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IMPACT OF DISPERSION PARAMETERS ON  
CALCULATED REACTOR ACCIDENT CONSEQUENCES

MASTER

David C. Aldrich

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ON CALCULATED REACTOR ACCIDENT CONSEQUENCES

David C. Aldrich  
Sandia Laboratories  
Albuquerque, New Mexico 87185

November 1979

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Albuquerque, New Mexico 87185  
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## Abstract

Much attention has been given in recent years to the modeling of the atmospheric dispersion of pollutants released from a point source. Numerous recommendations have been made concerning the choice of appropriate dispersion parameters. A series of calculations has been performed to determine the impact of these recommendations on the calculated consequences of large reactor accidents. Results of those calculations indicate that predicted accident consequences are in general not strongly sensitive to assumed dispersion parameters. However, adjustment of the Pasquill-Gifford dispersion curves for release duration and surface roughness, or use of the Vogt rather than Pasquill-Gifford curves, can have a significant impact on calculated early fatalities.

## TABLE OF CONTENTS

I.	Introduction . . . . .	9
II.	Dispersion Parameters. . . . .	11
III.	Calculation of Reactor Accident Consequences . .	23
IV.	Conclusions and Recommendations. . . . .	39

# IMPACT OF DISPERSION PARAMETERS ON CALCULATED REACTOR ACCIDENT CONSEQUENCES

## I. Introduction

The dispersion of radioactive pollutants released to the atmosphere as a result of a reactor accident would depend on the weather conditions during and following the release, the characteristics of the release (duration, release height, heat content\*...), characteristics of the site (surface roughness, topography...), and downwind distance from the release point. The hypothetical accidents addressed in the Reactor Safety Study (RSS)<sup>1</sup> have a broad range of release characteristics. Estimated release durations range from 0.5 to 10 or more hours. Initial release heights range from 0 to 25 meters, and plume rise ( $\Delta H$ ) can range from 0 to several hundred meters. Conditions at specific sites may range from flat grasslands (low surface roughness) to heavily forested areas with significant topography (high surface roughness). Early fatalities are calculated to be possible at distances of 50 km or more. Latent cancer fatalities can occur beyond 500 km. To accurately assess the consequences of these hypothetical reactor accidents, models incorporating dispersion parameters that are appropriate for the particular release and site are required.

Much attention has been given in recent years to the modeling of the atmospheric dispersion of pollutants released from a point source.<sup>2,3,4</sup> Numerous recommendations have been made concerning the choice of appropriate dispersion parameters.<sup>5,6</sup> The consequence

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\*The heat content of the released plume determines the extent of buoyant plume rise.

model (CRAC) of the RSS<sup>1,7</sup> used a modified Gaussian dispersion model with Pasquill-Gifford (PG) dispersion parameters<sup>8</sup> for releases of 0.5 hour duration.\* The PG curves, however, have important limitations. The curves were based on data obtained at distances of less than 1 km from the release point, for near-surface releases of 3 minute duration over terrain having a low surface roughness (grasslands, with roughness length\*\*  $r \approx 3$  cm).<sup>4</sup> A recent workshop<sup>6</sup> on models used for the atmospheric transport of radionuclides suggested the use of at least two sets of  $\sigma_y$  and  $\sigma_z$  curves.\*\*\* For surface releases, the PG curves were recommended with an adjustment for release duration suggested by Pasquill,<sup>9</sup> and with a surface roughness adjustment suggested by Briggs.<sup>5</sup> For elevated releases (including surface releases with considerable plume rise), use of either the Smith<sup>10</sup> or Vogt<sup>2</sup> curves was recommended. Pasquill<sup>4</sup> suggests an additional adjustment for wind direction shear to be used with the PG curves. A simple correction has also been proposed<sup>5</sup> to allow for the increased growth of  $\sigma_z$  due to plume buoyancy. Briggs<sup>1,3</sup> has proposed a set of interpolation formulas that agree with the PG curves out to 10 km, except for "unstable"  $\sigma_z$  values. Finally, Hosker<sup>11</sup> has suggested a set of equations for  $\sigma_z$  that depend on surface roughness as well as stability and downwind distance.

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\*0.5 hour was the shortest duration assumed in the RSS. Correction for longer release durations was made using the factor  $(\Delta t \text{ (hours)}/0.5)^{0.33}$ .

\*\*Normally termed  $z_0$ .

\*\*\* $\sigma_y$  and  $\sigma_z$  are the lateral and vertical dispersion parameters, respectively.

To determine the impact of the above recommendations on calculated reactor accident consequences, a series of calculations was performed using CRAC. The results of those calculations are presented and compared in this report. A brief description of the dispersion parameters and proposed adjustments used is provided in Section II. The calculation of reactor accident consequences is described in Section III, and conclusions and recommendations are presented in Section IV.

## II. Dispersion Parameters

The dispersion parameters and proposed adjustments introduced in the preceding section are briefly presented below. Further details are available in the references indicated.

### Pasquill-Gifford (PG) Curves<sup>2,3,4,5,6,8</sup>

The PG curves were based on diffusion measurements made to a distance of 800 m for near-surface releases of passive (i.e., nonbuoyant) tracer gas. CRAC<sup>1,7</sup> uses a series of equations that were fit to the PG curves by Martin and Tikvart<sup>12</sup> and reported by Eimutis and Konicek.<sup>13</sup> These equations are presented in Table 1 for stability categories A through F, and are compared in Figure 1 to the curves proposed by Briggs<sup>1,3</sup>. Note that the Martin and Tikvart equations for the vertical parameter,  $\sigma_z$ , are not applicable for small distances ( $x < \sim 300\text{m}$ ).

TABLE 1

Martin and Tikvart Equations for Pasquill-Gifford  
Dispersion Parameters, as used in CRAC

Stability Category	Dispersion Parameters	
	$\sigma_y$	$\sigma_z$
A	$0.3658x^{0.9031}$	$0.00024x^{2.094-9.6}$
B	$0.2751x^{0.9031}$	$0.055x^{1.098+2.0}$
C	$0.2089x^{0.9031}$	$0.113x^{0.911}$
D	$0.1471x^{0.9031}$	$1.26x^{0.516-13.0}$
E	$0.1046x^{0.9031}$	$6.73x^{0.305-34.0}$
F	$0.0722x^{0.9031}$	$18.05x^{0.18-48.6}$

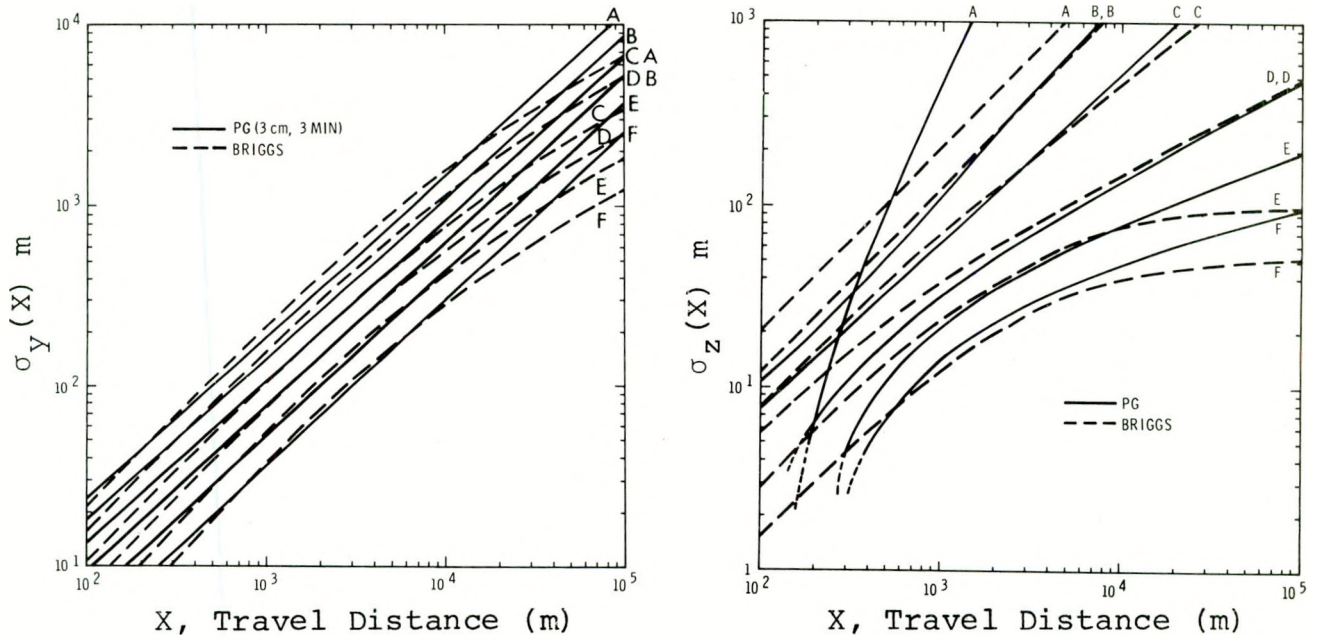


Figure 1. Comparison of Pasquill-Gifford (Martin and Tikvart fit) and Briggs Dispersion Parameters ( $\sigma_y$  and  $\sigma_z$ ) for Stability Categories A through F. Note that the vertical scales for the  $\sigma_y$  and  $\sigma_z$  plots are not the same.

### Release Duration Adjustment for PG Curves

The PG lateral dispersion curves ( $\sigma_y$ ) are based on data obtained for releases of 3 minute duration. It has therefore been suggested<sup>3,6,9</sup> that they should be adjusted for longer release durations ( $t_2$ ) using the following expression

$$\sigma_{y2}/\sigma_{y1} = (t_2/t_1)^{0.2} ,$$

where  $\sigma_{y1}$  is the unadjusted parameter, and  $t_1 = 3$  minutes.

### Surface Roughness Adjustment for PG Curves

The PG curves are based on data from releases over terrain with very low surface roughness (grasslands, with roughness length  $r \approx 3$  cm).<sup>5</sup> An adjustment for larger roughness lengths has been recommended:<sup>5,6</sup>

$$\sigma_{z2}/\sigma_{z1} = (r_2/r_1)^{0.2} ,$$

where  $\sigma_{z1}$  is the unadjusted parameter, and  $r_1 = 3$  cm. Estimated roughness lengths for various types of surfaces are given below.<sup>14</sup>

		<u>Roughness length, r(cm)</u>
Moderately rough	- short grass	0.1
	grass and crops	3-7
	rural	20
Rough	- woods	100
	suburbs	150
Very rough	- urban	100-400

#### Wind Shear Adjustment for PG Curves

Wind direction shear, or the turning of wind direction with height, can result in additional crosswind (lateral) spread that may become important at distances greater than 10 km.<sup>4</sup> Accordingly, for  $x \geq 20$  km, Pasquill<sup>4</sup> suggests the following approximate adjustment for wind direction shear:

$$\sigma_y^2 = \sigma_{yPG}^2 + 0.03\Delta\theta^2x^2 ,$$

where  $\sigma_{yPG}$  is the unadjusted parameter,  $\Delta\theta$ (radians) is the shear over the entire depth of the plume, and  $x$  is downwind distance.

#### Plume Rise ( $\Delta H$ ) Adjustment for PG Curves

The PG curves are based on data from passive (i.e., non-buoyant) ground level releases. For a buoyant plume, an additional dispersion process would be induced by the relative motion of the plume and the ambient air. Pasquill<sup>4</sup> has recommended a correction for the PG curves to account for this

added dispersion:

$$\sigma_z^2 = \sigma_{zPG}^2 + \Delta H^2/10 ,$$

where  $\sigma_{zPG}$  refers to the passive (i.e., non-buoyant) release parameter, and  $\Delta H$  is the height of plume rise above the release height.

### Briggs' Curves

Briggs has proposed<sup>3</sup> a series of interpolation formulas for  $\sigma$  curves that agree with the PG curves to distances of ~10 km, except for the A and B stability  $\sigma_z$  curves which approximate the very unstable and unstable curves recommended by Smith.<sup>10</sup> Briggs' formulas for open-country conditions (low surface roughness) are summarized in Table 2 and are compared to the Martin and Tikvart fit to the PG curves in Figure 1.

### Vogt Curves

The Vogt curves<sup>2</sup> are based on tracer experiments performed near Julich, West Germany, for release heights of 50 and 100 m. The releases had durations of 1 hour, and occurred over relatively rough terrain with roughness length  $\cong$  100 cm.<sup>6</sup> Measurements were taken at distances of up to 11 km from the release point. Dispersion parameters were evaluated separately for the two release heights, and are described by power functions

and 
$$\sigma_y(x) = p_y x^{q_y}$$

$$\sigma_z(x) = p_z x^{q_z}$$

TABLE 2

Briggs' Interpolation Formulas for  $\sigma_y(x)$  and  $\sigma_z(x)$ .  
 Open-Country Conditions

Stability Category	Dispersion Parameters	
	$\sigma_y$	$\sigma_z$
A	$0.22x(1 + 0.0001x)^{-1/2}$	$0.20x$
B	$0.16x(1 + 0.0001x)^{-1/2}$	$0.12x$
C	$0.11x(1 + 0.0001x)^{-1/2}$	$0.08x(1 + 0.0002x)^{-1/2}$
D	$0.08x(1 + 0.0001x)^{-1/2}$	$0.06x(1 + 0.0015x)^{-1/2}$
E	$0.06x(1 + 0.0001x)^{-1/2}$	$0.03x(1 + 0.0003x)^{-1}$
F	$0.04x(1 + 0.0001x)^{-1/2}$	$0.016x(1 + 0.0003x)^{-1}$

the coefficients of which are specified in Table 3 as a function of stability category. The Vogt curves for both 50 and 100m release heights are shown in Figure 2.

### Hosker and Smith $\sigma_z$ Curves

For a given stability category and roughness length,  $r$ , Hosker<sup>11</sup> has recommended the following expression for the vertical dispersion parameter,  $\sigma_z$ :

$$\sigma_z(x) = F(r,x)g(x)$$

$F(r,x)$ , a roughness correction factor, is defined as follows:

$$F(r,x) = \begin{cases} \ln c_1 x^{d_1} \left[ 1 + (c_2 x^{d_2})^{-1} \right] & \text{for } r > 10 \text{ cm} \\ \ln c_1 x^{d_1} \left[ 1 + c_2 x^{d_2} \right]^{-1} & \text{for } r < 10 \text{ cm} \end{cases}$$

Coefficients  $c_1$ ,  $d_1$ ,  $c_2$  and  $d_2$  are defined in Table 4.  $g(x)$  is defined as

$$g(x) = \frac{a_1 x^{b_1}}{1 + a_2 x^{b_2}}$$

with coefficients defined in Table 5. Similar expressions for roughness compensated  $\sigma_y$  curves have not yet been formulated. However, lateral dispersion is probably not strongly affected by surface roughness.

TABLE 3

Coefficients for Vogt 50 and 100 m Dispersion Parameter Power Functions

<u>Release Height</u>		<u>Stability Category</u>					
		<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>
50 m	$p_y$	0.87	0.87	0.72	0.62	1.69	5.38
	$q_y$	0.81	0.81	0.78	0.77	0.62	0.58
	$p_z$	0.22	0.22	0.21	0.20	0.16	0.40
	$q_z$	0.97	0.97	0.94	0.94	0.81	0.62
100 m	$p_y$	0.23	0.23	0.22	0.22	1.69	5.38
	$q_y$	1.00	0.97	0.94	0.90	0.62	0.58
	$p_z$	0.10	0.16	0.25	0.40	0.16	0.40
	$q_z$	1.16	1.02	0.89	0.76	0.81	0.62

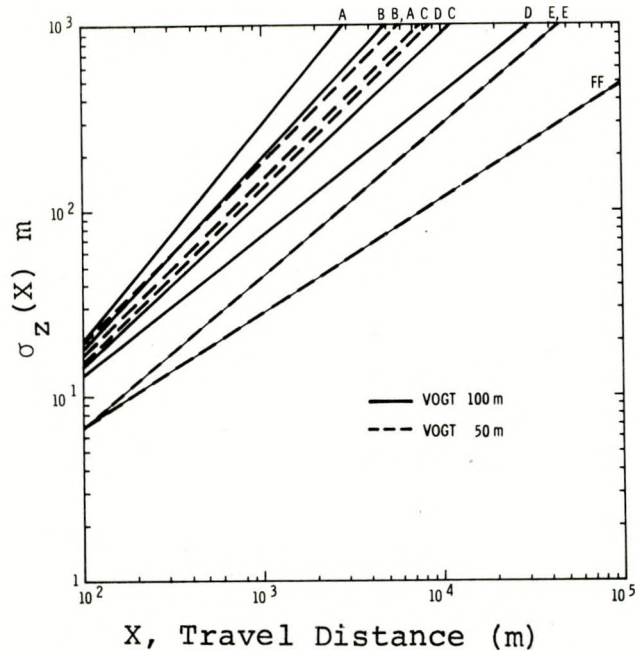
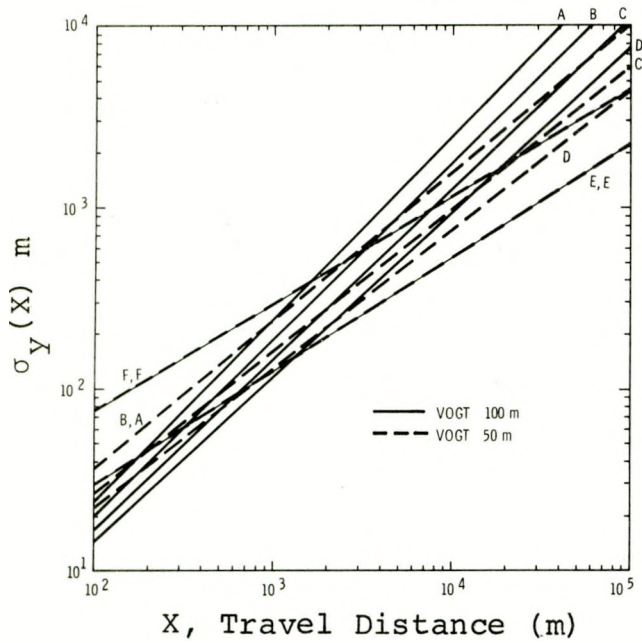


Figure 2. Vogt Dispersion Parameters ( $\sigma_y$  and  $\sigma_z$ ) for Release Heights of 50 and 100 m and Stability Categories A through F. Note that the vertical scales for the  $\sigma_y$  and  $\sigma_z$  plots are not the same.

TABLE 4

Coefficients of the Roughness Correction Factor  
 Used in Calculating  $\sigma_z(x)$  for Various Roughness Lengths  
 (x is given in meters)

Roughness length (cm)	$c_1$	$d_1$	$c_2$	$d_2$
1	1.56	0.0480	$6.25 \times 10^{-4}$	0.45
4	2.02	0.0269	$7.76 \times 10^{-4}$	0.37
10	2.718	0	0	0
40	5.16	-0.098	18.6	-0.225
100	7.37	-0.0957	$4.29 \times 10^3$	-0.60
400	11.7	-0.128	$4.59 \times 10^4$	-0.78

TABLE 5

Coefficients of the Function  $g(x)$ , Used in Calculating  
the Vertical Dispersion Coefficient  $\sigma_z(x)$ , as a Function of  
Stability Category ( $x$  is given in meters)

Stability Category	$a_1$	$b_1$	$a_2$	$b_2$
A	0.112	1.06	$5.38 \times 10^{-4}$	0.815
B	0.130	0.950	$6.52 \times 10^{-4}$	0.750
C	0.112	0.920	$9.05 \times 10^{-4}$	0.718
D	0.098	0.889	$1.35 \times 10^{-3}$	0.688
E	0.0609	0.895	$1.96 \times 10^{-3}$	0.684
F	0.0638	0.783	$1.36 \times 10^{-3}$	0.672

The Vogt curves for release heights of 50 and 100m are compared with the PG curves in Figures 3 and 4. For consistency, all of the  $\sigma_y$  curves in Figure 3 have been adjusted for a release duration of 30 minutes using the adjustment factor described above.\* Additionally, the PG  $\sigma_z$  curves in Figure 4 have been adjusted for a surface roughness length of 100 cm to correspond to the Vogt curves. Hosker and Smith  $\sigma_z$  curves are also presented in this figure for a roughness length of 100 cm. Because of the complexity of the Hosker and Smith expressions, their incorporation into CRAC would have been difficult. Therefore, they were not addressed further in this study.

### III. Calculation of Reactor Accident Consequences

To determine the impact of the above recommendations on calculated reactor accident consequences, a series of calculations was performed using CRAC. Consequences were calculated for the worst accident category in the RSS (PWR 1), assuming both COLD (small  $\Delta H$ ) and HOT (large  $\Delta H$ ) releases.<sup>1</sup> The assumed release duration was 0.5 hour. A uniform population density of 100 persons/mile<sup>2</sup>, and evacuation of persons within 25 miles with a speed of 1.2 mph were also assumed. Stability categories were assigned according to temperature lapse rate.<sup>1</sup>

For each adjustment or set of dispersion parameters, 91 weather sequences were used to calculate probability distributions

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\*The factor, although recommended for the PG curves, was used for the Vogt curves as well. However, the value of that factor for reducing a 1 hour release to 1/2 hour is only 0.87.

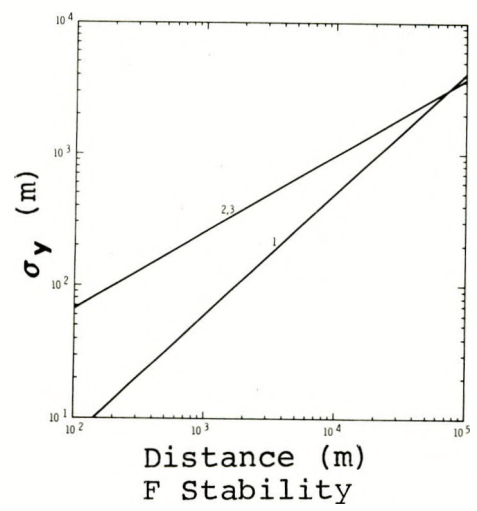
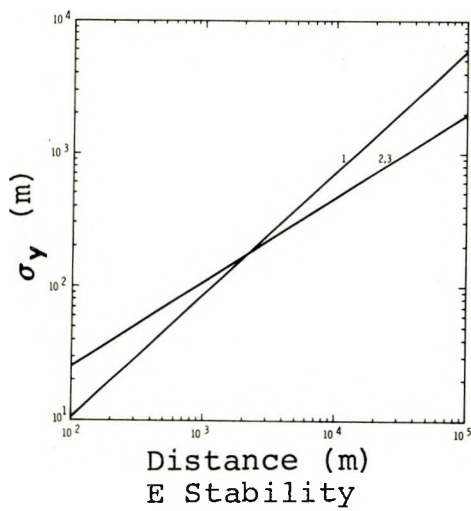
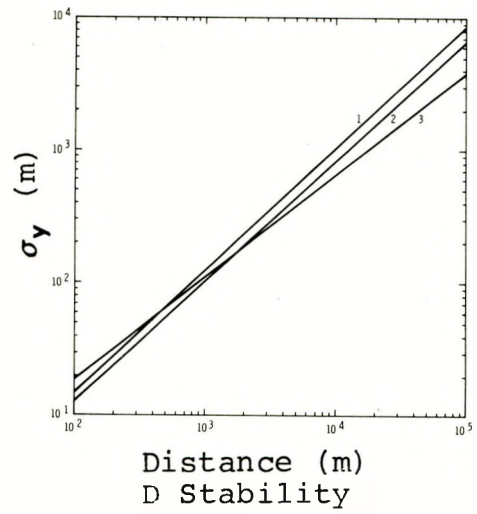
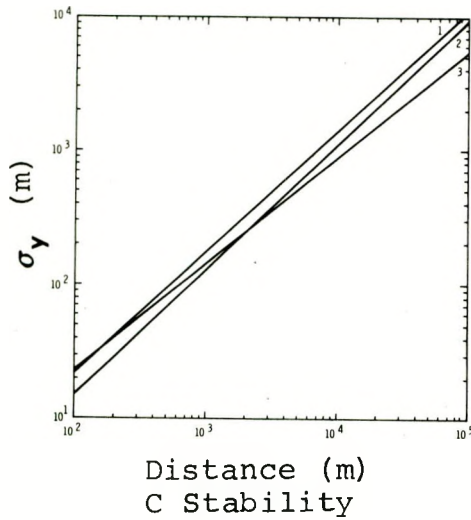
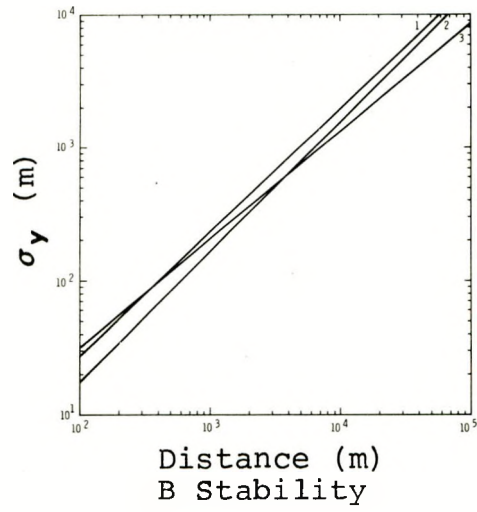
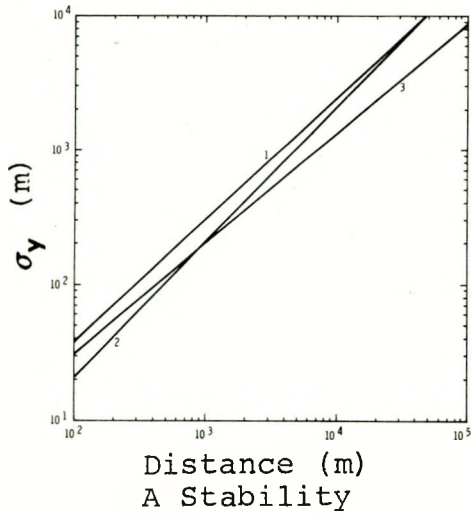


Figure 3. Comparison of Lateral Dispersion Curves ( $\sigma_y$ ) for Stability Categories A through F.

1. PG (adjusted to 30 min)
2. Vogt - 100 m (adjusted to 30 min)
3. Vogt - 50 m (adjusted to 30 min)

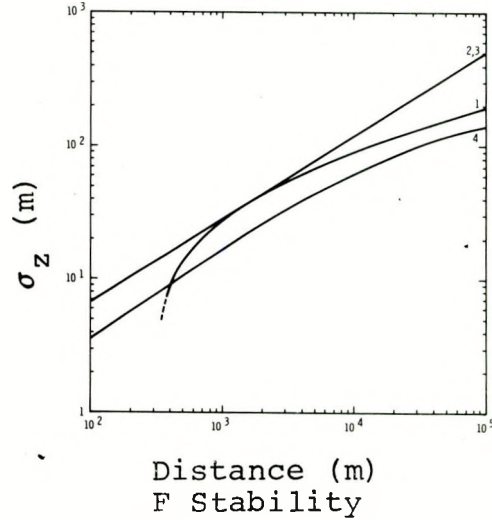
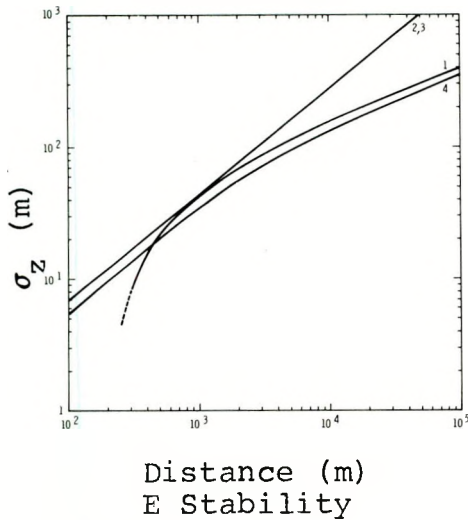
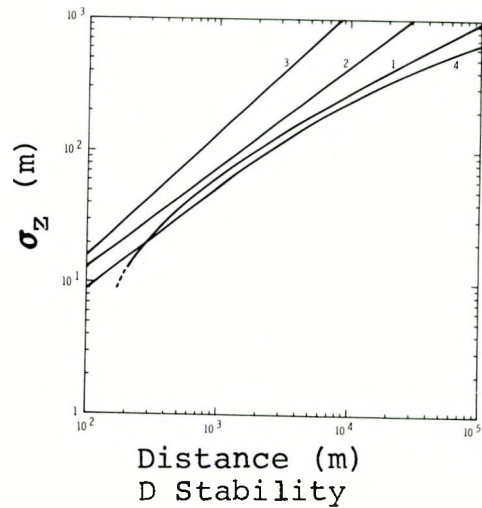
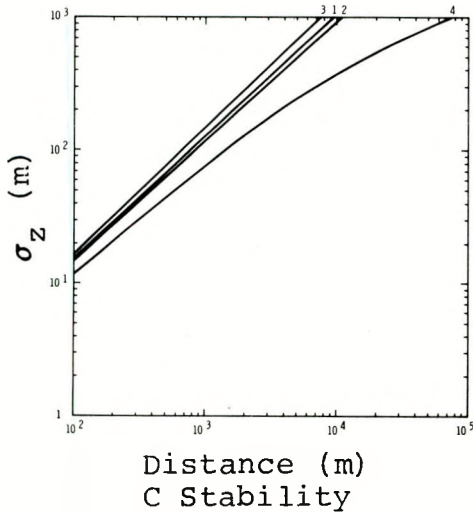
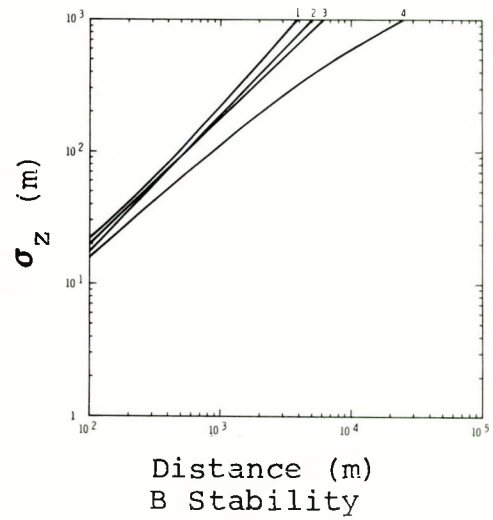
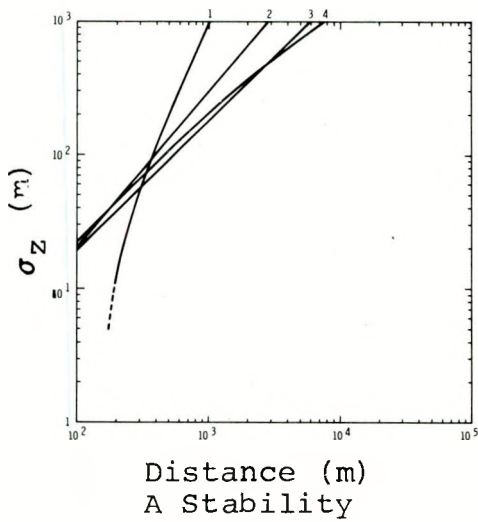


Figure 4. Comparison of Vertical Dispersion Curves ( $\sigma_z$ ) for Stability Categories A through F.

1. PG (adjusted to 100 cm roughness length)
2. Vogt - 100 m
3. Vogt - 50 m
4. Hosker and Smith (adjusted to 100 cm)

(ccdf's\*) for early fatalities, early injuries and latent cancer fatalities. The mean and peak values of these distributions are compared in Tables 6 and 7 for the COLD and HOT releases, respectively. All values have been normalized to the corresponding value calculated using the PG (3 min, 3 cm) curves. Selected ccdf's from the above calculations are compared in Figures 5 through 14.

From the results presented in Tables 6 and 7 and Figures 5 through 14, the following observations can be made:

1. Adjustment of the PG curves for a release duration of 30 rather than 3 minutes substantially reduced the number of calculated early fatalities for most of the assumed weather sequences (Figures 5 and 7). Although the maximum value remained essentially unchanged, mean predicted early fatalities were reduced by 60 and 30 percent for COLD and HOT releases, respectively. Early injuries and latent cancer fatalities (Figure 6) were somewhat less effected. Since the assumed release duration for the PWRI accident category is 0.5 hour, all further calculations were performed using the 30 minute release duration adjustment for the PG curves.
2. Adjustment of the PG curves for surface roughness lengths greater than 3 cm moderately increased the mean number of predicted early fatalities for the COLD release (Figure 8). Early fatality predictions for the HOT release and early

\*Complementary cumulative distribution function.<sup>1</sup>

TABLE 6

COLD Release - Comparison of Calculated Health Effects for Selected Dispersion Parameter Sets

<u>Dispersion Parameters</u>	<u>Early Fatalities<sup>f</sup></u>		<u>Early Injuries<sup>f</sup></u>		<u>Latent Fatalities<sup>f</sup></u>	
	<u>Mean<sup>a</sup></u>	<u>Peak<sup>a</sup></u>	<u>Mean<sup>a</sup></u>	<u>Peak<sup>a</sup></u>	<u>Mean<sup>a</sup></u>	<u>Peak<sup>a</sup></u>
Pasquill - Gifford						
3 min, <sup>b</sup> 3 cm <sup>c</sup> (RSS)	1.0	1.0	1.0	1.0	1.0	1.0
10 min, 3 cm	0.7	1.1	0.9	0.7	1.1	1.2
30 min, 3 cm	0.4	0.9	0.7	1.1	1.2	1.3
30 min, 10 cm	0.6	0.9	0.7	1.1	1.2	1.4
30 min, 30 cm	0.7	0.9	0.6	1.2	1.2	1.4
30 min, 100 cm	0.7	0.9	0.5	1.2	1.2	1.4
30 min, 3 cm, 10° <sup>d</sup>	0.4	0.9	0.6	1.0	1.2	1.3
30 min, 3 cm, 25°	0.4	0.9	0.4	0.6	1.5	2.1
30 min, 3 cm, 45°	0.4	0.9	0.3	0.4	2.1	1.8
30 min, 3 cm, $\Delta H^e$	0.5	0.9	0.7	1.1	1.2	1.3
Briggs						
30 min, 3 cm	0.4	1.0	1.0	1.2	0.9	0.8

- a) 91 weather sequences are used to generate a probability distribution for each consequence. The mean and peak refer to this distribution.
- b) Release duration. Values of 3 or 30 minutes are assumed.
- c) Roughness length. Assumed values range from 3 cm (grasslands) to 100 cm (forest).
- d) Assumed wind direction shear over height of plume.
- e) Includes plume rise adjustment.  $\Delta H$  for each weather sequence is calculated by the code.
- f) Normalized to the mean and peak calculated using the PG curves (as in the RSS) with 3 minute release duration and 3 cm roughness length.

TABLE 7

## HOT Release - Comparison of Calculated Health Effects for Selected Dispersion Parameter Sets

Dispersion Parameters	Early Fatalities <sup>f</sup>		Early Injuries <sup>f</sup>		Latent Fatalities <sup>f</sup>	
	Mean <sup>a</sup>	Peak <sup>a</sup>	Mean <sup>a</sup>	Peak <sup>a</sup>	Mean <sup>a</sup>	Peak <sup>a</sup>
Pasquill - Gifford						
3 min, <sup>d</sup> 3 cm <sup>c</sup> (RSS)	1.0	1.0	1.0	1.0	1.0	1.0
10 min, 3 cm	0.8	1.2	0.8	0.8	1.1	1.2
30 min, 3 cm	0.7	1.0	0.7	1.1	1.2	1.5
30 min, 10 cm	0.7	1.0	0.8	1.1	1.2	1.5
30 min, 30 cm	0.7	1.0	0.8	1.1	1.2	1.5
30 min, 100 cm	0.7	1.0	0.8	1.1	1.2	1.5
30 min, 3 cm, 10° <sup>d</sup>	0.7	1.0	0.6	1.0	1.3	1.5
30 min, 3 cm, 25°	0.7	1.0	0.4	0.6	1.6	2.5
30 min, 3 cm, 45°	0.7	1.0	0.3	0.4	2.3	2.1
30 min, 3 cm, $\Delta H^e$	0.7	1.0	0.7	1.1	1.2	1.5
Briggs						
30 min, 3 cm	0.9	1.1	1.0	1.2	0.9	0.9
Vogt (100 m release height)						
60 min, 100 cm	0.8	1.1	0.8	0.9	1.2	1.5
30 min, 100 cm	0.9	1.2	0.9	1.1	1.2	1.5
Vogt (50 m release height)						
60 min, 100 cm	1.1	1.2	0.7	1.1	0.9	0.9
30 min, 100 cm	2.3	3.5	0.8	1.2	0.9	0.9

- a) 91 weather sequences are used to generate a probability distribution for each consequence. The mean and peak refer to this distribution.
- b) Release duration. Values of 3, 30, or 60 minutes are assumed.
- c) Roughness length. Assumed values range from 3 cm (grasslands) to 100 cm (forest).
- d) Includes plume rise adjustment.  $\Delta H$  for each weather sequence is calculated by the code.
- e) Two sets of Vogt dispersion parameters are available, corresponding to release heights of 100 m and 50 m.
- f) Normalized to the mean and peak calculated using the PG curves (as in the RSS) with 3 minute release duration and 3 cm roughness length.

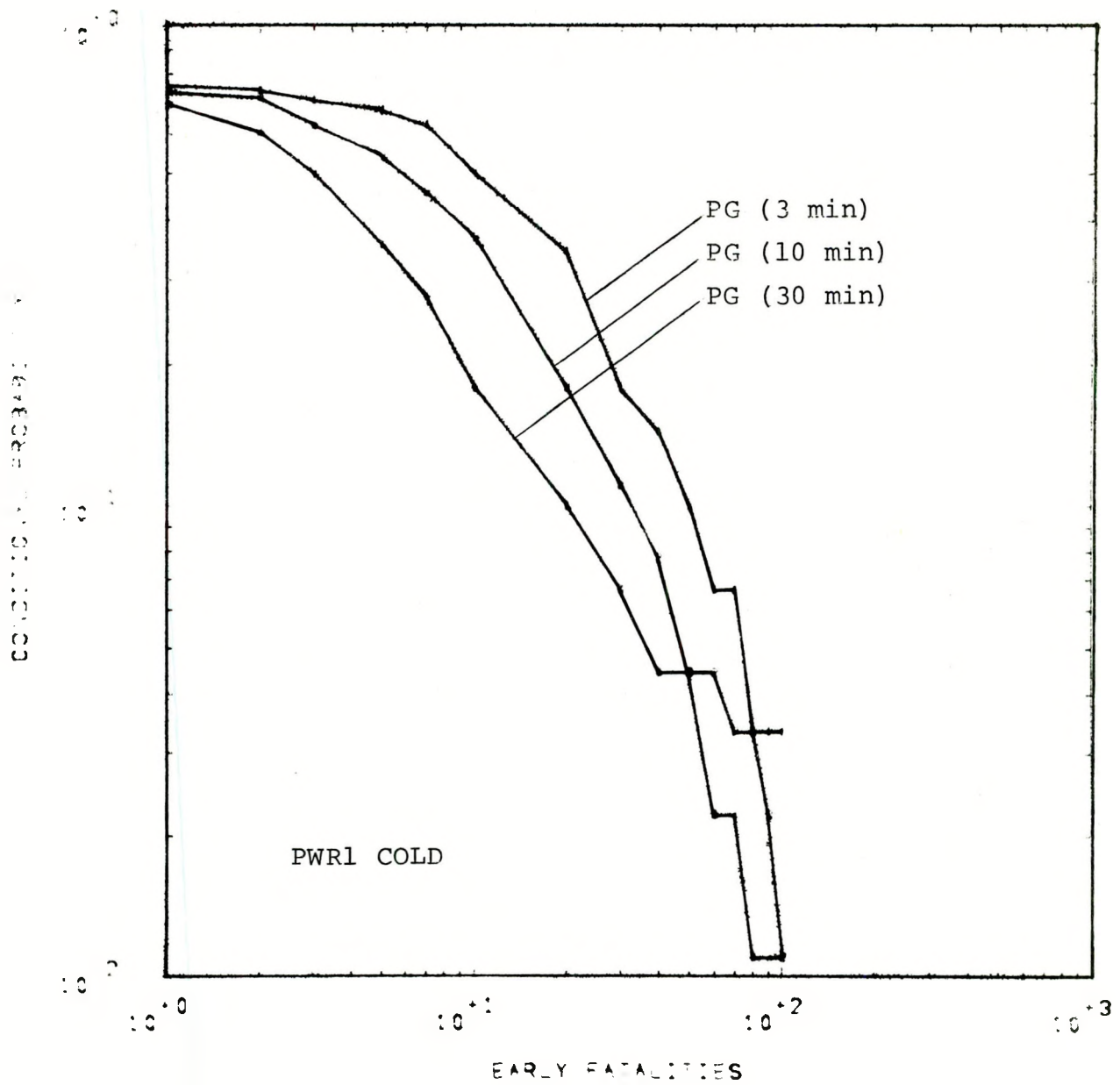


Figure 5. Effect of release duration adjustment on early fatality cdf calculated using the Pasquill-Gifford curves. Release durations of 3, 10 and 30 minutes are assumed. Ccdfs are conditional on a PWRL COLD release.

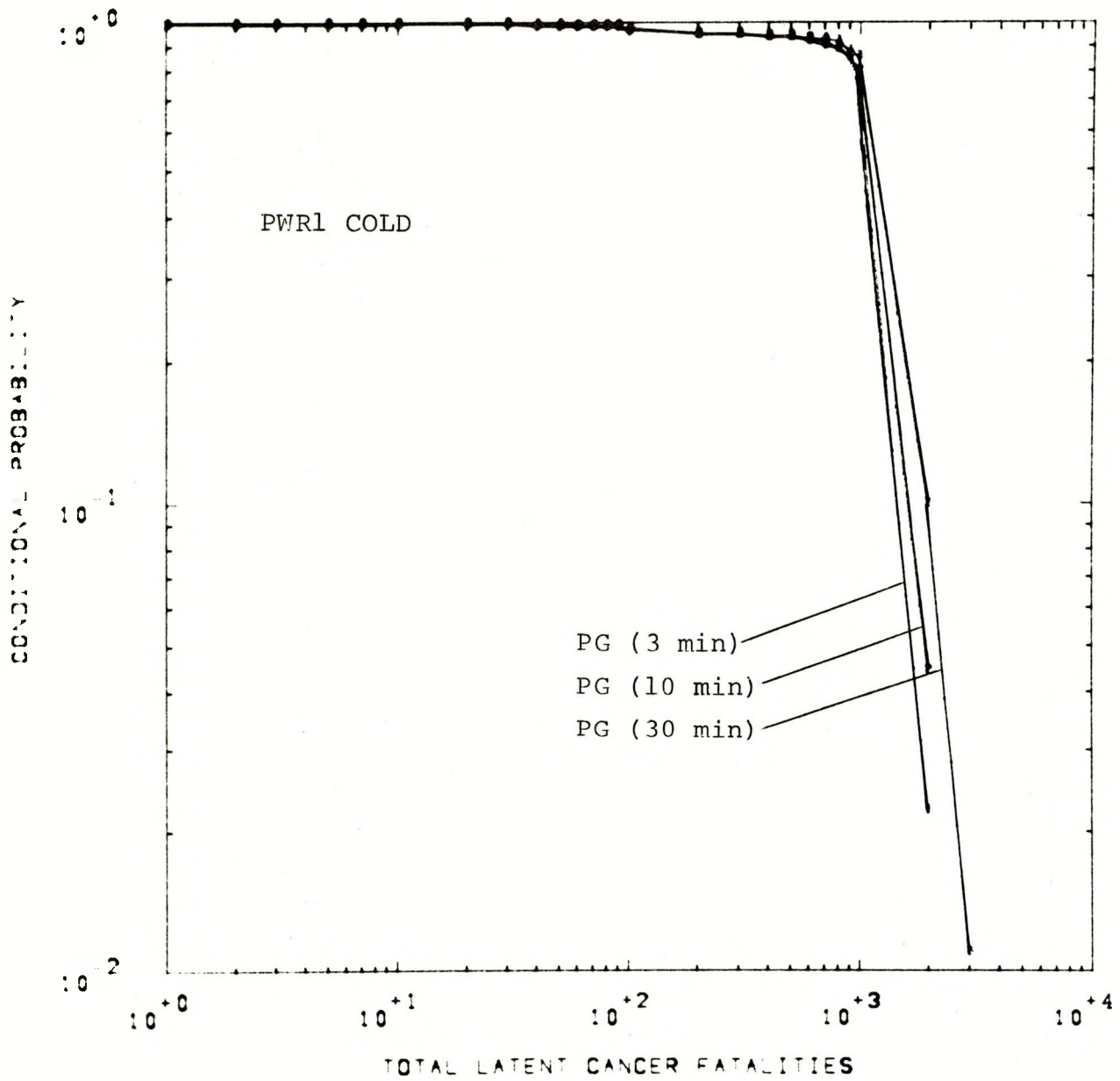


Figure 6. Effect of release duration adjustment on latent cancer fatality cdf calculated using the Pasquill-Gifford curves. Release durations of 3, 10 and 30 minutes are assumed. Ccdfs are conditional on a PWRI COLD release.

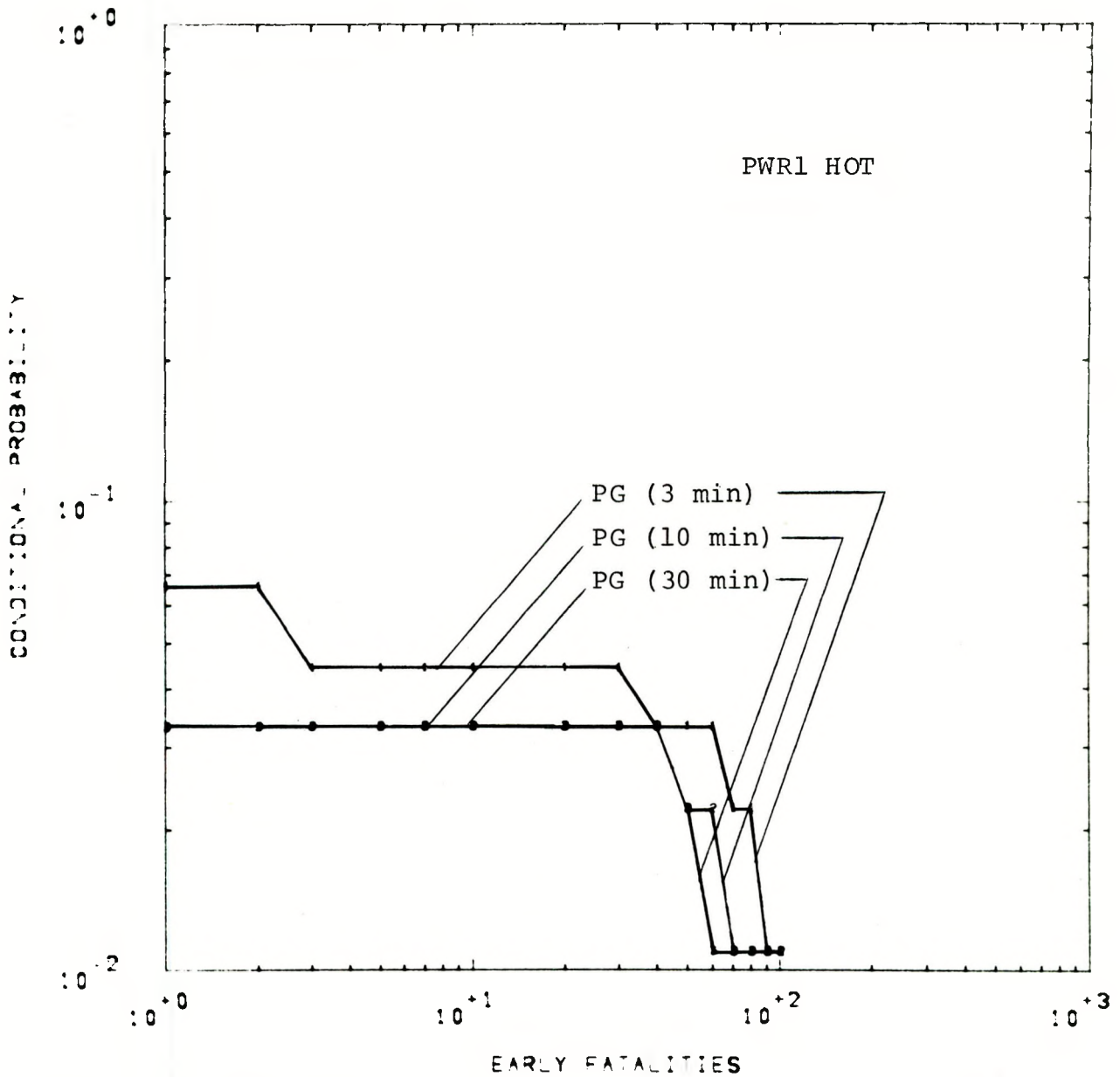


Figure 7. Effect of release duration adjustment on early fatality ccdf calculated using the Pasquill-Gifford curves. Release durations of 3, 10 and 30 minutes are assumed. Ccdfs are conditional on a PWR1 HOT release.

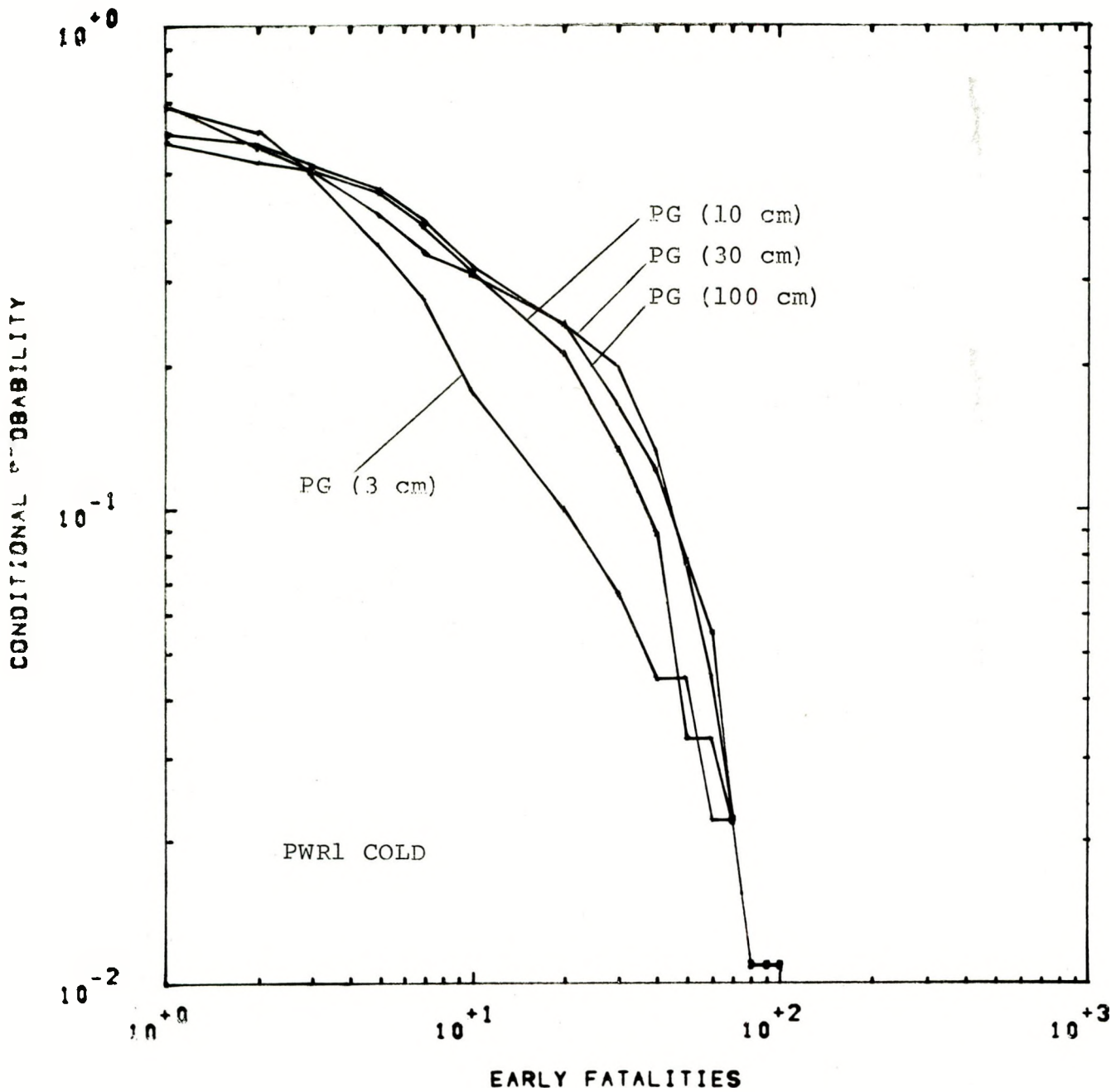


Figure 8. Effect of surface roughness adjustment on early fatality ccdf calculated using the Pasquill-Gifford curves. Roughness lengths of 3, 10, 30 and 100 cm are assumed. Release duration equals 30 minutes. Ccdfs are conditional on a PWRI COLD release.

injury and latent cancer fatality predictions for both HOT and COLD releases were essentially unchanged. Adjustments for roughness lengths of 10, 30 and 100 cm resulted in essentially equal consequence predictions.

3. Use of the wind shear adjustment had no significant effect on the calculation of early fatalities for either the COLD or HOT release (Figure 9). This is due largely to the fact that early fatalities occur predominantly within 20 km of the reactor, the distance at which the proposed adjustment for wind shear begins. Predicted early injuries, which occur at somewhat larger distances, were reduced by the wind shear correction. Latent cancer fatality predictions were increased (Figure 10). Although assumed wind direction shears of 25-45° appear to significantly alter early injury and latent cancer predictions, shears of this magnitude may be unreasonable for average conditions.
4. Use of the plume rise adjustment for the PG curves had no significant effect on any calculated consequences (Figure 11).
5. The Briggs and PG curves are very similar as indicated in Figure 1. Early fatality predictions made using the two sets of curves\* are therefore quite similar (Figures 12 and 13). The Briggs curves do not increase as rapidly with distance as the PG curves, however. As a result, use of the Briggs curves leads to a small increase in predicted

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\*Note that both the PG and Briggs curves were adjusted for a release duration of 30 min.

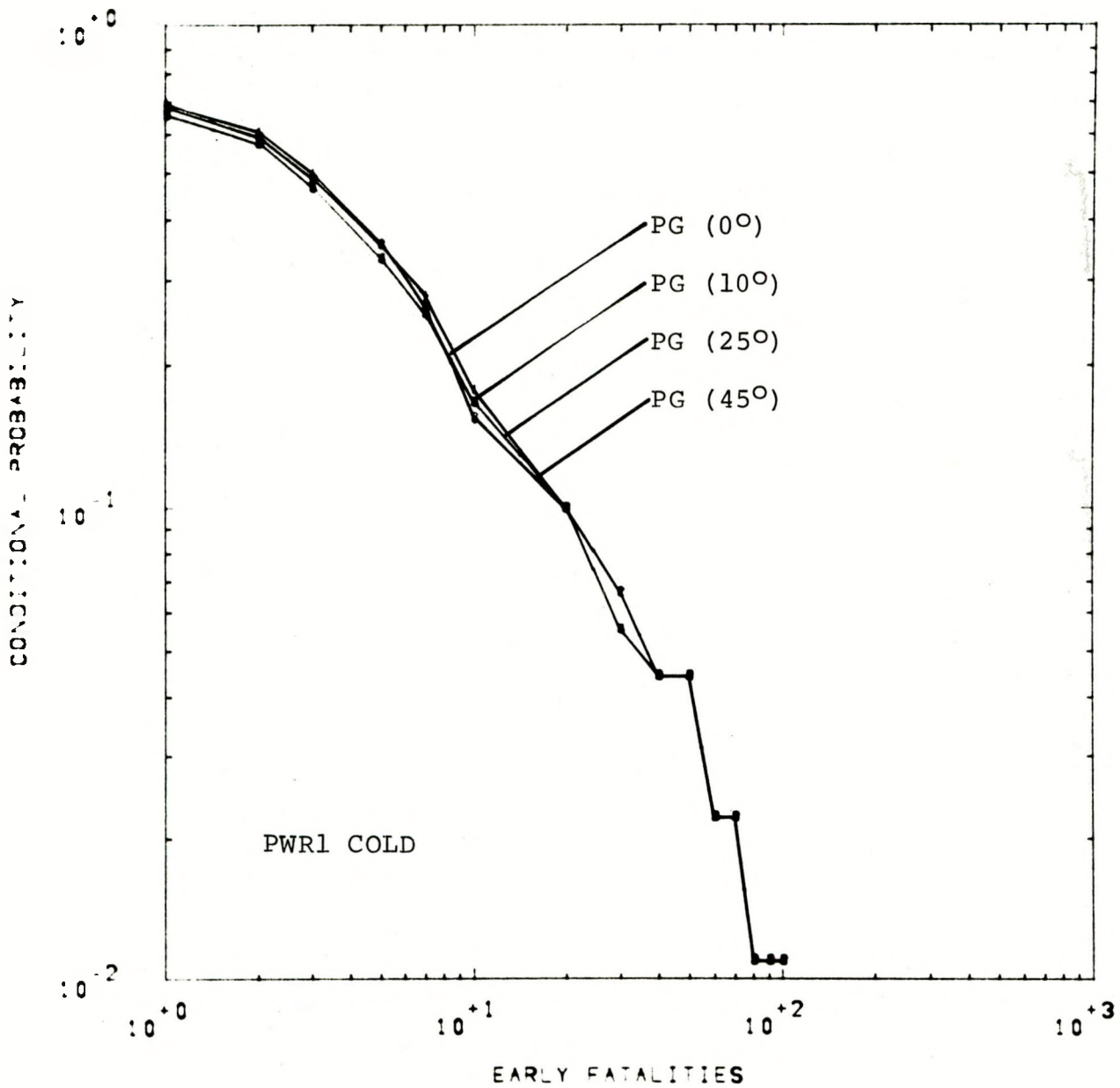


Figure 9. Effect of wind direction shear adjustment on early fatality ccdf calculated using the Pasquill-Gifford curves. Direction shears of 0°, 10°, 25° and 45° are assumed. Release duration equals 30 minutes. Roughness length equals 3 cm. Ccdfs are conditional on a PWR1 COLD release.

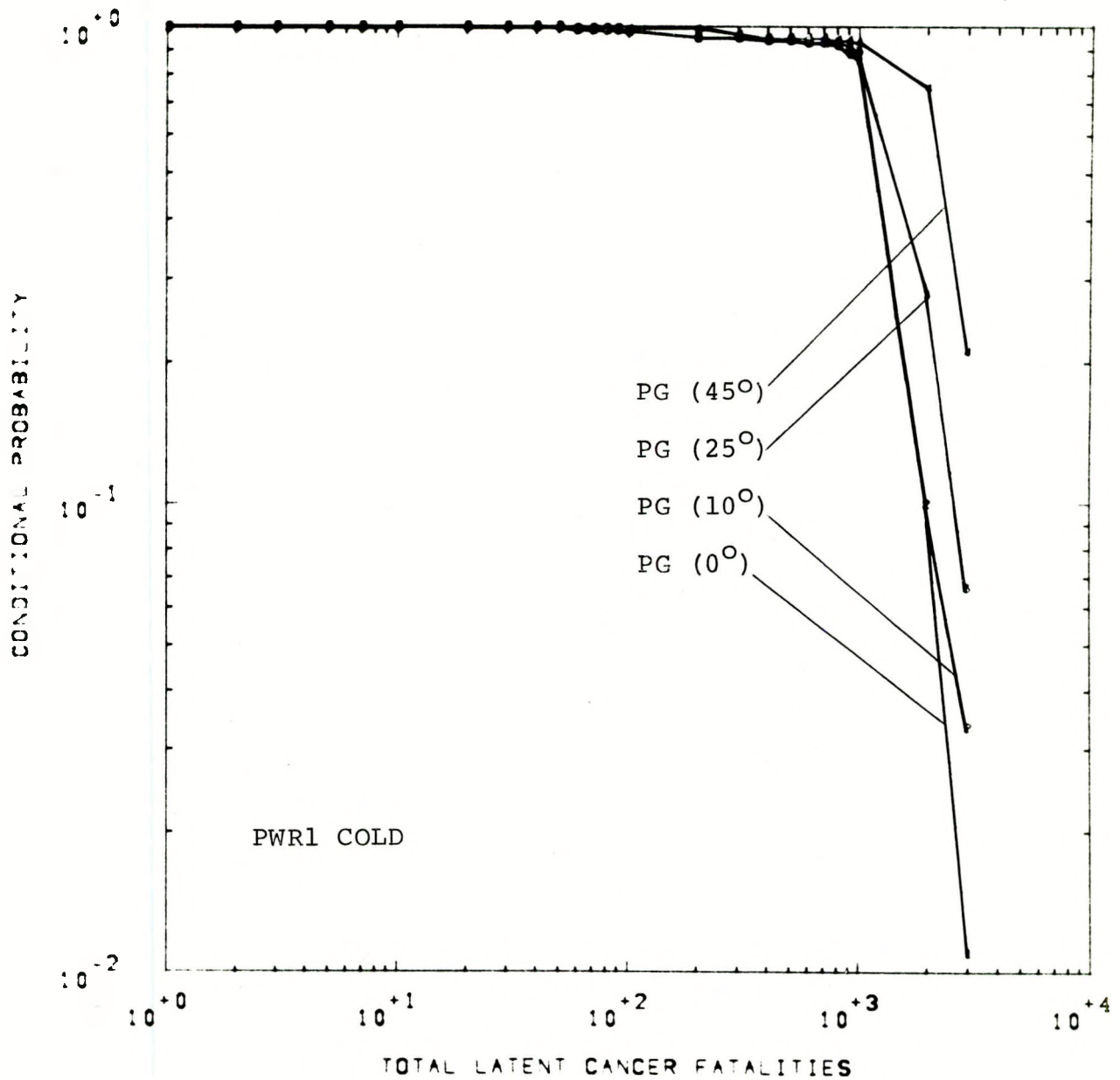


Figure 10. Effect of wind direction shear adjustment on latent cancer fatality cdf calculated using the Pasquill-Gifford curves. Direction shears of  $0^\circ$ ,  $10^\circ$ ,  $25^\circ$  and  $45^\circ$  are assumed. Release duration equals 30 minutes. Roughness length equals 3 cm. Ccdfs are conditional on a PWR1 COLD release.

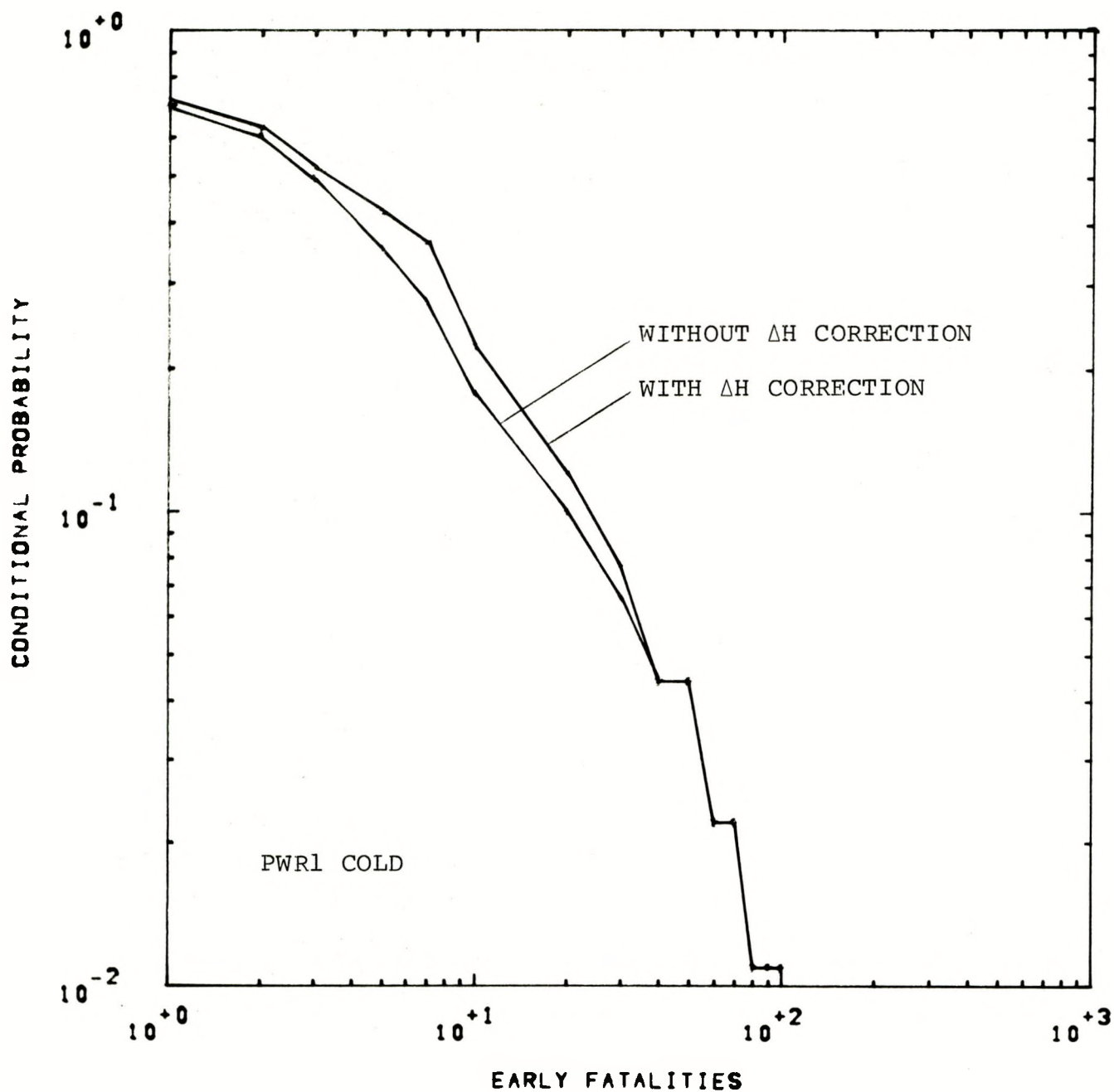


Figure 11. Effect of plume rise ( $\Delta H$ ) adjustment on early fatality cdf calculated using the Pasquill-Gifford curves. Release duration equals 30 minutes. Roughness length equals 3 cm. Cdfs are conditional on a PWR1 COLD release.

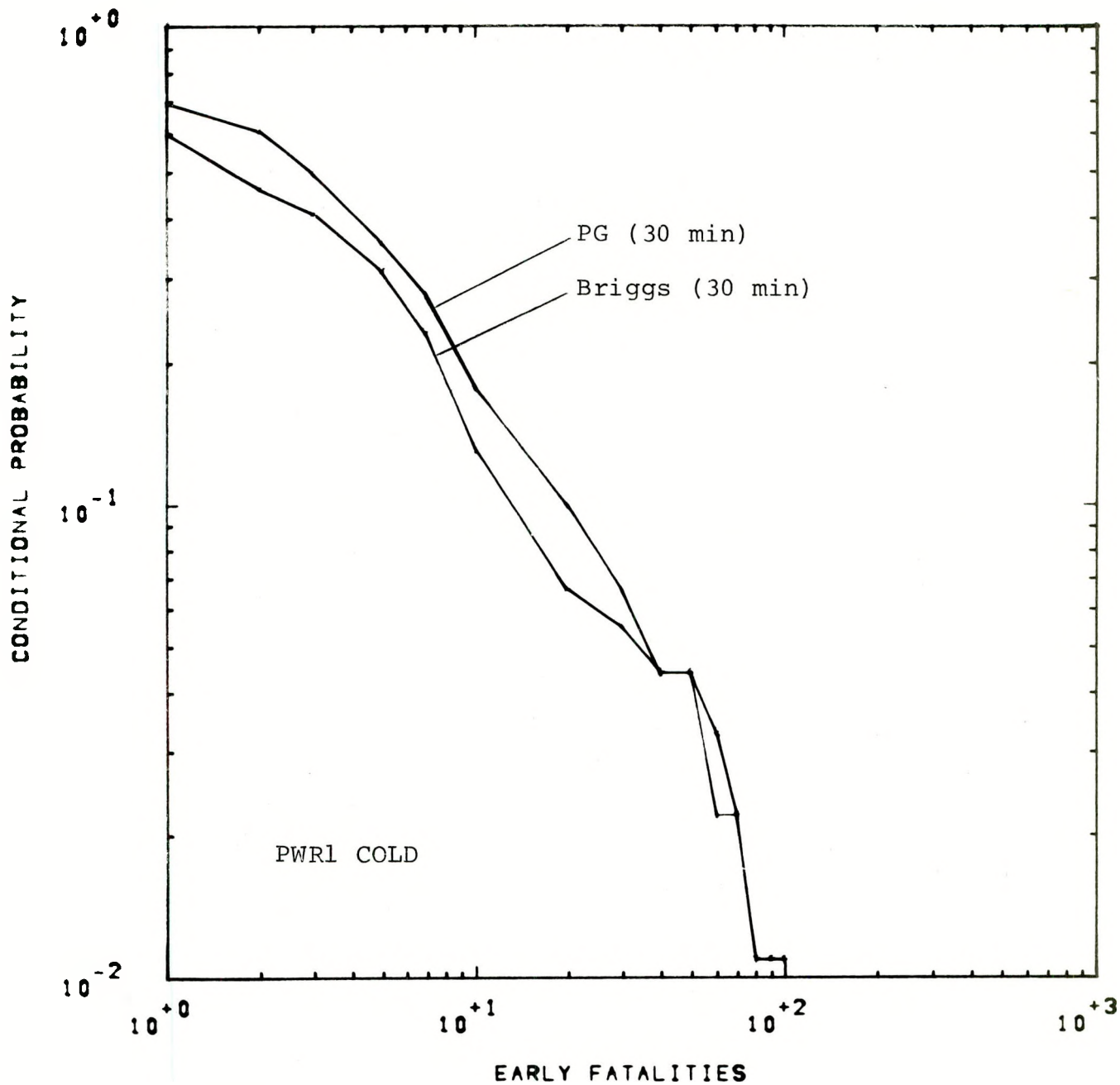


Figure 12. Comparison of early fatality cdfs calculated using Pasquill-Gifford and Briggs curves. Release duration equals 30 minutes. Roughness length equals 3 cm. Cdfs are conditional on a PWR1 COLD release.

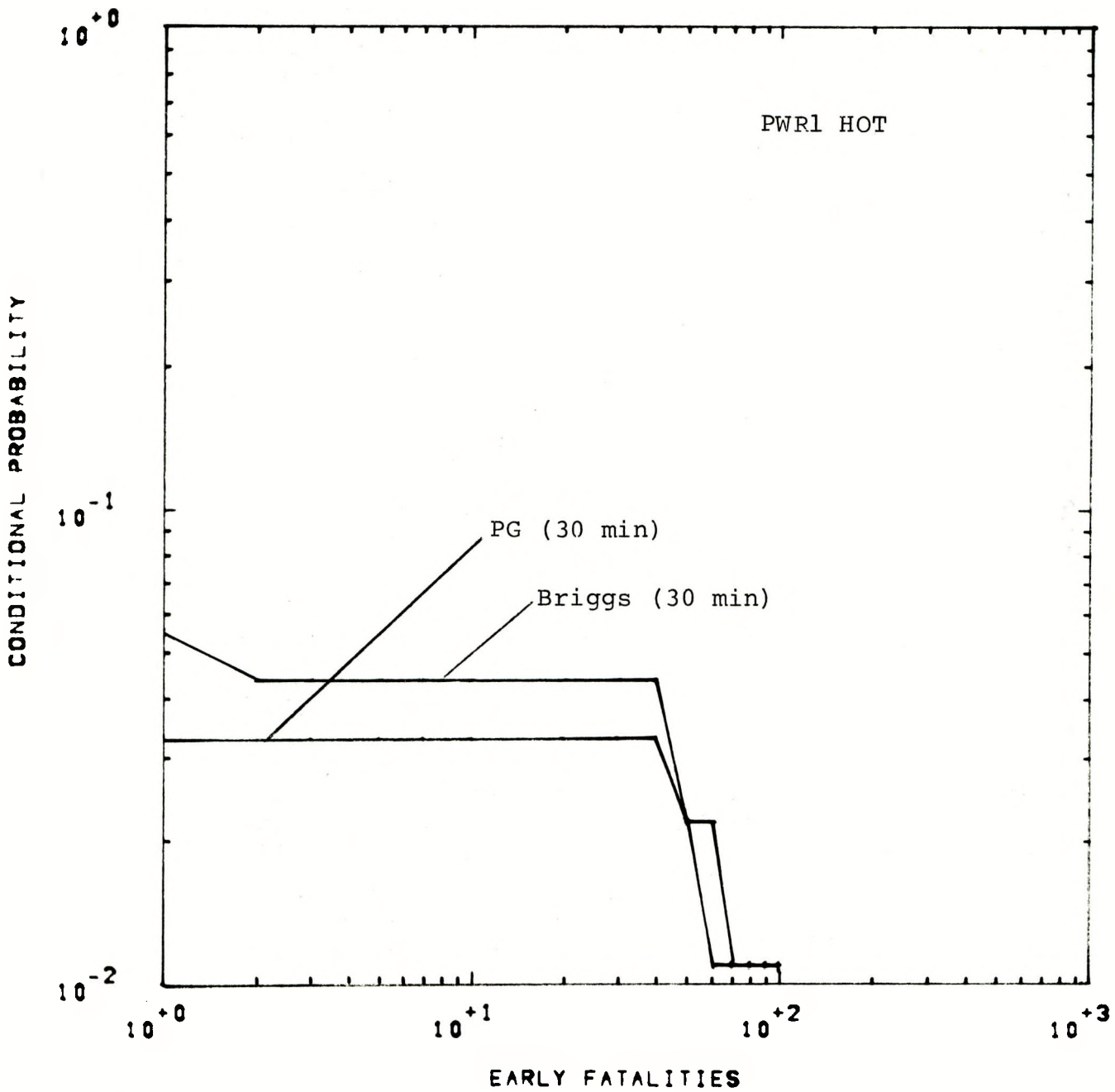


Figure 13. Comparison of early fatality ccdfs calculated using Pasquill-Gifford and Briggs curves. Release duration equals 30 minutes. Roughness length equals 3 cm. Ccdfs are conditional on a PWR1 HOT release.

early injuries and small decrease in latent cancer fatalities.

6. Figure 14 shows the early fatality ccdf's calculated using the Vogt-50 and -100 meter release height curves for the PWRI HOT release.\* Release durations of both 60 and 30 minutes were assumed. The Vogt-100 m curves result in moderately higher early fatality predictions than the PG (30 min, 3 cm) curves (Figure 7). Early injury and latent cancer fatality predictions are essentially the same. The Vogt-50 m curves result in substantially higher early fatality predictions, particularly when adjusted for a 30 minute release duration, and somewhat lower latent cancer fatalities.

#### IV. Conclusions and Recommendations

The results presented above indicate that early injury and latent cancer fatality predictions are in general quite insensitive to assumed dispersion parameters. Correction for wind direction shears of 25-45° does increase latent cancer fatality predictions and decrease early injuries somewhat, although shears of this magnitude may be unreasonable for average conditions. Peak predicted early fatalities are also quite insensitive to the dispersion parameters assumed. However, adjustment of the PG curves from a 3 to a 30 minute release duration substantially reduced (COLD - 60%,

\*The Vogt curves are assumed to be appropriate for either elevated releases or for releases with considerable plume rise ( $\Delta H$ ). They were therefore used only for predicting consequences of the HOT release.

HOT -30%) mean predicted early fatalities. Mean early fatalities were increased to some extent by use of the Vogt curves for HOT releases and surface roughness adjustments for COLD releases. Early fatality predictions were minimally affected by corrections for wind shear and  $\Delta H$  and by use of the Briggs formulas. It should be noted that the results presented above were calculated assuming a uniform population distribution surrounding the reactor site, and that they might have been different had an actual site population been used. However, the qualitative conclusions drawn would probably not differ significantly.

In conclusion, calculated reactor accident consequences are not strongly sensitive to assumed dispersion parameters. However, an attempt should be made to utilize the most appropriate dispersion parameters for the release and site under investigation. In the absence of site-specific data, the PG curves, with correction for release duration and surface roughness, appear to be appropriate for surface releases with small  $\Delta H$ . For releases with large  $\Delta H$ , the Vogt curves (or a similar set) should probably be used.

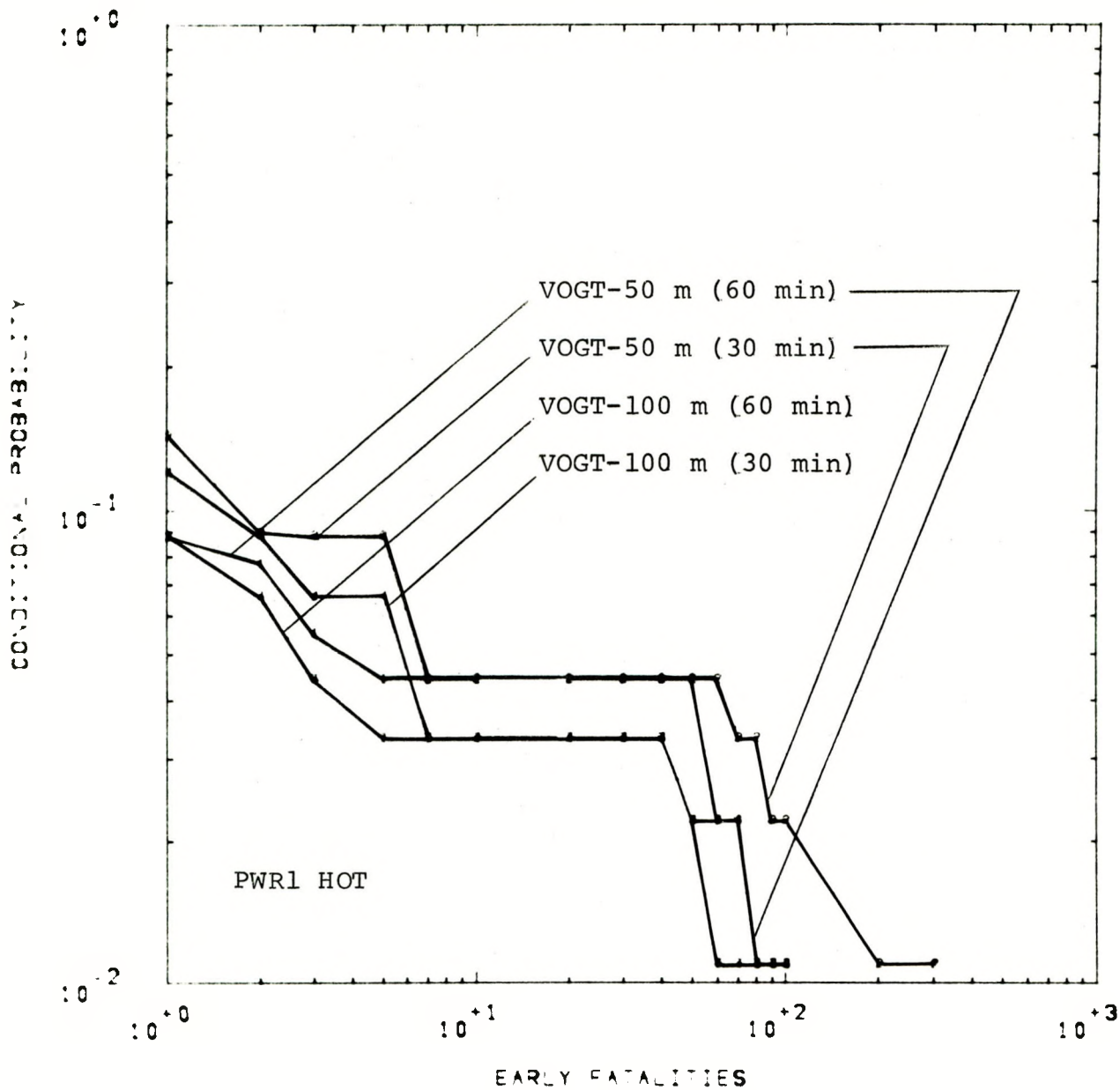


Figure 14. Comparison of early fatality cdfs calculated using Vogt 50 meter and Vogt 100 meter curves. Release durations equal 60 minutes or 30 minutes. Cdfs are conditional on a PWRI HOT release.

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Distribution:

Roger Blond (5)  
Probabilistic Analysis Staff  
Office of Nuclear Regulatory Research  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555

A. Bayer  
INR-Kernforschungszentrum Karlsruhe  
75 Karlsruhe 1  
Postfach 3740  
W. Germany

Douglas Cooper  
Department of Environmental Health Physics  
Harvard School of Public Health  
663 Huntington Avenue  
Boston, MA 02215

Keith Woodard  
Pickard & Lowe Associates  
1200 18th Street NW  
Washington, DC 20036

Joseph Logsdon  
U.S. Environmental Protection Agency  
AW 461  
401 M Street NW  
Washington, DC 20024

S. Chakraborty  
Abteilung für die Sicherheit der Kernanlagen  
Eidgenössisches Amt für Energiewirtschaft  
Würenlingen  
Switzerland

N. Rasmussen  
Nuclear Engineering Department  
Massachusetts Institute of Technology  
Cambridge, MA 02139

Dr. Ulf Tveten  
Institutt for Atomenergi  
P. O. Box 40  
2007 Kjeller  
Norway

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Blegdamsvej 17  
DK-2100 Copenhagen 0  
Denmark

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