HLWYM HEmails

From: Osvaldo Pensado
Sent: Tuesday, August 07, 2007 11:57 AM
To: James Mancillas; 'PA_Group'; Nancy Adams; Philippe Dubreuilh; Donald Hooper
Subject: Seismic and Volcanic consequences discussion
Attachments: Seismic Undersampling Solution.ppt; Volcanic Convolution Method.ppt

See attachments for today's discussion.

Philippe, Nancy, and Don may be interested in attending.

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-----Original Message-----
From: James Mancillas [mailto:jmancillas@cnwra.swri.edu]
Sent: Tuesday, August 07, 2007 8:25 AM
To: jmancillas@cnwra.swri.edu; 'PA_Group'; 'Nancy Adams'; 'Philippe Dubreuilh'
Cc: 'Christopher Grossman'
Subject: RE: A137 Seismic Consequences Convolution meeting

Sorry I forgot to mention that it will be held on Tuesday August 7th .

James Mancillas

-----Original Message-----
From: James Mancillas [mailto:jmancillas@cnwra.swri.edu]
Sent: Monday, August 06, 2007 4:46 PM
To: PA_Group; Nancy Adams; Philippe Dubreuilh
Cc: 'Christopher Grossman'
Subject: A137 Seismic Consequences Convolution meeting

Reminder:

We will be having a meeting to discuss planning for seismic convolution approach as a comparison to the CNWRA's mean consequences with confidence bounds low-probability seismic event methodology. Anyone who is interested in approaches to dealing with low probability high consequence events is invited to attend.

I have reserved room A137 from 2:00 to 4:00 pm CST

James Mancillas

Hearing Identifier: HLW_YuccaMountain_Hold_EX
Email Number: 1026

Mail Envelope Properties (02ab01c7d90b$a34b57c0$d4c8a281)

Subject: Seismic and Volcanic consequences discussion
Sent Date: 8/7/2007 11:57:20 AM
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From: Osvaldo Pensado

Created By: opensado@cnwra.swri.edu

Recipients:
"James Mancillas" <jmancillas@cnwra.swri.edu>
Tracking Status: None
"'PA_Group'" <PA_Group@cnwra.swri.edu>
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"Nancy Adams" <nadams@cnwra.swri.edu>
Tracking Status: None
"Philippe Dubreuilh" <pdubreuilh@cnwra.swri.edu>
Tracking Status: None
"Donald Hooper" <dhooper@cnwra.swri.edu>
Tracking Status: None

Post Office: cnwra.swri.edu

Files	**Size**	**Date & Time**
MESSAGE	1401	8/7/2007 11:57:22 AM
Seismic Undersampling Solution.ppt	278080	
Volcanic Convolution Method.ppt	627264	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

An Approach to Calculating Mean Dose for Seismic Undersampling

Richard Codell

USNRC

August 6, 2007

Problem with Seismic Undersampling

- Seismic forces coupled with static load from drift collapse can lead to failures of waste packages.
- Possibility of large number of WP failures from large, but infrequent earthquakes.
- Smooth mean dose curves cannot be calculated by regular means because of unreasonably large number of realizations necessary.

One Solution to Seismicity Dose Calculation

1. From large number of realizations (or from external calculations), get mean number of seismic failures vs time of failure.
2. Correct mean number of failures for fraction wetted.
3. Generate a numerical table or fitted function of failures vs time. *i.e.*

$$N_{fail}=764.2 \times (1 - \exp(-0.00001\ t_{fail})$$

One Solution, Continued

4. Run TPA5.1 setting parameters so that only initial failures would occur.
5. Sample time of initial failure from U(0,Tmax)
6. Get number of initial failures and time of failure from WPSFAIL.RES file.
7. Get dose vs time for each realization from RGWSR.TPA file.

One Solution, Continued

8. Correct number of failures taken from WPSFAIL.RES by mean failure-vs-time function.
9. Using corrected number of failures, average all realizations into a mean dose vs time for seismic failures.

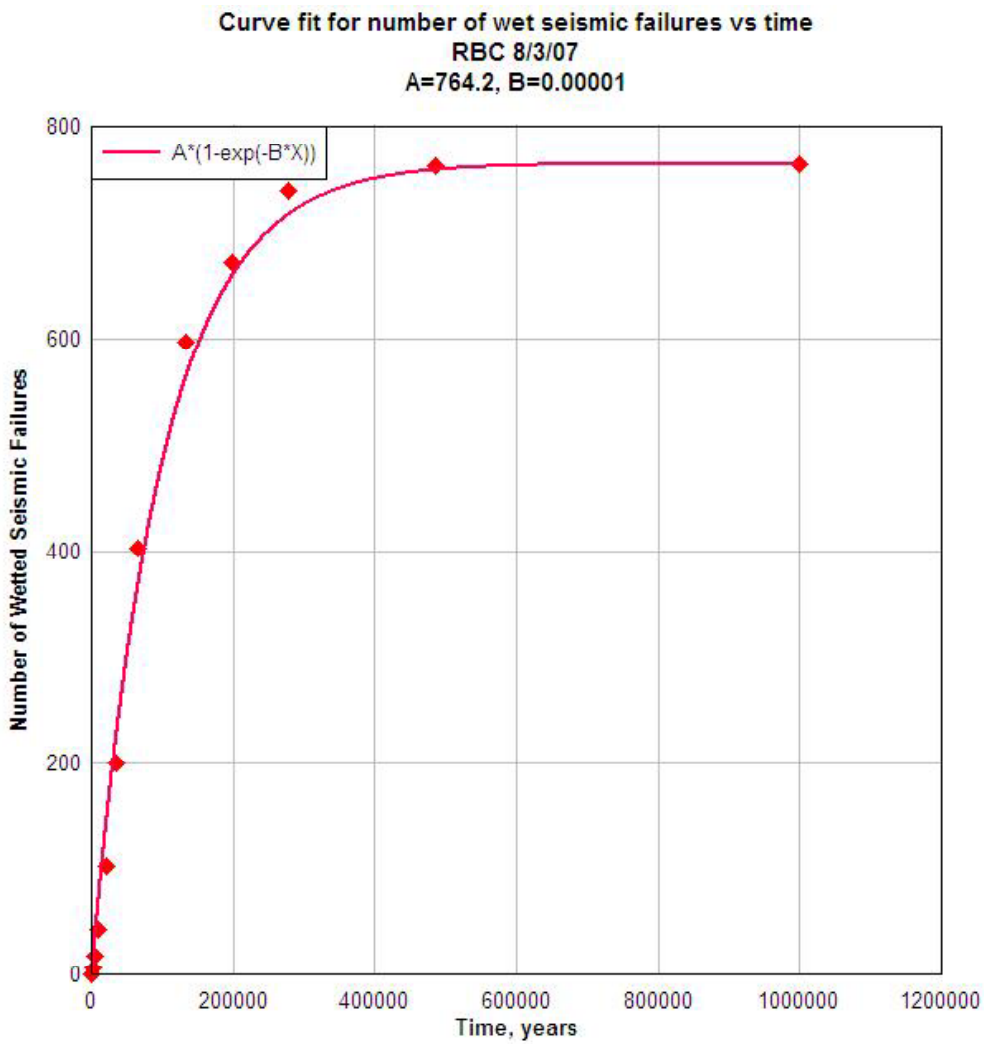
Example

- Example uses subarea 3 results only for fast calculation of proof of concept.
- 100,000 years, reduced radionuclide set.
- Run 1 – 512 LHS realizations, normal sampling except no seismicity.
- Run 2 – 512 LHS realizations, set up for no failures by corrosion or seismicity. Only initial failures with uniform distribution of failure times.

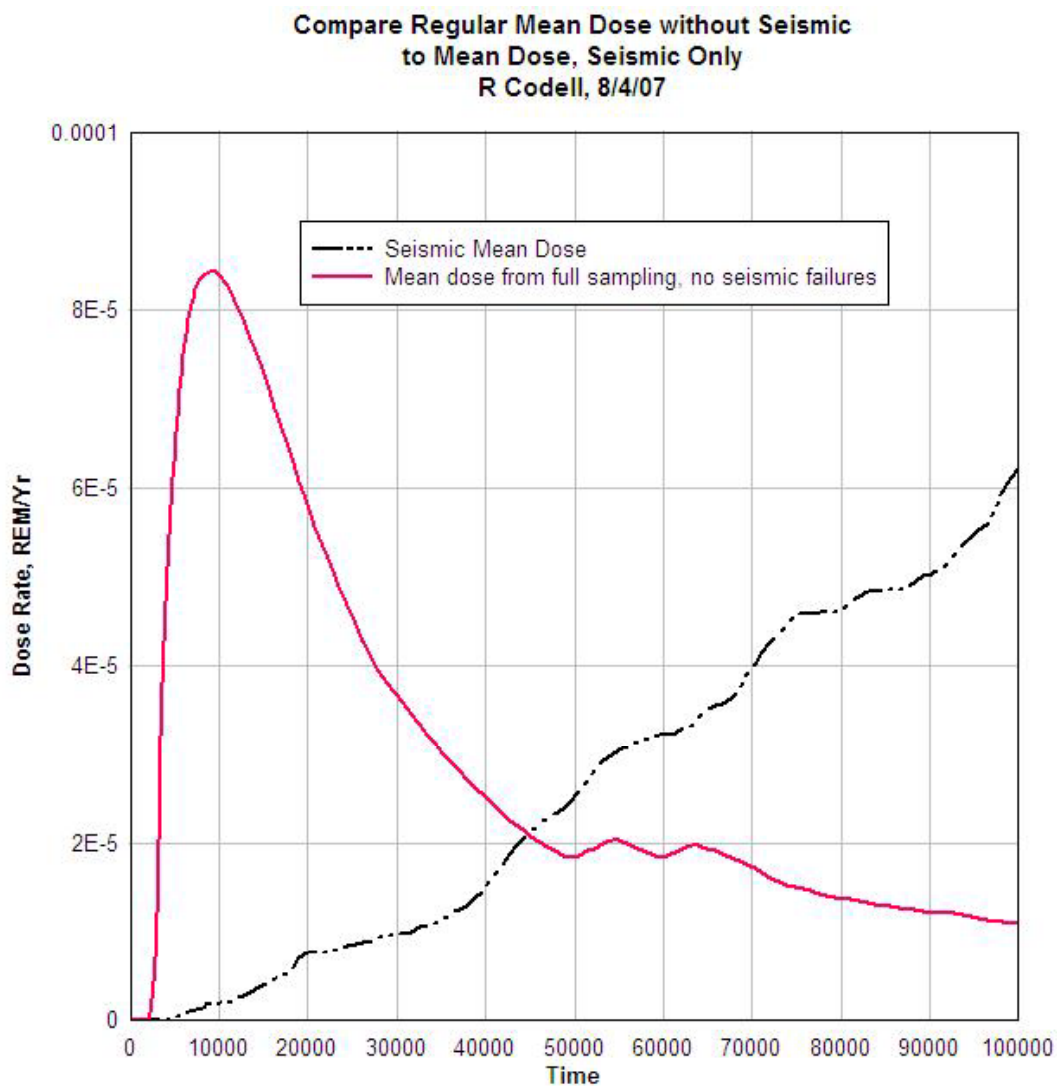
Example, Continued

- Wrote FORTRAN program CALCSEIS.F to get failure numbers from WPSFAIL.RES and doses from RGWSR.TPA, and combine them into a mean dose.
- Got mean seismic failure vs time from 4000 runs of TPA5.1 beta versions concatinated together and used to fit a simple distribution.

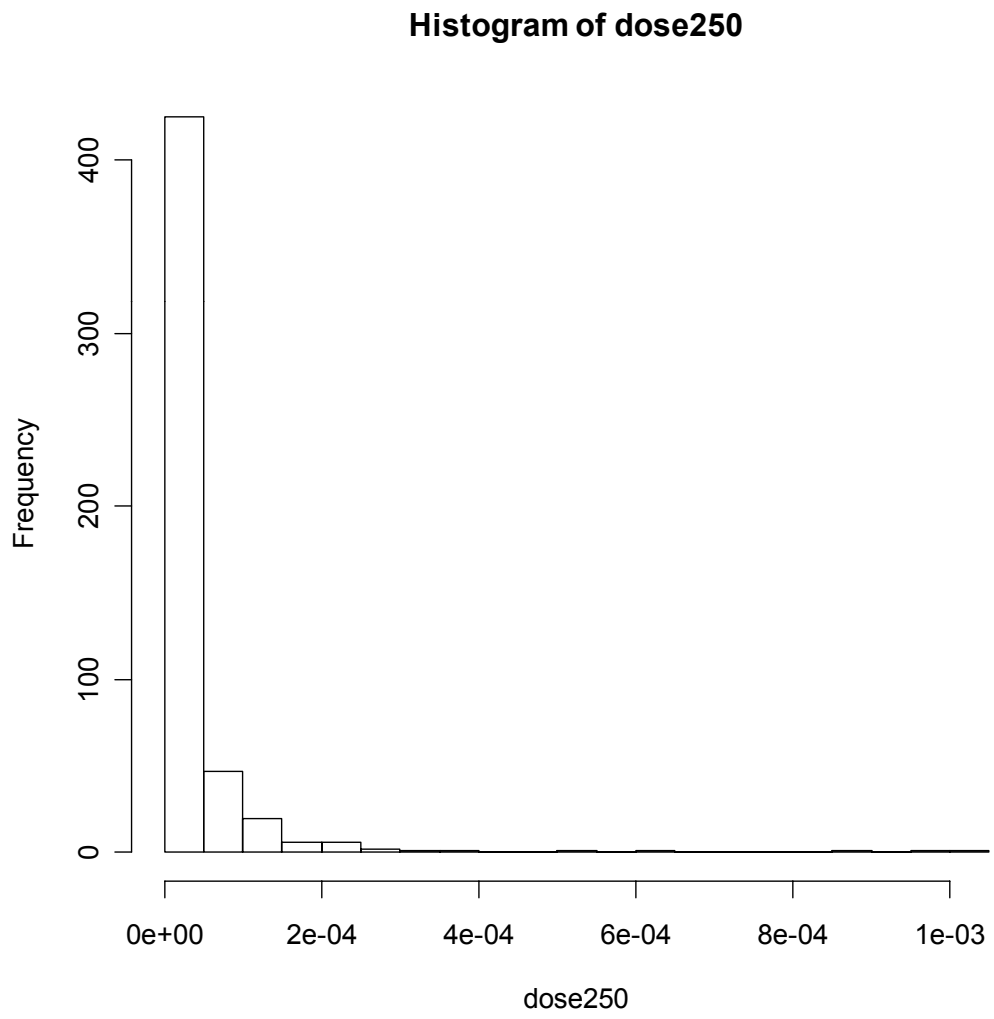
Seismic Failure Distribution from 4000 TPA Runs



Results Mean Seismic contribution



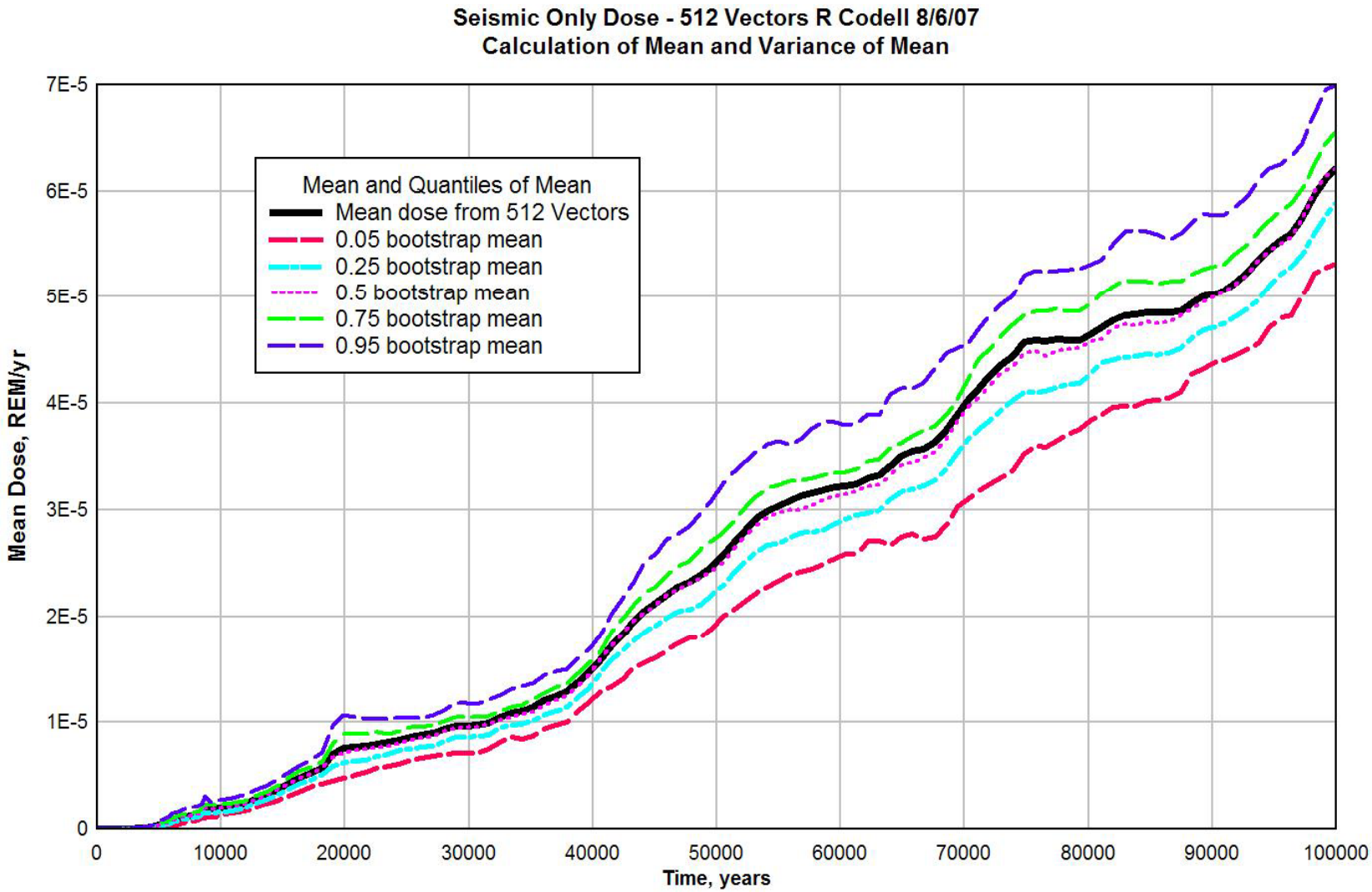
Distribution of Dose at Each Time is Highly Skewed



Calculation of Quantiles of Mean

- Calculated quantiles by “bootstrap” method.
- Uses sample distribution (512 samples) of dose at each time step.
- Samples randomly from that distribution with replacement and finds mean.
- Repeat for 100 means.
- Sorts all 100 bootstrap means to define quantiles.

Quantiles of Mean



Summary and Conclusions

- Procedure seems to work well and is easy to implement, with no TPA code changes necessary.
- Should have external routine to get good seismic failure rate curve (e.g., Osvaldo and James' algorithm in GoldSim).
- Uncertain about how to treat wetting of seismic failures in context of "initial failure" calculations.
- Quantiles of mean calculated by bootstrapping.

Volcanic Convolution Method

Richard Codell
USNRC
August 8, 2007

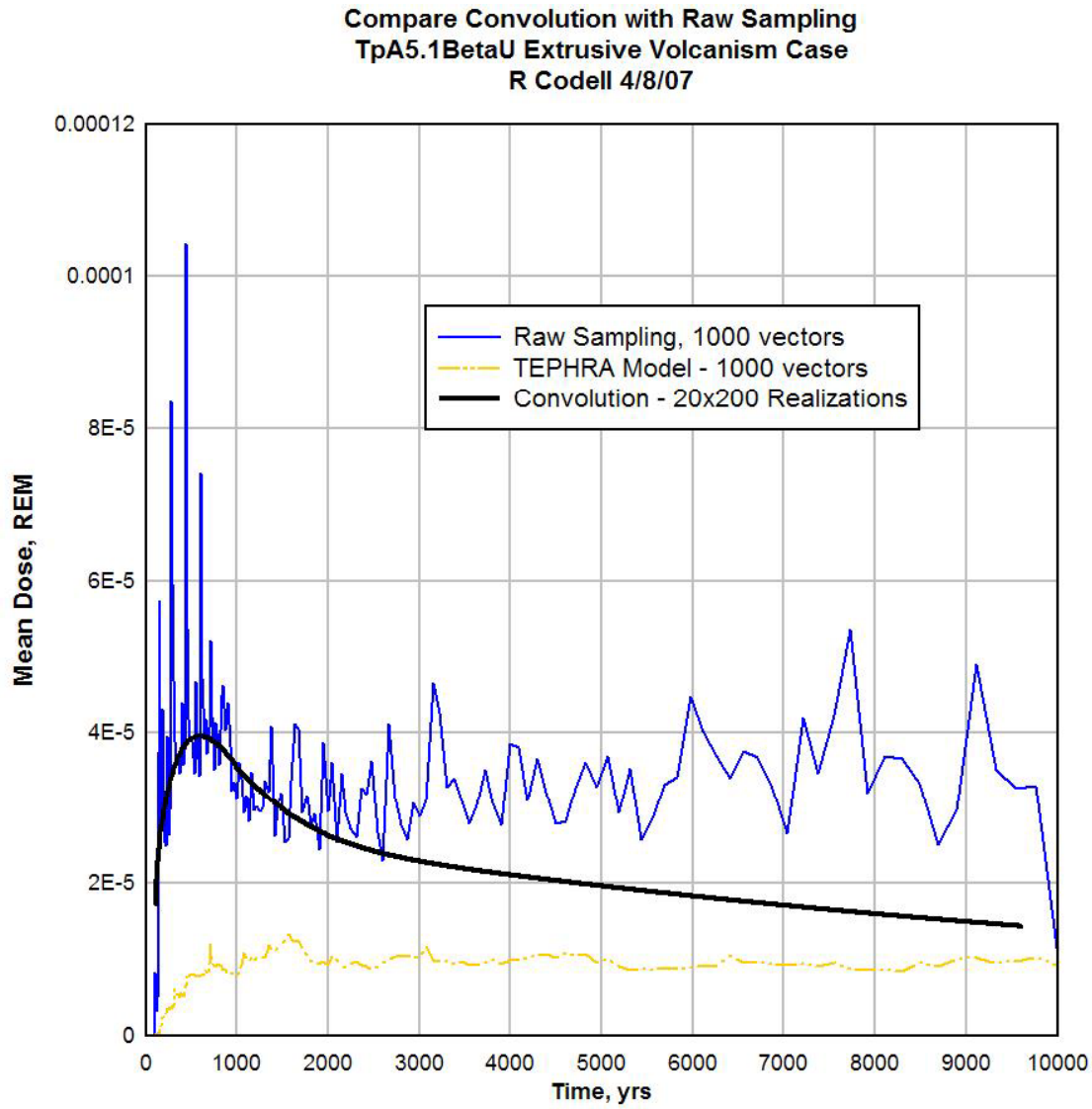
Problem Statement

- Latin Hypercube Sampling (LHS) works well for nominal release scenario, for which processes evolve slowly and predictably.
- Disruptive events (e.g., seismicity, volcanism) occur with low probability and frequently produce large doses.
- Calculation of the mean dose for disruptive events by normal LHS procedure may require inordinate number of realizations to produce a smooth dose curve.

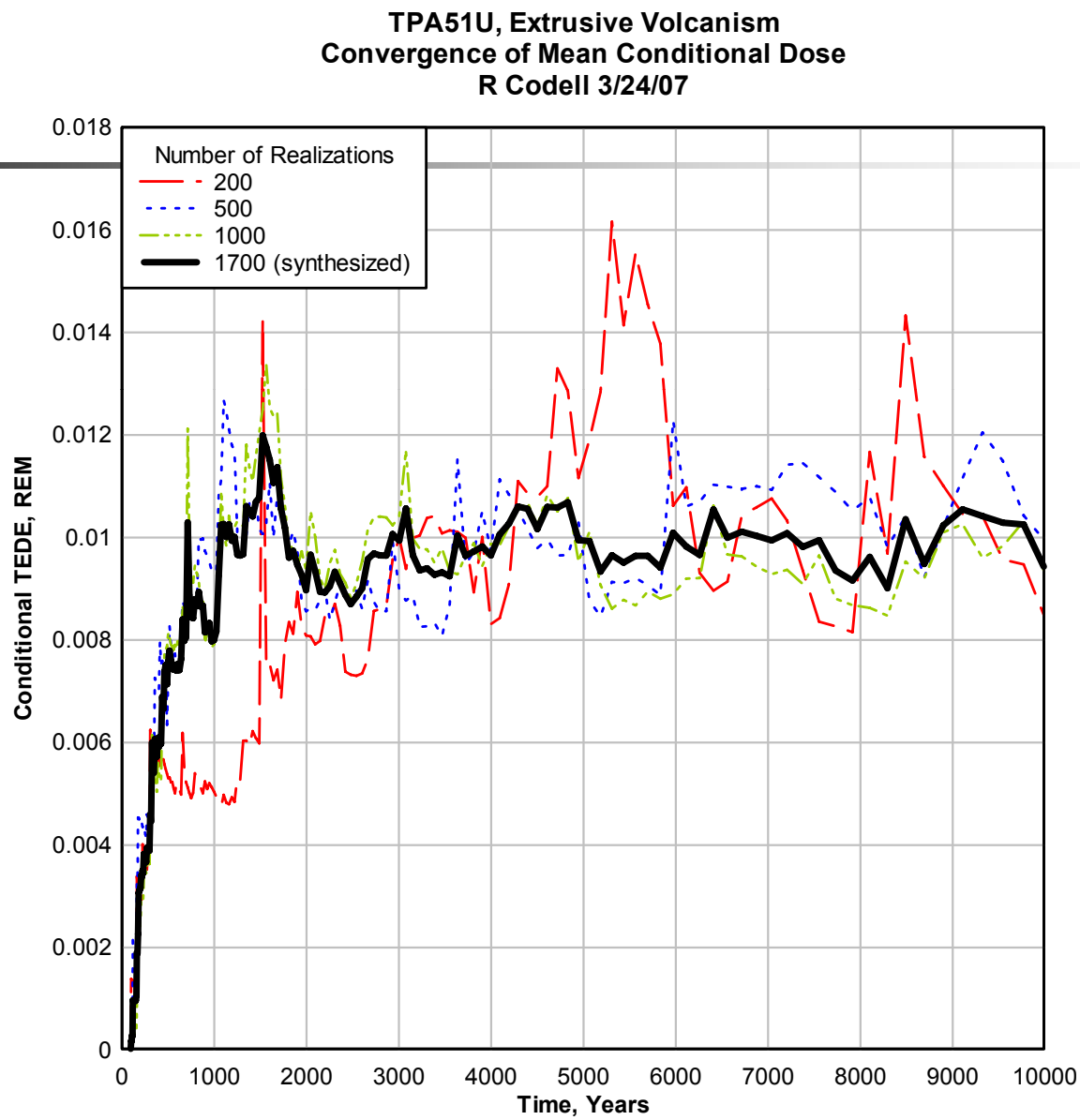
Disruptive Event Procedures

- Seismicity – Low-probability, large earthquakes can lead to relatively large doses. Procedures developed by CNWRA and NRC for this problem.
- Extrusive volcanism – Low-probability basaltic volcanism can lead to relatively large doses, with relatively short time constants. Procedure developed by NRC.

Poor Convergence with ASHPLUME Model



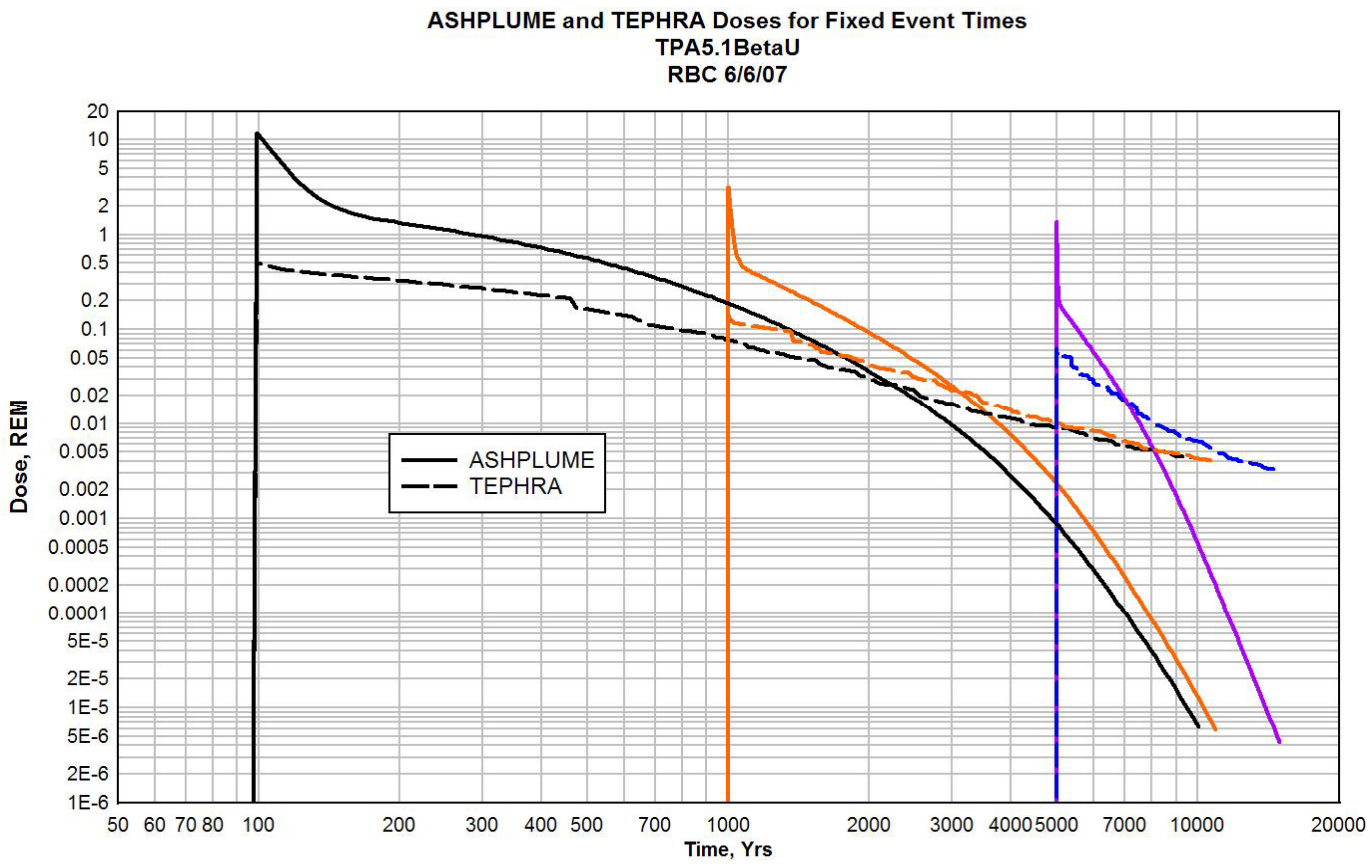
Better Convergence with TEPHRA Model



Convergence of Extrusive Volcanism Models with LHS

- TEPHRA results for mean dose reasonably converged within 1700 realizations (but hardly smooth).
- ASHPLUME results not well converged, even for many realizations.
- Difference in results because of longer time constant for TEPHRA model (i.e., redistribution processes relatively slow)

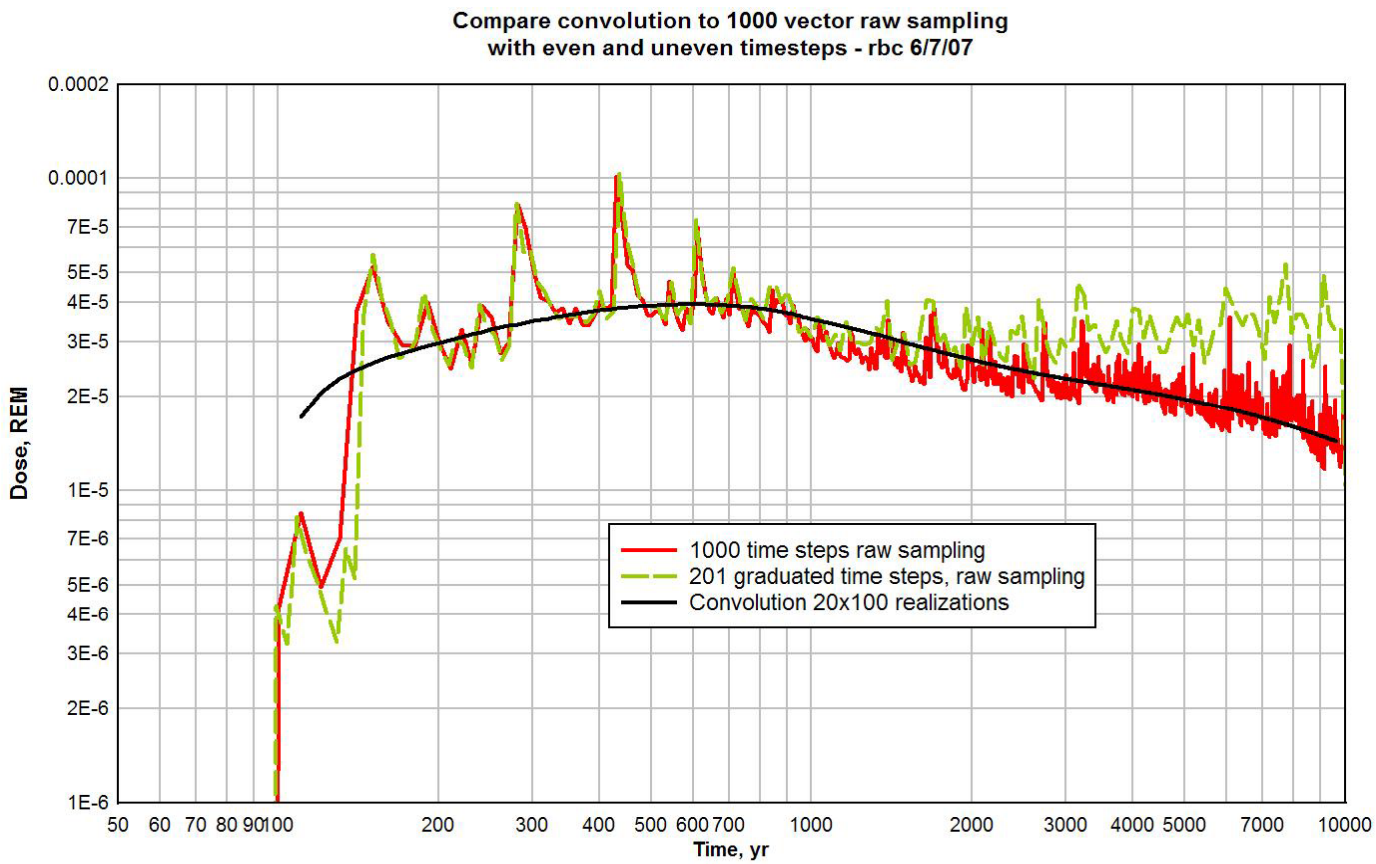
Conditional Doses for ASHPLUME and TEPHRA Models Showing Different Time Constants



Additional Problem with Straight LHS for Extrusive Volcanism

- Calculation of mean dose with LHS leads to appearance of mean remaining high at long times.
- Result is an artifact of default sampling with increasing time step length in TPA.
- Results improved by specifying fixed rather than variable time steps for extrusive volcanism.

Fixed vs Variable Time Steps for Extrusive Volcanism with ASHPLUME Model



Convolution Procedure

- A person living at time t' will only be at risk from events taking place prior to t'.
- Average annual conditional dose at time t' for and event at time t_e:

$$\overline{D}(t' \mid t_e) = f(t_e, t' - t_e)$$

$$\overline{D}(t' < t_e) \equiv 0$$

Convolution Procedure (Cont'd)

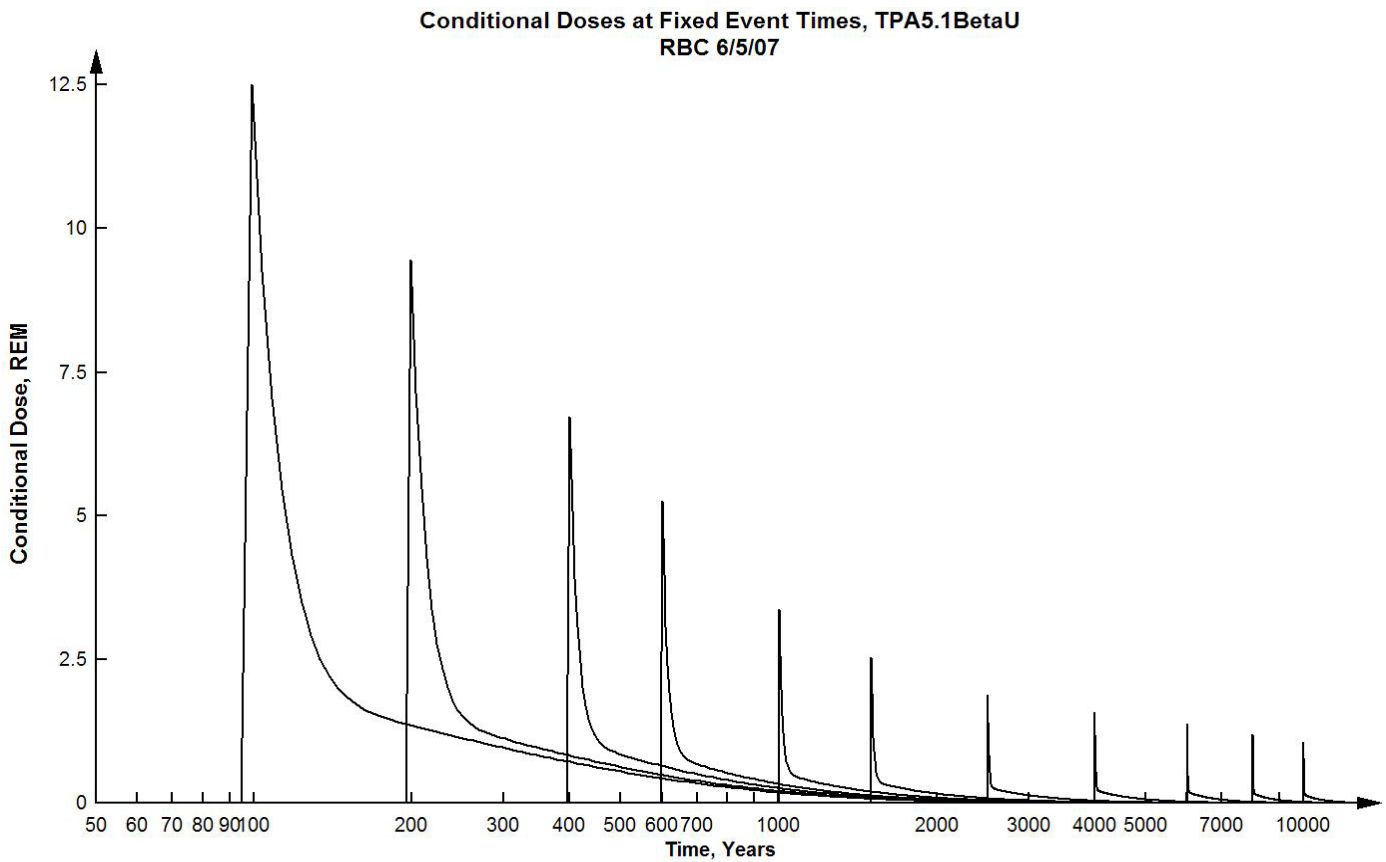
- Instantaneous dose to person living at time t' is convolution of all possible prior volcanic doses multiplied by probability of event:

$$\overline{D}(t') = p_r \int_{t_{\min}}^{t'} f(\tau, t' - \tau)\, d\tau$$

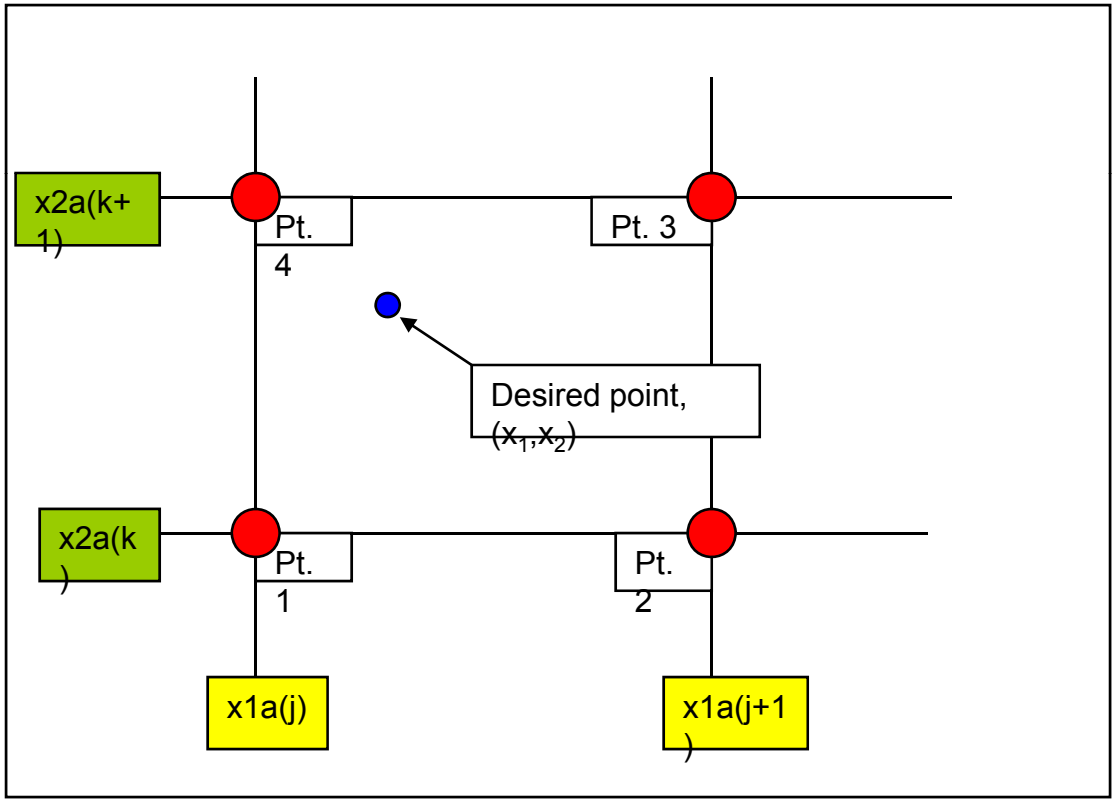
Implementation of Convolution Procedure

- Definition of main function $f(\tau, t' - \tau)$:
  - Mean doses calculated at discrete event times only, but function must be continuous.
  - Use bilinear interpolation (Press, 1994) to generalize function to any value of time of event and time after event.

Discrete Values of Mean Dose



Bilinear Interpolation



Program CVOLC7L – Main Convolution Procedure

- Combines mean dose files for fixed event times into a single dose vs. time curve for risk assessment.
- Uses log transform of time in all models for increased accuracy and efficiency of interpolation.

Manual Operation of Convolution Procedure

Multiple steps required to calculate mean dose by convolution:

1. Generate mean dose curves for fixed event times using *AverageCalenderYearAssumedForEmplacement[A.D.]*
2. Run TPA for 100 realizations. Get mean dose results from file RGSSA.TPA.

Manual Procedure (Cont'd)

3. Generate an input file specifying names of files containing mean dose information.

4. Run CVOLC7L to convolute mean doses into single overall mean dose curve.

Semi-Automated Procedure

- MS-DOS Script RUNVOLC.BAT to generate mean dose files from TPA:
- Uses program CHANGEAGE2 to modify burial date in TPA.INP file.
- When completed, run CVOLC7L to complete calculation of overall mean dose.

Fully Automated Procedure

Program CONVOTPA fully automates procedure:

- Generates mean dose files using CHANGEAGE2 and TPA
- Runs CVOLC7L to generate overall mean.
- Requires an input file CONVO.IN to specify model parameters.

File CONVO.IN for CONVOTPA Procedure

```
19      \nskip
1.0e-7,10,100,2033   \pvolc,dtlife,tmin,yrburied
tpa_volc_ashplume.inp                    \fname
volcte                                   \root
12      \nevents
100,200,300,400,500,600,700,1000,2000,3000,50
  00,10000          \tevent
```

Conclusions

- LHS works well for nominal case with slow evolution of processes, but not well for disruptive events with low probability, high consequences and short duration.
- Convolution procedure developed for extrusive volcanism case to generate a smooth mean dose curve with relatively few realizations.
- Manual to fully automated procedures.