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

JUN 5 1979

MEMORANDUM FOR: Saul Levine, Director
Office of Nuclear Regulatory Research

FROM: Robert J. Budnitz, Deputy Director
Office of Nuclear Regulatory Research

SUBJECT: INFORMATION ABOUT INDIVIDUALS AND ORGANIZATIONS CONTACTED BY ME DURING FIRST FEW DAYS AFTER THE TMI ACCIDENT

I am responding to the memorandum of May 31, 1979, from E. K. Cornell, "Request for Information from Presidential Commission." I have gone over my log book for that period, and have found seven outside individuals with whom I had substantive contact. In each case, my contact was the only or the primary NRC contact. Besides these individuals, there is a large number with whom I spoke but for whom the primary contact was you or T. Murley. I assume that you and he are assembling your own lists, similar to mine, and that you will cover those other individuals.

For each individual, I will indicate their organizational affiliation, address and telephone number, as well as a brief description of what information was furnished.

1. Dr. Richard L. Garwin (I.B.M., Yorktown Heights, NY 10598, (914) 945-2555). On Saturday morning, March 31, I was called at home by Dr. Garwin, an old friend, and he provided a number of ideas to me about things that one might attempt to do to eliminate or reduce the pressure from hydrogen within the primary system of the TMI reactor. His ideas included putting a snake-like tube into the vessel, and using chemical means to combine hydrogen with other substances. He also gave me some insight into how important the back reaction is in calculating the shock pressure in a fast burn or detonation of hydrogen in a vessel like the TMI reactor vessel. He referred me to Dr. Harry Petschek of AVCO (see below) for assistance on the hydrogen combustion problem. Later that date, and again on Sunday, April 1, I talked with Dr. Garwin by telephone, to follow up on his understanding of pressure shock waves, something about which he had extensive advice.

2. Dr. Harry Petschek (AVCO Everett Research Laboratory, Everett, MA 02149, (617) 389-3000). On Dr. Garwin's suggestion, I called Dr. Petschek on March 31, finally reaching him at home in late

morning. He responded immediately by indicating that he and some colleagues could assist in understanding the issue of hydrogen combustibility and combustion kinetics in a reactor vessel such as at TMI. Later that day and through Sunday, April 1, I spoke, two or three times, to Dr. Petschek and one or two of his colleagues. They worked on the questions of what concentration of oxygen in pure hydrogen would be the threshold for combustion, particularly at the temperatures and pressures thought to be present at TMI (about 1000 psi at many hundreds of degrees F), and he reported back sometime Sunday on those. Dr. Petschek also referred me to Dr. Bernard Lewis in Pittsburgh, who turned out to be a highly-regarded expert in just these same issues.

3. Dr. Bernard Lewis (Combustion and Explosives Research, Inc., 1016 Oliver Building, Pittsburgh, PA 15222, (412) 391-3633). I finally reached Dr. Lewis, on referral from Dr. Petschek, on Sunday morning, April 1. He acknowledged expertise on the combustibility of hydrogen and oxygen; indeed, he is the coauthor of the definitive textbook on this subject. He and an assistant, reached at home on Sunday morning, worked through that day and part of Monday, April 2, and gave important advice on the issues that governed the physical behavior of hydrogen and oxygen burning in conditions such as were thought to exist at TMI. He gave information about the mixture of oxygen in pure hydrogen that would be a combustion threshold, talked at length to me about the physical difference between combustion and explosion, and what would be the impact of gaseous impurities. He reported back his preliminary conclusions sometime after midday on Sunday, April 1, and his final conclusions in midmorning of Monday, April 2. He calculated pressure ratios (pressure within a fast burning situation vs. starting pressure), detonation thresholds, heat release, flame temperatures, and other parameters. His insight was valuable in providing a perspective on which parameters were, and which were not, important in modifying the result of what was calculated using approximations.

4. Dr. Harold A. Schwarz (Brookhaven National Laboratory, Upton, NY 11973, FTS Tel. 666-4330). Dr. Schwarz was referred to us by Dr. H. J. Kouts of BNL, who called several times during the TMI incident to provide advice. Dr. Schwarz worked much of the weekend of March 31 and April 1 on calculating the production and recombination rates of oxygen in the TMI primary coolant water. He did these calculations at home mostly, I think; telephone contacts with him during the weekend were at his home. He reported on the considerations that were involved in his calculations, and showed definitively that oxygen generation from radiolysis would not result in much oxygen in the gas phase, because of the recombination reaction with the assumed large hydrogen gas overpressure and the associated dissolved hydrogen. We were apprised of the preliminary results of Dr. Schwarz' work early on the morning of April 1, in my memory, but it was not firmed up until sometime shortly after midday on that day. Dr. Schwarz continued with his work for several days after Sunday, April 1, and filed a description of his calculation with NRC on April 24.

5. Dr. Heinz Heinemann (Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720, (415) 486-6000). I telephoned Dr. Heinemann in early morning of Saturday, March 31 to follow up a suggestion of Dr. Garwin that the oil companies might have expertise in snake-like methods for extracting hydrogen from a pressure vessel like the TMI reactor vessel. Dr. Heinemann is a chemical engineer at my former laboratory in Berkeley and is a colleague and friend there, who spent most of his life working for Mobil Oil Corporation. Dr. Heinemann referred me to Dr. J. Penick of Mobil, whom I called subsequently. Dr. Heinemann also discussed with me the question of addition of catalytic chemical agents to reduce the hydrogen in water solution. Dr. Heinemann gave me the names of several catalysis chemists who might have expertise in this matter, and also enlisted in advice of two Berkeley colleagues. We talked several times over the weekend of March 31-April 1, but I turned over the entire problem of chemical hydrogen removal to others in NRC, and did not concern myself with the issue directly.

6. Mr. Joseph E. Penick (Mobil Oil Corporation, 150 E. 42 Street, New York, NY 10017, (212) 628-9757). I contacted Mr. Penick on Saturday morning, March 31, on referral from Dr. Heinemann. He said that he thought Mobil could assist NRC with advice on the availability of snake-like devices to extract gas from a TMI-like pressure vessel. He called back later during the weekend (I recall his return contact as occurring on Sunday, April 1) and indicated that devices such as we sought were not readily available in the Mobil Corporation, and unlikely to be available elsewhere in the petroleum industry. The problem was that the path into the reactor vessel from the outside to the upper dome was too tortuous for the use of the devices that did exist, and the fabrication of a special device would be quite difficult.

7. Dr. Laura Cherubini (17 Pandover Road, Billerica, MA 01821, (617) 667-9699. Dr. Cherubini called me on her own on Saturday, March 31, with a suggestion of chemical means to reduce or eliminate hydrogen dissolved in the reactor coolant water. I do not know how Dr. Cherubini received a reference to me. The method was to use algae that trap hydrogen from solution by presence of free electron acceptors. Since I was not expert in this matter I turned it over to others at NRC for follow-up. However, by the time anything more could be done with this suggestion, the perception of the importance of a "hydrogen bubble" had diminished, and I think that no further follow-up occurred.

Robert J. Budnitz, Deputy Director
Office of Nuclear Regulatory Research

cc: T. Murley

INFORMATION FOR TMI PRESIDENTIAL COMMISSION ON OUTSIDE

ORGANIZATION HELP TO ~~NRC RESEARCH~~

RSR

Outside Organization/Individual	Assistance Requested	Time of Request / Time of Assistance
A. Department of Energy - Idaho Operations Office, Idaho Falls, Idaho		
1. Willis Bixby	Coordination of INEL Research Assistance from on-site at Harrisburg	April 4/April 6-13
2. John James & Robert Long	Locate Emergency Pumps	April 6/April 6-9
3. George Vivian	Arranged for Mobile Radiological Survey Lab. at site	April 6/April 6
B. Idaho National Engineering Laboratory (INEL) EG&G Idaho, Inc., Idaho Falls, Idaho		
1. J. Henscheid	TMI Water Samples Analysis at INEL (dissolved H_2 content)	March 30/April 1 & 13
2. J. Dearien and Code Assessment Personnel	Vessel and core structural response calculations to possible H_2 detonation	March 30/ March 30 - April 1
3. L. J. Ybarrondo and N. C. Kaufman	On-site technical assistance. Evaluate sequence of event during TMI. Evaluate various natural circulation conditions.	March 30/April 1-6
4. J. Liebenthal, et al	Calculate H_2 and O_2 Concentrations in TMI Primary Cooling Loop	March 30/March 31 - April 1

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Outside Organization/Individual	Assistance Requested	Time of Request / Time of Assistance
5. P. North & Code Development Personnel	Natural circulation calculations with RELAP for various cold shutdown conditions Small break calculations Simulation (analytical of TMI transient)	March 30/March 30 to present
6. M. Stanley & Instrumentation Personnel	Experimentally evaluate capability of resistance temperature detector-RTD to measure pressurizer level	April 3/April 4
7. D. J. Hanson & Semiscale Operational Personnel	Experimentally evaluate means to vent hydrogen bubble Experimental simulation of TMI sequence of events	March 29/March 30 to present
8. C. F. Obenchain and Code Assessment Personnel	Performed calculations of core component temperatures during the accident	April 6/April 9-12
C. Billings Energy Corporation, Provo, Utah	Evaluate means for degassing H_2. H_2 solubility as a function of depressurization Examine various catalysts for H_2 scavenging	March 31/ April 1 - 17
D. Knolls Atomic Power Laboratory, Schenectady, N.Y.		
Dan Krommenhock, et al	Evaluate the quantities of H_2 that could be dissolved in the primary coolant water following a Zr-H_2 reaction in the core Evaluate the means by which H_2 in the primary coolant system might be reduced Evaluate the available methods for reducing H_2 in the containment atmosphere	April 3/April 3 - 13

Outside Organization/Individual	Assistance Requested	Time of Request / Time of Assistance
E. Sandia Laboratories, Albuquerque, N.M.		
J. V. Rivard, et al	Determine the coolability of a postulated rubblized TMI reactor core	April 5/April 9 - 20
F. Los Alamos Scientific Laboratory, Los Alamos, N.M.		
J. Vigil, et al	Calculate the TMI-2 transient using the TRAC reactor transient computer code	April 5/April 5 to present
G. Brookhaven National Laboratory, Upton, Long Island, NY		
J. M. Guppy, et al	Use the SSC computer code to calculate the TMI-2 transient and natural circulation characteristics	May 14/May 15 to present
H. Oak Ridge National Laboratory, Oak Ridge, TN		
Ray Booth, et al	Determine the status of the TMI core using noise analysis techniques	April 3/April 5 April 27

Input from Arsenault

After consultation with C. Bartlett of RES, J. Collins, NRR, a member of the NRC-TMI team, contacted INEL, a RES contractor, to arrange for analysis of a highly radioactive sample of primary reactor coolant and for the dispatch of a mobile counting laboratory and a four man team to assist in sample taking and sample analysis. Date of initial contact with INEL 4/9/79.