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MEMORANDUM FOR: John J. Linehan, Director
Repository Licensing and Quality Assurance
Project Directorate
Division of High-Level Waste Management

THRU: Kenneth R. Hooks, Section Leader
Quality Assurance Section
Repository Licensing and Quality Assurance
Project Directorate

FROM: Tilak R. Verma
Quality Assurance Section
Repository Licensing and Quality Assurance
Project Directorate

SUBJECT: INTEGRATED GROUTING TECHNIQUES IN THE SOVIET UNION

An abstract and a detailed trip report from my September 30 through October 14, 1990, visit to the soviet Union are enclosed. Potential applications of this integrated grouting technology for nuclear and toxic waste problems were presented during the Yucca Mountain Team meeting on December 5, 1990. In addition, detailed debriefings on the subject were provided to the DHLWM and NMSS management on December 10 and 17, 1990.

ORIGINAL SIGNED BY

Tilak R. Verma
Quality Assurance Section
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Enclosure: As stated

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TRIP REPORT ABSTRACT YEAR 1990
DATE OF REPORT November 15, 1990

OFFICIAL TRAVELERS:
Tilak R. Verma

TRAVEL TO:
Moscow, Antratsit, Donetz, and Leningrad, USSR

BEGINNING ON: September 30, 1990

OFFICE: NMSS
Division: High-Level Waste Management
Branch: Repository Licensing and Quality Assurance, Directorate

UNTIL: October 14, 1990

* * * * *

MEETING TITLE AND/OR AFFILIATION:

APPLICATION OF INTEGRATED GROUTING TECHNIQUES FOR GROUNDWATER FLOW CONTROL AND IN-SITU STABILIZATION OF TOXIC AND NUCLEAR WASTE

ORGANIZED BY: Country or Organization U.S.S.R.

ABSTRACT AND/OR SUMMARY OF MEETING RESULTS

At the invitation of Dr. Ernest Kipko, Director General, STG (SPETSTAMPONAZH-GEOLOGIA), Antratsit, Voroshilograd Region, U.S.S.R., Dr. Tilak R. Verma of HLPD visited several sites where the Soviets have applied integrated grouting techniques for groundwater flow control in deep underground mining operations and in underground openings associated with tunnels and other structures. Applications of grouting technology for water pollution control and in-situ stabilization of toxic waste tailings and spoils that have been under taken by the Soviets, were discussed in detail with Dr. Kipko and his staff at STG.

Spetstamponazh-geologia (STG) stands for specialized Grouting and Hydrogeology Trust of the U.S.S.R. It is within the Soviet Ministery of Coal has a monopoly on geotechnical grouting construction in the entire U.S.S.R. The STG has been successful in applications of integrated grouting for groundwater flow control in deep underground mine operations throughout the Eastern Block countries and is currently working on a uranium mill-tailings project in Australia.

ENCLOSURE

REPORT ON FOREIGN TRAVEL

BY

Tilak R. Verma

Repository Licensing and Quality Assurance Directorate

Division of High-Level Waste Management

Nuclear Material Safety and Safeguards

U.S. Nuclear Regulatory Commission

December, 1990

PURPOSE OF THE TRIP

The purpose of my trip to the Soviet Union was to observe and discuss the application of integrated grouting technilogy developed by the Soviet geotechnical engineers and hydrogeologists for groundwater flow control into the deep underground openings. The discussions with the Soviet geotechnical engineers and hydrogeologists included their experience in developing and applying some uniquely integrated grouting techniques for groundwater flow control in the deep underground mine openings. Application of this Soviet grouting technology for nuclear and toxic waste management was also discussed.

SUMMARY OF ACTIVITIES

September 29, 1990	Traveled from Washington, D.C. to Moscow, U.S.S.R.
September 30, 1990	Arrived in Moscow, U.S.S.R.
October 1-2, 1990	Met with the STG Management and held discussions with the U.S.S.R. Ministry of Coal staff on application of integrated grouting to environmental and waste management problems. Meetings and discussions on application of grouting with the staff from the Ministry of Coal.
October 3-8, 1990	In Donetz and Antratsit, meetings and discussions with the STG geotechnical engineers and hydrogeologists. Theoritical aspect and concepts of grout-formulations and grout-curtain design were discussed. Field-trips to Youth League Organization Coal Mine and Central Coal Mine in the Donetz Basin, and the 50-Year U.S.S.R. Mine in the Rostov Region were taken to look at the application of grouting for groundwater flow control in the deep underground mine openings.
October 9-10, 1990	In Moscow, meetings and discussions with the technical and management personnel from the U.S.S.R. Mininstry of Atomic Energy and Industry. Also, meetings and discussions with the hydrogeology faculty at the Moscow Mining Institute. Applications of grouting in the area of environmental problems were discussed.
October 11-13, 1990	In Leningrad, meetings and discussions with the hydrogeology and geotechnical engineering faculty of the Leningrad Mining Institute. Application of grouting in mining and environmental problem areas were discussed. The hydrogeology faculty gave an overview of their research program in the area of hydrogeology. Use of grouting for geochemical alterations for toxic waste stabilization was discussed.
October 14, 1990	In Moscow, sight seeing.
October 15, 1990	Traveled back to Washington, D.C.

KEY INDIVIDUALS CONTACTED

Dr. Ernest Kipko, Director General, STG, Antratsit; Dr. Jury Polozov, Deputy Director General (Research and Technology Development), STG, Antratsit; Dr. Jury Spichak, Chief Engineer, STG, Antratsit; Mr. Vitaly Zabora, Project Supervisor, STG, Antratsit; Mr. Yuri Chernomorchenko, Mining engineer, STG, Antratsit; Mr. Nicoli Evanowich, Geotechnical Engineer, STG, Krasnodon; Mr. Victor Choroless, Chief, STG, Krasnodon; Mr. Genia Chernicov, Manager, 50 Years of U.S.S.R. Mine, Rostov; Mr. Spirn Alexei, Director, 50 Years of U.S.S.R. Mine, Rostov; Mr. Boris Anisimov, Site Manager, Grouting for Shaft Construction at the Central Coal Mine, Central, Donetz Basin; Mr. Sergei Nazarenko, Deputy chief of Division (Grout Placement), STG, Antratsit; Mr. Anatoli Dengin, Director, Komsomolskaya (Youth League Organization) Mine, Antratsit; Mr. Victor Mirchok, Chief Geologist, Komsomolskaya (Youth League Organization) Mine, Antratsit; Mr. Anatoli Matlaev, Geotchnical Engineer, U.S.S.R. Ministry of Coal, Moscow; Dr. V. Kracnoperov, Senior Lecturer, Moscow Mining Institute, Moscow; Mr. N. Rizhev, Mr. Vladimir P. Kuchinov, Mr. N. Kyshtyn, Mr. J. Kulichenko and Mr. I. Ruzhov, U.S.S.R. Ministry of Atomic Energy and Industry, Moscow; and Dr. Lomthdze Ivanov, Senior Lecturer, Dr. Nicoli Petrov, Professor V. Mironenko, Professor V. A. Kiriuhin, Professor Alex Korotron, and Professor Rumimin, Leningrad Mining Institute, Leningrad.

TECHNICAL OBSERVATIONS

The title Spetstamponazhgeologia (STG) stands for Specialized Grouting and Hydrogeology Trust of the U.S.S.R. STG is a government owned and controlled agency under the U.S.S.R. Ministry of Coal. It has a monopoly on geotechnical grouting construction in the entir U.S.S.R. It has successfully conducted work throughout the Eastern Block countries and is currently involved in projects in Australia, India and China. It has worked on grouting exclusively, which is called the integrated grouting method, for the last 20 years. In the begining, STG started application of customized grouts in the shaft construction for underground minimg of coal. Its primary purpose was to control the gorundwater flow into the shafts during and after the construction of shafts through the water-bearing formations. There are approximately 3,000 employees at STG of which 700 are geotechnical engineers, mining engineers, geochemists, hydrogeologists and geologists. Among these 700 professionals, approximately 300 are in research and development. STG has successfully completed over 200 ful-sized grouting projects in the U.S.S.R. and satellite countries during 20-year period. Most of these projects were applied to control of groungdwater inflow into the mine opening and shafts. STG has also applied grouting technology to other problem areas such as underground rail road construction, waste isolation and wate pollution control projects. some details of the STG grouting technology are published in a textbook (in Russian) entitled "Integrated Grouting Methods," by E. Kipko, Yuri Polozov and others. During the discussion at STG, Dr. Yuri Polozov had used some technical information from this book. I have a copy of this book available with me.

A key element in Russian technology revolves around grout composition. Currently, this runs approximately 89% clay of different types, 10% cement, and 1% special additives. Note: This is the reverse of a typical United States grout mix i.e., 94% cement, 5% clay, and 1% other. The economic advantages due to the amount of cement required is obvious. The clay portion of the grout can be obtained from almost any type of clay available in the construction site vicinity, which has huge economic advantages in that transport of the material is not a high-cost factor. Another feature of importance is that this particular grout remains plastic throughout its history. STG has laboratory samples that were cast over 20 years ago and these samples are still monitored for flexibility and durability. We have no such database in the United States. The 1% of additive includes sodium silicate, calcium chloride, and some other chemicals that were not known to me. The fact that STG can use dirty clays from local sites can be of huge economic importance. Furthermore, the grout material is inert and nontoxic, as opposed to many U.S. and foreign grouts.

A feature of STG's grouting technique is the low cement content, which precludes cracking and remains plastic. Furthermore, STG can use a grout with a very low water content; thus, under grouting pressures, there is very little loss of water and the grout will continue to move. This is a traditional problem in high-cement grouts. In addition, STG feels that flotation tailings can be used in its grouting materials.

STG has extensive and probably a better understanding of clay chemistry because of their heavy investment in this area. The hydrogen ions in the lattice structure are controlled. If possible, they prefer to use other than montmorillonite clays. Illite or kaolinite clays function very well. However, by adjusting the additives, they can use other clays also. The additives, among other things, replace the susceptible cations in the ion exchange positon with cations that are stable. The usual cation that is replaced is that of potassium.

At two field sites, I observed this method being applied to control water inflow into a new shaft being constructed in a coal mine in the Donetz Basin. After mixing, grout viscosity, specific gravity, percent solids, etc., are controlled by in-line monitoring similar to those methods applied in the United States and other countries, so no new mix control technology was observed at this site. However, techniques of interpreting hydrogeologic events prior and after grouting were somewhat new. The Russians utilize redrilling of grout holes and acoustic and sonic equipment to find out the location and degree of penetration of the gorut. I was clearly explained the intricacies of how the hydrogeology is interpreted and how the performance of the grout is evaluated.

Dr. Williams, University of Idaho, intends to interact with Kipko to further refine some of the information expected from the translation, over the next year. It is anticipated that we will be able to expand the state of the art application of this integrated grouting technology to nuclear and toxic waste problems for controlling environmental pollution. The hydrogeologic equipment

for controlling water and measuring water inflow is unique; information about this equipment should also be recovered from the text. I have already determined that the Russian textbook contains a description of a technology for flow metering that we do not believe is available in the United States. The flow meter described in the book reportedly facilitates measurements of the horizontal component of the velocity vector from one side of a borehole through an aquifer to the other side of the borehole. We will try to describe the device more carefully as the document is translated.

In summary, I feel that the Russians have a unique low cost grout, a unique long-term database, on the performance of that grout, and geohydrology measuring devices to assist them in the design of the gtout mix for each specific site. The textbook contains much information that is unkown to Europeans and the United States and that should be looked at. Russian grouting techniques could be used for environmental problems in the United States, as opposed to the traditional groundwater flow control methods being used in the U.S.S.R. and the Eastern Block countries and indeed the European community. The United States doesn't seem to have the overwhelming water inflow problems that the European community does. By far, the most inportant application in the United States will be environmental. To date, the Russians have not utilized any of their grouting processes for environmental control (for example, pond liners, acid mine drainage, etc.).

RECOMMENDATIONS FOR FUTURE ACTIONS:

A means to simplify or improve and expand technology transfer between the Soviet Union and the United States should be developed. This could be some form of formal exchange program--maybe one-on-one visits between individuals such as myself or others who have visited the area. Grouting is one topic from which new technology could be gained for the United States.

I feel that the book written by Kipko, "Integrated Methods of Grouting," should receive further attention. On the basis of the limited translation during our visit, it appears that there is new information for us on grout composition, on techniques to measure hydrogeologic parameters prior to grouting, and on determining the performance of the grout after it is placed. In this regard, it was suggested that STG should be presented data on a U.S. site to describe how STG would use its grouting technology to rectify the water pollution problem. We might get a better understanding of how the Russians would treat such a problem. This would be one way of understanding and developing a cost picture for their technologies.

I feel that U.S. application of Russian technologies can best be served by using the integrated grouting technologies for environmental problems. For example, the technology could be used to develop flexible, permanent, tear-free liners of grout materials. It could also be used in backfilling to provide sealing and/or controlling surface subsidence and constructing artificial curtains. I also feel that composites could be made with natural materials, coarse materials, and mine tailings.

In summary, I feel that the Russians do have some technologies that could be applied very economically to environmental control measures. Their textbook should be translated into English. Further interaction with this particular group within the U.S.S.R. could prove beneficial as a reverse technology transfer. Professor Polozov and his interpreter would like to visit the United States next year. They are making arrangements for this visit through the University of Idaho; I plan to assist in this visit.