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APR 10 1984

JOHN S. KEMPER
VICE-PRESIDENT
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Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket Nos.: 50-352
50-353

Subject: Limerick Generating Station, Units 1&2
Severe Accident Risk Assessment (SARA)

Reference: Letter from J. S. Kemper to A. Schwencer
dated March 13, 1984.

File: GOVT 1-1 (NRC)

Dear Mr. Schwencer:

Transmitted herewith are twenty copies of SARA
Supplement 3 consistent with the schedule and purposes
provided in the reference letter.

Sincerely,

John S. Kemper

JLP/gra/040384310

cc: See Attached Service List

*B001
1/20*

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A PDR

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Supplement 3

REVISED CONSEQUENCE AND UNCERTAINTY ANALYSIS

1. PURPOSE OF SUPPLEMENT

As noted in a letter* from PECO to A. Schwencer of Licensing Branch No. 2 of the U.S. Nuclear Regulatory Commission, in the process of converting meteorological data from computer tape to the input appropriate for the consequence program CRAC2, certain errors were made which resulted in incorrect wind direction frequencies in the CRAC2 calculation. As a result, some corrections to the Severe Accident Risk Assessment are required. The corrections do not affect the predicted frequency of core-melt and containment failure; they only affect the predicted off-site consequences. The purpose of this supplement is to present revisions of the most important or "essential" results of SARA. The essential results are defined as follows.

1. The results quoted in Chapter 12 of SARA.
2. Any results used in the ER-OL, Chapter 7.

Overall, the changes that arise from the revisions described above are small relative to the uncertainty bands and do not significantly affect the magnitude of the risk predicted in SARA (at the point estimate, median, or upper estimate) or the validity of any conclusions appearing in SARA or the ER-OL.

2. REVISED RESULTS

As noted in Section 12.5.1, one of the principal purposes of SARA is to calculate the public risk of early fatalities, latent-cancer fatalities, and other health and economic effects that might result from an accidental release of radioactive material to the environment. In Chapter 12, this risk is presented in the form of complementary cumulative distribution functions (CCDFs). Revised CCDFs are presented in this supplement as detailed below.

Figures 1 through 9 (revised Figures 12-6 through 12-14) give the results for the following cases:

1. Early fatalities from all causes (i.e., all internal and external events) (Figure 1 (revised Figure 12-6)).
2. Early fatalities from the initiating events analyzed in the LGS PRA (Figure 2 (revised Figure 12-7)).

*"Limerick Generating Station, Units 1 and 2 Severe Accident Risk Assessment (SARA)," letter from John S. Kemper (Philadelphia Electric Company) to A. Schwencer (U.S. Nuclear Regulatory Commission), March 13, 1984.

3. Early fatalities from the initiating events of the LGS PRA plus a random vessel failure (Figure 3 (revised Figure 12-8)).
4. Early fatalities from seismic initiating events (Figure 4 (revised Figure 12-9)).
5. Latent-cancer fatalities* from all causes (Figure 5 (revised Figure 12-10)).
6. Latent-cancer fatalities* from internal initiating events (Figure 6 (revised Figure 12-11)).
7. Latent-cancer fatalities* from fire initiating events (Figure 7 (revised Figure 12-12)).
8. Latent-cancer fatalities* from seismic initiating events (Figure 8 (revised Figure 12-13)).
9. Latent-cancer fatalities* from seismic and fire initiating events (Figure 9 (revised Figure 12-14)).

The early fatalities and latent-cancer fatalities** (excluding thyroid cancers) are examined in detail in Figures 1 through 9 (revised Figures 12-6 through 12-14). The other health and economic effects are given without such a detailed breakdown in Figures 10 through 17 (revised Figures 12-15 through 12-22):

1. Latent-cancer fatalities (excluding thyroid cancers), population out to 50 miles only, from all causes (Figure 10 (revised Figure 12-15)).
2. Thyroid-cancer fatalities, population out to 500 miles, from all causes (Figure 11 (revised Figure 12-16)).
3. Thyroid-cancer fatalities, population out to 50 miles, from all causes (Figure 12 (revised Figure 12-17)).
4. Whole-body population dose out to 500 miles from all causes (Figure 13 (revised Figure 12-18)).
5. Whole-body population dose out to 50 miles from all causes (Figure 14 (revised Figure 12-19)).

*For the population out to 500 miles and excluding thyroid cancers.

**The latent-cancer fatalities are the total appearing in the surrounding population, not the number per year as was presented in the Reactor Safety Study. The numbers presented here should be divided by 30 to obtain the estimated number of latent cancers per year in the period from 10 to 40 years after an accident.

6. Bone-marrow dose of 200 rem or more from early exposure from all causes (Figure 15 (revised Figure 12-20)).
7. Offsite costs from all causes (Figure 16 (revised Figure 12-21)).
8. Individual risk of early fatality as a function of distance from the plant from all causes (Figure 17 (revised Figure 12-22)).

The results are expressed as families of curves. The areas under the different curves are summarized in Table 1 (revised Table 12-9). As has been explained, these areas can also be used as measures of public risk. The way in which CCDFs like those in Figure 1 should be read is described on pages 12-10 and 12-11.

Figure 18 (revised Figure 12-23) shows the early-fatality median total-risk curves and the corresponding curves for various internal and seismic accident classes (fire-initiated accidents make a negligible contribution to the risk of early fatalities). Figure 19 (revised Figure 12-24) shows the upper estimate (95th percentile level) risk curves.

Figure 20 (revised Figure 12-25) shows how the results of this study compare with those of the LGS PRA. Figure 21 (revised Figure 12-26) shows a comparison of the results of this study with the CCDF for early fatalities for the boiling-water reactor analyzed in the Reactor Safety Study, both at the RSS composite site and the Limerick site.

Figure 22 (revised Figure 12-27) shows the median CCDF for latent-cancer fatalities and the contributions from internal, fire, and seismic accident classes. Figure 23 (revised Figure 12-28) is like Figure 22 (revised Figure 12-27) except that it shows the upper estimates. Note that the revisions of Figures 12-27 and 12-28 include correction of the original curves for seismic Class IV accidents which were inadvertently misdrawn. This leads to a slight modification of paragraph 12.5.4.1, which states that seismically initiated Class IV accidents are also significant contributors to latent risk. The replotted curves show that seismically initiated sequences are not significant contributors to the risk of latent cancer fatalities. The risk results for this class were properly included in all other results given in SARA.

Figure 24 (revised Figure 12-29) shows the results of the uncertainty analysis on the CCDF for latent cancer fatalities for internal events only, compared with the point estimate CCDF from the LGS PRA. Figure 25 (revised Figure 12-30) shows the median CCDF for latent cancer fatalities from the present study for internal events only, the median result for all initiating events, and the CCDF from the Reactor Safety Study.

Finally, revised values of the individual risk of early fatality averaged over the population within one mile of the site boundary have been calculated to be $3\text{E-}9$ per year at the median level and $6\text{E-}8$ per year at the upper-estimate level. The revised individual risk of latent cancer fatality among the population out to 50 miles is $1\text{E-}9$ per year at the median level and $3\text{E-}9$ per year at the upper estimate level.

Table 1. Areas under CCDFs^a
(Revised Table 12-9 of LGS-SARA)

Consequence ^b	5th percentile	50th percentile	95th percentile	Point estimate
Early fatalities				
Initiating events of the LGS PRA	2.8-6 ^c	2.0-5	1.6-4	2.78-5
Initiating events of the LGS PRA plus random vessel failure	3.2-6	2.5-5	2.3-4	5.11-5
Seismic initiating events	0	5.2-6	1.2-3	2.80-4
All initiating events	5.3-6	6.8-5	1.1-3	3.24-4
Latent-cancer fatalities (excluding thyroid), popula- tion to 500 miles				
Internal initiating events	4.4-4	3.5-3	5.7-2	1.74-2
Fire initiating events	1.4-5	1.8-4	8.9-3	3.79-3
Seismic initiating events	9.4-6	2.6-3	3.0-2	1.14-2
Seismic and fire initiating events	1.5-3	1.1-2	3.5-1	1.52-2
All initiating events	2.0-3	1.1-2	1.8-1	3.26-2
Latent-cancer fatalities (excluding thyroid), popula- tion to 50 miles	1.3-3	6.9-3	1.1-1	2.05-2
Thyroid cancer fatalities, population to 500 miles	1.8-4	1.1-3	1.3-2	6.39-3
Thyroid cancer fatalities, population to 50 miles	1.7-4	8.7-4	1.0-2	5.03-3
Whole-body population dose (man-rem) to 500 miles	1.3+1	7.5+1	7.5+2	4.44+2
Whole-body population dose (man-rem) to 50 miles	7.6+0	4.4+1	4.4+2	2.61+2
Bone-marrow dose of 200 rem or more ^d	4.3-5	3.4-4	8.9-3	1.97-3
Offsite economic costs	1.5+3	1.0+4	1.7+5	1.56+4

^aAll units are per reactor-year except for offsite economic costs (1980 dollars per reactor-year).

^bUnless otherwise indicated, the consequences listed are due to all initiating events.

^c2.8-6 = 2.8×10^{-6} .

^dDue to early exposure.

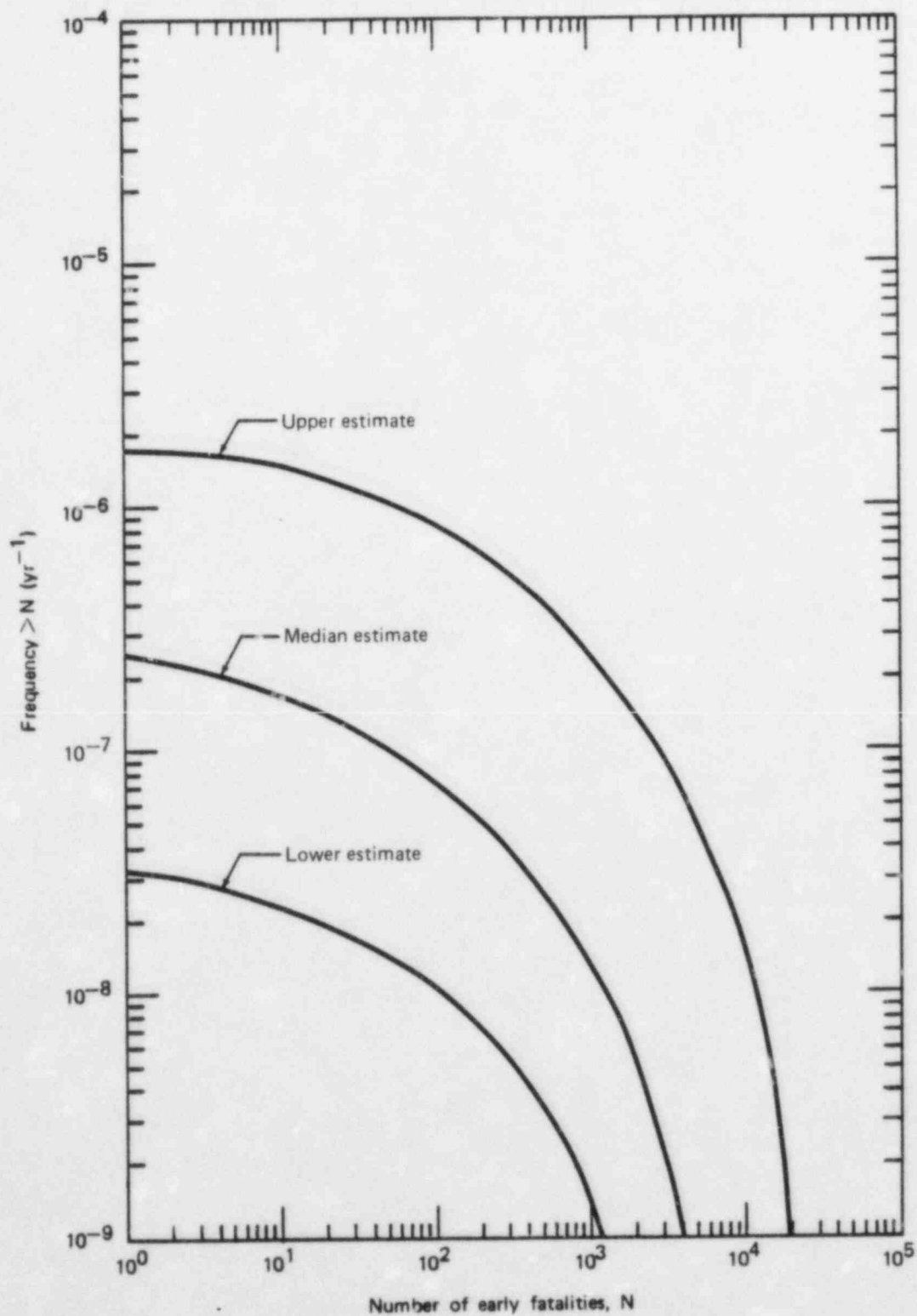


Figure 1. CCDFs for early fatalities from internal and external initiating events.
(Revised Figure 12-6 of LGS-SARA)

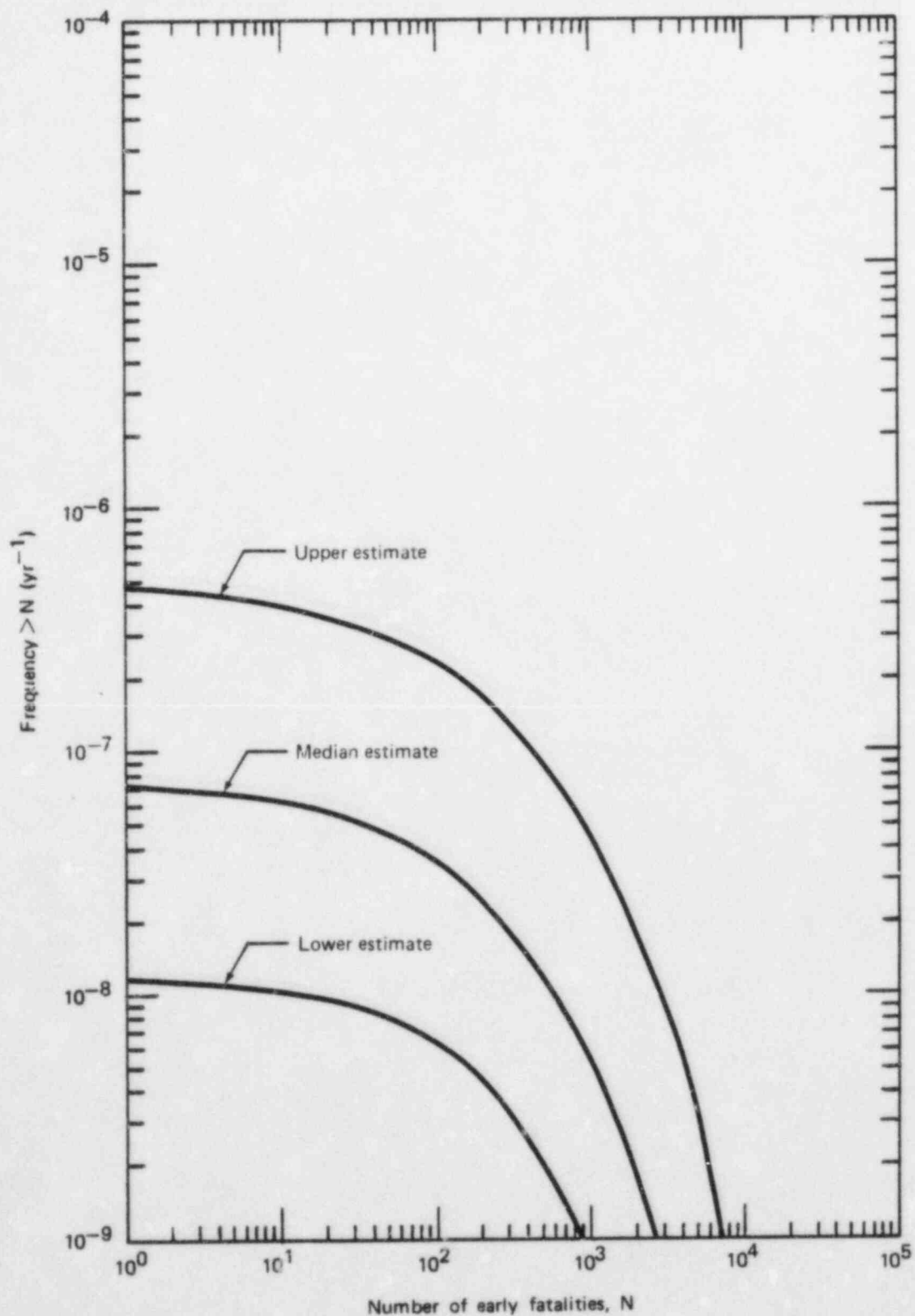


Figure 2. CCDFs for early fatalities from the internal initiating events of the LGS PRA.
(Revised Figure 12-7 of LGS-SARA)

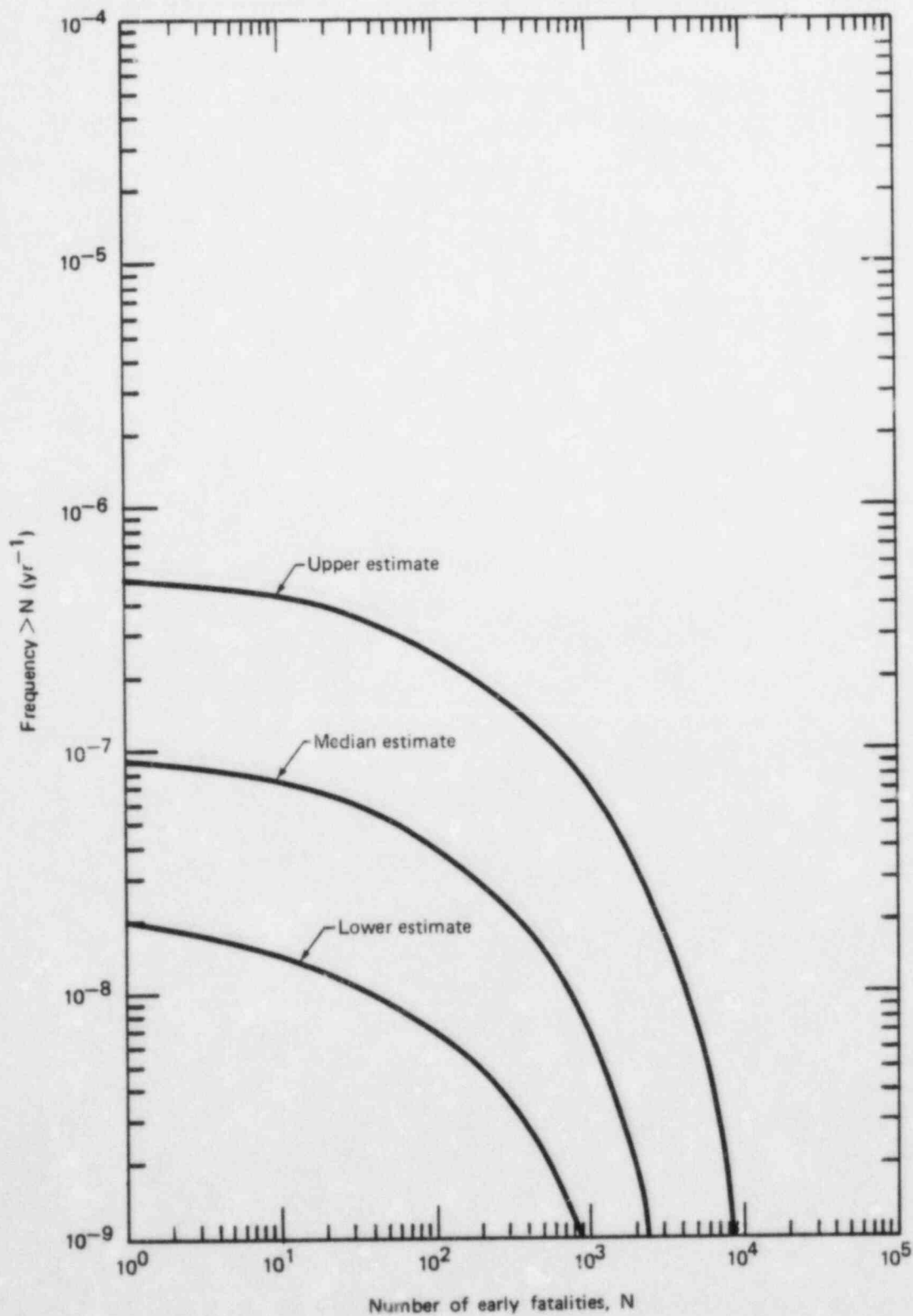


Figure 3. CCDFs for early fatalities from internal initiating events and random vessel failures.
(Revised Figure 12-8 of LGS-SARA)

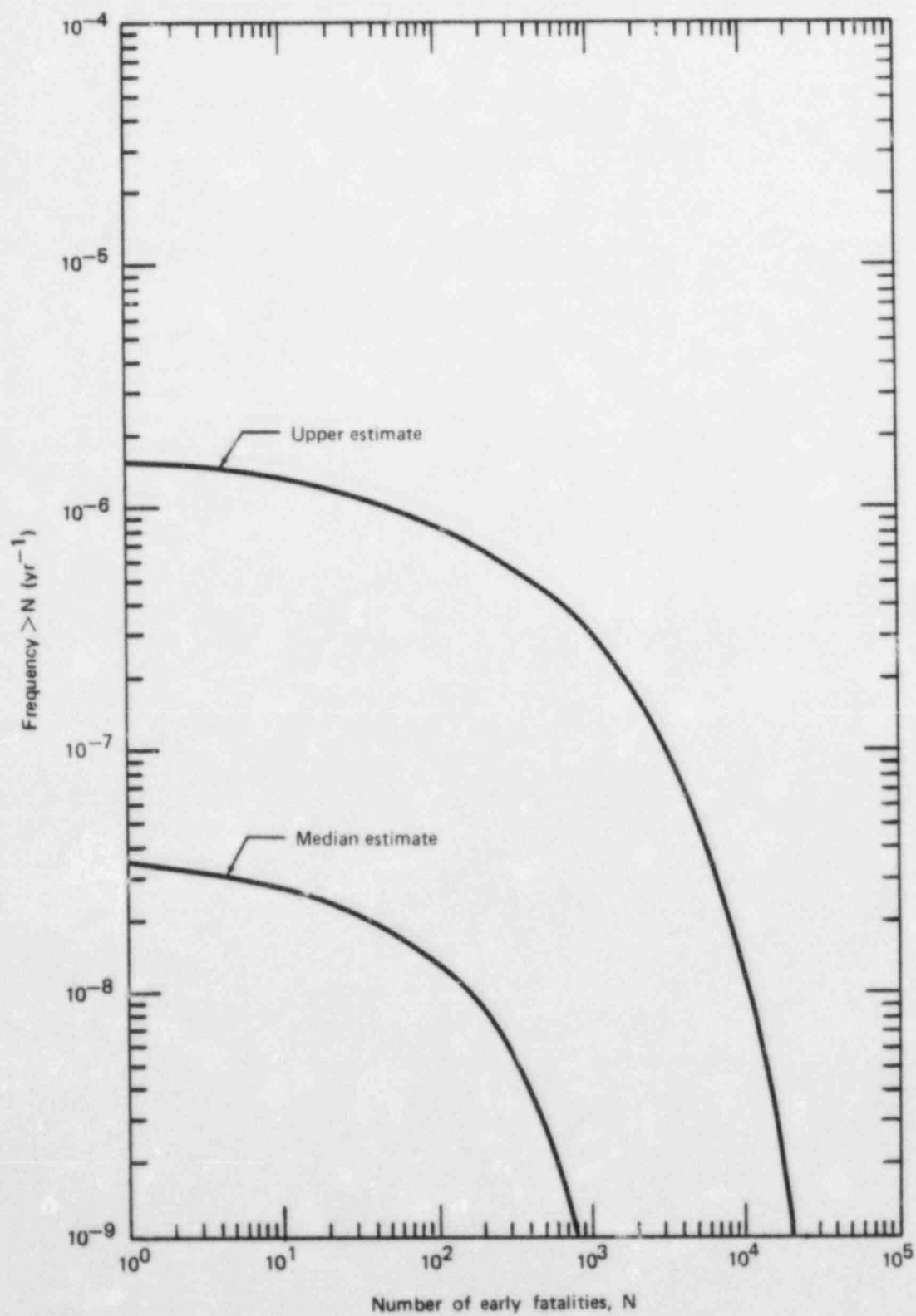


Figure 4. CCDFs for early fatalities from seismic initiating events.
(Revised Figure 12-9 of LGS-SARA)

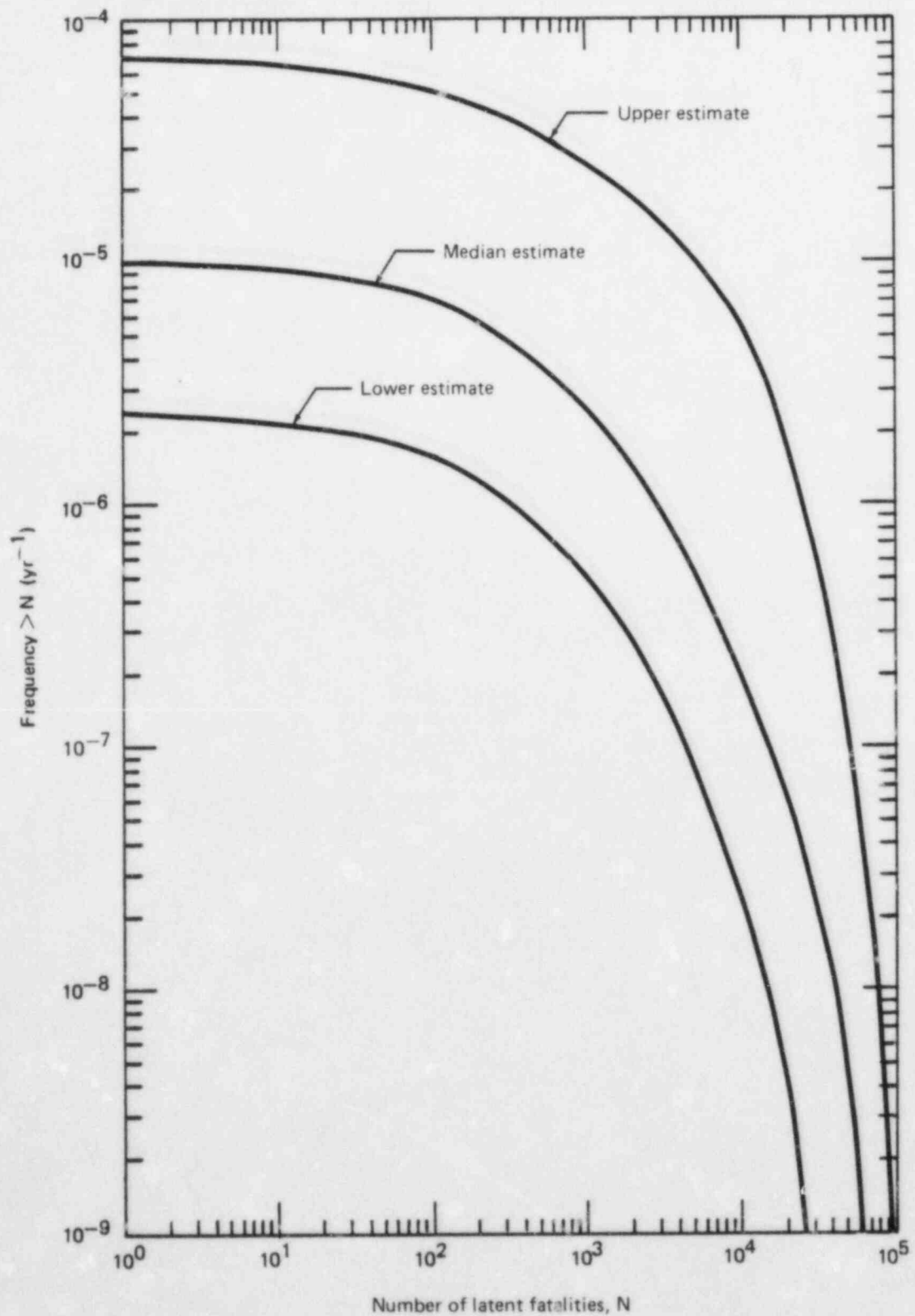


Figure 5. CCDFs for latent-cancer fatalities from internal, seismic, and fire initiating events.
(Revised Figure 12-10 of LGS-SARA)

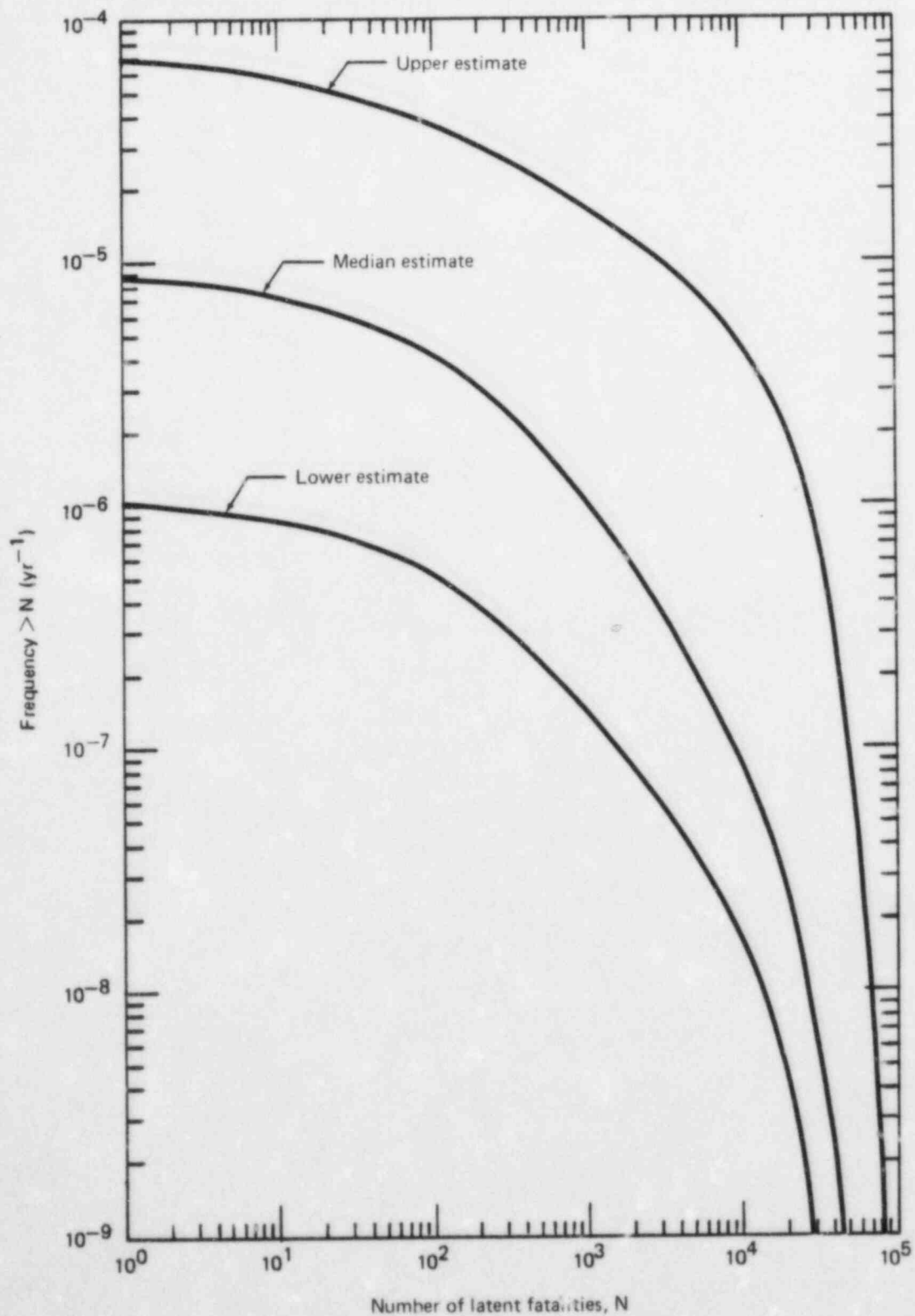


Figure 6. CCDFs for latent-cancer from internal initiating events.
(Revised Figure 12-11 of LGS-SARA)

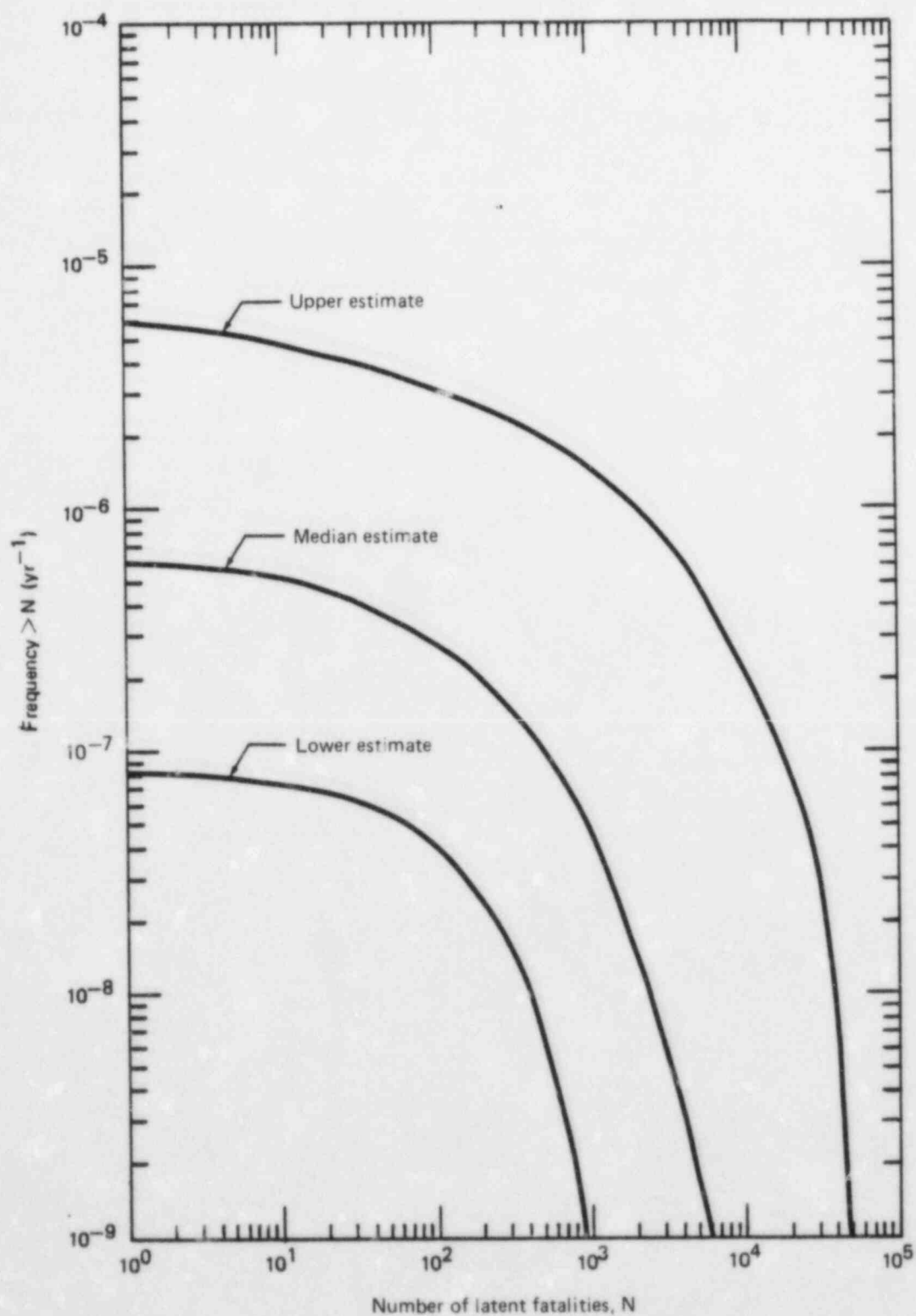


Figure 7. CCDFs for latent-cancer fatalities from fire initiating events.
(Revised Figure 12-12 of LGS-SARA)

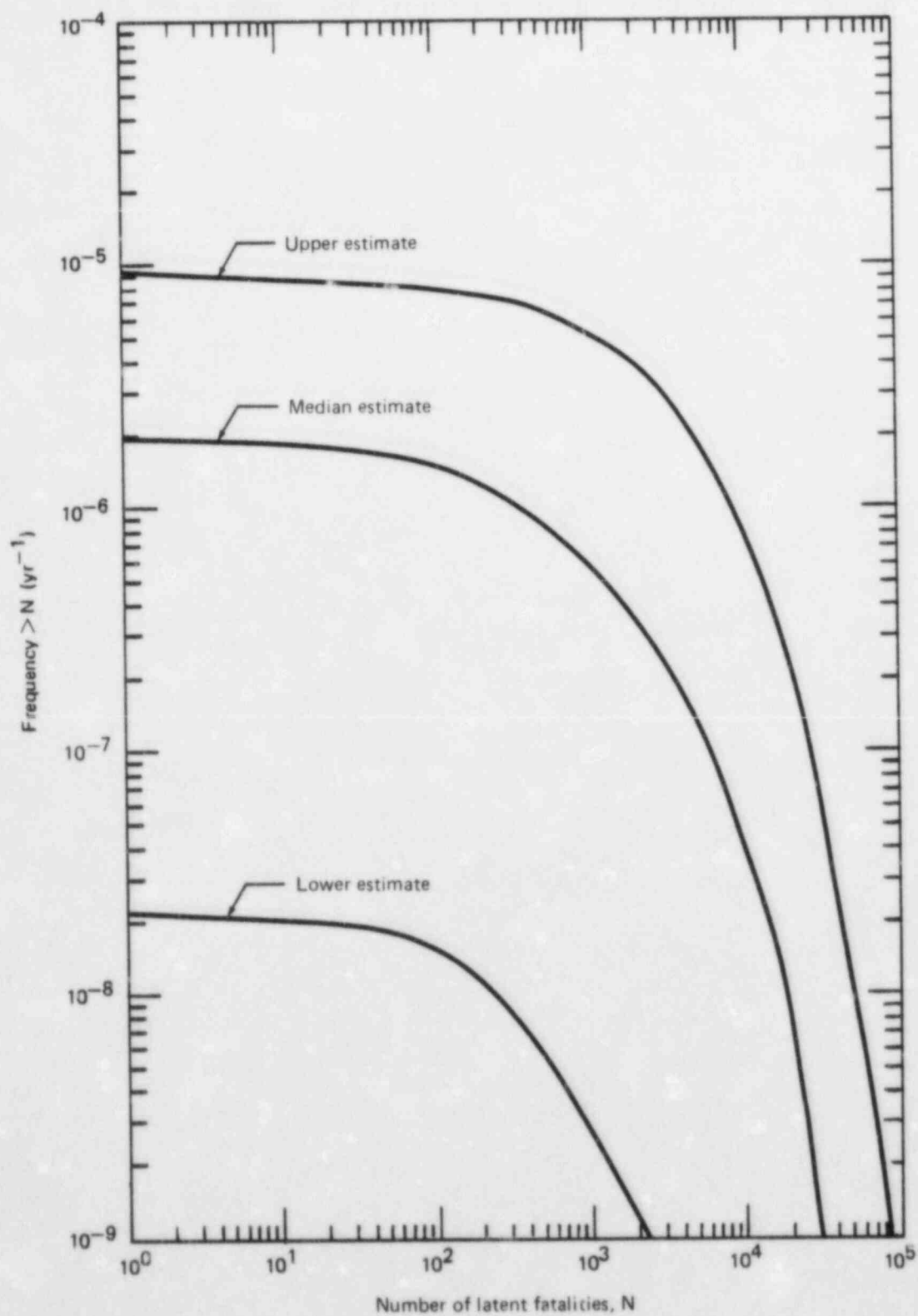


Figure 8. CCDFs for latent-cancer fatalities from seismic initiating events.
(Revised Figure 12-13 of LGS-SARA)

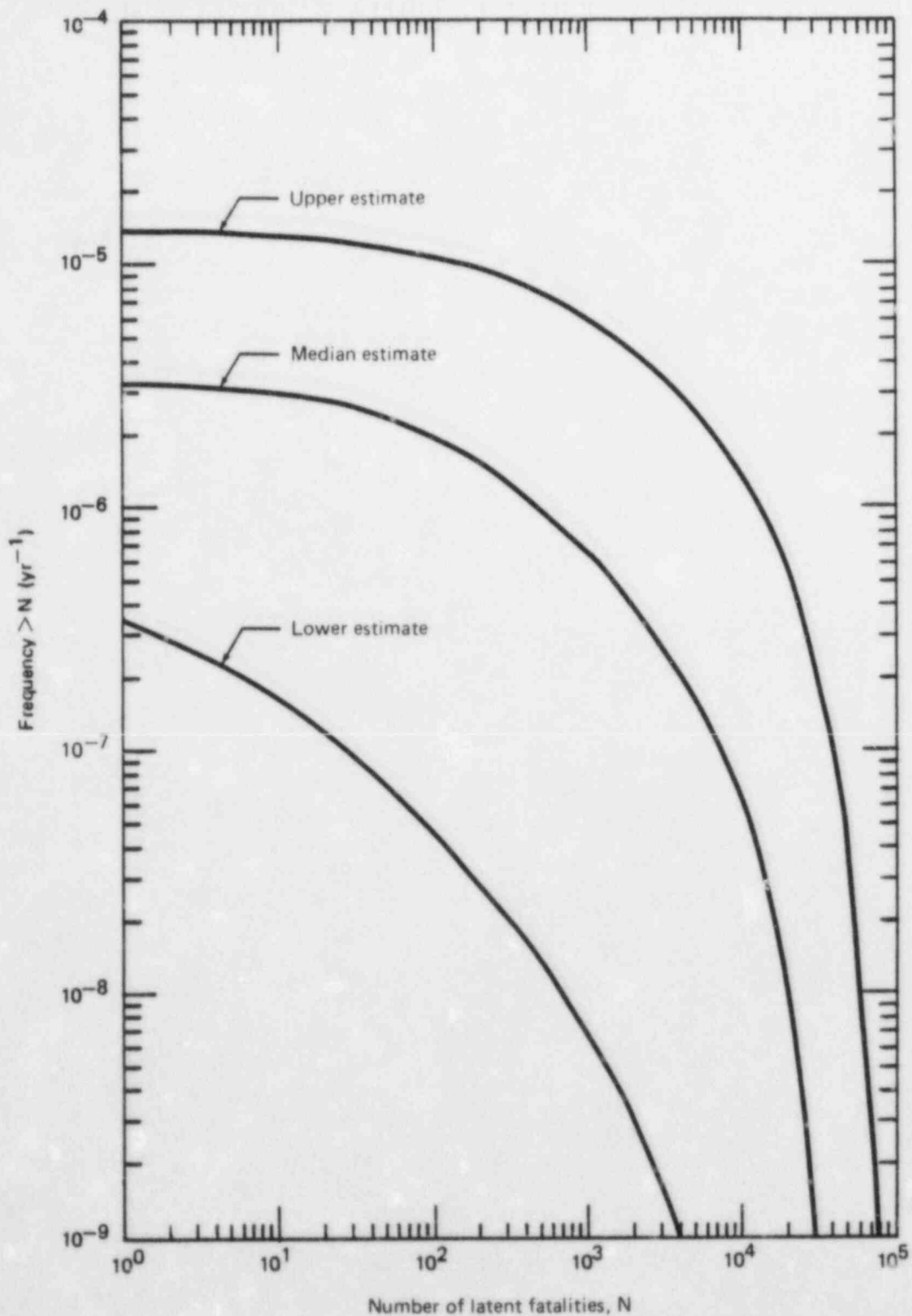


Figure 9. CCDFs for latent-cancer fatalities from seismic and fire initiating events.
(Revised Figure 12-14 of LGS-SARA)

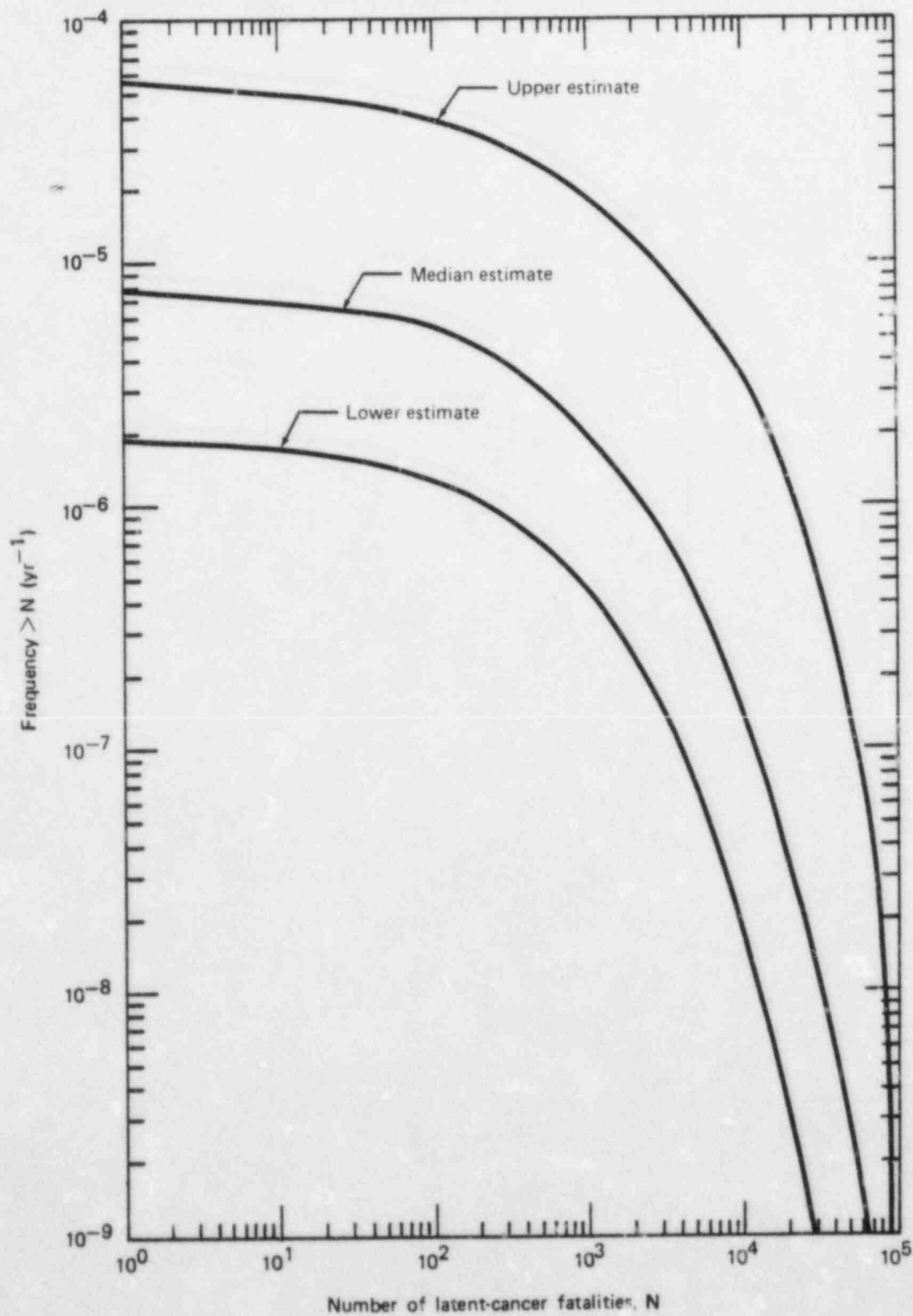


Figure 10. CCDFs for latent-cancer fatalities (excluding thyroid cancer), population to 50 miles, all initiating events.
(Revised Figure 12-15 LGS-SARA)

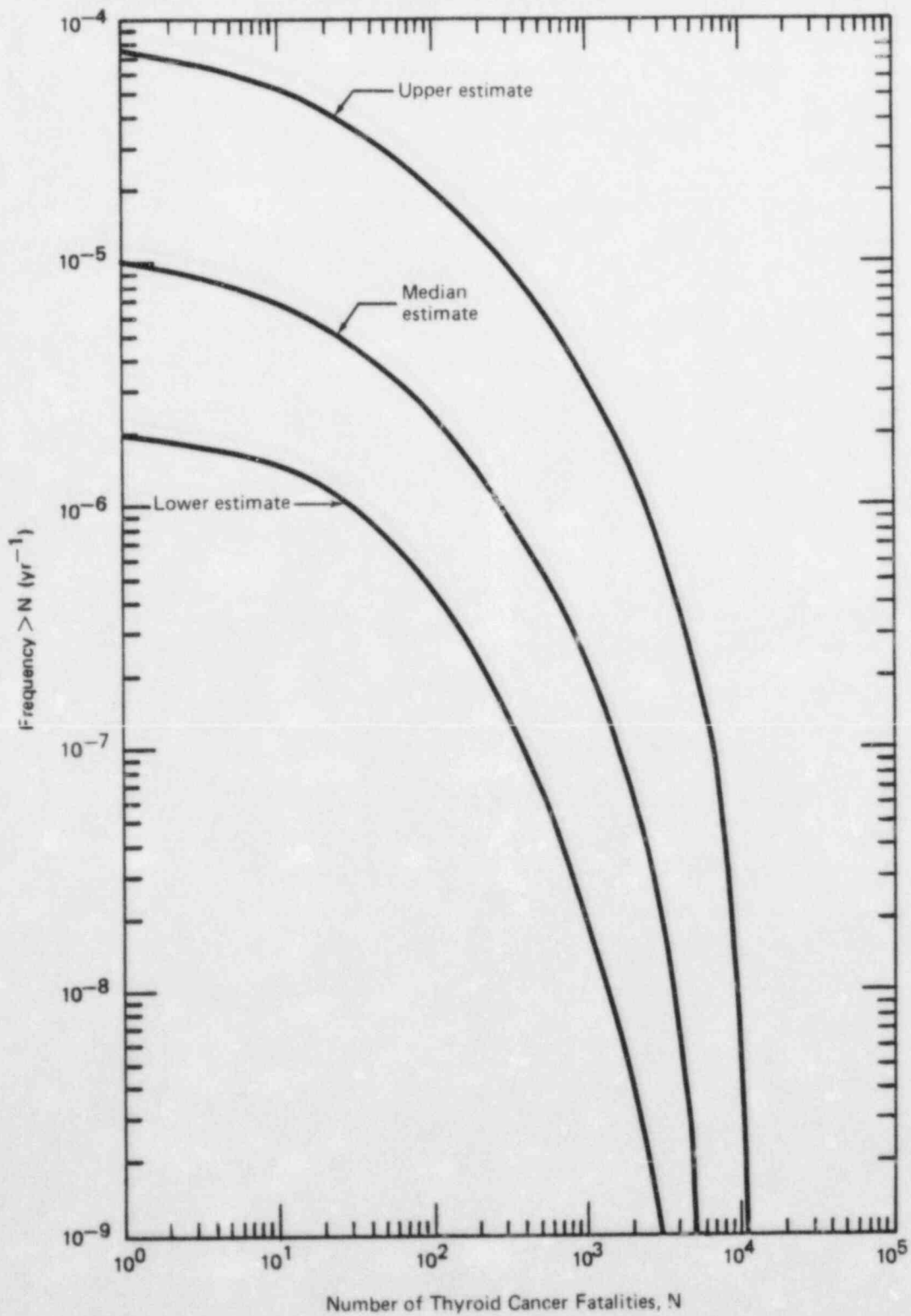


Figure 11. CCDF for thyroid-cancer fatalities, population to 500 miles.
(Revised Figure 12-16 of LGS-SARA)

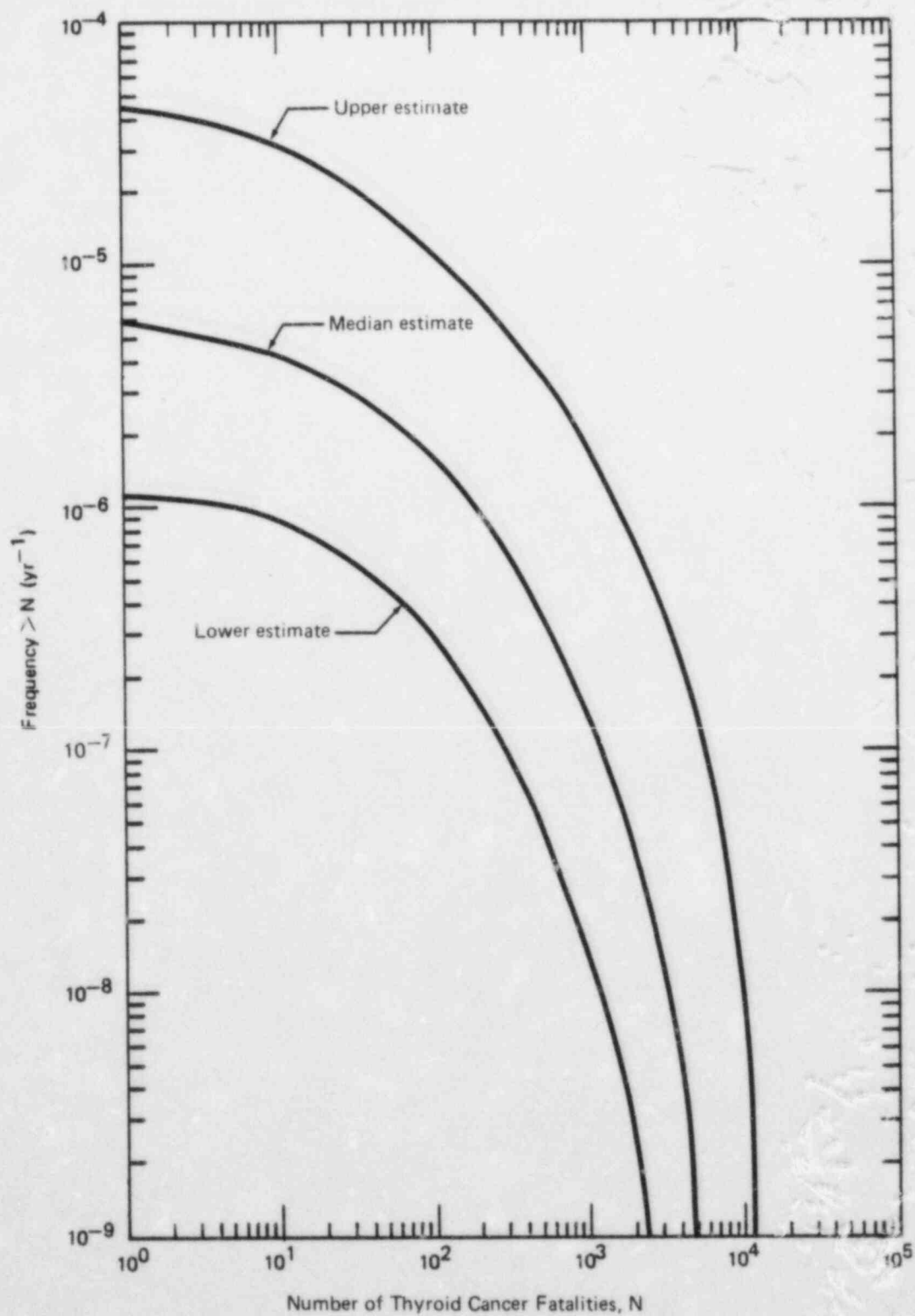


Figure 12. CCDF for thyroid-cancer fatalities, population to 50 miles all initiating events.
(Revised Figure 12-17 of LGS-SARA)

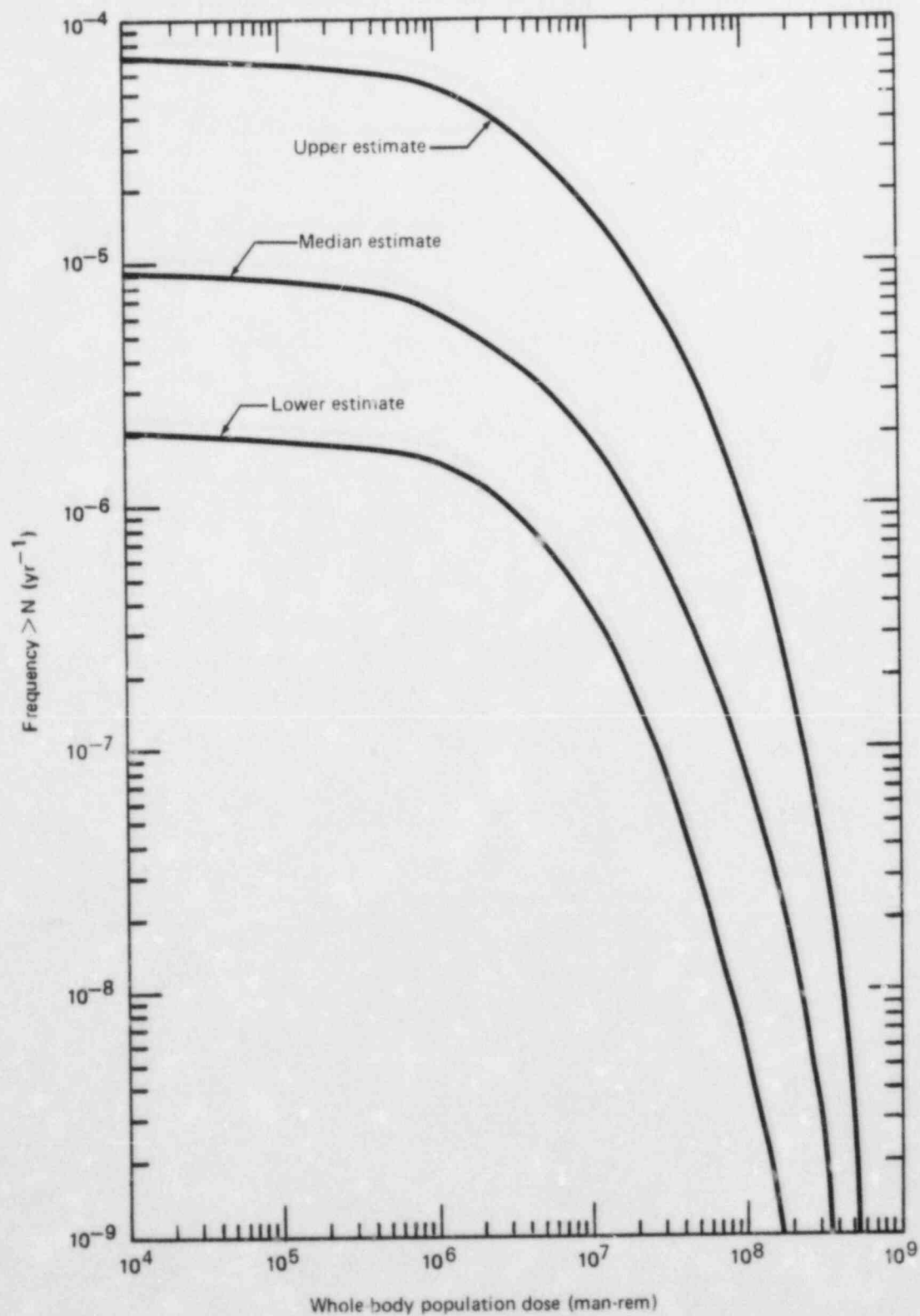


Figure 13. CCDF for whole-body population dose (man-rem), population to 500 miles.
(Revised Figure 12-18 of LGS-SARA)

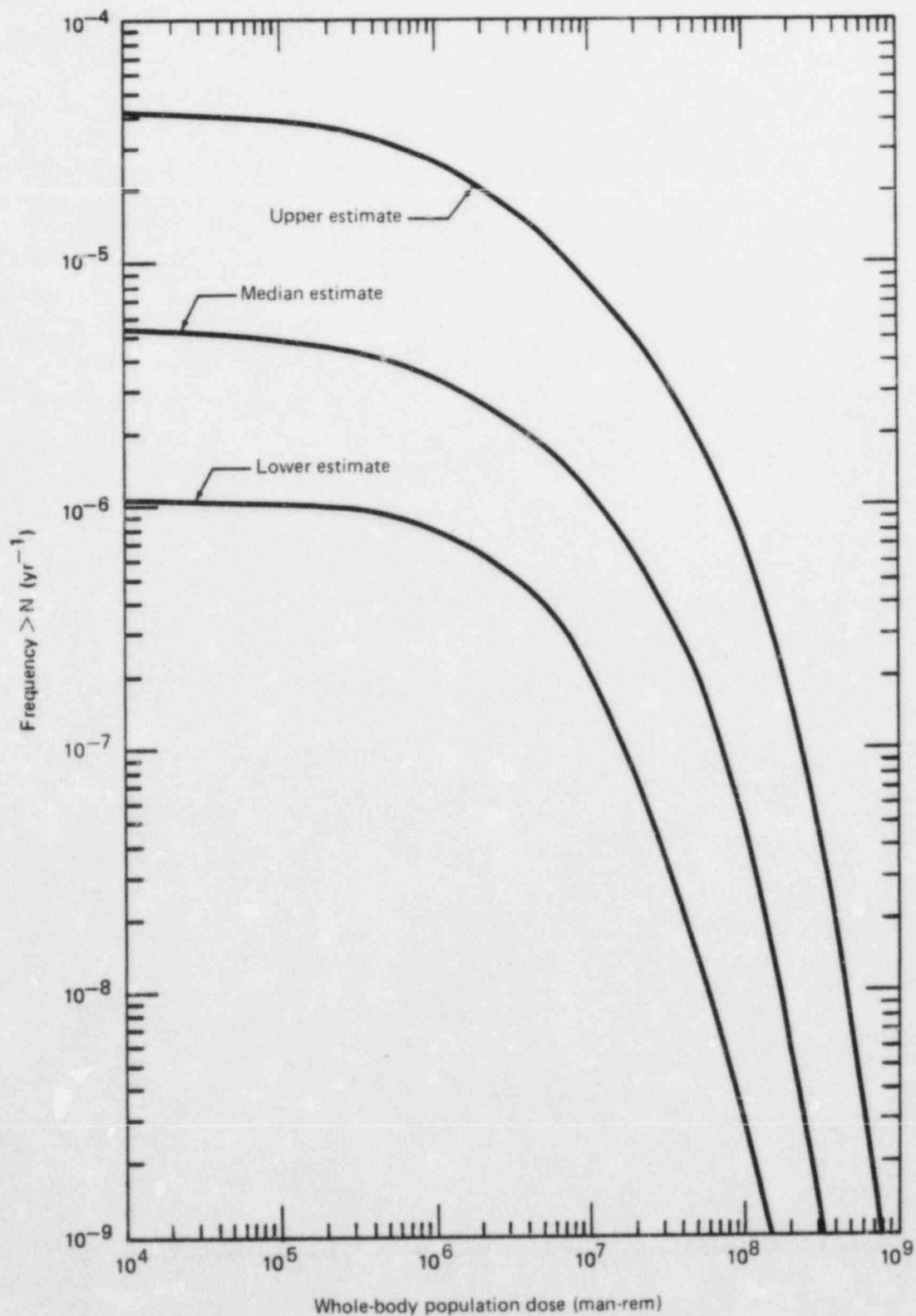


Figure 14. CCDF for whole-body population dose (man-rem), population to 50 miles, (Revised Figure 12-19 of LGS-SARA)

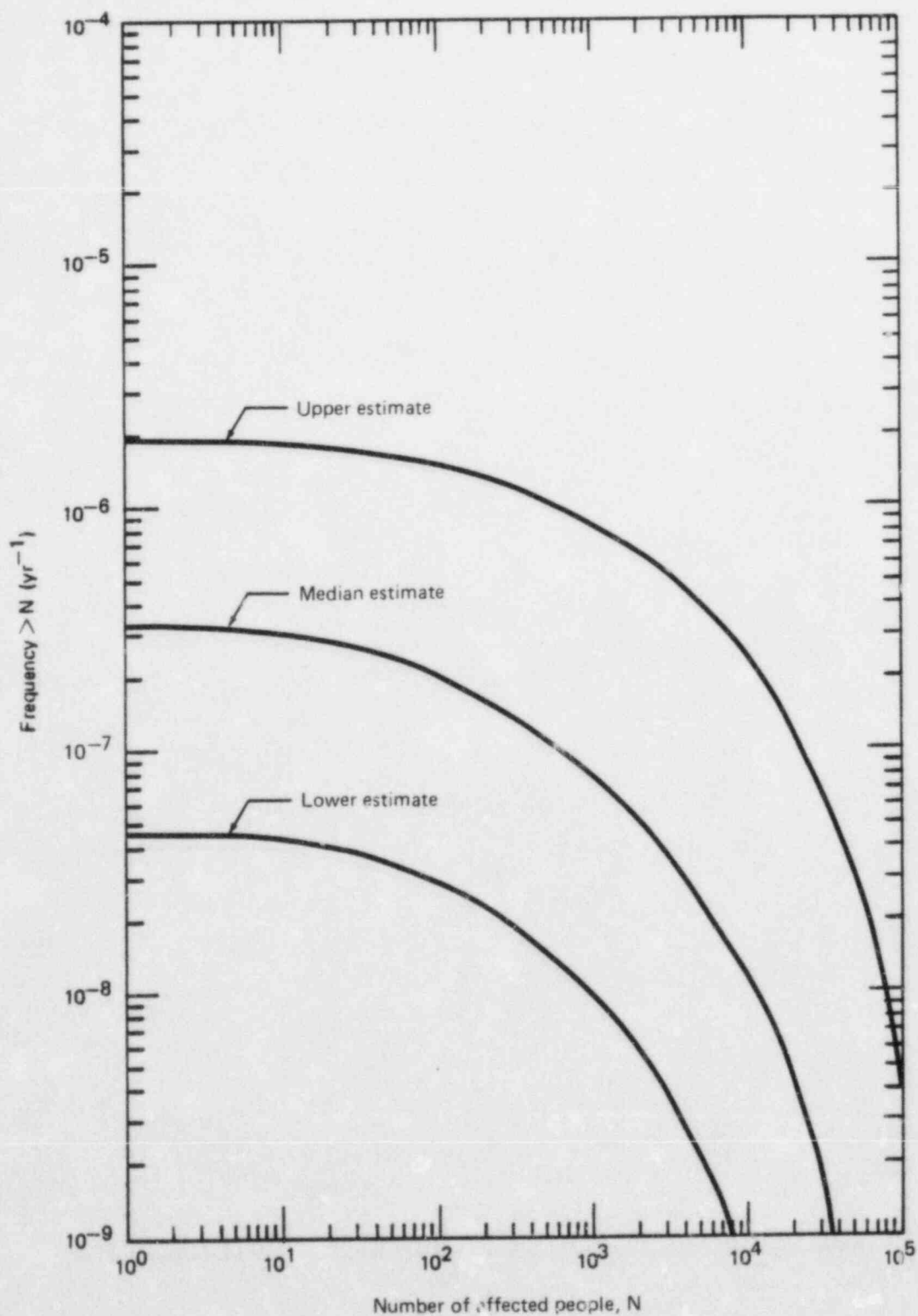


Figure 15. CCDFs for the number of people with a bone-marrow dose of 200 rem or more from early exposure.
(Revised Figure 12-20 of LGS-SARA)

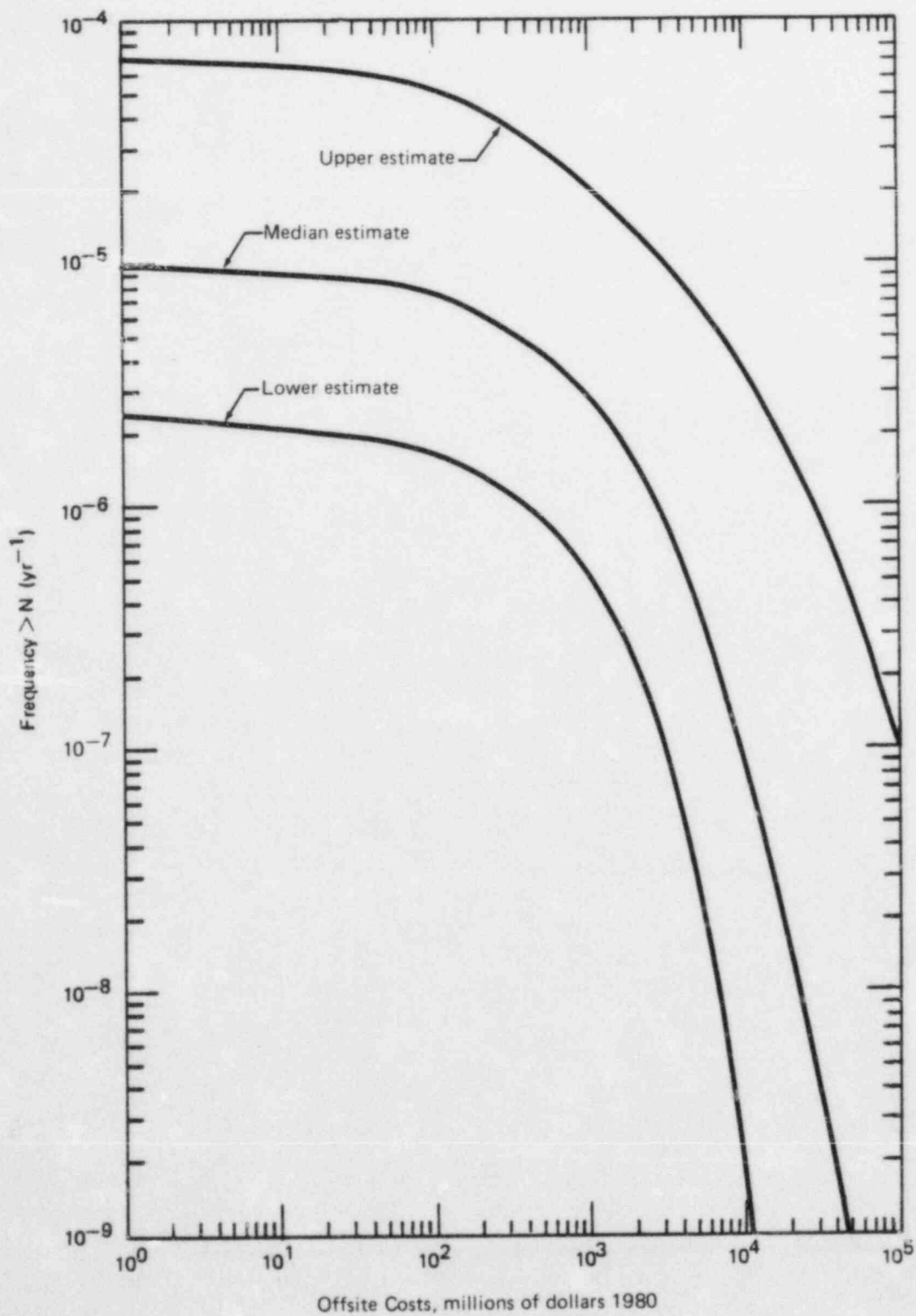


Figure 16. CCDF for offsite costs. (Revised Figure 12-21 of LGS-SARA)

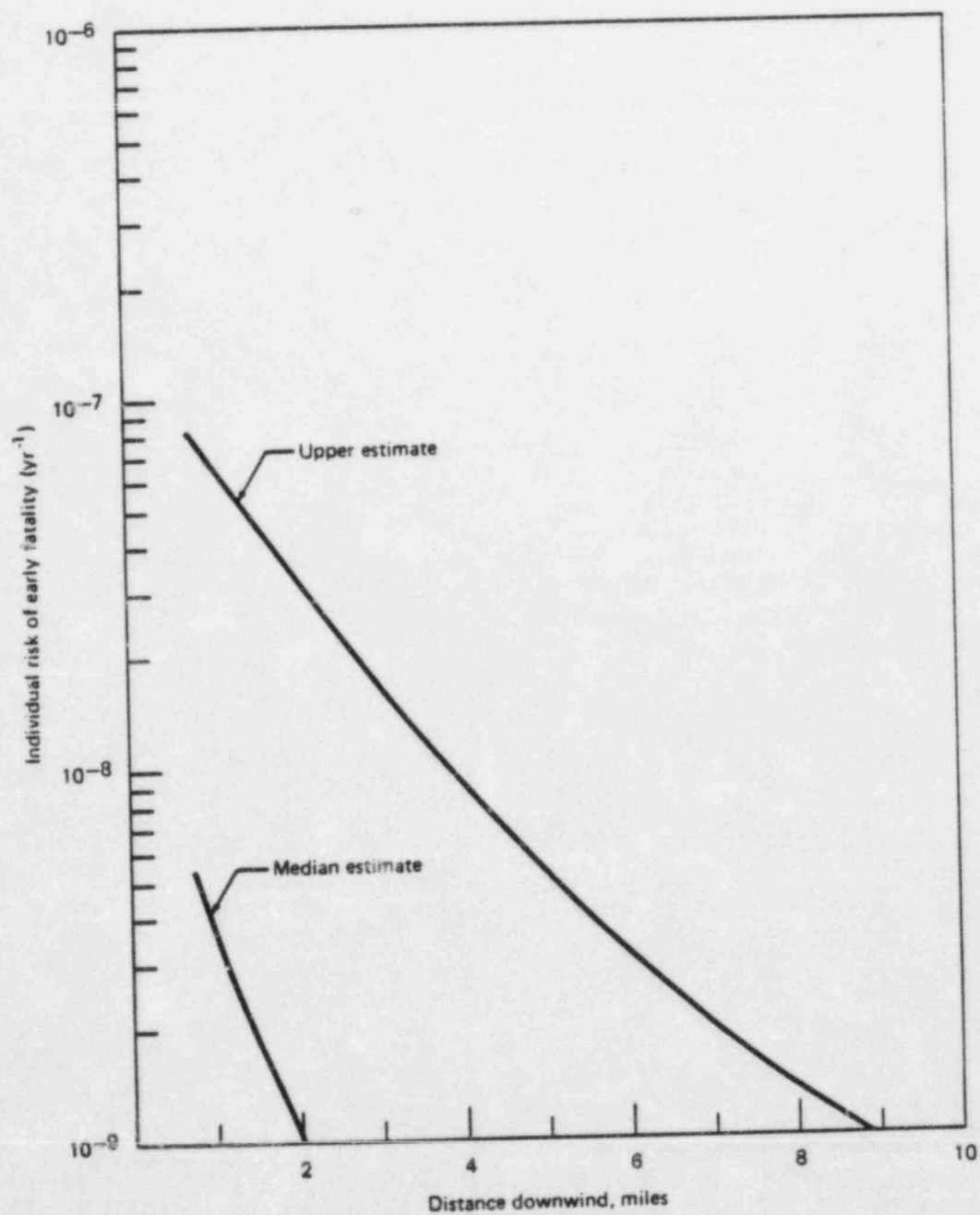


Figure 17 Individual risk of early fatality as a function of distance.
(Revised Figure 12-22 of LGS-SARA)

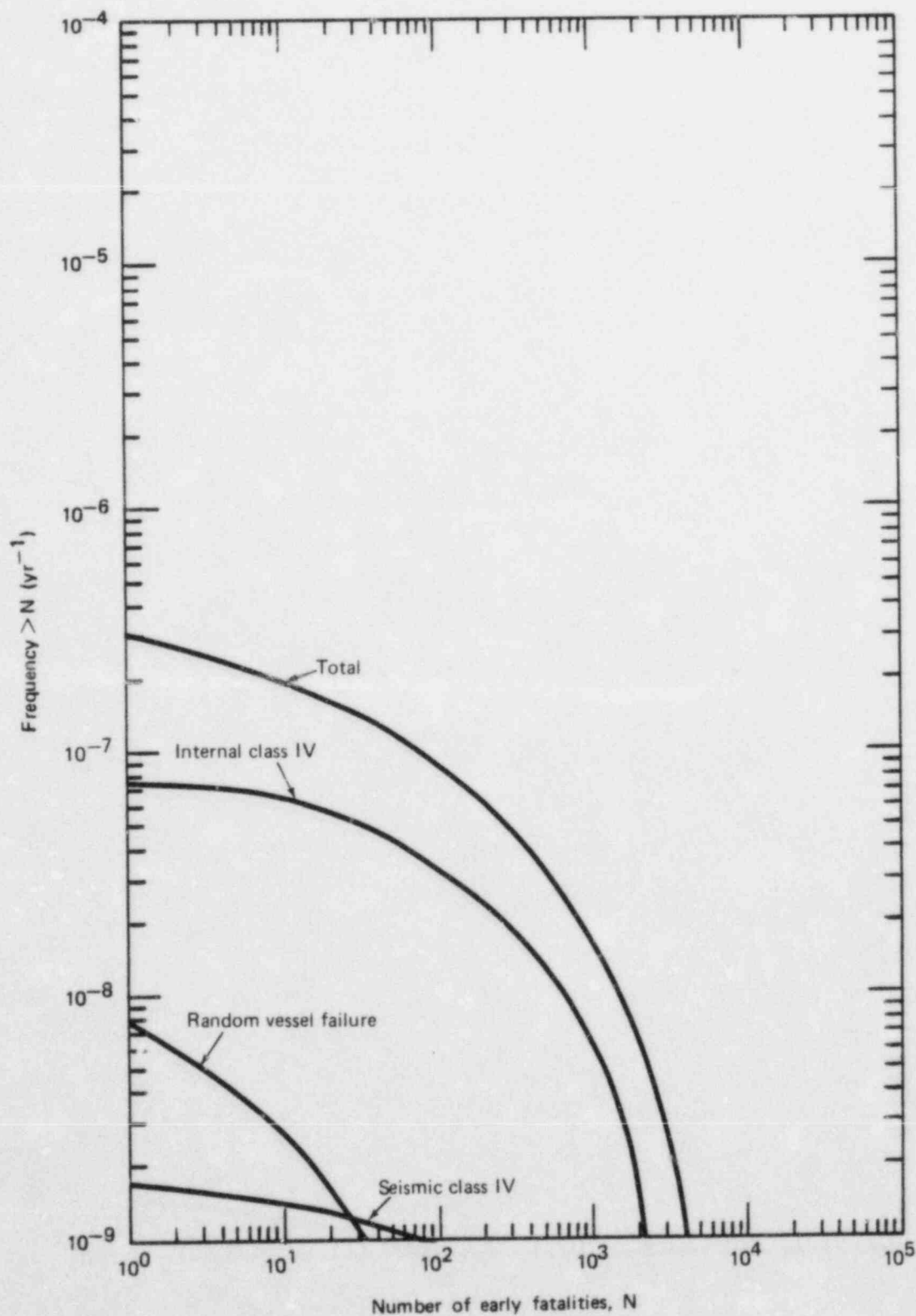


Figure 18. Median estimate of CCDFs for early fatalities, all causes.
(Revised Figure 12-23 of LGS-SARA)

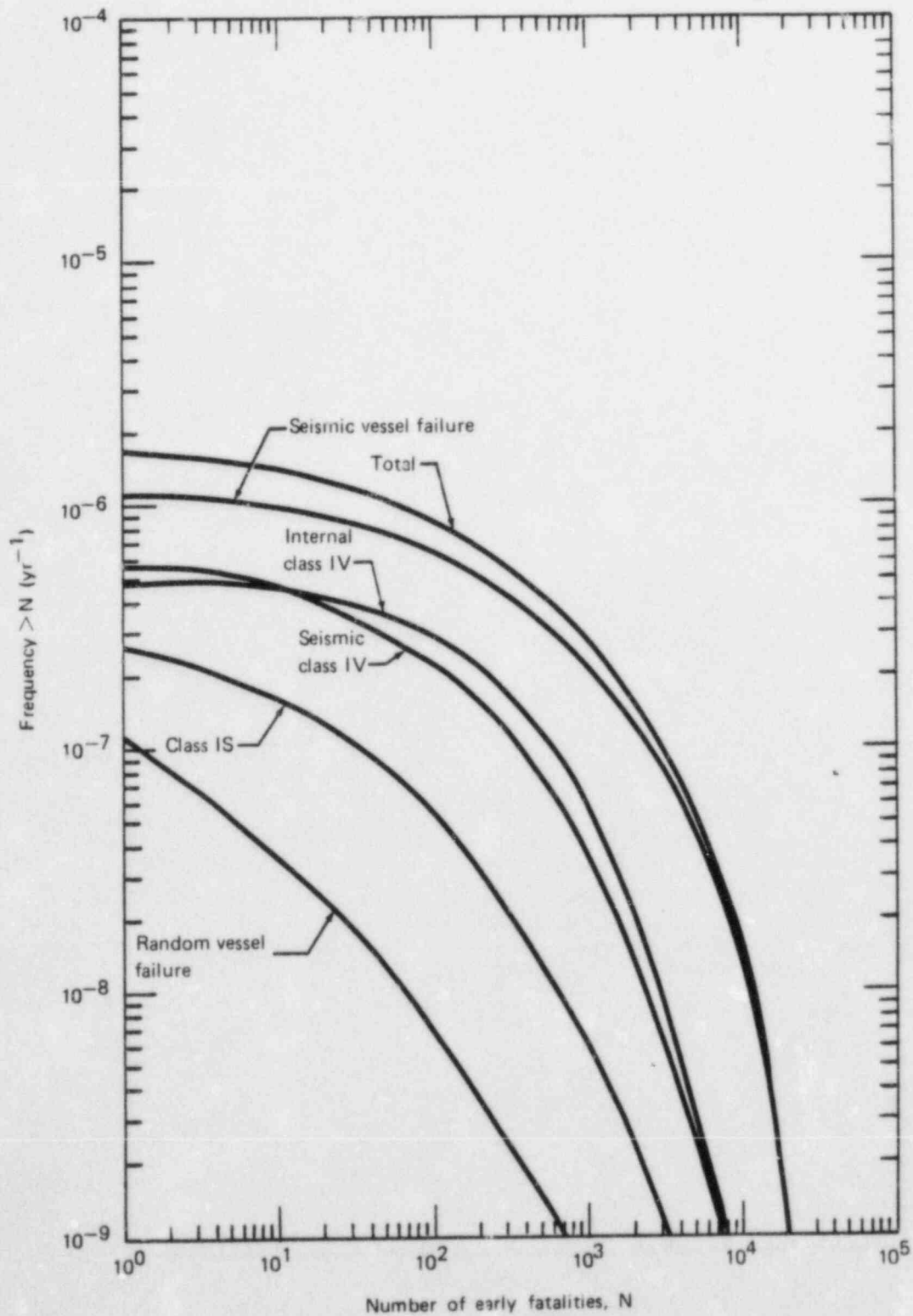


Figure 19. Upper estimates of CCDFs for early fatalities, all causes.
(Revised Figure 12-24 of LGS-SARA)

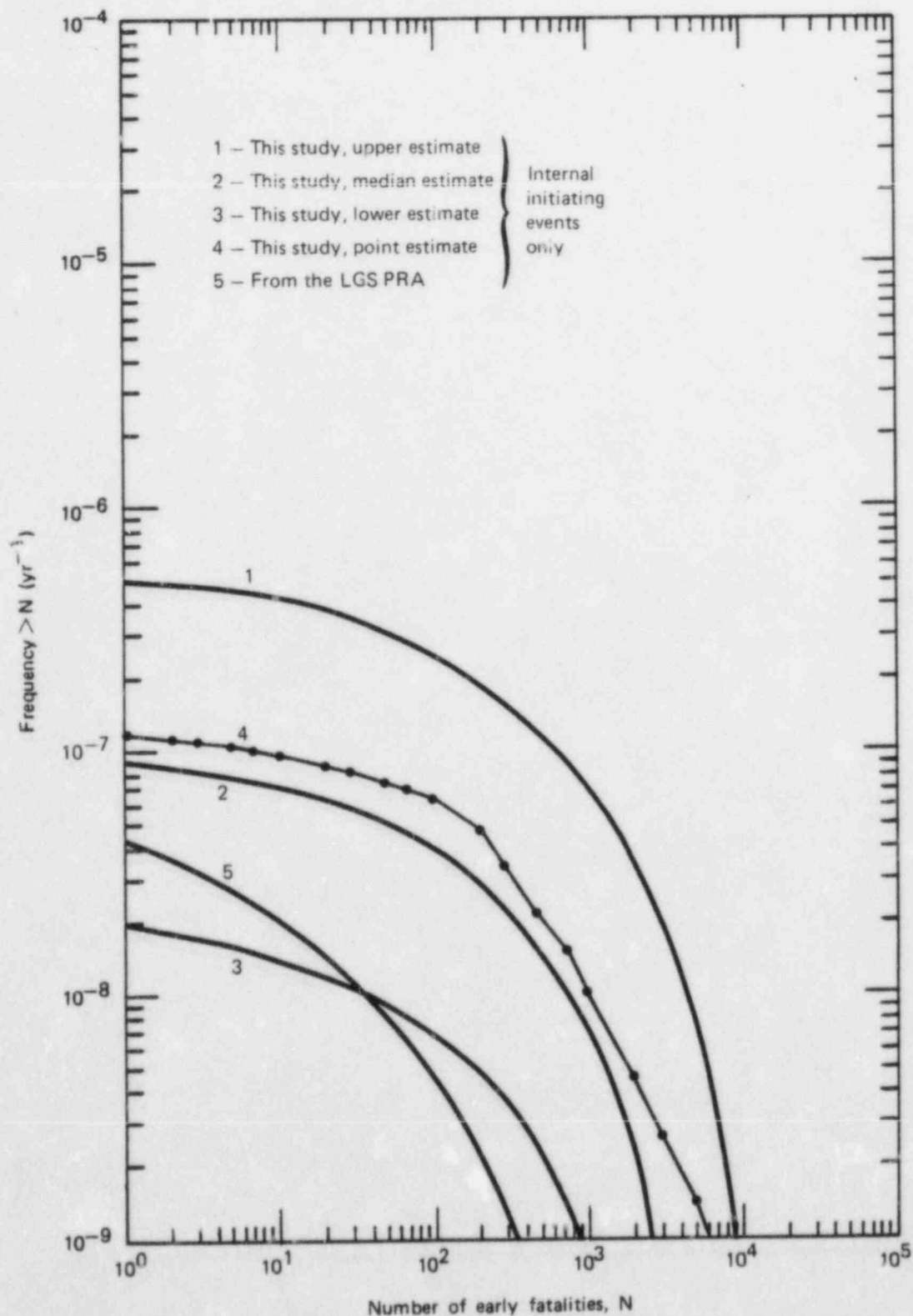


Figure 20. CCDFs of early fatalities - comparison of this study with the results of the LGS PRA.
(Revised Figure 12-25 of LGS-SARA)

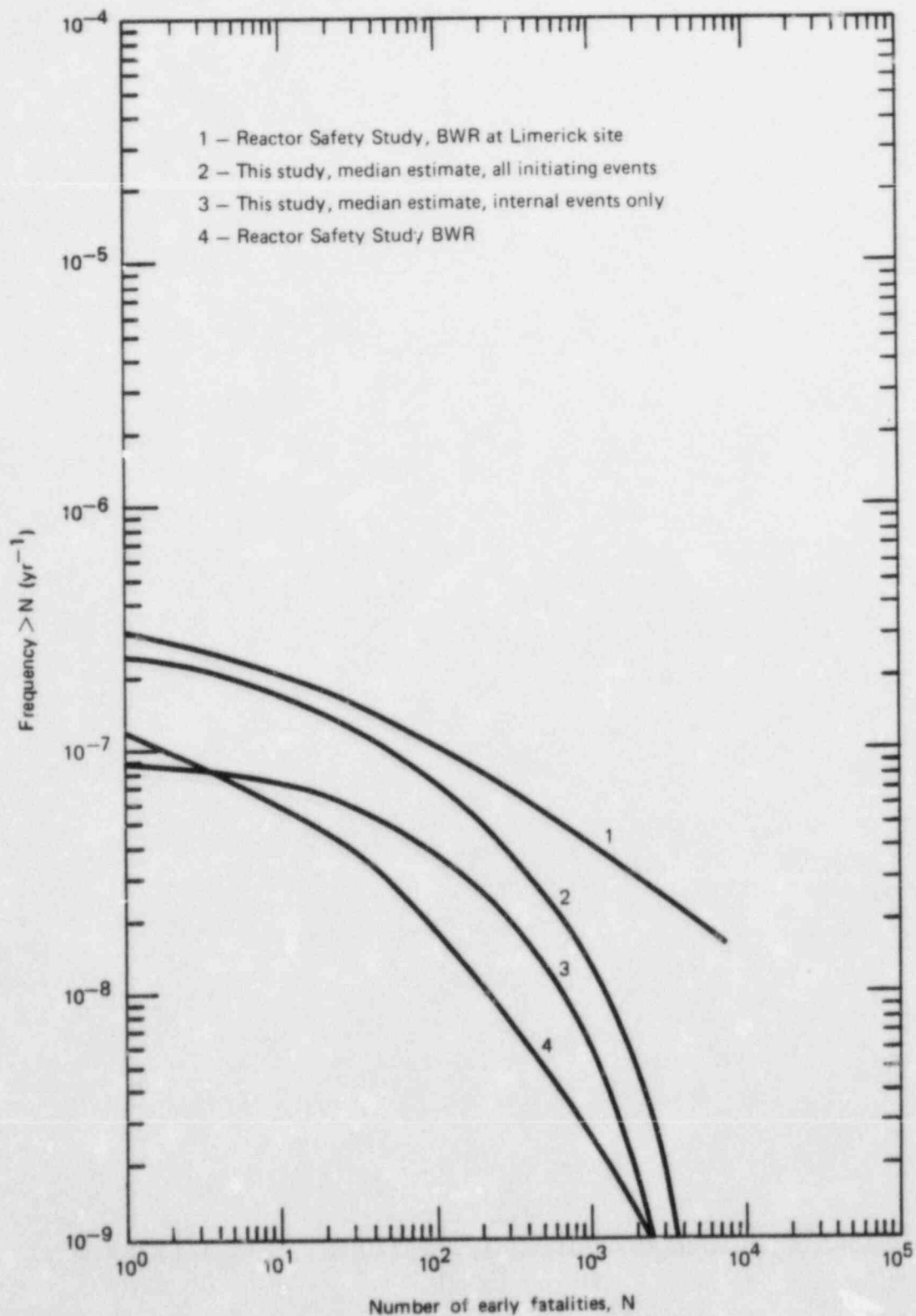


Figure 21. CCDFs of early fatalities - comparison with the reactor safety study.
(Revised Figure 12-26 of LGS-SARA)

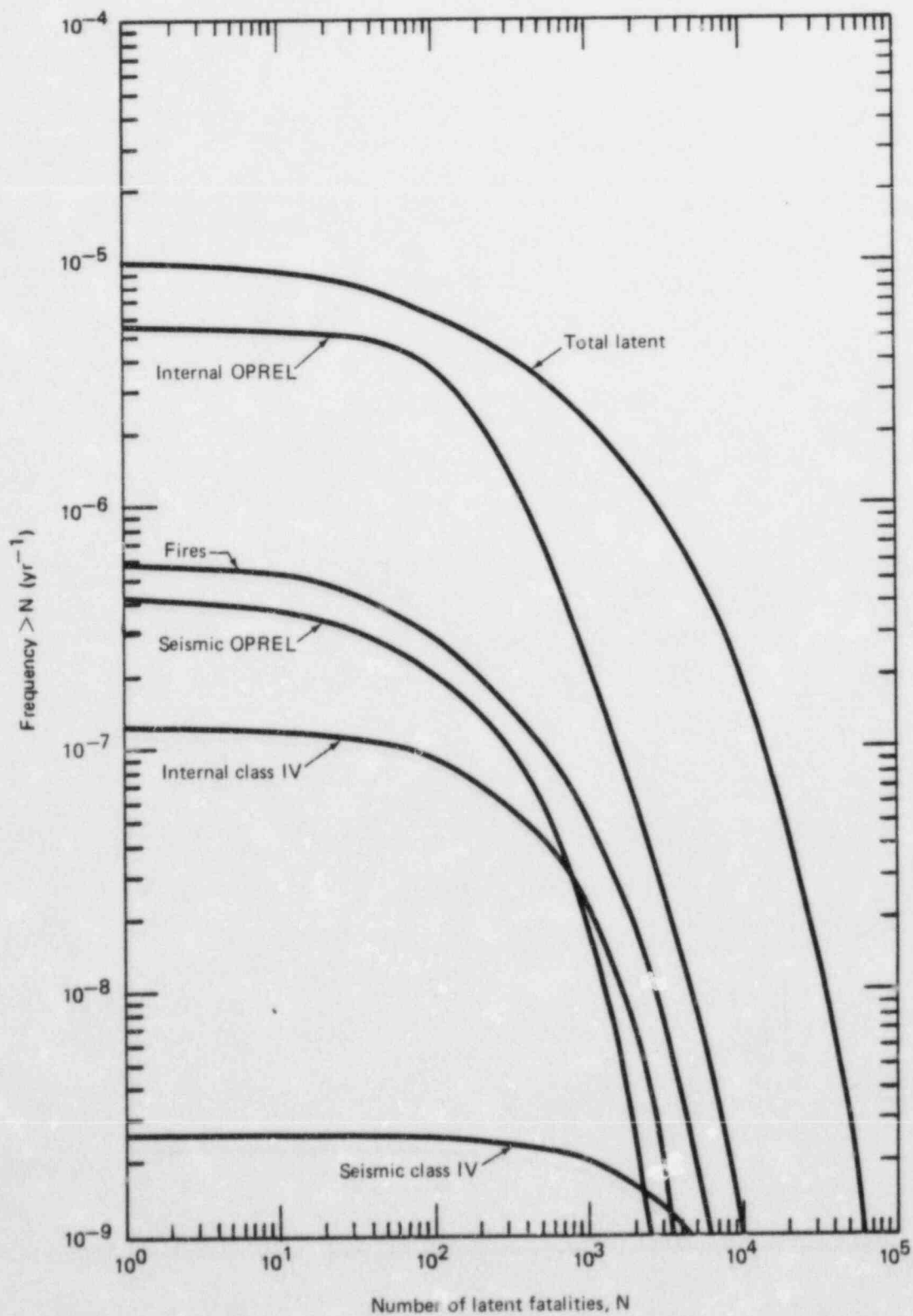


Figure 22. Median estimate of CCDFs for latent cancer fatalities.
(Revised Figure 12-27 of LGS-SARA)

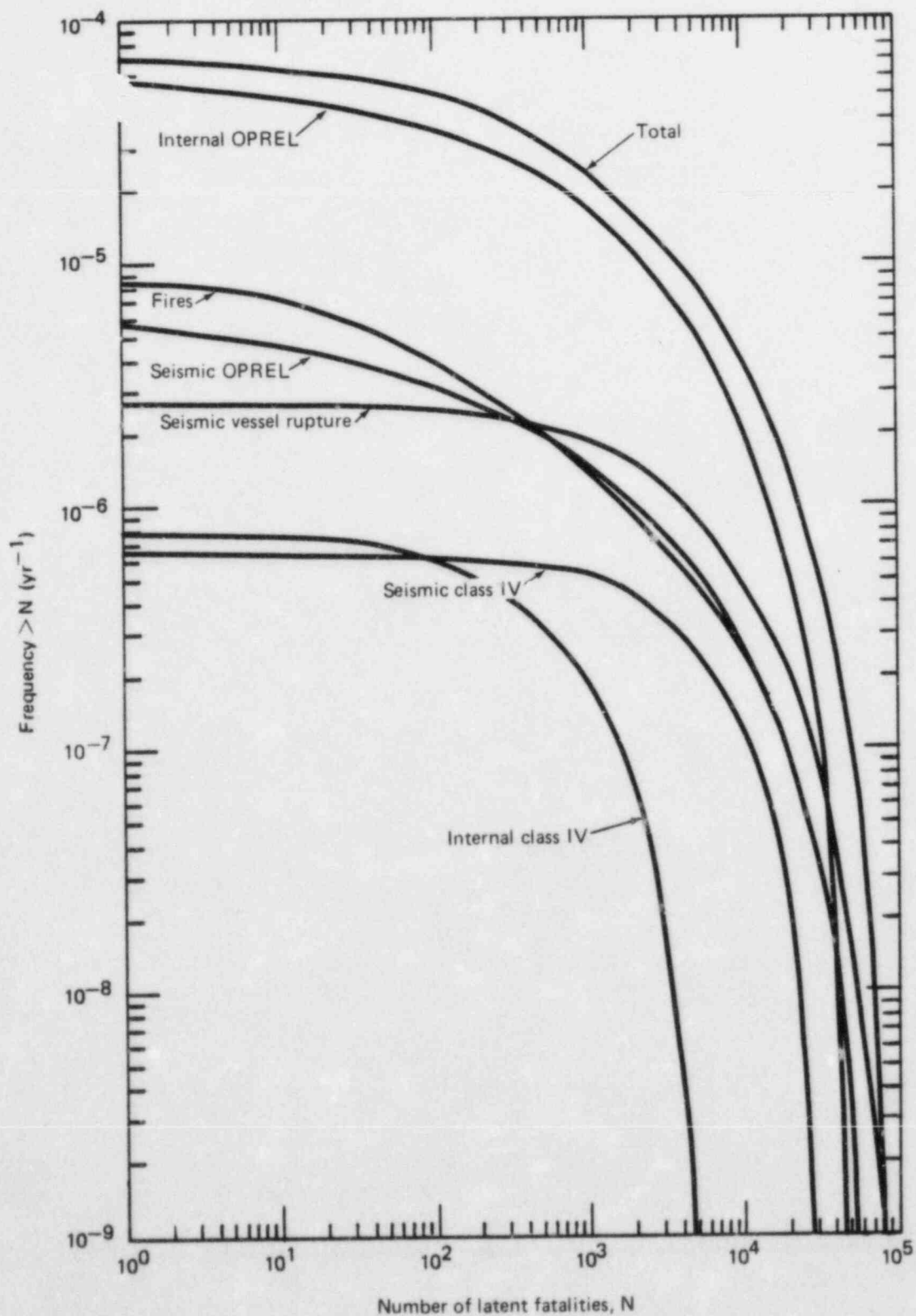


Figure 23. Upper estimate of CCDFs for latent cancer fatalities.
(Revised Figure 12-28 of LGS-SARA)

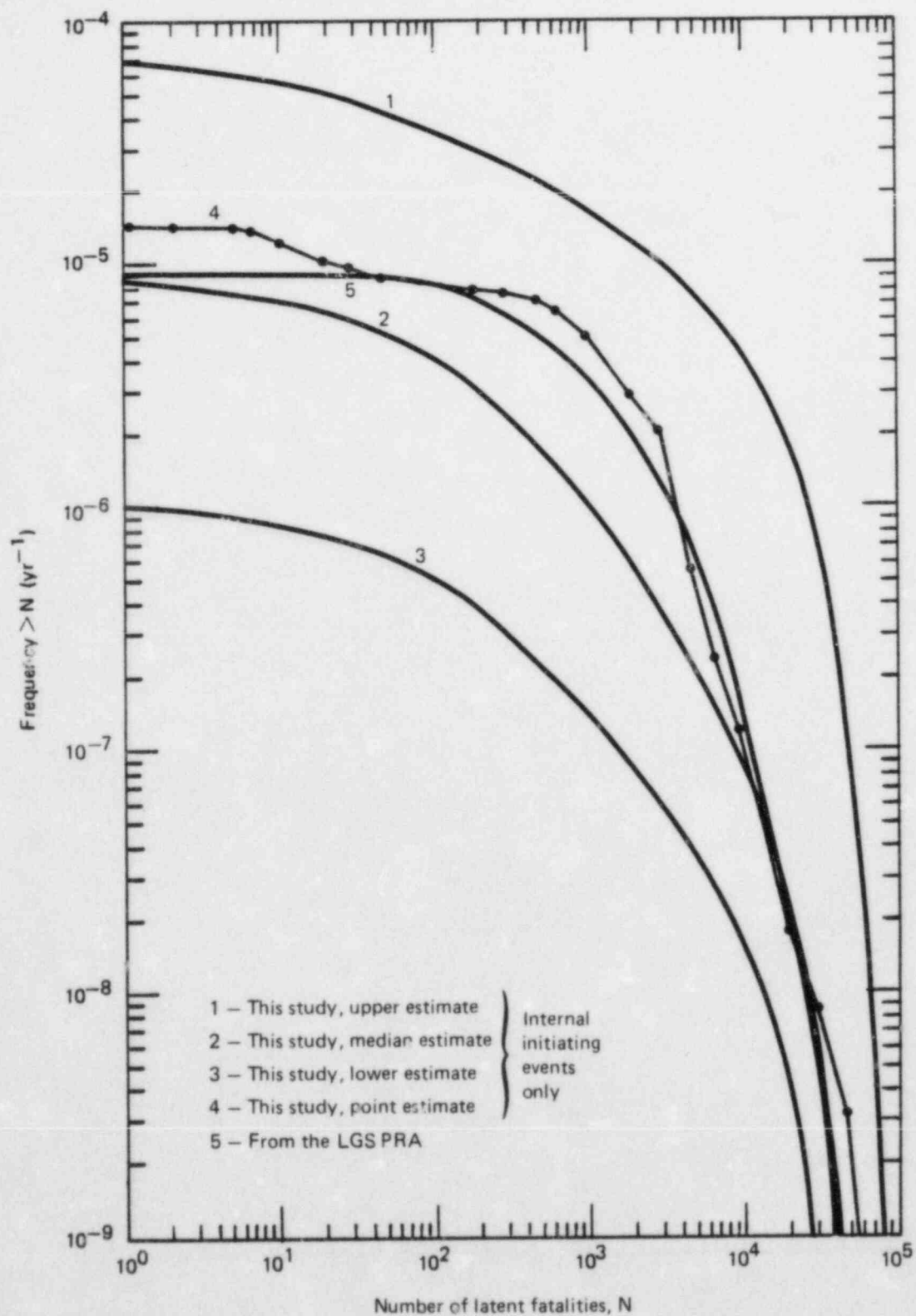


Figure 24. CCDFs for latent-cancer fatalities - comparison with LGS PRA.
 (Revised Figure 12-29 of LGS-SARA)

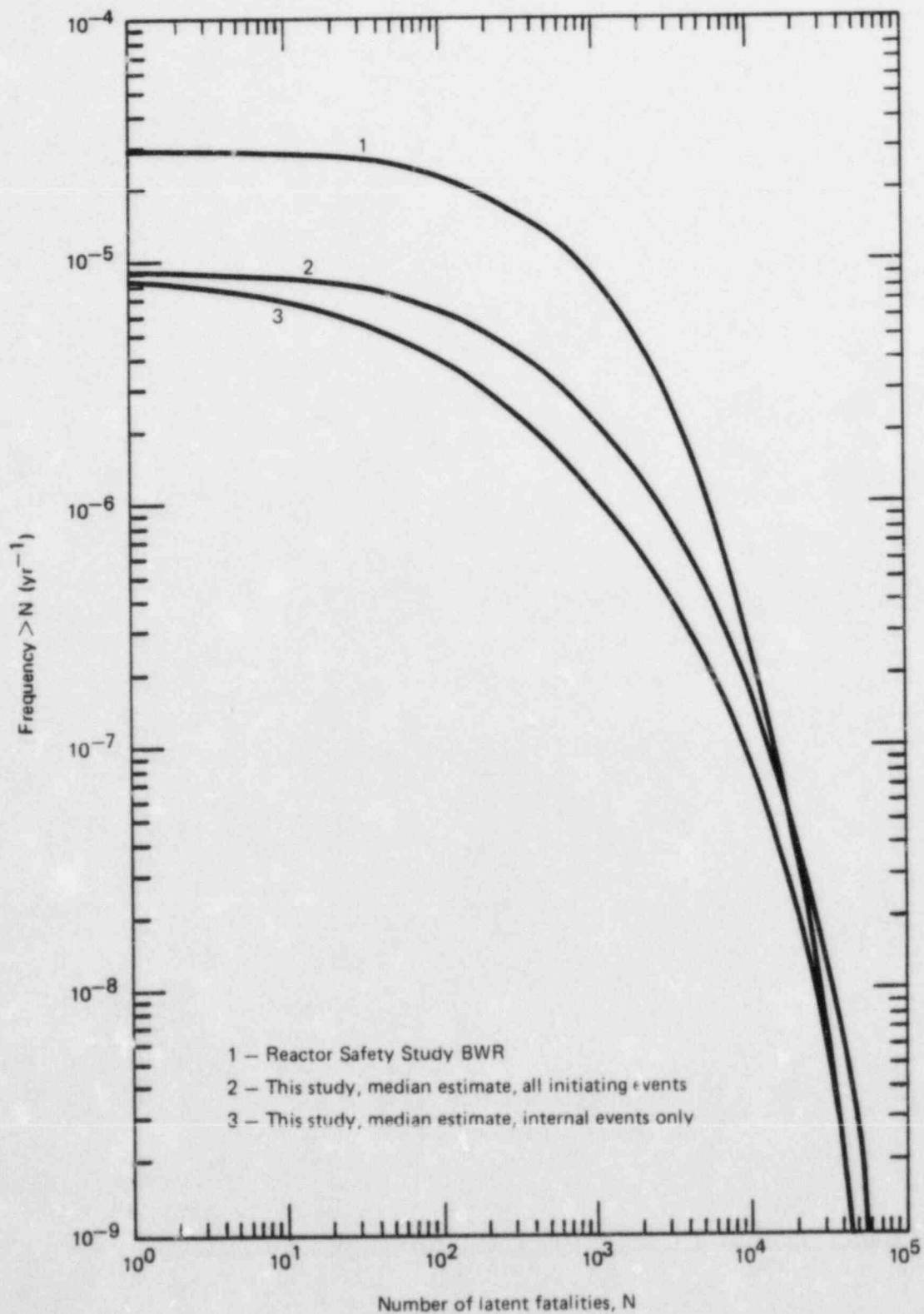


Figure 25. CCDFs for latent-cancer fatalities - comparison with Reactor Safety Study.
(Revised Figure 12-30 of LGS-SARA)