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November 30, 1993

Falk Kantor
U.S. Nuclear Regulatory Commission
Division Of Radiation Protection
and Emergency Response
Washington, D. C. 20555

Dear Mr. Kantor:

Attached is a copy of my review of Mr. Raymond W. Rucker's September 8, 1993 response to my May 23, 1993 review of the Watt's Bar March 1993 Evacuation Time Estimates. My conclusion is that the time estimates are excessive and need to be revised.

If you have any questions, please let me know.

Sincerely yours,

Thomas Urbanik II, Ph.D., P.E.

c: Gary Bethke

REVIEW OF RUCKER REPORT ON WATTS BAR ETE (Sept. 8, 1993)

by

Thomas Urbanik II, Ph.D., P.E.

November 29, 1993

My review is based on the material contained in a letter of September 8, 1993 by Mr. Raymond W. Rucker, Regional Traffic Engineer, State of Tennessee, Department of Transportation, transmitting his report in response to my May 23, 1993 review of the March 1993 Watts Bar Evacuation Time Estimates contained in The State of Tennessee Multi-Jurisdictional Radiological Emergency Response Plan for Watts Bar, Volume I. The review is based on the guidance of NUREG-0654, FEMA-REP-1, Rev. 1. My response will follow the paragraph numbering used by Mr. Rucker in response to my May 23, 1993 review.

PARAGRAPH ONE: Past reviews of studies done at other sites may not be relevant as they may have been done under earlier guidance. The licensee may also wish to consult NUREG/CR-4831 for additional guidance in conducting evacuation time estimate studies.

PARAGRAPH TWO: NUREG-0654, FEMA REP 1, Rev. 1, describes two methods, sequential and distribution curves, for determining evacuation times. The Watts Bar analysis inappropriately combines the two methods in a manner which results in an excessively long evacuation time estimate. This will be explained in more detail in Paragraph 6.

Reference is made to the assumption that no one leaves home for 45 minutes. In fact, the analysis assumes, as will be discussed further in Paragraph Six, that no one leaves home for 150 minutes.

PARAGRAPH THREE: The use of an average auto occupancy of 2.5, representing all types of conditions for all types of trips is a less than desirable approach. This assumption is relatively minor in its potential impact. However, reference to the methods in NUREG/CR-4831 would be more appropriate.

PARAGRAPH FOUR: The basic capacities as stated are conservative. However, in reality, the method used as described in Paragraph 6 makes the capacities more conservative than stated with an effective capacity less than 400 vehicles per hour for the longest path out of the EPZ.

PARAGRAPH FIVE: The addition of a delay time of 2 seconds per vehicle reduces the capacity of 958 vehicles per hour (3.76 second headways) to an effective capacity of 625 vehicles per hour (5.76 second headways), or a reduction of 35 percent. Likewise, adding 2 seconds of delay time to a 622 vehicle per hour capacity (5.79 second headways) reduces the capacity to 462 vehicles per hour (7.79 second headways), a 26 percent capacity reduction.

PARAGRAPH SIX: NUREG-0654, FEMA REP 1, Rev. 1, describes two methods for computing evacuation time. The sequential method adds preparation time to any roadway delay time which is computed by dividing demand (number of evacuating vehicles) by roadway capacity (vehicles per hour). The result overestimates evacuation time because it assumes that no one evacuates until everyone leaves. The distribution curve method was intended to take credit for some people leaving before *everyone* was prepared. The distribution curve method should provide lower and more realistic evacuation times than the sequential method. The Watts Bar analysis incorrectly uses the distribution curve method. Effectively, the Watts Bar analysis uses the sequential method with distribution curves.

First, the Watts Bar analysis assumes it takes 150 minutes for everyone to be prepared. Then, the analysis assumes that within the sector, vehicles move at what is effectively 3 to 5 mph for two to three miles. Then, effectively, all vehicles wait until the last vehicle leaves the sector before it is again assumed that all vehicles simultaneously enter the main evacuation roadway. The time required to evacuate the main roadways, which is calculated in the manner which would be used in the sequential method, is added to the 150 minute preparation time, plus the earlier delay within the sector. In addition, some "segment delay" is computed, in a manner which is not clear.

If the distribution method was properly applied, the ETE would probably be about 3 or 4 hours. If the sequential method was used (with the relatively conservative capacities), the ETE would be about 5.25 hours. The method actually used results in an extremely long ETE of 7.13 hours. The effective speed of the Watts Bar ETE is 1.4 mph, less than normal walking speed.

PARAGRAPH SEVEN: The method for determining the transient population estimate is still vaguely described.

PARAGRAPH EIGHT: There is credible data on the effects of adverse weather. Refer to NUREG/CR-4831.

PARAGRAPHS NINE AND TEN: Volume II of the Tennessee emergency plan was not provided for review. The traffic management material should include specific objectives for traffic control. Refer to Figure 1 of NUREG/CR-4831 to determine what constitutes adequate information.

PARAGRAPH ELEVEN: The conclusion of no problem in evacuation from U.S. 27 at its intersection State Route 30 is predicated on a 7.13 hour ETE. If a lower ETE is determined to be appropriate, then the intersection of U.S. 27 and State Route 30 should be explicitly analyzed.

PARAGRAPH TWELVE: See response to Paragraph Six.

CONCLUDING PARAGRAPH: The analysis is based on a series of conservative assumptions which are added together to form a very conservative analysis. This level of conservatism is not warranted and should be corrected. The method is NOT consistent with the guidance of NUREG-0654.