TGT-CALC-103-011

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|---|---|
| Project/System | Hall A Tritium Target |
| Number | PS-TGT-14-001 |
| Author | Dave Meekins |
| Date | 8/20/2015 |
| Applicable Codes and Standards | |

References:

- Pan and Rigdon, Tritium Oxidation in Atmospheric Transport

Description:

This calculation uses Hot Spot to predict the expected dose to workers and public (MEI of 300m). Two scenarios are discussed

- Full release of tritium target in acute 10 min interval at the top of the Hall A truck ramp
- Full release of tritium target in acute 10 min interval through the stack.

Assumptions include:

- Target load of 1100 Ci of T2
- Release is immediately converted to HT(90%)+HTO(10%)
- Topography is “city”
- Weather is class F
- DCF is FGR-13
- Inversion layer is enabled at 500m
- Resuspension is allowed

# 1 Truck Ramp Release

The conditions assume for the release at the top of the truck ramp are:

- Target load of 1100 Ci of T2
- Release is immediately converted to HT(90%)+HTO(10%)
    - This should be very conservative based on work given in references.
- Stability class “F” calm (conservative) and city.
- Wind speed at 10m height is 1 m/s
- Stack height 2m (average for truck ramp exit and HT will be released at the top of the ramp)
- Stack diam is 5m
- FGR-13 Dose conversion factor
- 4 day exposure time

## 1.1 Hot Spot results

The results are summarized in the Hot Spot output file below:

```
HotSpot  Version 3.0.2 Tritium Release
Aug 26, 2015 02:43 PM

Source Material          : Tritium
Material-at-Risk  (MAR)  : 1.1000E+03 Ci  10 % Tritium Oxide
Damage Ratio      (DR)   : 1.00
Airborne Fraction (ARF)  : 1.000
Respirable Fraction (RF) : 1.000
Leakpath Factor   (LPF)  : 1.000
Respirable Source Term   : 1.10E+03 Ci
Non-respirable Source Term : 0.00E+00 Ci
Physical Stack Height    : 2.0 m
Stack Exit Velocity      : 0.00 m/s
Stack Diameter           : 5.0 m
Stack Effluent Temp.     : 0.0 deg C
Air Temperature          : 0.0 deg C
Effective Release Height  : 2.00 m
Wind Speed (h=10 m)      : 1.00 m/s
Wind Direction           : 340.0 degrees  Wind from the NNW
Wind Speed (h=H-eff)     : 0.38 m/s
Stability Class (City)   : F
Respirable Dep. Vel.     : 0.00 cm/s
Non-respirable Dep. Vel.  : 8.00 cm/s
Receptor Height          : 1.5 m
Inversion Layer Height   : 500 m
Sample Time              : 10.000 min
Breathing Rate           : 3.33E-04 m3/sec
Distance Coordinates     : All distances are on the Plume Centerline
```

Maximum Dose Distance : 0.010 km
MAXIMUM TED : 1.5 rem
Inner Contour Dose : 0.100 rem
Middle Contour Dose : 0.080 rem
Outer Contour Dose : 0.010 rem
Exceeds Inner Dose Out To : 0.056 km
Exceeds Middle Dose Out To : 0.064 km
Exceeds Outer Dose Out To : 0.20 km

FGR-13 Dose Conversion Data - Total Effective Dose (TED)
Note: Dose Results Include HTO Skin Absorption

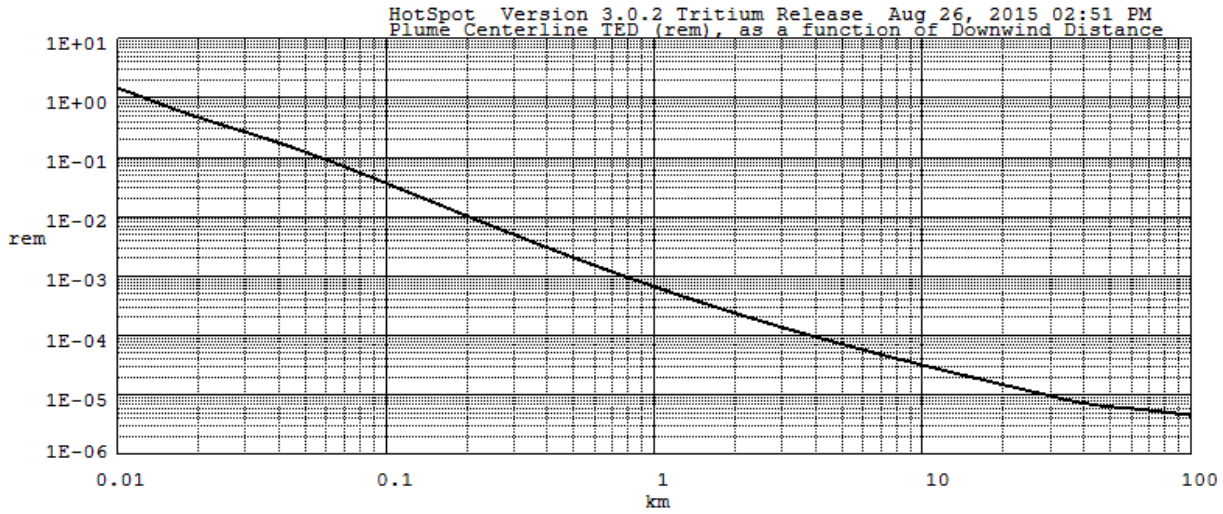
Include Plume Passage Inhalation and Submersion
Include Resuspension 0.35000
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

RESPIRABLE

| DISTANCE km | T E D (rem) | TIME-INTEGRATED AIR CONCENTRATION (Ci-sec)/m3 | ARRIVAL TIME (hour:min) |
|---|---|---|---|
| 0.010 | 1.5E+00 | 4.3E+02 | <00:01 |
| 0.100 | 3.7E-02 | 1.1E+01 | 00:04 |
| 0.200 | 1.0E-02 | 3.0E+00 | 00:08 |
| 0.300 | 5.0E-03 | 1.5E+00 | 00:13 |
| 0.400 | 3.0E-03 | 8.9E-01 | 00:17 |
| 0.500 | 2.0E-03 | 6.0E-01 | 00:21 |
| 0.600 | 1.5E-03 | 4.4E-01 | 00:26 |
| 0.700 | 1.2E-03 | 3.4E-01 | 00:30 |
| 0.800 | 9.4E-04 | 2.8E-01 | 00:35 |
| 0.900 | 7.8E-04 | 2.3E-01 | 00:39 |
| 1.000 | 6.6E-04 | 2.0E-01 | 00:43 |
| 2.000 | 2.4E-04 | 7.0E-02 | 01:27 |
| 4.000 | 9.4E-05 | 2.8E-02 | 02:55 |
| 6.000 | 5.7E-05 | 1.7E-02 | 04:22 |
| 8.000 | 4.1E-05 | 1.2E-02 | 05:50 |
| 10.000 | 3.2E-05 | 9.3E-03 | 07:17 |
| 20.000 | 1.5E-05 | 4.4E-03 | 14:35 |
| 40.000 | 7.2E-06 | 2.1E-03 | >24:00 |
| 60.000 | 5.9E-06 | 1.8E-03 | >24:00 |
| 80.000 | 5.1E-06 | 1.5E-03 | >24:00 |

## 1.2 Total effective Dose

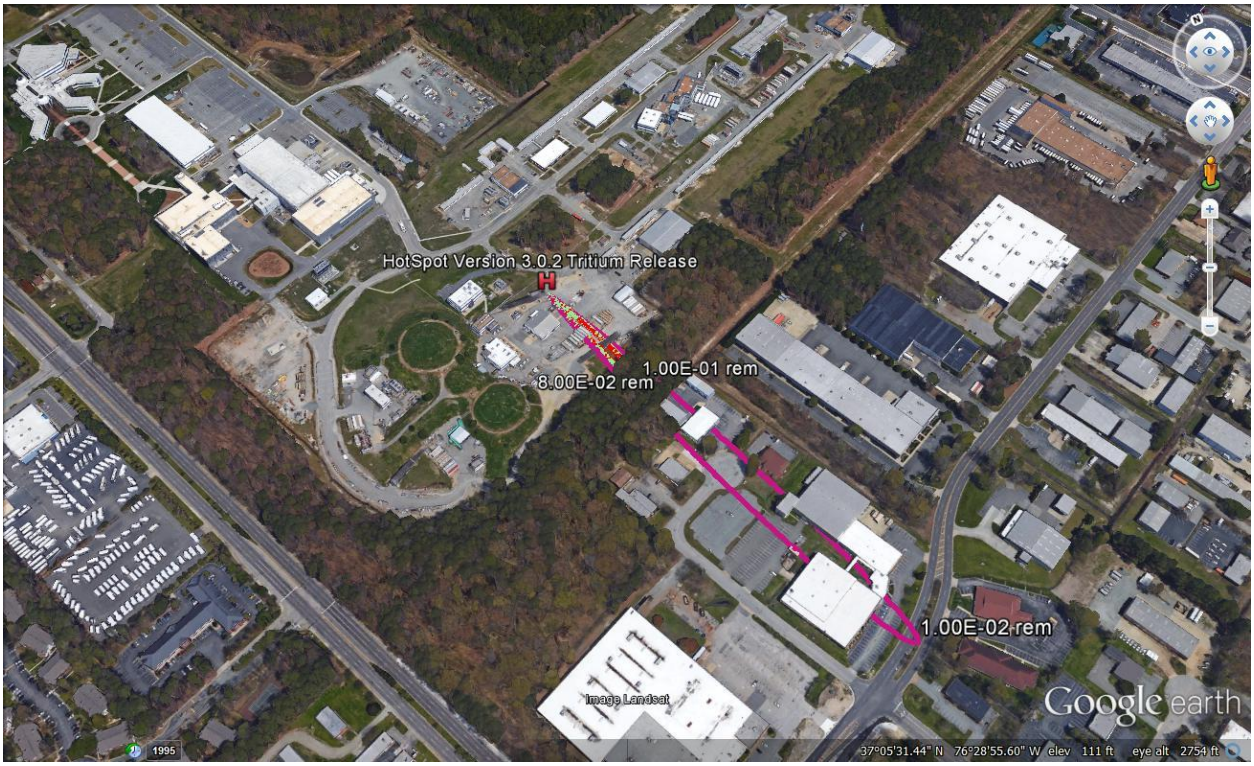
The following plot shows the total effective dose from this release condition:




```
Source Material      :Tritium
Total Tritium Release:1.1000E+03 Ci (10 % Tritium Oxide)
Eff. Release Height :2.00 m
Wind Speed (h=10 m) :1.00 m/s @ 340 deg
Stability Class (City):F (Sample Time: 10.00 min)
Deposition Velocity :0.00E+00 cm/s
Receptor Height     :1.5 m                    Inversion Layer Height :500 m
```

## 1.3 Map Overlay

A map overlay from Google Earth:



## 1.4 Case Summary

The model indicates that even for this worst case scenario with extremely conservative assumptions regarding the amount of HTO converted at release time that the JLAB MEI of 10 mrem at 300m is not exceeded. The dose to a worker positioned at the top of the ramp is expected to be about 1 rem (for 4 days of exposure time).

# 2 Stack Release

The second case considers a full release through the exhaust stack. The stack is assumed to be 20 m higher than the site boundary and positioned at the Northeast smoke removal blower on the Hall dome. The conditions assume for the release through the stack are:

- Target load of 1100 Ci of T2
- Release is immediately converted to HT(90%)+HTO(10%)
    - This should be very conservative based on work given in references.
- Stability class “F” calm (conservative) and city.
- Wind speed at 10m height is 1 m/s
- Stack height 20m (average for truck ramp exit and HT will be released at the top of the ramp)
- Stack diam is 0.5 m
- FGR-13 Dose conversion factor
- 4 day exposure time

## 2.1 Hot Spot results

The results are summarized in the Hot Spot output file below:

```
HotSpot  Version 3.0.2 Tritium Release
Aug 26, 2015 03:08 PM

Source Material          : Tritium
Material-at-Risk   (MAR)   : 1.1000E+03 Ci  10 % Tritium Oxide
Damage Ratio       (DR)   : 1.00
Airborne Fraction  (ARF)   : 1.000
Respirable Fraction (RF)   : 1.000
Leakpath Factor    (LPF)   : 1.000
Respirable Source Term     : 1.10E+03 Ci
Non-respirable Source Term : 0.00E+00 Ci
Physical Stack Height      : 20.0 m
Stack Exit Velocity        : 0.00 m/s
Stack Diameter             : 0.5 m
Stack Effluent Temp.       : 0.0 deg C
Air Temperature            : 0.0 deg C
Effective Release Height   : 20 m
Wind Speed (h=10 m)        : 1.00 m/s
Wind Direction             : 340.0 degrees  Wind from the NNW
Wind Speed (h=H-eff)       : 1.52 m/s
Stability Class (City)     : F
Respirable Dep. Vel.       : 0.00 cm/s
Non-respirable Dep. Vel.   : 8.00 cm/s
Receptor Height            : 1.5 m
Inversion Layer Height     : 500 m
Sample Time                : 10.000 min
```

Breathing Rate : 3.33E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.20 km
MAXIMUM TED : 9.61E-04 rem
Inner Contour Dose : 0.100 rem
Middle Contour Dose : 0.080 rem
Outer Contour Dose : 0.010 rem
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : Not Exceeded

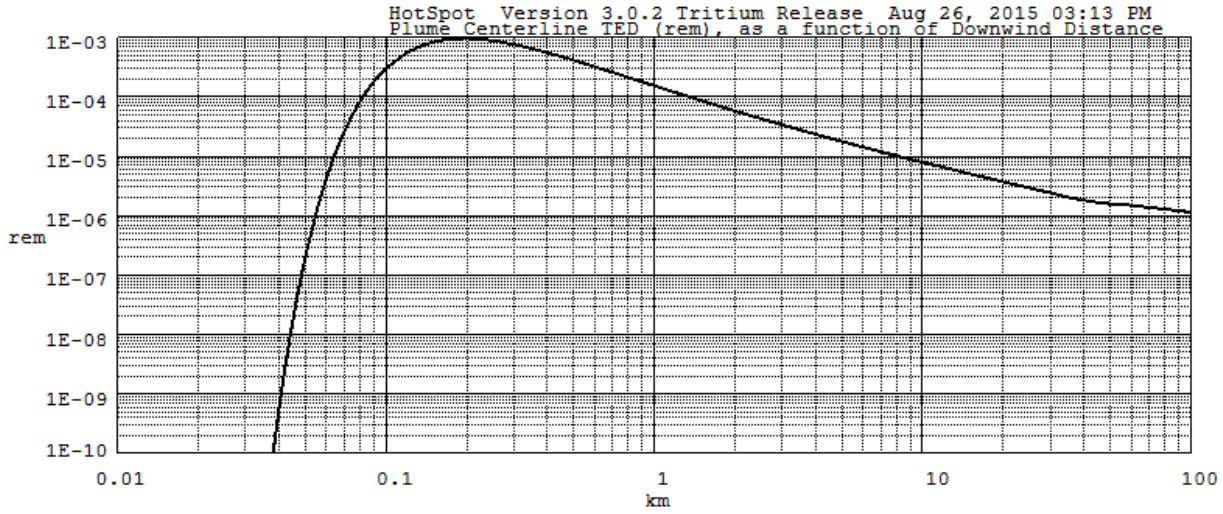
FGR-13 Dose Conversion Data - Total Effective Dose (TED)
Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension 0.35000
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

| DISTANCE | T E D | RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION | ARRIVAL TIME |
|---|---|---|---|
| km | (rem) | (Ci-sec)/m3 | (hour:min) |
| 0.030 | 1.7E-15 | 4.9E-13 | <00:01 |
| 0.100 | 3.0E-04 | 8.9E-02 | 00:01 |
| 0.200 | 9.6E-04 | 2.8E-01 | 00:02 |
| 0.300 | 7.6E-04 | 2.2E-01 | 00:03 |
| 0.400 | 5.5E-04 | 1.6E-01 | 00:04 |
| 0.500 | 4.1E-04 | 1.2E-01 | 00:05 |
| 0.600 | 3.2E-04 | 9.5E-02 | 00:06 |
| 0.700 | 2.6E-04 | 7.6E-02 | 00:07 |
| 0.800 | 2.1E-04 | 6.3E-02 | 00:08 |
| 0.900 | 1.8E-04 | 5.3E-02 | 00:09 |
| 1.000 | 1.5E-04 | 4.5E-02 | 00:11 |
| 2.000 | 5.8E-05 | 1.7E-02 | 00:22 |
| 4.000 | 2.3E-05 | 6.9E-03 | 00:43 |
| 6.000 | 1.4E-05 | 4.2E-03 | 01:05 |
| 8.000 | 1.0E-05 | 3.0E-03 | 01:27 |
| 10.000 | 7.9E-06 | 2.3E-03 | 01:49 |
| 20.000 | 3.7E-06 | 1.1E-03 | 03:39 |
| 40.000 | 1.8E-06 | 5.3E-04 | 07:19 |
| 60.000 | 1.5E-06 | 4.4E-04 | 10:59 |
| 80.000 | 1.3E-06 | 3.8E-04 | 14:39 |

## 2.2 Total effective dose

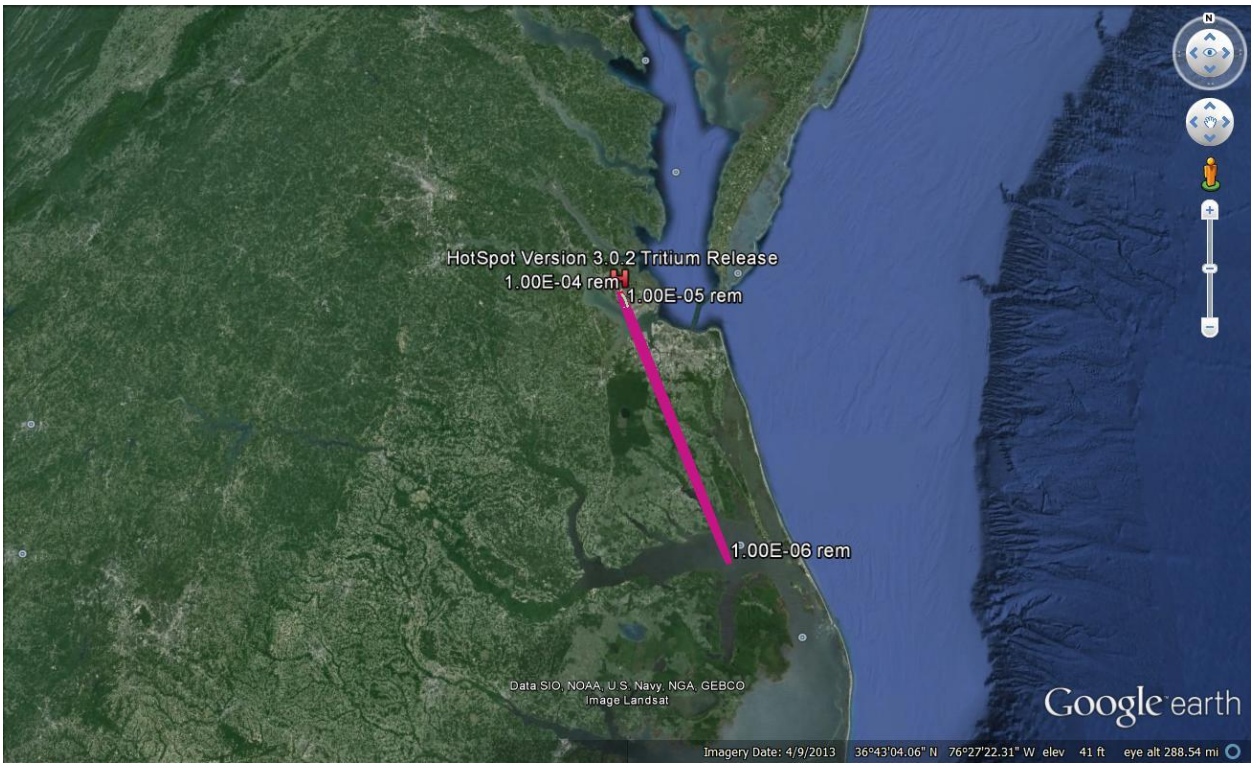
The following plot shows the total effective dose from this release condition:




```
Source Material      :Tritium
Total Tritium Release:1.1000E+03 Ci (10 % Tritium Oxide)
Eff. Release Height :20 m
Wind Speed (h=10 m) :1.00 m/s @ 340 deg          u (h=20 m)              :1.52 m/s
Stability Class (City):F (Sample Time: 10.00 min)
Deposition Velocity :0.00E+00 cm/s
Receptor Height      :1.5 m                      Inversion Layer Height :500 m
```

## 2.3 Map Overlay

A map overlay from Google Earth:




## 2.4 Case Summary

The model indicates that even for this worst case scenario with extremely conservative assumptions regarding the amount of HTO converted at release time that the JLAB MEI of 10 mrem at 300m is not exceeded. The dose to anyone positioned on the ground is expected to be less than 1 mrem (for 4 days of exposure time).