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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-3789

DATE: October 22, 1990

SUBJECT: Report of Foreign Travel of John R. Trabalka, Senior Research Staff, Environmental Sciences Division

TO: Alvin W. Trivelpiece

FROM: John R. Trabalka

PURPOSE: Attended conference on Comparative Assessment of the Environmental Impact of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, and Chernobyl and presented paper giving a western perspective of the Kyshtym (Chelyabinsk-40) high-level waste explosion that occurred in 1957.

SITES VISITED:		
10/1-5/90	Luxembourg, Duchy of Luxembourg	Conference at the Commission of European Communities

ABSTRACT: The traveler attended the conference, Comparative Assessment of the Environmental Impact of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, and Chernobyl and presented an invited paper giving a western perspective of the Kyshtym (Chelyabinsk-40) high-level waste explosion that took place in 1957. Papers of interest to several ORNL and DOE programs were presented. These covered the topics of accident source terms, atmospheric dispersion, resuspension, chemical and physical forms of contamination (e.g., "hot" particles), environmental contamination and transfer, radiological effects on humans and the environment, and countermeasures. The traveler also made valuable contacts with Soviet and other scientists related to an ongoing assessment sponsored by the International Union of Radioecologists of releases from the Chelyabinsk-40 site. This included an agreement in principle for direct participation by key Soviet scientists.

SUMMARY OF ACTIVITIES, INCLUDING TRAVELER'S ROLE

The traveler attended the conference, Comparative Assessment of the Environmental Impact of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, Chernobyl in Luxembourg, October 1-5, 1990. Three major nuclear accidents have resulted in the release of large quantities of radioactive fission products into the environment and the contamination of substantial areas in the northern hemisphere. The first was the high-level waste explosion at the Chelyabinsk-40 plutonium-production center (Ch-40; also known as the Kyshtym nuclear complex) in the Urals in September 1957, the second involved a gas-cooled plutonium-production reactor at Windscale in October 1957, and the third occurred at the Chernobyl atomic electric station in the Ukraine in April-May 1986. Many subsequent studies have investigated the nature and consequences of these accidents. The aim of the conference was not simply to present, but, more particularly, to compare assessments of the environmental significance of the three accidents. There were five consecutive technical sessions, plus a poster session and concluding panel discussion:

1. Accident Source Terms (6 papers)
2. Atmospheric Dispersion, Resuspension, Chemical, and Physical Forms of Contamination (8 papers)
3. Environmental Contamination and Transfer (30 papers)
4. Radiological Implications for Man and His Environment (13 papers)
5. Countermeasures (9 papers).

Several videotape presentations were also available to participants. There was one each on the Windscale and Ch-40 accidents, and there were several on the Chernobyl accident, covering such topics as lessons learned and decontamination measures. This conference was a historical event for several reasons. First, it was attended by over 50 Soviet scientists. This was the largest Soviet turnout ever for an international scientific meeting, and 50 of the 66 formal presentations were made by Soviet scientists. There also were nine delegates from Eastern Bloc countries. Second, the Soviets who attended did so as many separate delegations--not as one, as in the past. It was apparent from both the presentations and the ensuing discussions that they did not have one single official position on the issues, contrary to past practice. Further, it did not appear that representatives of the government or the KGB were present to monitor what transpired.

Unfortunately, the information transfer via presentations made by Soviet scientists was not of historic proportions. It was in fact quite disappointing. The record turnout of Soviet scientists was apparently unexpected, and thus all presentations had to be cut from 20-25 minutes to 15 minutes in length to accommodate the larger number of speakers. Although simultaneous translations were available, the rapid pace and obvious inexperience of many speakers, coupled with visual aids that were generally of very poor quality--often totally unreadable--produced

generally unsatisfactory, sometimes incoherent, presentations. One factor that may have made it difficult for translators to keep pace with the Soviet speakers was that Russian was first translated into French and then into English. In addition, few preprints of papers were made available at the meeting. Thus, understanding and interpretation of presentations were hampered by a lack of familiarization with the material beforehand and an inability to make cross-comparisons during presentations and afterwards. Copies of preprints are to be mailed to participants once all of the Soviet papers have been translated. This will obviously take time. Because the traveler is able to read Russian and is generally familiar with much of the subject matter, his experience at the conference was probably better than that of many other participants. However, the traveler's efforts to pursue questions about individual papers were hampered because relatively few Soviet scientists spoke English and those who did were in demand as translators.

The causes and development of the accidents were to be described in the first session, but this was done only for the accidents at Ch-40 (by G. N. Romanov, U.S.S.R., and the traveler) and Windscale (by A. C. Chamberlain and A. E. Eggleton, United Kingdom). Estimations of the source terms were performed for all three accidents. The subsequent atmospheric dispersion and ground deposition from the 1957 Soviet accident were topics covered in this session. The most interesting revelations on source terms came from a brief presentation by L. M. Khitrov of the U.S.S.R. during the concluding panel discussion and from discussions with participants after the session on Source Terms. The presentation by Khitrov highlighted the fact that the Soviets have revised their estimate of the ^{137}Cs released during the Chernobyl accident upward, resulting in estimates more consistent with earlier U.S. and U.K. estimates.

The traveler's participation in this conference was directly related to an environmental assessment of the 1957 Soviet nuclear accident commissioned by the International Union of Radioecologists (IUR). The traveler and S. I. Auerbach, past director of the Environmental Sciences Division at ORNL, were asked to perform such an assessment based on all available information, but particularly that released by the Soviet Union over the past 15 months. The conference represented the first opportunity to present our findings. The traveler's expenses were covered by the Commission of the European Communities (CEC), which cosponsored the Luxembourg conference with the IUR. The ultimate product of this activity should be of benefit to several ORNL and DOE programs.

The traveler had pointed out inconsistencies in the Soviet source term for ^{137}Cs from the 1957 high-level waste explosion at Ch-40 in his own paper, with the objective of obtaining clarification from Soviet scientists during the meeting. A formerly classified 1974 Soviet report published in 1990 indicates that much more ^{137}Cs was released (or was present in the contaminated areas at the time of the 1957 accident--possibly from one of the unconfirmed reactor accidents at Ch-40) than do other recent Soviet reports.

Independent analyses of radionuclides in soil samples collected in 1990 from areas in and near the contamination zone resulting from the 1957 accident have been made by extremely reputable western scientists. The results were provided to the traveler at the conference following the first session. These indicate that either significant unreported airborne releases of ^{137}Cs have occurred from Ch-40 or there is a major discrepancy in the source term for the 1957 accident. Soviet scientists (including Dr. Romanov) contacted at the meeting stated that no discrepancy existed and that the information in their recent reports was simply more accurate than that in the 1974 report. Other inconsistencies with published information appeared in the videotape presentation on the 1957 accident.

Thus, it appears that the concerns expressed in the traveler's paper were indeed warranted. It is the traveler's judgment that the ongoing process of declassification of information about Ch-40 by the Soviet Union, which has recently revealed significant overexposure of workers to radiation and massive additional environmental contamination produced by early operations, is probably incomplete with respect to radioactive releases from Ch-40, as well as their consequences.

Special topics in the second session, in addition to atmospheric dispersion and deposition of the releases, were resuspension of deposited activity and the fate of "hot" particles. One particularly graphic demonstration of the latter was in a presentation by N. V. Victorova, U.S.S.R., in which autoradiographs of tree leaves were used as a monitoring tool. Perhaps the most interesting Soviet paper (by A. V. Konoplyov and T. M. Bobovnikova) covered differences in environmental migration behavior of ^{90}Sr and ^{137}Cs released by the Chernobyl and Ch-40 accidents. Most of the fallout at Chernobyl occurred as nonexchangeable chemical forms (fuel particles), whereas soluble nitrates dominated at sites in the Urals contaminated by the 1957 high-level waste explosion.

Following the second session, the traveler and Dr. Rene Kirchmann of the IUR met with Dr. G. N. Romanov, Director of the Experimental Scientific Research Institute, established by the U.S.S.R. to deal with the aftermath of the 1957 explosion at Ch-40. Dr. Romanov agreed (in principle, subject to approval by higher authority) to collaborate with the traveler in preparing a joint environmental assessment of the 1957 accident. The first step was to be a review of the paper prepared by the traveler and S. I. Auerbach for the Luxembourg conference, if possible prior to departure from the conference. This was to be followed by individual written contributions from Dr. Romanov and his colleagues for the final assessment report sponsored by the IUR. This was also to include travel, if necessary, to and from the Soviet Union for work sessions and information gathering activities. A meeting was scheduled for the last day of the conference to discuss Dr. Romanov's review comments and to iron out more details of the proposed collaboration.

During the course of this first meeting and subsequent discussions with Dr. Romanov and Yury Nozach, a high-level representative from the Ch-40 plutonium-production complex who cochaired the opening session of the

conference, the traveler obtained additional details about the 1957 accident regarding evacuations and remedial measures. However, it was expected that much more would be provided via the review of the traveler's paper and follow-up meetings and discussions. However, no review comments or further information were provided in the meeting that took place on the final day of the conference. Instead, Dr. Romanov indicated that he would return his comments to the traveler by mail and asked Dr. Kirchmann to develop a formal agreement for his continued participation in this effort through official channels. He did, however, indicate that the subject of releases from Ch-40, other than those from the 1957 accident, could be included within the scope of the proposed assessment. Although this may only include those already identified currently (discharge of 3 MCi of radioactivity to the Techa River in 1949-1951 and aerosol and liquid releases from the Karachay reservoir, which contains 120 MCi of ^{90}Sr and ^{137}Cs), it offers the possibility that information on unreported releases of the type described above may also be obtained. In any event, further information on releases to the Techa River and from the Karachay reservoir, along with past and planned remedial activities, should prove beneficial to DOE's Environmental Restoration Program. Further, and possibly even more significant, Dr. Romanov suggested that the release of a comprehensive Soviet report on remedial actions and emergency responses to radiation accidents (see later discussion on Session 5 of the conference) might also be expedited through an arrangement with the IUR/CEC. Such a report should contain a wide variety of information potentially useful to the Environmental Restoration Program.

The 30 papers presented in the third session of the conference covered observations of radioactive contamination in soils and waters produced by all three accidents, together with studies on the transfer of radioactive substances in terrestrial, aquatic, and agricultural ecosystems. A total release of 23 kg of $^{239,240}Pu$ from the Chernobyl accident was estimated by V. M. Kulakov et al., U.S.S.R., from ground deposition measurements. Agricultural problems following the Chernobyl release were described by B. S. Prister, U.S.S.R. High levels of ^{137}Cs contamination are found in the Polyesiye region of Byelorussia and the northern Ukraine. This is an area where ^{137}Cs uptake by biota is enhanced by unique soil conditions. Additions of lime, high-potassium fertilizers, and zeolites, coupled with plowing have apparently been effective in reducing uptake of ^{137}Cs. There were also 13 papers devoted to migration and biological effects of radionuclides, primarily ^{137}Cs, released by the Chernobyl accident.

The fourth session began with a presentation not on the program. Soviet scientist G. A. Kuznetsov of the Vernadsky Institute of the U.S.S.R. Academy of Sciences gave an eyewitness account of a major submarine reactor accident that occurred in the northwest Atlantic in 1961. He was a sailor on board the Soviet nuclear submarine at the time of the accident. A major environmental release was narrowly averted, but the accident cost the lives of eight shipmates as a result of acute radiation exposure (reportedly up to 6000 man-Sv). The traveler returned with copies of this presentation, but unfortunately one is handwritten in Russian and the other is a French translation of the former. This accident was also described in two articles in *Pravda* in July 1990.

Scheduled presentations from the fourth session of the conference dealt with human and ecological effects of the Chernobyl and Ch-40 accidents. The Soviets have estimated that the committed effective radiation dose equivalent from ^{137}Cs from the Chernobyl accident amounts to 100 mSv for a person inhabiting areas contaminated at 10 Ci/km^2 (M. I. Balonov, U.S.S.R.). The presentation by L. A. Buldakov et al., U.S.S.R., on medical consequences of the 1957 high-level waste explosion contained no new information and little quantitative data on radiation effects or dosimetry for inhabitants of areas most highly contaminated. Until quantitative data for medical examinations and dosimetry are provided, the Soviet conclusions of no significant effects of radiation exposure following the 1957 accident should be viewed with skepticism. For example, some farm animals were already dying of acute radiation exposure in the most highly contaminated part of the 1957 deposition zone at the time that evacuation of the human population was being conducted. Yet humans reportedly received radiation doses only 5-10% of those delivered to farm animals.

According to I. A. Ryabtsev, U.S.S.R., despite the great differences in scale and consequences of the Chernobyl and the 1957 accidents, the responses of vertebrate populations exhibited a similar pattern. Many species have benefitted over the long term because of the reduction in human intrusion into and disturbance of highly contaminated areas, even though most vertebrates were killed during the initial "acute exposure" period immediately following both accidents. Dr. Ryabtsev agreed to send the traveler a complete set of his published works on both accidents. Areas of 20 and 50 km^2 of pine forest were killed by the 1957 high-level waste explosion and the Chernobyl reactor accident, respectively, as described by F. A. Tikhomirov, U.S.S.R. Damage to pine trees at Chernobyl might have been greater if the accident had not occurred in the spring of the year. Ninety percent of the fallout was washed out of the canopy during the first year, whereas it took 3-5 years at the Urals sites that were contaminated in the autumn. A paper by V. A. Shevchenko, U.S.S.R., provided a comprehensive review of radiation genetics research conducted in the Chernobyl and Urals contamination zones. One major finding was a superlinear mutation response to radiation exposure at doses >1 mGy/d. In later discussions, Dr. Shevchenko indicated that results from the work conducted in Urals is to be published in an issue of the *Journal of the Total Environment* later in 1990. These publications should be of major interest to ecological programs sponsored by the Office of Health and Environmental Research.

The final set of presentations dealt with remedial actions and emergency response. Land-use controls proved to be most effective (by a factor of 200) in reducing ^{90}Sr uptake in agroecosystems in the Urals, followed by surface decontamination (5-15 times), deep ploughing (2-7 times), and physical-chemical treatments (2-4 times), according to Dr. Romanov. (The traveler was able to obtain a preprint of this paper.) Some of the various physical-chemical treatments were described by I. T. Moiseyev and F. A. Tikhomirov, U.S.S.R., but many of the details were unintelligible (for reasons described earlier), and interpretation will have to await receipt of the preprint or the final paper. (Unfortunately, the latter

comment applies to many of the papers presented at the conference.) Little information was provided on countermeasures of most interest to the traveler: environmental decontamination and contamination control. There appears to have been little Soviet interest in controlling groundwater contamination in the Urals contamination zone, for example, and information on actual decontamination procedures (e.g., the specifics) was not provided. A major Soviet treatise on remedial measures and emergency responses to radiation accidents has reportedly been prepared but appears to be held up in the review process. The individual most knowledgeable about this document is Dr. Romanov, Director of the Experimental Scientific Research Center located near the Urals contamination zone.

The actions taken after the 1957 Windscale reactor accident were reappraised by D. Jackson and S. R. Jones, United Kingdom, based on current recommendations for responses to off-site releases of radioactivity. They concluded that greater emphasis on meat and vegetables would have been appropriate and the milk ban area could have been extended substantially. There were several other papers that dealt with retrospective critiques of responses to the Windscale and Chernobyl accidents. These would appear to be of interest to those concerned with defining emergency reference levels, evacuation criteria, and countermeasures for dealing with radiation accidents.

The conference in Luxembourg was a historic event, and the conference proceedings should prove to be an extremely important resource for comparative assessments of the three historical nuclear accidents, as well as a major source of information for those charged with developing countermeasures and emergency response criteria for dealing with future accidents. The conference afforded the traveler to make contact with many Soviet scientists known to him previously only by names and writings. Several contacts, most notably with G. N. Romanov, should prove extremely beneficial in increasing western access to an enormous amount of Soviet data and experience on remedial measures and consequences of the 1957 high-level waste explosion and other releases from the Ch-40 complex in the Urals.

Should such an opportunity for interaction with Soviet scientists present itself in future, the traveler recommends that the DOE consider sending its own delegation, complete with translator(s), to foster closer ties and promote improved communications. This should prove to be extremely beneficial in increasing the level and quality of technical exchanges.

APPENDIX A

ITINERARY

September 29-30	Travel from Oak Ridge, Tennessee, to Luxembourg, Duchy of Luxembourg
October 1-5	Conference at the Commission of European Communities, Luxembourg, Duchy of Luxembourg
October 6	Travel from Luxembourg, Duchy of Luxembourg, to Oak Ridge, Tennessee

APPENDIX B

PRINCIPAL CONTACTS AT THE CONFERENCE SPONSORED BY THE COMMISSION OF EUROPEAN COMMUNITIES LUXEMBOURG, DUCHY OF LUXEMBOURG

Aarkrog, Asker	RISØ National Laboratory DK-4000, Roskilde, Denmark
Arkhipov, Nikolai	Director of Research Program Pripyat Research and Industrial Organization U.S.S.R.-252167 Kiev
Bennett, Burton	UNSCEAR, Vienna, Austria
Davidchuk, Vasily	Institute of Geophysics U.S.S.R. Academy of Sciences U.S.S.R.-252003 Kiev
Demin, Vladimir	U.S.S.R. State Committee for Utilization of Atomic Energy, Dept. of Nuclear Safety I. V. Kurchatov Institute of Atomic Energy U.S.S.R.-123182 Moscow
Dreicer, Mona	IAEA, Div. Nuclear Safety Radiation Safety Section A-1400, Vienna, Austria
Ilyazov, Robert	Byelorussian Institute of Agricultural Radiology U.S.S.R.-246020 Gomel
Kirchmann, Rene[1]	International Union of Radioecologists B-4480, Oupeye, Belgium
Konoplyov, Alexey	Chief of Laboratory Institute of Experimental Meteorology Kaluga Region U.S.S.R.-249020 Obninsk
Linsley, Gordon	IAEA, Div. Nuclear Fuel Cycle Waste Management Section A-1400, Vienna, Austria

[1]Supplemental discussions held with traveler related to collaborative assessment of 1957 Soviet nuclear accident at Chelyabinsk-40 (Kyshtym) complex; see text.

Medvedev, Zhores	National Institute for Medical Research Mill Hill GB-London NW7 1AA
Nozach, Yury	Production Operations Ministry of Medium Machine Building U.S.S.R.-454065 Chelyabinsk, 40
Polikarpov, Gennady	Institute of Biology of South Seas Department Radiation and C. Biology U.S.S.R.-335000 Sevastopol
Prister, Boris	Deputy Director Ukrainian Branch of the All-Union Agricultural Radiobiology Research Institute Kiev Region U.S.S.R.-255205 Chabany
Romanov, Gennady[1]	Director Experimental Scientific Research Institute Ministry of Atomic Energy and Industry U.S.S.R.-454065 Chelyabinsk, 65
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Shevchenko, Vladimir	Institute of General Genetics U.S.S.R. Academy of Sciences U.S.S.R.-117809 Moscow
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Templeton, William	Battelle Pacific Northwest Laboratory Richland, WA 99352
Van Den Hoek, Jan	Wageningen Agricultural University NL-6709 PJ, Wageningen, The Netherlands
Whicker, F. Ward	Colorado State University Fort Collins, CO 80523

Yushkov, Petr

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Urals Division of the U.S.S.R.
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APPENDIX C

LITERATURE OBTAINED

Book of Abstracts, Seminar on Comparative Assessment of the Environmental Impacts of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, Chernobyl, Luxembourg, October 1-5, 1990.

L. Foulquier and Y. Baudin-Jaulent, Radioecological Impact of the Chernobyl Accident on Continental Aquatic Ecosystems, XI-3522/90 FR, Commission of the European Communities (1990).

R. Kirchmann (Rapporteur), Agricultural Countermeasures Taken in the Chernobyl Region and Evaluation of Results, International Union of Radioecologists (April 1990).

G. N. Romanov, L. A. Buldakov, and V. L. Shvedov, Comparative Analysis of the Effectiveness of Measures for Radiation Protection of the Population After the Kyshtym Accident, preprint of paper from Seminar on Comparative Assessment of the Environmental Impact of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, Chernobyl, Luxembourg, October 1-5, 1990 (in Russian).

G. A. Kuznetsov, A Quarter Century Before Chernobyl (Eyewitness Account of Reactor Accident On Board a Soviet Nuclear Submarine in 1961), unscheduled presentation made during seminar on Comparative Assessment of the Environmental Impact of Radionuclides Released During Three Major Nuclear Accidents: Kyshtym, Windscale, Chernobyl, Luxembourg, October 1-5, 1990 (in Russian or French, see text).

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