -1 IF GREATER.  THE
* VALUE IS THEN LIMITED TO BE BETWEEN 0.0 AND 1.0.  THUS, THE
* RESULT OF THIS CONTROL FUNCTION IS:
* 0.0     IF INTEGRAL IS GREATER THAN 1000 M**3 (FLOW IMPOSSIBLE)
* 1.0     IF INTEGRAL IS LESS THAN 1000 M**3 (FLOW IS POSSIBLE)
*
CF10200   MULTIPLIER     SIGNI     1    1.0  0.0
CF10201    1.0
CF10202    3        0.0       1.0
CF10210   -1.0      1000.0    CFVALU.101
*
* NOW MULTIPLY DEMANDED SOURCE BY FLOW POSSIBLE MULTIPLIER (ABOVE)
CF10300   SPSOURCE  MULTIPLY  2    1.0  0.0
CF10310   1.0  0.0  CFVALU.100
CF10311   1.0  0.0  CFVALU.102
*
* THIS CONTROL FUNCTION (103) MUST BE REFERENCED ON SPRAY PACKAGE
* RECORD SPRSRNN01 AND REPRESENTS THE ACTUAL VOLUMETRIC FLOW RATE
* TO BE SENT TO THE SPRAYS
```

6. Example Output

In the following output listings, the term "volume weighted frequency" is defined as the sum over all droplet sizes of the droplet frequency multiplied by the cube of the droplet diameter. The sign convention is positive for heat and mass transfer from the spray droplets to the control volume.

6.1 MELGEN Output

```
***** CON SPRAY SETUP EDIT *****

TOTAL NUMBER OF CON SPRAY SOURCES    =   2
TOTAL NUMBER OF CON SPRAY VOLUMES    =   4
TOTAL NUMBER OF CON SPRAY JUNCTIONS =   4

EDIT OF CON SPRAY SOURCE NUMBER    2
CON SPRAY NAME = MAINSPRAY
SPRAY SOURCE CONTROL VOLUME = 100
SPRAY SOURCE SPRAY VOLUME INDEX =  1
SPRAY SOURCE VOLUME SUMP INDEX =   0
SPRAY SOURCE ELEVATION = 0.10000D+02
SPRAY SOURCE CONTROL FUNCTION =    -1

DROPLET TEMPERATURE =    0.30000D+03
DROPLET TEMPERATURE CONTROL FUNCTION =  -1
DROPLET FLOW RATE = 0.25000D+01
DROPLET FLOW RATE CONTROL FUNCTION =    -1
VOLUME WEIGHTED FREQUENCY =   0.63906D-09
DATA FOR THE   3 DROPLET GROUPS IN THIS SOURCE
**** DROPLET GROUP 1 ****
INITIAL DROPLET DIAMETER =    0.10000D-02
DROPLET FREQUENCY = 0.60000D+00
DROPLET FLOW RATE = 0.44828D+10
INITIAL DROPLET MASS =   0.52133D-06
**** DROPLET GROUP 2 ****
INITIAL DROPLET DIAMETER =    0.50000D-03
DROPLET FREQUENCY =      0.30000D+00
DROPLET FLOW RATE =      0.22414D+10
INITIAL DROPLET MASS =   0.65166D-07
**** DROPLET GROUP 3 ****
INITIAL DROPLET DIAMETER =    0.25000D-03
DROPLET FREQUENCY =      0.10000D+00
DROPLET FLOW RATE =      0.74713D+09
INITIAL DROPLET MASS =      0.81457D-08

EDIT OF JUNCTION DATA FOR THE 4 JUNCTIONS
IN THE FLOW PATH FOR THIS SOURCE
JUNCTION 1 FROM SPRAY VOL 1 TO SPRAY VOL 2 TRAN FAC 0.30000D+00
JUNCTION 2 FROM SPRAY VOL 2 TO SPRAY VOL 4 TRAN FAC 0.10000D+01
JUNCTION 3 FROM SPRAY VOL 1 TO SPRAY VOL 3 TRAN FAC 0.70000D+00
JUNCTION 4 FROM SPRAY VOL 3 TO SPRAY VOL 4 TRAN FAC 0.10000D+01

EDIT OF CON SPRAY SOURCE NUMBER    6
CON SPRAY NAME = BACKUPSPRAY
```

```
SPRAY SOURCE CONTROL VOLUME = 110
SPRAY SOURCE SPRAY VOLUME INDEX =  2
SPRAY SOURCE VOLUME SUMP INDEX =   0
SPRAY SOURCE ELEVATION = 0.10000D+02
SPRAY SOURCE CONTROL FUNCTION =    -1
DROPLET TEMPERATURE =    0.32000D+03
DROPLET TEMPERATURE CONTROL FUNCTION =  -1
DROPLET FLOW RATE = 0.13000D+01
DROPLET FLOW RATE CONTROL FUNCTION =    -1
VOLUME WEIGHTED FREQUENCY =   0.38828D-09
DATA FOR THE 2 DROPLET GROUPS IN THIS SOURCE
**** DROPLET GROUP 1 ****
INITIAL DROPLET DIAMETER =    0.75000D-03
DROPLET FREQUENCY = 0.75000D+00
DROPLET FLOW RATE = 0.47958D+10
INITIAL DROPLET MASS =   0.21842D-06
**** DROPLET GROUP 2 ****
INITIAL DROPLET DIAMETER =    0.66000D-03
DROPLET FREQUENCY = 0.25000D+00
DROPLET FLOW RATE = 0.15986D+10
INITIAL DROPLET MASS =   0.14885D-06

EDIT OF JUNCTION DATA FOR THE 1 JUNCTIONS
IN THE FLOW PATH FOR THIS SOURCE

JUNCTION 1 FROM SPRAY VOL 2 TO SPRAY VOL 4 TRAN FAC 0.10000D+01

EDIT OF CON SPRAY JUNCTION NUMBER  5
'FROM' CONTROL VOLUME NUMBER =     100
'TO' CONTROL VOLUME NUMBER =  110
TRANSMISION FACTOR =     0.30000D+00

EDIT OF CON SPRAY JUNCTION NUMBER  15
'FROM' CONTROL VOLUME NUMBER =     100
'TO' CONTROL VOLUME NUMBER =  120
TRANSMISSION FACTOR =    0.70000D+00

EDIT OF CON SPRAY JUNCTION NUMBER  25
'FROM' CONTROL VOLUME NUMBER =     110
'TO' CONTROL VOLUME NUMBER =  130
TRANSMISSION FACTOR =    0.10000D+01

EDIT OF CON SPRAY JUNCTION NUMBER  35
'FROM' CONTROL VOLUME NUMBER =     120
'TO' CONTROL VOLUME NUMBER =  130
TRANSMISSION FACTOR =    0.10000D+01
```

```
EDIT OF SPRAY VOLUME AND CONTROL VOLUME TABLE

SPRAY VOLUME   CONTROL VOLUME CARRY-OVER FRACTION SUMP INDEX
1              100            0.100D+01           0
2              110            0.100D+01           0
3              120            0.100D+01           0
4              130            0.000D+00           1

EDIT OF CONTROL VOLUMES CONNECTED TO SUMP CONTROL VOLUME = 140

130
```

6.2 MELCOR Output

```
****************************************
*   CONTAINMENT SPRAY PACKAGE EDIT     *
****************************************

CONTAINMENT SPRAY SOURCES

SOURCE     CONTROL VOL    DROP TEMP TEMP DROP FLOW RATE FLOW
NO. NAME        NO.            K    CON FUN   M**3/SEC  CON FUN

2 MAINSPRAY    100  3.00000E+02    -1   2.50000E+00    -1
6 BACKUPSPRAY  110  3.20000E+02    -1   1.30000E+00    -1

NO. DROP SIZES STATUS
3         ON
2         ON

DROPLET DISTRIBUTIONS FOR SOURCE 2

GROUP  DIAMETER     REL. FREQ.     FLOW RATE      DROPLET MASS
NO.      M                         DROPS/SEC           KG

1    1.0000E-03     6.0000E-01     4.4828E+09     5.2133E-07
2    5.0000E-04     3.0000E-01     2.2414E+09     6.5166E-08
3    2.5000E-04     1.0000E-01     7.4713E+08     8.1457E-09

DROPLET DISTRIBUTIONS FOR SOURCE 6

GROUP  DIAMETER     REL. FREQ.     FLOW RATE      DROPLET MASS
NO.      M                         DROPS/SEC           KG

1    7.5000E-04     7.5000E-01     4.7958E+09     2.1842E-07
2    6.6000E-04     2.5000E-01     1.5986E+09     1.4885E-07
```

```
SPRAY JUNCTION DATA FOR SOURCE 2

JUNCTION NO.   FROM VOLUME    TO VOLUME TRANSMISSION FACTOR

5              100            110       3.00000E-01
25             110            130       1.00000E+00
15             100            120       7.00000E-01
35             120            130       1.00000E+00

SPRAY JUNCTION DATA FOR SOURCE 6

JUNCTION NO.   FROM VOLUME    TO VOLUME TRANSMISSION FACTOR

25             110            130       1.00000E+00

SPRAY HEAT AND MASS TRANSFER DATA

CONTROL VOL    HEAT TRAN RATE      MASS TRAN RATE
NO.                 W                   KG/S

100            -8.92000E+08        -3.02538E+02
110            -3.25078E+08        -8.97975E+01
120             1.03529E+07         2.46219E+01
130             2.58977E+07         6.15919E+01

SPRAY DROPLETS LEAVING THESE CONTROL VOLUMES WILL ENTER SUMP
VOLUME 140

130

SPRAY SUMP HEAT AND MASS TRANSFER DATA

CONTROL VOL    HEAT TRAN RATE      MASS TRAN RATE
NO.                 W                   KG/S

140            1.76877E+09         4.08073E+03

END OF EDIT FOR SPR
```

7. Diagnostics and Error Messages

A diagnostic message is printed whenever the differential equation solver is having difficulty integrating the droplet mass equation as the droplet falls through a control volume. This can occur when the problem is determined to be stiff.

A diagnostic message is printed if a droplet enters a control volume in which the saturation temperature corresponding to total pressure is lower than the temperature of the spray droplet. In that case, the heat and mass transfer rates are not calculated, though calculation of the fall of the droplet will continue.

A diagnostic message is printed if the code is not able to determine the equilibrium temperature of the spray droplet in the steam environment.