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WORLD ENVIRONMENT CENTER

ENVIRONMENTAL AND WASTE MINIMIZATION ASSESSMENT

TISZAI VEGYI KOMBINAT, RT.

TISZAUJVAROS, HUNGARY

JULY 13 - 18, 1993

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I. INTRODUCTION

In early 1993 the World Environment Center contacted the author to consult on environmental conditions at the Tiszai Vegyi Kombinat, Rt (TVK) in Tszaujvaros, Hungary. After a few telephone conversations the decision was made to accept the invitation.

From July 13 to 18, 1993 the complex at TVK was visited. Discussions were held on environmental and health related matters. The schedule of meetings and people visited are attached in Appendix D.

Thanks to the full cooperation of Mr. Gyorgy Kalman, General Director, and Mr. Laszlo Majerusz, the Director of Environmental Protection for TVK, the trip from my perspective was very successful. Due to this cooperation, the recommendations developed in this report are an accurate reflection of the needs and priorities facing this chemical plant in the next several years.

II. EXECUTIVE SUMMARY

At the invitation of the World Environment Center, the Tiszai Vegyi Kombinat (TVK) Company in Tszaujvaros, Hungary was visited between July 13-18, 1993. The plant located on the Tiszai river in the northeastern part of Hungary was established in the 1960s on a 350 ha (825 acres) site. The state owned plant is managed by a Director and employs about 5,700 people. The main products are a range of plastic materials derived from olefin, ethylene and propylene.

One of the objectives of the trip was to make recommendations on how the operation of the plant from an environmental point of view might be improved. It was quickly discovered that the company was run by a well-trained and highly motivated group of managers. This was reflected in the general overall feeling of neatness that was in evidence while walking around the plant.

As with any organization, there are always places to improve. The following are a few of the areas that emerged from conversation with the staff at TVK. They are listed in order of priority. For a more detailed discussion of these and other recommendations, refer to the main report.

1. Benzene levels must be lowered in the olefin plant to meet the Hungarian standards.

2. The contamination of the groundwater underlying the region needs to be addressed. The technology is available to clean the aquifer; however, money is lacking. Funds need to be found to resolve this problem.

3. Effort needs to be made to discuss health and environmental issues with non-governmental organizations. When regulations emerge from the government, all parties (government, company and local community officials) need to have an understanding of the numbers. This can be accomplished through consultation between all parties.

4. Solutions to the final disposition of the solid waste from the incinerator were discussed. A course of action needs to be identified that will eliminate this problem.

III. FINDINGS

A. The Companies

1. Tiszai Vegyi Kombinat (TVK) Rt.

This is one of the major Companies in Hungary employing 5,700 people with sales in the range of $480 million dollars. The complex is located in the northeastern part of the country in the town of Tiszaujvaros on the Tiszai river. The main products are olefins, polyethylene and polypropylene resins, plastic products and ammonium nitrate fertilizers.

2. AKZO-TVK Paint Company

Any discussion of the TVK complex would not be complete without mentioning AKZO-TVK Rt. This is a joint venture operation formed in 1990 by merging assets of AKZO (51%) based in Holland with assets of TVK (49%). The site is located on the 350 ha property of TVK and occupies 70,000 m^2 (about 2% of the area). The main products from AKZO-TVK Rt. are a line of coatings used by both the general public and the auto industry. The past year saw the production of 14,000 metric tons down significantly from the previous high of 50,000 metric tons. The various discharges from this operation will be discussed in the appropriate sections that follow.

B. Environmental Issues

1. Groundwater

There is a large ground water aquifer beginning at a depth of 5 m and extending downward a further 100-200 m. Estimations have been made which indicate that the volume of water in this reservoir is 5-6 km^3. The aquifer is so huge that movement can not be detected. As might be imagined, this treasure serves a large population and needs to be protected with every available resource.

In 1969, the operation of a Russian built olefin plant ordered by the Hungarian Ministry of Heavy Industries in Budapest created a major contamination problem. The plant had a capacity of 35,000 metric tons/year of ethylene and was designed to release between 400-500 mg/L of COD to the waste water stream. After 3-4 years operation, it was discovered that the plant actually discharged 5,000-30,000 mg/L of COD containing a great deal of oil. By the time the problem had been detected, the waste had filtered into the subsoil. Estimations indicate that approximately 8,000 metric tons of hydrocarbon had been lost. The plant was decommissioned 10 years ago. In 1989, TVK discovered that the groundwater had been contaminated. This

was immediately reported to the authorities and remedial action has been ordered.

Three years of study and discussion have demonstrated that the structure of the aquifer has prevented any movement or further mixing of the contaminant. The zone of contamination is about 20 hectares in area covering the south central portion of the TVK site. Further, most of the oil (6,000 metric tons) is floating on the surface of the aquifer, 1,500 metric tons is absorbed on the soil and the remainder (500 metric tons) is mixed in the top 1 m of the water layer.

That is the problem and TVK has promised the authorities that a solution will be found in the next three years. One possible solution is as follows:

> Drill wells and bring the oil to the surface by pumps. In a similar fashion the contaminated water would be pumped out and incinerated. The contaminated soil presents a most difficult problem. Excavation is one possibility with the contaminated soil either neutralized by biological degradation or by incineration. Another procedure to handle the contaminated soil is in situ biological degradation. No final decisions have been made at this time.

Estimations made by TVK staff indicate that the total cost of decontaminating the aquifer will run between 1 and 2 million dollars. It is strongly recommended that resources be found to help TVK alleviate this major problem.

2. Solid Waste and Incineration

a) TVK is presently generating about 6,000 metric tons of solid waste/year, all of which is incinerated in three furnaces of Japanese design at a temperature of 700-1000 °C. These furnaces are capable of handling 860 kg/hour (which is approximately the amount of waste being generated). The equipment has served the company well; however, they are not designed to handle hazardous materials. In today's world, this becomes a major problem as more materials are now classified as hazardous. The output of these furnaces is 150 metric tons of ash/year. At present, there is no solution for the final disposal of the ash. A thousand tons have accumulated so far and is temporarily being stored on the site. TVK is looking at various options for the ultimate disposal. One possibility requires transportation of the ash to a certified land fill located a few kilometers from TVK. However, the Company would prefer to handle the material on site.

A more serious problem has emerged with the issuance of new regulations on July 1 of 1993. These regulations govern the concentration of certain gases and materials in the incinerator stacks. The limits are shown in Table 1. Officials at TVK have no idea concerning the origin of the numbers. The assumption is that they are patterned after German regulations.

The numbers indicate that regulations governing air emissions in Hungary are becoming complicated and restrictive. They are so new that TVK is not sure how they will all be implemented. For example, the level for dioxin is well below the companies ability to measure. One thing is clear - the incinerator stacks must meet the concentrations shown in Table 1. Presently, TVK can not meet the standard for CO and once the analytical work is done there may be more constituents that are in violation (such as TCDD).

TABLE 1

Allowed concentration of certain materials in the incinerator stacks.

Material	Limit[1] mg/Nm^3
solid (dust)	30
SO_2	200
NO_2	400
CO	100
organic matter not incinerated	20
HCl	50
HF	2
Cr,Vn,Ar,Ni,Co	1
Cd,Th,Hg	0.1
TCDD	1×10^{-7}

TVK would like to modernize the incinerator plant in order to continue burning material on site. Estimations of the costs amount to 3 -5 million dollars. The high number is for new furnaces while the lower figure would modernize the present equipment.

TVK has asked the government for an extension to see if they can't make the incinerator meet the limits. Various suggestions were discussed to solve the problem:

i) Reduce the load to the furnace and create a longer retention time. This does not appear to be a suitable solution as the retention time is not the problem so much as the inability to attain higher temperatures.

ii) Separating the trash into hazardous and non hazardous and burning the later on site. The former could then be shipped to a certified incinerator such as the one being used by AKZO-TKV Rt. (see discussion below relating to DOROG). TVK would like

[1] These numbers are in units of mg/Nm^3 where the N refers to normal temperature and pressure i.e. 1 atmosphere and 0° Celsius

to continue to burn their material on site; however, shipping hazardous material off site is a viable option.

b) AKZO-TVK Rt. - The solid waste from the paint operation consists of two parts:

i) General waste such as cardboard etc. makes up to 6-7 tons a month and is handled by the incinerators at TVK.

ii) Hazardous waste which makes up the bulk (30-35 metric tons/month) is transported to a Hazardous Waste Site located in DOROG, outside of Budapest. The incinerator owned and operated by a French Company is certified by the Hungarian Government. The arrangement is working well with the result that the handling of hazardous waste at AKZO-TVK Rt. poses few problems.

3. Air Emissions

The general emissions from the TVK plant seem to be under control. This is reflected in the overall neatness and the lack of odor that are noticed by a person walking around the various operations. There are a number of valves that are leaking and would fall under the general category of fugitive emissions. Advantage could be taken of some of the procedures that have been developed to contain such emissions. However, I don't believe this is a big priority.

Solvent recovery in the packaging operation is a problem. At the present time, the vapors are being released directly to the atmosphere. I was told that meetings are presently in progress to decide how to solve this problem. Several possibilities are being considered, including adsorption of vapors, catalytic incineration and vapor filtration. All of them are expensive (about $1,000,000 US) and since the Company did not make a profit this past year, it might take a year or so before resources can be directed to eliminating this discharge.

AKZO-TVK Rt. has a similar problem in that suction is used to remove odors from the work place and then the solvent vapors are vented directly to the atmosphere. We did not get into a discussion of how they plan on handling this leak.

There are 46 stacks at TVK and 2 at AZKO-TVK Rt. that are monitored on an infrequent basis (about once a month on the average). Monitoring is done in the stack and this is converted to an emission rate. All stacks are monitored for CO, CO_2, NO_2, and SO_2. For some plants, like the catalyst recovery complex HCl, Pb and Chromium, are added to the list. In other stacks that are part of the packaging operation, various solvents are added, i.e. perchloroethylene, butyl alcohol, ethanol, butanol, propanol, ethyl acetate and butyl acetate. All emissions are within the standards set by the Hungarian government. More continuous monitoring would be desirable; however, at this time attention needs to be focused on other issues, such as ground water contamination and the emissions from the incinerator.

4. Wastewater Emissions

Wastewater from the different plants including AKZO-TVK Rt. is treated in four stages:

i) Physical stage - removal of solids;
ii) Chemical stage;
iii) Biological stage - activated sludge with a sedimentation basin; and
iv) Clarification ponds where the water is retained for approximately 25 days prior to discharging to the river.

The amount of wastewater treated is 8,000 m^3/day. Oxygen is added mechanically in the aeration pond. The outfall to the river must have the same parameters as the water entering at the front end. These are set by the Hungarian Government and are as follows:

COD - 30 - 40 mg/L
pH - neutral
No detectable metals

The Company is meeting these criteria; however, the plant is running at capacity and a potential problem is on the horizon as production increases.

5. Industrial Hygiene

Industrial Hygiene does not fall under the supervision of Mr. Laszlo Majerusz; however, he was able to provide the key information. Presently, there are four materials that must be controlled to prevent over exposure of workers in the workplace. Table II ir dicates the chemicals and the exposure limits.

Table II

Chemicals and the Exposure Limits Established by the Hungarian Authorities

Chemical	Maximum Exposure (Mg/m^3)	OSHA Standard[2]
Benzene	5	3
Toluene	100	25
Petrol	300	
Ethyl Acetate	400	100

[2] OSHA Occupational Safety and Health Administration, the numbers cited are standards for the exposure of American workers.

Benzene is characterized as a human carcinogen.

TVK monitors the work place and maintains a set of records[3]. I was informed that TVK has a potential problem of workers being overexposed to benzene vapors. This is true in the olefin plant and the racking station. The Company is presently constructing a device to remove the excess vapors and run them through the incinerator. This problem needs to be solved.

6. General Observations

Neatness and Pride are the words that come to mind as one walks around the plant. It was obvious from the care with which people tidied up their workplace that they really loved the plant. I even saw a person sweep up a little pile of rubbish and throw it in the dumpster for incineration. In addition, valves were being cleaned and spots were being touched up with paint. The process plants were clean and for the most part odor free. All in all, I can't say enough good things about the housekeeping.

From my conversations with TVK I concluded that meetings between TVK and AKZO-TVK Rt. occur very infrequently, if at all. The meeting that was arranged for my benefit might have been the first in some time. I would recommend that meetings should be scheduled to address common problems like air and water emissions, as well as the handling of solid waste. Once this is accomplished, consideration should be given to meeting with the political leaders in the community. It has been proven in the U.S. that it is very advantageous to bring the community into the planning operation at an early stage. Contacts need to be made with the authorities who are setting standards. This would insure that TVK has input into the setting of the final numbers.

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[3] I did not have a chance to examine these records due to lack of time.

IV. RECOMMENDATIONS

1. Benzene levels in the work place must be lowered to meet the standards set by the Hungarian government. As Table II indicates, these standards are more lenient than the corresponding values found to be acceptable by the authorities in the United States. The expectation is that eventually there will be common worldwide standards for all these materials. Since exposure levels never become larger, TVK can expect more stringent controls in the future. The time for planning is now.

2. Groundwater contamination needs to be solved. Funds need to be found to decontaminate this aquifer.

3. Funds need to be obtained and planning undertaken to modernize the incinerator plant. Until this occurs, the solid waste needs to be separated into hazardous and non-hazardous and the former shipped to DOROG.

4. Eliminate the vapors from escaping to the atmosphere in the packaging department. This is true for both TVK and AKZO-TVK Rt.

5. Find an appropriate solution for the final disposition of the ash from the incinerator.

6. Consideration needs to be given to more frequent monitoring of the air emissions from the plant.

7. The final recommendation comes from years of experience working with non-industry organizations. While the situation in Hungary and the United States are different, there are many similarities. I would urge that TVK seriously considers working more closely with non-governmental organizations and the local municipality.

Working relations with AKZO-TVK Rt. on environmental, health and other mutual interests should be established. The two companies have common borders and the emissions reinforce each other as they disperse into the surrounding countryside.

Also, TVK should establish a working interface between the company and the community. Such an interaction can be beneficial to both parties.

I was struck by the statement that the Company was not aware of the numerical limits being set for incinerators that took effect on July 1, 1993. The company is being impacted by such numbers and TVK needs to know on what basis the numbers were promulgated. For example, the limit for dioxin is set at 1×10^{-7} mg/Nm^3. What reasons did the authorities have for setting such a number? Somehow the company and the rest of the Hungarian Chemical Industry need to have a voice in the establishment of any number that influences the operation. Serious consideration is given to the economic world outside TVK. The same consideration needs to be given to the environmental world. I apologize if I come on too strong; however, it is simply a reflection of my concern.

V. APPENDICES

A. CHEMICAL PRODUCTION

Between 2,000 and 2,500 m^3 of Naptha are used daily by the plant to produce the products shown in Table III.

TABLE III
Products from the Naptha cracker

Ethylene
Propylene
C4- fraction
C5-fraction
C7/8 - fraction

The ethylene and propylene fractions are carried by pipeline to the processing plant located at the site. There, various plastic materials are manufactured and sent by rail for marketing.

In addition to the above, there is an old Russian design fertilizer plant that is no longer economical to operate.

B. AIR MODELING

Of the many volatile emissions from the stacks at TVK, only two (Carbon monoxide and Nitrogen dioxide) are listed by the USEPA[4] as primary pollutants. As such, national air quality standards have been developed which these materials must meet in the United States. Accordingly, with the help of air dispersion modeling, an attempt will be made to estimate the ground level concentrations of these materials at the fence line of the TVK complex. The data for the stacks emitting CO and NO_2 are tabulated in Table IV.

[4] The United States Environmental Protection Agency.

TABLE IV

Stack Characteristics and CO, NO_2 Emissions from the Plants at the TVK and the TVK-AKZO Complex

Plant	Stack #	Height (m)	Measured Concentration mg/m^3	Calculated Emission Kg/hr
Olefin	P008	16	88[5]	0.18
			40	0.08
	P009	22	268	0.33
			117	0.15
Stoves	P010	16	24	0.016
			31	0.017
	P012	6	25	0.015
			32	0.018
Catalyst	P022	25	21	0.030
			53	0.060
Boiler	P024	36	75	0.179
			45	5.638
	P025	80	234	114.50
			126	49.30
	P026	22	47	0.36
			30	0.534
Olefin	P121	36	86.6	3.80
			41	30.9
AKZO	1	24	66.7	0.06
			15.6	0.02
	2	24	66.7	0.06
			15.6	0.02

The data in Table IV was rearranged and emissions for CO and NO_2 for the various stack heights were calculated as shown in Table V.

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[5] For each stack the first row is for CO and the second row is NO^2.

Table V

Emissions of CO and NO2 for the indicated stack heights

Stack Height m	CO g/s	NO2 g/s
6	0.004	0.005
16	0.05	0.027
20-25	0.233	0.216
36	1.10	10.13
80	31.8	13.69

For purposes of this demonstration, the 350 ha site will be assumed square yielding sides of 1.8 km. A further assumption is that all stacks are concentrated at the center of the site and are divided into five groups according to their height. Using the air dispersion models of Turner[6] as programmed by Neely[7], the emissions shown in Table V were used to calculate the ground level concentrations at the fence line. Table VI shows the results of this calculation using a wind speed of 2 m/s.

TABLE VI

Fence line concentrations (at 0.9 km from the source) of CO and NO_2 from the emissions listed in Table V.

Stack Height (m)	CO $g/m^3 \times 10^{-5}$	NO_2 $g/m^3 \times 10^{-5}$
6	0.0006	0.0008
16	0.008	0.005
20-25	0.038	0.036
36	2.37	2.15
80	6.76	2.89

The U.S. National Air Quality Standard for CO and NO_2 are 4,000 $\times 10^{-5}$ g/m^3 and 10×10^{-5} g/m^3 respectively[8].

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[6] Turner, B. Z., "Workbook of Atmospheric Dispersion Estimates" US Dept. of Health and Education, PB-191-482, Cincinnati, Ohio, 1970.

[7] Neely, W. B., "Emergency Response to Chemical Spills", Lewis Publishers, Ann Arbor, Michigan, 1992.

[8] USEPA Standards

The only sources that make a significant contribution are the 36 and the 80 m stacks. Combining the fence line concentrations (Table VI), NO_2 levels of 5.04×10^{-5} g/m^3 (2.15 + 2.89) were calculated. As can be seen, this approaches the air quality standard of 10×10^{-5} g/m^3. Once the plume disperses beyond the fence line, the concentration rapidly falls off. Thus, at 3 km from the source the NO_2 concentration becomes 0.25×10^{-5} g/m^3.

The combined concentration of CO for these two stacks at the fence line is 9.13×10^{-5} g/m^3 (0.2% of the standard).

The purpose of this exercise is to demonstrate the value of modeling and the insights that can be gained from the analysis. In this case, the pollutant that appears close to violating any standard is nitrogen dioxide. Consequently, this is the main constituent that needs monitoring.

C. RESUME FOR W. B. NEELY

CAREER SUMMARY

Dr. Neely has had more than 30 years experience with the Dow Chemical Company working in a variety of research areas such as agricultural pesticide development, environmental exposure and fate, and antimicrobial development and toxicology. His main interest has been in the area of environmental chemistry where he has an international reputation in the field of modeling environmental systems having published a number of papers in this and related fields. He is a member of several scientific groups, including the American Chemical Society and the Society of Environmental and Toxicological Chemistry.

CONSULTING COMPETENCIES

Neely specializes in projects dealing with the environmental fate and exposure from chemicals. In this connection he has the expertise to develop mathematical models which can predict the movement of chemicals in various environmental media such as air, water and soil. This description is a necessary prelude to developing a risk assessment for the chemical in question.

PROFESSIONAL EXPERIENCE AND ACCOMPLISHMENTS

1. ENVIROSOFT, Midland, MI 1986 - Present

- In 1986 Neely began a company called EnviroSoft for the purpose of marketing the skills he had acquired over the years at the Dow Chemical Company.

- During the past five years a software package was developed for the purpose of determining the exposure of chemicals that had been accidentally spilled into either the water, air or soil. Once these exposures were estimated the concentrations were matched with a toxicological data base for the purpose of assessing the risk from the accident. The program and documentation have been published by CRC Press in Boca Raton, Florida under the title of "Emergency Response to Spills of Hazardous Materials".

- In addition, a number of consulting projects have been undertaken which include the following:

  - A project for the International Isocyante Institute to develop a risk assessment model for the key monomers that go into the manufacture of the isocyante polymers.

  - A project for The Dow Chemical Company to develop a model for

a generic harbor. The purpose of the model was to help convince the EPA that the use of a chemical to preserve the wood pilings in a typical harbor would not cause a hazard.

- Served as a member of the EPA's Scientific Advisory Board to help write the document dealing with Water Quality Criteria.

2. TEACHING EXPERIENCE 1986 - Present

- Taught Chemistry at Saginaw State University. In addition to Chemistry, a course in Environmental Risk Assessment was developed and taught to a group of sophomores. This is a continuing project where the goal is to develop the material for the Liberal Arts major. In this latter connection, the Risk Assessment course was taught to a class of Business students at Northwood Institute in Midland, Michigan.

- Prior to 1986, Neely was an adjunct Professor at Michigan State University teaching a course in environmental fate.

3. THE DOW CHEMICAL COMPANY 1957 - 1986

- Served as Chairman of the Chemical Manufactures Association Task Force dealing with Water Quality Criteria. He coordinated the effort of several representatives from the Chemical Industry to develop the rational for answering the EPA's request for documentation.

- Served as a member of an Industry Task Force devoted to establishing Air emissions for the Solvent Industry. Worked with the Solvent Industry in helping to develop reasonable emission controls for Methylchloroform. In this connection became a modeler of the movement and reactivity of volatile materials in the atmosphere -- including the stratosphere.

- Developed the mathematical models that went into the documents related to Environmental Impact Statements. For example:

  - Developed a model for the Delaware River in connection with a proposed terminal that was to be built at Bordentown, New Jersey.
  - Developed a model for the movement of chemicals in the tidal waters of Spencer Gulf in Southern Australia. The purpose of the model was to help convince the authorities that a proposed construction of a Chlor Alkali plant near Adelaide would not cause an undue environmental risk. The model and assessment were accepted by the authorities, however, the economic times were

such that the company altered their business plans.

- A model of the estuary in Vancouver, British Columbia was developed. The purpose of the model was to assess the environmental impact of possible chemical spills into the harbor. The impact statement was accepted by the authorities and the Chemical Terminal was built and has been operating successfully for several years.

- Worked on several models to assess the fate of pesticides in the soil environment.

EDUCATION

B.A. in Chemistry University of Toronto	1948
Ph.D. in Biochemistry Michigan State University	1952
Post Doctoral Fellow Ohio State University	1953
Rockefeller Fellow University of Birmingham, England	1954

HONORS

Synthetic Organic Chemical Manufactures Association Gold Medal for Outstanding Contribution to the fields of Environmental Science, 1978.

D.PERSONS CONTACTED AND PLANT TOUR

1. People visited.

- Mr. Gyorgy Kalman - Director of TVK (Tiszai Vegyi Kombinat).

- Mr. Benedek Liptak from the village of Szirmabesenyo acted as my Interpreter for the week and did a very excellent job. He always had a smile on his face and a ready translation on his lips.

- Mr. Laszlo Majerusz - He is the director of energy and environmental processes and was my principal contact at TVK. Mr. Majerusz was very patient with me all week and helped to make the experience valuable and worthwhile. I can only hope that in some small way I can help return the favor.

- Mr. Laszlo Nemes - Product Director at AKZO-TVK Rt gave us an excellent review and walk through the paint operations located on the site of TVK.

2. Tour

Monday July 13 - The day was spent in general discussion between Mr. Kalman and Mr. Majerusz with Mr. Benedek acting as interpreter.

Tuesday July 14 - Spent the day with Mr. Majerusz and Mr. Benedek walking through the plant and examining the air effluent.

Wednesday July 15 - The day was occupied with more number refining and then a discussion of the contaminated area at the site. This was followed by a visit to the AKZO ccmplex located on the property of TVK.

Thursday July 16 - Spent the morning talking about the groundwater and incineration problems. This was followed by a visit to the waste disposal pond and tank farm. We ended up with lunch at the company cafeteria. The remaining time was occupied with more talk and a visit with Mr. Kalman.

Friday July 17 - Had more discussion on the ground water and then an in depth discussion on the very complicated incinerator regulations that have just been promulgated. Mr. Kalman joined us for the wrap up and then we had lunch and I departed for Budapest.