UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 21, 1994

MEMORANDUM FOR: The Chairman
Commissioner Rogers
Commissioner Remick
Commissioner de Planque

FROM: James M. Taylor
Executive Director for Operations

SUBJECT: REVIEW OF MIT DOCTORAL THESIS BY A. R. SICH, "THE CHERNOBYL ACCIDENT REVISITED: SOURCE TERM ANALYSIS AND RECONSTRUCTION OF EVENTS DURING THE ACTIVE PHASE"

The Office of Nuclear Regulatory Research (RES) has performed a preliminary review (Enclosure 1) of the above doctoral thesis, recently submitted to the Massachusetts Institute of Technology (MIT), by Mr. A. R. Sich. A copy of this report was sent to the Chairman by MIT in a letter dated February 10, 1994 (Enclosure 4).

This work is relevant to ongoing evaluations of the Chernobyl accident. Mr. Sich's thesis, which has received wide circulation in the press, claims, among other things, that actual releases of the volatile nuclides (iodine, cesium, and tellurium) were 185 megacuries, or about four times greater than the value of 50 megacuries reported by the Soviets at the IAEA meeting in Vienna in September 1986. A table from his thesis listing his estimated releases is enclosed as Enclosure 5.

Our preliminary review has focussed only upon the magnitude and characteristics of the source term and consequent releases. We have found several obvious errors that indicate that the release of cesium and iodine has been overestimated by Mr. Sich. With these corrections, Mr. Sich's estimate is reduced to almost 100 megacuries, or about twice the original Soviet estimate. We are aware that the Soviets estimated that their original value could be in error by about 50 percent, and more recent estimates have indeed increased the original estimated volatile releases at Chernobyl by up to a factor of two.

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Enclosure 1

The Commissioners

We are continuing to review this work more fully, including assumptions for the release fractions, of which some appear also to be on the high side. As noted in Enclosure 1, for now we have used Mr. Sich's release fraction assumptions in our reevaluation of total releases. We are asking two outside experts, Drs. T. Kress and D. Powers of Oak Ridge National Laboratory and Sandia Laboratories, respectively, to review additional areas. We have also discussed the results of this review with Dr. Norman C. Rasmussen of MIT, Mr. Sich's thesis advisor, who is aware of our findings.

Original signed by
James M. Taylor

James M. Taylor
Executive Director
for Operations

Enclosures:
1. Review of Sich Thesis
2. Chronology of the Accident at the Chernobyl Nuclear Power Station
3. Est. I-131 & I-33 Release vs. Time Chart
4. Letter to I. Selin from M. Kazimi dtd 2/10/94
5. Table VI.15

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Review of Sich Thesis
(Preliminary)

Enclosure 1

1. The initial core inventory of Cs-136 has been greatly overestimated. Sich estimates the Cs-136 initial inventory to be 169 Mci. This is incorrect since Cs-136 is a special case (so-called shielded nuclide) and comes largely from activation of Cs-135, with only a small contribution from fission. Using the cumulative fission yield of the 136 mass chain produces an incorrect result, since the chain "ends" with Xe-136, a stable nuclide, which does not decay to Cs-136. From Sandia estimates using MELCOR for NUREG-1150 studies, the initial core inventory for Chernobyl of Cs-136 was about 3.6 MCi. This is generally confirmed by a German study, referenced by Sich, which estimated the initial Cs-136 inventory for Chernobyl to be 2.2 MCi. If Sich's release fractions are used with an initial inventory of 3.6 MCi, the release of Cs-136 becomes about 1 MCi, compared with the value of 18.1 Mci given by Sich.

2. The release of I-133 has also been overestimated for two reasons:

   a) The initial core inventory of I-133 has been overestimated by about 20 percent. This is because the power level of Chernobyl was significantly lower than the value of 3200 MWt for about a day prior to the accident (Enclosure 2). This does not significantly affect I-131, but has a noticeable effect on I-133. Because of the reduced power level just before the accident, the initial core inventory for I-133 was about 140 Mci, rather than the value of 181 MCi listed by Sich.

   b) In addition, Mr. Sich has not considered preferential decay of I-133 compared with I-131 during the accident. Since I-133 decays at a faster rate than I-131, the ratio of I-133 to I-131 would be much lower at the end of a prolonged release than at the beginning. Sich estimates that an identical fraction of both I-131 and I-133 (about 37 percent) was released over the ten day period of the "active" release. This would be possible only if all the iodine were released at the same time, which is contrary to the available data. While a precise calculation is difficult, an estimate of this effect can be made if one uses the releases over the ten day period cited by the Soviets at Vienna as relative releases and accounts for the decay of I-131 as well as I-133 (Enclosure 3). Accepting Sich's estimate that 37 percent of the I-131 was released, only about 16 percent of the I-133 is estimated to have been released. Sixteen percent of 140 MCi yields about 22 MCi, rather than the value of 67 Mci quoted by Sich.

(from NUREG-1250)

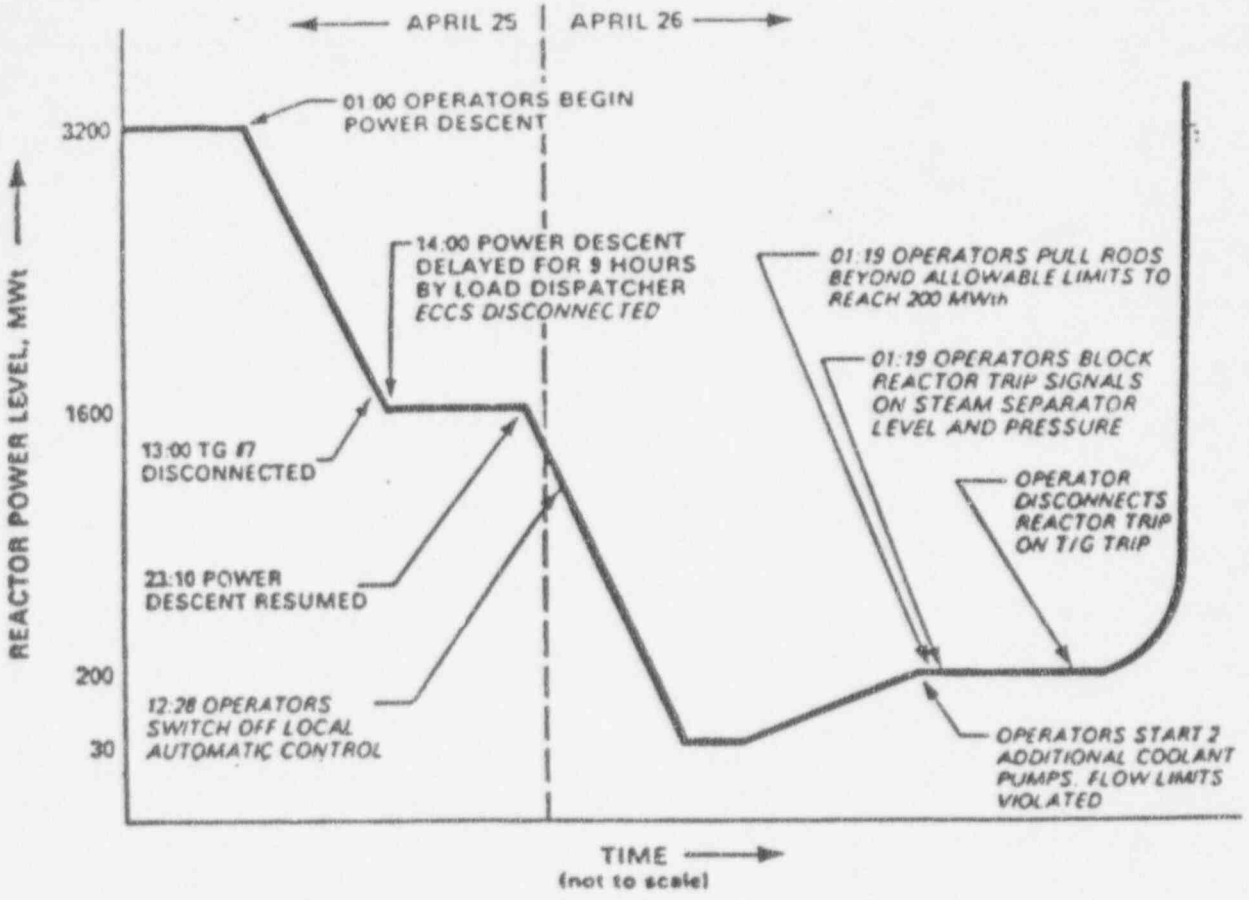
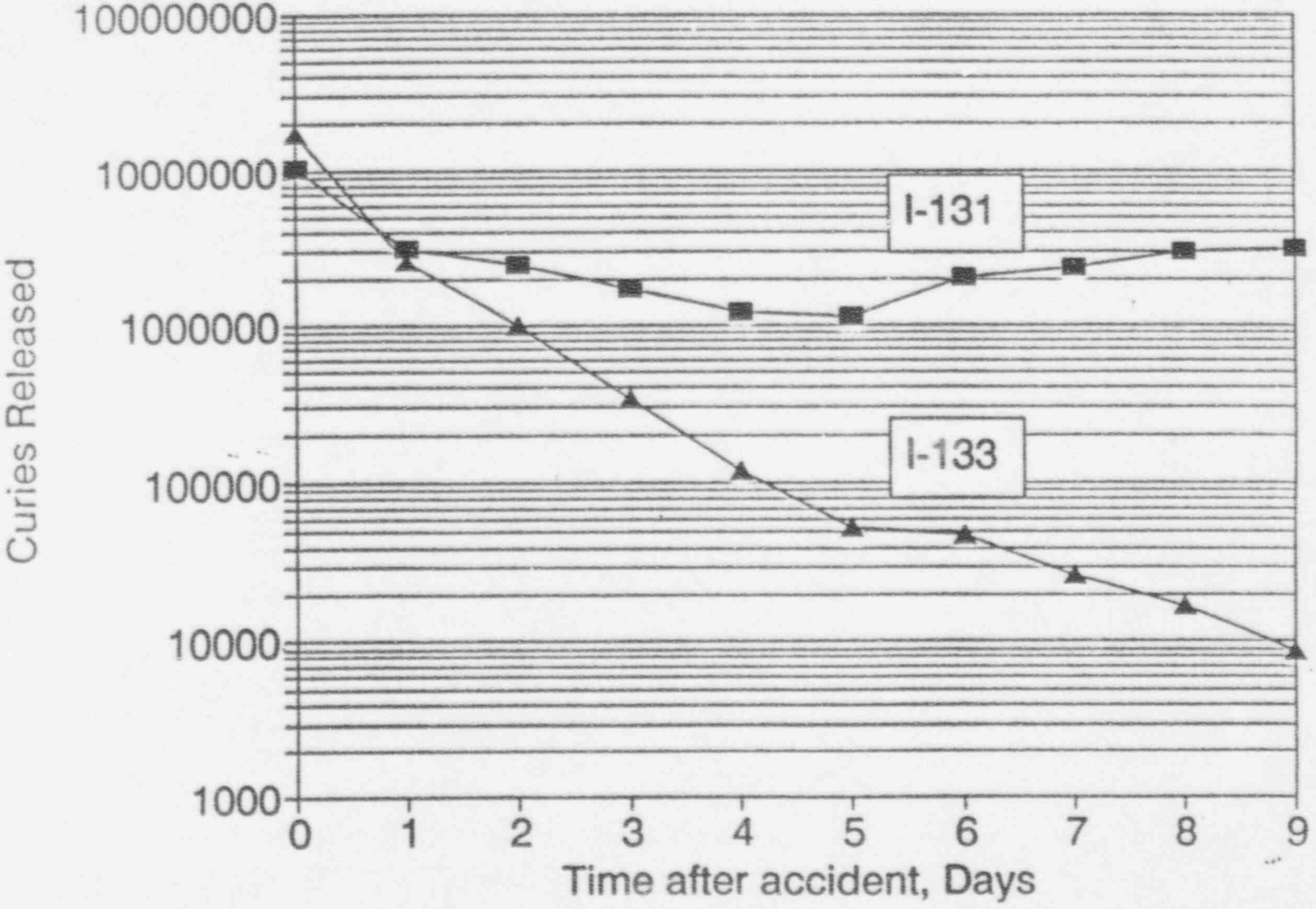


Figure 4.1 Chronology of the accident at the Chernobyl Nuclear Power Station (not to scale)

The events leading to the accident started at 01:00* on April 25 when station personnel started reducing reactor power, according to test procedures. By 13:05 reactor power had been reduced from 3200 MWt to about 1600 MWt. Turbine generator No. 7, one of the unit's two main turbine generators, was then removed from service. The electrical systems were then reconfigured so that two of four motor-driven feedwater pumps and four of eight main circulating pumps were switched to the busbar of turbine generator No. 8, the generator to be used in the test. The remaining feedwater and main circulating pumps were aligned to the station's service transformer (offsite power).

*References to time will use a hybrid military time designation. For example, 0100 becomes 01:00. The purpose is to provide a framework for more detailed time reference (e.g., in seconds such as 01:00:30) where such information is available and relevant.

Est. I-131 & I-133 release vs. time
For Chernobyl accident



Enclosure 3