PD-ABP-709

EVALUATION OF KRAKOW

CLEAN FOSSIL FUELS AND ENERGY EFFICIENCY PROJECT

USAID Contract AEP-0085-I-00-6017-00
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for

Energy and Infrastructure Division
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by

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EXECUTIVE SUMMARY

This report evaluates the past performance, present status, and future course of the Krakow Clean Fossil Fuels and Energy Project (the Project) on behalf of the United States Agency for International Development (USAID). USAID's project identification number is 180-0031. Formal Project activities began with the signing of an Interagency Agreement (IAA) between USAID and the United States Department of Energy (DOE) on August 5th, 1991. Based on this IAA, the DOE signed in October 1991 a Memorandum of Understanding (MOU) with the Polish Ministry of Environmental Protection, Natural resources and Forestry covering the policies, procedures, and details to be employed in the implementation of the Project.

The Project is currently expected to terminate on September 30, 1998. Thus, a number of Project activities are still on-going. All activities have been under DOE management.

A team of four persons selected by the International Science and Technology Institute, Inc. (ISTI) performed the evaluation, as authorized by Delivery Order No. 4 under ISTI's contract with USAID (AEP-0085-I-00-6017-00). The evaluation team worked in the field and in its headquarters between October 15th, 1996, when the initial briefing by USAID and DOE occurred, and January 13th, 1997, when one team member presented the evaluation results orally to the members of the United States/Poland Bilateral Steering Committee for the Project.

The mandate given to the evaluation team by the Delivery Order was to examine the progress and achievements of the Project to date; to identify potential problems in achieving the Project objectives; and to recommend how to improve the Project effectiveness. The mandate also specified topical areas which were to be specifically addressed in the findings and observations. Findings and observations on these topical areas are presented later in this Summary.

The objectives for the Project itself are to assist Poland through the municipality of Krakow to reduce pollution from the low emission sources in the metropolitan area; to improve the efficiency of energy consumption in the equipment producing the pollution; to encourage the transfer of results to other municipalities in Poland; and to catalyze the formation of private sector firms to undertake business opportunities associated with the results of the Project.

Background

The Project arose from a visit to Poland by the then U.S. President Bush in July 1989, who promised assistance to curb serious pollution in the historic City of Krakow which endangered the health of the citizens while attacking and deteriorating the historic limestone-based architecture. Krakow's topographical location in a basin surrounded by hills stagnate accumulations of atmospheric emissions within the basin, especially when atmospheric temperature inversions occur.

The U.S. Congress appropriated funds in April 1990 through its passage of the Support for European Democracy (SEED) Act in November 1989. These funds also cover the installation of flue gas desulfurization equipment in one of the power generation units at the Skawina station in the southwest of the Krakow metropolitan area. The performance of this sister project is not incorporated in this evaluation report.

Project activities were identified and managed by DOE through its Pittsburgh Energy Technology Center (PETC), which now is reorganized as the Federal Energy Technology Center (FETC). PETC enlisted services of two DOE national laboratories, Brookhaven National Laboratory (BNL) and Pacific Northwest Laboratory (PNL). BNL contracted with the Krakow Development Office (Biuro Rozwoju Krakowa - BRK), initially an agency of the municipal Krakow government but now a private sector firm. PNL worked with a U.S. contractor, Electrotek Concepts, Inc. BRK worked with local contractors in the various aspects of its work.

Low emissions are defined as gases and pollutants emanating from chimneys of low height, largely as the result of the combustion of coal. The Project identified several areas for action involving (1) increasing the efficiency of energy consumption in buildings, (2) discouraging the use of coal stoves in homes by converting from coal to natural gas or electricity (actually two areas), (3) encouraging connections to the district heating system to retire existing small boiler houses, and (4) increasing the thermal efficiency of local boilers supporting the district heating system based on circulating hot water[1].

The U.S. side and the Polish side agreed at the outset to implement the Project in three Phases. Phase 1 was intended to

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[1] The term "boilers" is a misnomer, but is used widely. The boiler equipment essentially is a pressurized water heater designed to raise the temperature of incoming water from the district system to the required temperature for feeding the system, without evaporation.

generate the technical, cost, and institutional data needed for enabling the ultimate elimination of coal from the low emission sources. Phase 2 was intended to enable the selection of U.S. firms working with Polish partners to engage in cost-shared, cooperative agreements with DOE aimed at the Project objectives. DOE's cost sharing was set at a maximum of 50% for each agreement. DOE funds were to be made available in two tranches: initially upon award of the cooperative agreement (budget period 1); and subsequently when the firm in question was able to justify going ahead with the balance of the funds (budget period 2).

Phase 3 was, and still is, intended to cover the activities of the eight firms which were ultimately selected. Some of the firms have completed their activities. Activities for the remaining firms are still in progress. The activities of two of these firms are in serious question as to their relevance to the objectives of the Project.

Phase 1 was essentially completed with the issuance in June 1995 of the Phase 1 report by Brookhaven National Laboratory. BNL both contributed to and compiled the information it contains. Major portions of the report were contributed by PNL and its contractor and BRK and its contractors. The report contents cover technical data produced from experimentation on coal consuming equipment in the Krakow area to identify the options for achieving efficiency increases and emissions decreases. They also cover engineering studies that seek to determine costs as well as institutional studies to identify obstacles and develop incentives. One effort focused on understanding public opinion and public awareness of the problems of reducing low emissions.

Phase 2 began in February 1992 and was essentially completed with the award in February 1994 of eight cooperative agreements to U.S. firms. These firms were identified through three public meetings, two in the United States and one in Krakow. DOE prepared a draft project opportunity notice (PON) for discussion at these meetings, used the Krakow meeting to introduce U.S. firms to prospective Polish partners, and conducted a bidders' meeting during the Krakow meeting.

Phase 3 began with the award of the cooperative agreements and includes work delegated to BRK by BNL for support of the activities of the eight firms and for continuing elements of the work begun during Phase 1. The progress and status of these activities is presented below in the "Overall Results" section of this Summary.

Overall, the Project has achieved impressive successes in a number of areas in terms of its primary objective of reducing low

emissions in the Krakow area, a primary goal of the Project. At the same time there have been some failures and some potential failures. A likelihood exists that activities in at least two of the current cooperative agreements will be terminated and the agreements canceled. Further information in these respects follows.

Overall Results

If the directions established by the Project are pursued after formal Project activities are completed, the prospect is that the use of coal in equipment producing the low emissions sources will eventually be eliminated in favor of natural gas, electricity, and district heating. The open question, of course, is when this result will have been achieved. The timing will depend on preservation by the Polish side of the momentum generated by the Project when it is formally terminated.

Phase 1 results produced a data base which identified the technical, cost, and institutional problems which need to be addressed. This identification was comprehensive and objective. It covered the topical areas originally identified for the Project. Some results generated a momentum which resulted in other parties undertaking similar activities. A notable example is the continuation of the work accomplished to increase the efficiency of energy consumption in buildings by Pacific Northwest Laboratory/Electrotek Concepts, Inc.

Phase 1 also produced a powerful tool to estimate the precise impact of Project results on reducing ambient pollution concentrations in the Krakow area. Other emission sources in the Krakow area prevent the direct measurement of precise impact. These are pollution imported from neighboring regions, the increase in emissions from automotive vehicles since the Project activities began, and the emissions from high chimneys. This tool is the computerized spreadsheet model of the low emission sources in the Krakow metropolitan area. The scope of this model is now being expanded by BRK and by Krakow City authorities. It can provide inputs for other models which calculate ambient pollution concentrations.

Phase 2 activities resulted in the selection of eight U.S. firms to work with Polish firms in joint ventures to address the activities identified in Phase 1. The Polish side was disappointed in the selection because none of the firms addressed conversion of low emissions equipment from coal to natural gas or to electricity. The evaluation team found out that the selection process, which required about one-year to accomplish, was in conformance with U.S. Government procurement practices and was unbiased. The fact that all areas were not represented could be

attributed to the massive size of the Project Opportunity Notice, which likely discouraged a broader private sector response. Another negative effect on the breadth of the response to the Notice may have arisen from the further condition that the procurement process was begun before the Phase 1 activities were completed.

The objectives and activities of the eight cooperating firms during Phase 3 (much of which is still on going) are summarized as follows. The listing presents results and current status in the order of level of success or prospective success. It also covers the activities of the Krakow Development Office and the Bilateral Steering Committee.

- ***Honeywell, Inc./Control Techtronics, Inc. (CTI)***

  These two firms worked together in a complementary fashion to retrofit the Balicka boiler house of Miejskie Prezedsiebiorstwo Energetyki Cieplnej (MPEG), Krakow's major district heating enterprise, to consume coal more efficiently (CTI) and to manage the demand side to reduce consumption in the cooperative housing served from the boiler house (Honeywell). Emissions accordingly were reduced through the reduction in coal consumption in the generation of the energy supply to the district heating system.

  CTI installed automated combustion control equipment, including a Supervisory Control and Data Acquisition (SCADA) system. Honeywell installed heat exchange and control equipment in each building and individual room thermostatic controls in each apartment to avoid room temperature control by opening and closing windows, and remote monitoring of energy consumption by individual buildings.

  The installations have operated successfully, but are only now going through their first heating season. It is clear that performance is reducing coal consumption and energy demand. However, quantifying the results in terms of total emissions reduction and projecting the results for estimating the eventual total reduction, were all boiler houses in the Krakow metropolitan area to be similarly retrofitted, should await the completion of at least the current heating season, if not the entire first year of operation.

  Honeywell, with approval from DOE, used surplus funds in its cooperative agreement to assist the Krakow Combined Heat and Power Plant (EKSA), which operates the Leg Station in Krakow, to extend its district heating system by placing about 50 installations in various buildings which have reduced low emissions through the elimination of boiler houses.

Honeywell has, as a result of the Balicka and EKSA experiences, recognized a new marketing potential and has reorganized its European operations to elevate the profile of its Polish operations. It has already shown the Balicka installation to visitors from Bulgaria and has a similar project under way in Hungary. CTI has formed the Polish firm of CTI Polska with partners and has six new projects under consideration at the time of this evaluation.

The single deficiency, which should not be attributed to the two firms, is the apparent inability of the Balicka station management to purchase coal supplies suited to the operation of the stoker-fired, moving grate boilers. The coal seen during a visit in November 1996 had a large proportion of under 5 mm particles, which tend to blow out of the burning coal bed before combustion is completed. Thus, particulate emissions and coal consumption increase.

- ***LSR Technologies, Inc.***

This firm successfully completed a licensing agreement with the firm EcoInstal in Poznan to manufacture and market its core separator equipment. This equipment overcomes the poor particulate recovery in cyclones when load is considerably below the rated capacity of the cyclones. It does this by introducing a recycle gas stream which maintains constant gas flow through the cyclones regardless of load on the system. The equipment can be produced over a large range of capacities. To reduce particulate emissions, it competes with the conventional baghouse, offering cost advantages at the expense of marginally poorer recovery of the very fine particulates.

Differences in business philosophy accounted for the choice of a licensing approach over a joint-venture approach. LSR was willing to invest in a joint venture to install computer-controlled, automated fabrication of its equipment. EcoInstal believed that low Polish labor costs would not justify such an investment and preferred, instead, to invest in marketing the core separator equipment.

The licensing agreement over the last two years has resulted in 22 operating installations and another 13 in various stages of installation. Five of this total are located in the Krakow metropolitan area.

This cooperative agreement has been quite successful in addressing the objective of catalyzing the formation of private sector firms to undertake business opportunities. However, the pollution reduction effects are not concen-

trated primarily in the Krakow metropolitan area. EcoInstal's booth at the 1996 Poznan Trade Fair gave a high profile to the LSR equipment and the role of assistance from the United States.

The LSR cooperative agreement is scheduled to be completed in March 1998. It appears that this firm has already achieved success.

- ***Shooshanian Engineering Associates, Inc. (SEA)***

SEA worked closely with MPEG, Krakow's main district heating system owner. The efforts were mainly of a management consulting nature to help MPEG to expand its system through adding connections and eliminating boiler houses. SEA provided training for MPEG personnel in technical audits and feasibility studies to convince building owners to connect.

MPEG reported that they were fully satisfied with the quality of SEA's work. It has instituted organizational changes to increase the efficiency of its operations. The cost-sharing provided by DOE helped to make the cost of SEA services manageable by Polish standards. To maintain the momentum generated, SEA and Polinvest, a Polish firm, are at the time of this evaluation negotiating a cooperative agreement in which costs for the consulting services will be reduced through a measured involvement of SEA in future activities.

The SEA cooperative agreement is scheduled to terminate in February 1997.

- ***Tecogen, Inc.***

The work of this firm is in a relatively early stage. The nature of the work is similar to that of CTI (see above). It involves the introduction of automated combustion control in boiler houses. The work further involves the addition of heat transfer surface to the boiler economizer to increase inherent thermal efficiency and reduce coal consumption. The activities are conducted in Poland by a joint venture called "Ecogy".

At the time of a visit in November 1996, an economizer addition had already been retrofitted to one boiler at the Wieliczka boiler house and parts for the economizer retrofit for a second boiler were at hand ready for assembly and installation. A run for data acquisition had been completed the previous night. The data were to be used to design the

combustion control equipment. Tecogen is cooperating with CTI in this respect.

Tecogen's Polish partner, Naftokrak-Budowa has criticized Tecogen's management and activities as being a "one man show" conducted by Tecogen's project manager. Also, although the Japanese Industrial Development Organization (JAIDO) has contributed $500,000 to the joint venture, despite this major share in the financing it has taken no active role in the management.

The Wieliczka project will be the only one undertaken for this cooperative agreement. The cost seem to be well below the funds available under the agreement and from JAIDO. It appears that a detailed DOE/USAID review of the Tecogen project should be undertaken immediately. Accountability for the funds available to Tecogen should be established.

- *EFH Coal Company*

This firm plans to construct a large, one million tonne per year coal washing plant near Katowice to supply clean graded coal to a variety of consumers, including the remaining boiler houses in the Krakow metropolitan area. In the two and a half years since the award of the cooperative agreement there has been relatively little progress. The work is still in an early stage.

Much of the reason lies in securing environmental compliance permits from the local and national governments. The current estimated completion date is March 1997. There is currently no possibility that this completion date can be met.

Because of the small market for washed coal in the remaining Krakow boiler houses and the prospect that this will be declining market, the sub-project as now constituted does not fall within the current objective for the Project. Moreover, team discussions with Polish authorities did not paint an optimistic picture for the early granting of the environmental permits.

The evaluation team has serious doubts as to whether this sub-project can ever be implemented. It appears to require a large-capacity installation to provide a small quantity of specification coal to meet Krakow requirements. At the same time based on performance to date, the sub-project poses a large downstream risk of ultimate failure and possible embarrassment to the U.S. Government. Finally, the team was informed by a knowledgeable Polish source that coal washing

is already practiced in Poland, which includes the operations of a coal company close to Krakow.

- *TCS, Inc.*

This firm plans to install a new coal-fired boiler installation, employing a micronized coal and limestone fuel, to provide heat to a major greenhouse installation outside of Krakow at Krzeszowice, about 50 km to the west. The greenhouse is owned by PHRO (Production and Breeding of Horticultural Plants, Ltd.), whose interest in the sub-project is based on the savings they see from conversion to coal from their reliance on fuel oil. At current arbitrarily fixed prices for coal and fuel oil, the management estimates it will save approximately $250,000 annually. The present fuel bill is about 20% of total revenues.

The evaluation team believes there is no basis to expect that present pricing relationships will remain valid in the future. Rather, difficult mining conditions in the Polish coal industry are likely to force the present price advantage for coal over fuel oil to disappear.

TCS remote management of the work, the delays encountered in finding the PHRO site, and lack of a credible cost estimate for the installations have delayed DOE's approval for budget period 2 funding. Even with a successful demonstration for the PHRO installation, it is unlikely that the technology will find application elsewhere in the Krakow metropolitan area where the market for coal in low emissions sources will ultimately disappear.

In view of the foregoing observations, it is difficult for the evaluation team to understand the continuing support for the sub-project.

- *Acurex Environmental Corporation*

Acurex had proposed to manufacture a smokeless coal briquet with a proprietary technology involving a clay additive in the manufacturing process. The market for such briquets according to the Phase 1 results lies in fueling home stoves and steel, hand-fired boilers. Although this market may be significant at present, as low emissions reduction activities progress, this will be a declining market at least in the Krakow metropolitan area.

Acurex failed to receive DOE approval for second budget period funding and was thus forced to abandon its efforts. The reasons, according to Acurex, were its inability to

secure commitment from Polish investors without first demonstrating a successful semi-commercial operation and DOE's insistence that second budget period funding required investment commitments on the Polish side. The reason according to the Polish side was that Acurex failed to come up with an acceptable site for a manufacturing plant.

The evaluation team believes that the cost of a semi-commercial operation (U.S. $300,000) could easily have been incorporated in the first budget period funding. It also appears that the trial batch of briquets produced by Brikpol in Lublin did not have strength stability. Meanwhile, Brikpol plans to introduce marketing of briquets of its own manufacture early in 1997 in the Lublin area, and the Institute for the Chemical Processing of Coal in Zabzre is actively pursuing commercialization of briquets of its own manufacture.

It appears that the Acurex project has been inadequately implemented with poor public relations. An official in the U.S. Consulate in Krakow believes that Acurex came to Poland, took a clean coal, added sulfur to it, and made a dirty briquet.

- *Krakow Development Office (BRK)*

The Krakow Development Office, which is now a private sector firm, has had a continuing role during the three phases of the Project under its subcontract with the Brookhaven National Laboratory. Their roles have been both technical and catalytic, i.e., as facilitators for Project activities throughout the three phases. As a result this organization now has an institutional memory which can be useful, if not critical, in the continuation of efforts toward eliminating coal from low-emission sources after the formal completion of Project activities.

- *Bilateral Steering Committee*

The Bilateral Steering Committee appears not to have lived up to its name. It appears to have been a Committee which followed activities rather than steered them. Normal formal minutes of the many meetings of the Committee were not kept. Accordingly, the evaluation team could not document this observation. Rather, the evaluation team listened to views expressed by both sides (U.S. and Polish) represented in the Committee. This observation is significant because a descendant of this Committee would likely be the agency for continuing the elimination of low-emission sources after formal termination of the Project activities.

Project Management

The presence throughout the Project period of a resident permanent project manager with authority commensurate with responsibility might have avoided the problems recounted above. Responsibilities for project management were diffused throughout the U.S. government organizations participating in the Project activities. The two front line U.S. Government agencies in Poland, USAID/Warsaw and the Embassy/Consulate have had no authority to direct activities. Yet these organizations were the ones which directly received criticisms of the activities. Despite this diffuse management, it is a compliment to the efforts that the Project has had the positive achievements noted above.

Direct project management in the field now may be able to avoid prospective failures of activities which are still on-going. It could enhance the role of the Krakow Development Office. It could still serve to avoid unnecessary expenditures of Project funds and to bring the Bilateral Steering Committee into future decision making.

In retrospect, direct project management might have detected the need for mid-course corrections at an early stage. For a Project operating over a six-year period in a dynamic environment, such corrections are bound to arise.

Krakow Area Emission Reductions

The Project activities clearly have reduced the low emissions in the Krakow metropolitan area, particularly because of increased connections to the district heating system. But the quantities of reductions can only be estimated by the use of the computer-oriented spreadsheet model. These connections eliminated hundreds of small boiler houses. Conversions from coal to natural gas and to electricity, and reductions in emissions from remaining boiler houses selected for efficiency improvement have helped reduce low emissions.

However, measurements of general ambient conditions do not reflect short term conditions which can exist during severe cold waves in the area. For example, it was reported to the evaluation team in mid-January 1997 that visibility in the Krakow area had been reduced to several meters because of peak emissions of particulates and the carcinogenic low-volatile hydrocarbons emitted from coal combustion. With the introduction of market-driven forces in the Polish economy, the municipality has no control over the quality of coal offered in the Krakow market. Low-quality coals have entered the market at attractively low

prices and their poor combustion may be a contributing factor to this report.

City of Krakow officials had already significantly reduced emissions of particulates and SO_2 during the period 1989-94, before the Phase 3 activities began. It appears, nevertheless, that if the directions identified by the Project activities are pursued after the formal completion of the Project, low emissions can be reduced to the minimum through complete elimination of coal firing in these sources. But, the actual effect on ambient conditions would have to be measured by the use of computer modeling.

Commercial Markets/Private Sector Development

Private-sector development is to occur in a free-market atmosphere. While this is a desirable policy, it is in conflict in one respect with the Project's low-emissions reduction objective. Purchase of coal by consumers is totally free of constraints. Low-grade, "dirty" coal is available at prices so attractive that Acurex found its briquets could not compete. The team also learned that coal mines in Poland habitually mix tailings (the waste material from coal washing) with run-of-mine coal for sale. The municipality should find the legal means to control quality in the sale of coal in the local markets.

The evaluation team learned that a healthy competition had arisen in the Krakow area among the suppliers of district heat, electricity, and natural gas for the acquisition of new customers. Consequent price reductions should make the use of coal less and less attractive as time goes by.

As noted above, a number of sub-projects operating in the private sector have made definite contributions to the elimination of coal in the low emission sources or, at least, in reducing coal consumption. Momentum appears to have been generated for the activities to continue beyond the formal termination of the Project activities. Much of these results are private sector accomplishments which would not have occurred without the Project. However, the results, in retrospect, might have been enhanced if the solicitation procedure had been reversed.

DOE could have followed the practices of the U.S. Trade Development Agency. The focus then would have been on initiatives by Polish private sector firms to find U.S. partners, instead of the reverse. The funds required could have been granted to a Polish government agency, which then would have managed the solicitation under procedures mutually agreed between the U.S. and Polish sides. Most likely, the time consumed in the process would have been considerably shorter. In the implementation invoices would

have been submitted to the Polish grantee, which upon approval would have been paid by DOE.

None of the activities resulted in the formation of energy services companies (ESCOs). The evaluation team believes that the use of ESCOs would be more appropriate in the industrial sector, where it would be easier to identify cost savings for sharing with the ESCOs.

There now appear to be many sources of funding through loans and equity to finance future energy efficiency and emissions reduction installations, which did not exist when Project activities began. It is likely that the Project catalyzed the formation of these funding sources. Among these may be mentioned the Environmental Protection Bank and the EcoFund.

Technology Transfer and Information Dissemination

The Project results demonstrate a number of significant transfers of technologies and the dissemination of information concerning these transfers. Among these may be mentioned the systems approach introduced by Honeywell in demand side management and by CTI in the production of the energy supply; the building energy consumption decreases demonstrated by the Pacific Northwest Laboratory/Electrotek Concepts, Inc.; the introduction of Supervisory Control and Data Acquisition (SCADA) systems; the new particulate control equipment capability introduced to EcoInstal by LSR Technologies, Inc.; and the benefits received by MPEG from the management consulting services provided by Shooshanian Engineering Associates, Inc.

In contrast, the coal washing technology to be introduced to Poland by EFH Coal Company, if successful, should amount to "reinventing the wheel". Polish coal mining industries are reported to use this technology widely. The micronizer coal burner of TCS, Inc. is a successful technology but one not likely to find a market in Krakow for low emissions reduction.

Public Awareness and Participation

Polish public opinion and awareness are not likely to distinguish between the Low Emissions Reduction Project and the Flue Gas Desulfurization Demonstration Project at Skawina. Both are funded out of the same Congressional appropriation and managed by the same U.S. Government agency. Failures in one project are likely to reflect on the other.

Several public meetings were conducted during the course of Project activities, which no doubt made the general public aware of the Project and its activities through newspaper, radio, and

television reports. Participation in these meetings occurred through business firms and government and private organizations. None of these functions was directly oriented to the general public.

One activity in Phase 1 concerned in-depth surveys of consumer attitudes toward the pollution from low-emission sources and the means being taken to alleviate this situation. The results of these surveys are contained in detail in the Phase 1 report. These results most likely provide inputs to the identification and analysis of incentives to reduce low emissions contained in the Phase 1 report.

Although the installations at the Balicka boiler house are impressive, the visitor was not made aware that these installations resulted from U.S. assistance. Honeywell has produced a videotape of their Balicka installations, the commentary for which acknowledges the role of the Project. Finally, the Eco-Instal booth at the 1996 Poznan Trade Fair gave ample recognitions to the role of the U.S.-funded LSR Technologies contribution.

Other-Donor Project Relationships

The evaluation team is not aware of any impact on the Project results because of activities by other donors. Exceptions are the involvement of JAIDO in the Tecogen sub-project and the World Bank's contribution of funds to help finance the implementation of sub-projects directed toward the district heating system.

Local Government Policy and Capacity

The local government and the voyevodship (regional government) will need to identify the incentives needed to accelerate the elimination of coal from the low emission sources and, as well, incentives to increase the efficiency of energy consumption. The roster of incentives, which need be considered for both situations, are a significant result of the Phase 1 activities and are detailed in the Phase 1 report. They will also need to address the prospect that the quality of the coal entering the Krakow market can be controlled to the desired standards.

The choice of incentives is a judgment of the local and voyevodship government authorities, since they involve sociological and political factors beyond the knowledge and legitimate interest of the evaluation team. A powerful tool for choosing incentives would be the use of benefits/costs analyses.

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USAID/DOE and Polish Issues

The evaluation team found that there are four issues that merit attention and should be resolved.

- *Can the present bureaucratic arrangements be modified to provide a close-up project management effort in the field?*

  This is an issue whose resolution must be internal to USAID and the Department of Energy. It will become an important issue should Project activities continue or be restructured. The only view the evaluation team can offer in this respect is that there must be continuous close-up management in the field if the results are to be beneficial and maximized.

- *Can each side exercise more patience in understanding the other's point of view?*

  This is an issue whose resolution depends on taking the time for both sides to understand the constraints governing the actions of the other. It is clear to the evaluation team, for example, that DOE acted by the "book" and without bias in the selection of the eight cooperating firms. It is not clear how much effort DOE exercised to be sure this objectivity was understood and accepted without reservation by the Polish side. Given that Project activities are to continue, the exercise of patience when views differ will remain a necessity on both sides.

- *Should there be a role for USAID/Warsaw in the determination of the future of the Krakow Clean Fossil Fuels and Energy Efficiency Project?*

  This is an issue whose resolution is likely to be internal between USAID/Warsaw and AID/Washington. Nevertheless, it is clear to the evaluation team that local representatives of the U.S. Government - USAID/Warsaw and U.S. Embassy - take the brunt of recriminations which have and could continue to arise in the future concerning the course of the Project activities. In this respect, the resolution of this issue should result in some optimum level of responsibility and authority for project management residing with USAID/-Warsaw.

- *Has there been a conflict of interest in the selection of objectives for the Krakow Clean Fossil Fuels and Energy Efficiency Project?*

  The evaluation team believes there has been some degree of conflict of interest between the first and fourth objectives

of the Project as stated at the beginning of this Summary, namely: some degree of conflict of interest between the objective of reducing pollution from low emission sources in the City of Krakow and the objective of catalyzing the formation of private-sector firms to seek and undertake business opportunities in connection with low emissions reduction.

Certainly EFH is a good example of several interests co-existing at the same time within one organization which could conflict with the main objective of low-emissions reduction. One could question how the Project funds are employed in addressing the many interests. In this sub-project, there has been a total disregard for the fact that the coal-washing technology proposed is already employed in Poland, even in the vicinity of Krakow. The cooperating firm appears to be serving its own interests by "reinventing the wheel".

Another example may be Tecogen in which the desire to be helpful and to serve its own interest may be diluted by the infusion of Japanese capital. To give a third example, the TCS, Inc. project might be implemented outside the Krakow metropolitan area for the benefit of other local interests in reducing fuel costs by converting to coal (!) rather than reducing low emissions in Krakow. Also, TCS, Inc.'s business relationships with Babcock and Wilcox seem to be the determining factor as to how the sub-project would be implemented rather than the choice of an effective approach for reducing low emissions in Krakow itself.

- *Does Polish public perception that the Skawina Flue Gas Desulfurization Project and the Krakow Clean Fossil Fuels and Energy Efficiency Project are part of one and the same U.S. Government assistance effort, require a closer U.S. side administration for the two projects?*

The evaluation team was exposed to this issue during its field work, even though the Skawina project is outside the terms of reference for the evaluation of the low-emissions project. The SEED act did not distinguish between the two efforts and, in fact, legal opinion within DOE would permit the transfer of funds allocated by USAID to the low-emissions project to the Skawina project.

Resolution of this issue should consider that, if both projects are considered as a package (as no doubt is the view from the Polish side), the planned refurbishing of the installations at Skawina taken together with the positive results which have been achieved for low-emissions reduction

could help materially to reduce prevailing negative public perceptions of the U.S. sponsored emissions reductions activities authorized by the SEED Act.

Conclusions

Three possible conclusions emerge from the foregoing findings and observations. Each of these conclusions has positive and negative implications with respect to their practicality for subsequent actions. They are

- *The Krakow Clean Fossil Fuels and Energy Efficiency Project has run its course and, although significant beneficial results for reducing low emissions have been obtained, all current activities should be terminated.*

  On the positive side for this conclusion, the funds that would be deobligated could be combined and used for supporting the solution to the problems encountered in the sister project in Krakow, which is the reduction of SO_2 emissions from the steam generators at the Skawina power plant. According to U.S. Government policy it would seem that this failure should not remain unremedied.

  On the negative side, there appear to be contractual problems as to whether or not the EFH and TCS agreements can in fact be terminated. Both firms have encountered obstacles which have been beyond their control, although it could be argued that they have made reasonable attempts to overcome those obstacles. Moreover, an abrupt termination, coming at the heels of the problems at Skawina, could compound negative views on the part of the City of Krakow and the public on the reliability and effectiveness of U.S. assistance efforts.

- *The Krakow Clean Fossil Fuels and Energy Efficiency Project has produced beneficial results for reducing low emissions and should continue to the conclusion of the current activities within the project anticipated completion date.*

  On the positive side, such a conclusion provides the least difficulty in the management of the Project by DOE and USAID. DOE could grant extensions of time to complete activities, on request, until the project anticipated completion date of September 30, 1998 is reached.

  On the negative side, presently obligated funds will have been spent on results which at the best are likely to be marginal with respect to reduction of low emissions in the Krakow region. In addition, these funds will have been

spent with advance knowledge, recognized by others, that any results of such a completion are likely to be marginal at best in effect.

- *The Krakow Clean Fossil Fuels and Energy Efficiency Project has produced beneficial results for reducing low emissions, but these results could be enhanced by restructuring, in an appropriate manner, the activities still underway and yet to be completed.*

  On the positive side, the funds obligated but not yet spent are significant in amount. Restructuring the Project in the light of the experiences accumulated within the Project activities over the past six years should enable the activities now underway to be reoriented in order to assure maximum benefits from the funds still remaining to be spent. Consideration could be given to the deficiencies which have been noted above, and the restructuring effort could focus in part on eliminating these deficiencies to the maximum practical extent.

  There is little to note on the negative side. Amending the scopes of work in the two cooperative agreements under question should pose no contractual problem since it is reasonable to expect that the two firms will be cooperative, given that restructuring should largely eliminate obstacles they still face. A problem could exist if the restructuring should include cancellation of the cooperative agreements.

The evaluation team recognizes that factors exist within the USAID organization which are beyond the scope given to the evaluation efforts, and which could well determine the choice USAID decides to make. There can also be influences on the choice of conclusion arising from the views and positions of the U.S. Embassy in Warsaw.

Nevertheless, the evaluation team believes that restructuring the Project would best serve both U.S. and Polish interests, and that this is the conclusion which should be drawn. Given such a conclusion, the team can offer a number of recommendations and suggestions as to how the restructuring effort should be designed and implemented.

Recommendations

1. Coal Quality in the Krakow Markets

   Act immediately to provide the legal basis upon which the Municipality can control the quality of the coal available in the Krakow markets. The action here is obviously on the

Polish side, but the Project activities should provide the technical inputs required to establish acceptable coal qualities and the means to assure compliance.

2. EFH Coal Company

Terminate this cooperative agreement at the earliest practical date. There is a window up to the present completion date of March 1997. Given such a termination, the Krakow Development Office should be tasked to develop a plan for the supply of washed, clean coal to the Krakow area.

3. TCS Inc.

Reorganize this sub-project to demonstrate the micronizer technology at a minimum cost on existing equipment. If this is not practical, terminate the cooperative agreement at the earliest practical date.

4. Other Sub-projects

No need exists for actions on the remaining sub-projects, except for the successful LSR Technologies sub-project for which the distant completion date should be brought closer to the present.

5. Brookhaven National Laboratory and the Krakow Development Office

Provide key roles for these two organizations in a restructured Project which (a) would retain the supporting activities of the Krakow Development Office and (b) provide for this organization to represent the institutional memory after formal termination of the Project.

6. Bilateral Steering Committee

Strengthen the role of this Committee such that (a) it represents a true "steering" function and (b) in a descendant form it can serve to assure the ultimate elimination of coal from low emissions sources after formal Project termination.

7. Conversion of Coal-Fired Equipment to Natural Gas or Electricity

Remedy the current deficiency in authorized activities during the restructuring process either by (a) tasking the Krakow Development Office to undertake the work with a subcontractor and provide the technical support or (b)

providing a grant to the Municipality to seek a private sector Polish firm with a U.S. counterpart to undertake the work.

8. Termination Conference

Plan for a major public conference upon the formal completion of the Project. The scope for this plan should include, at least, a maximum emphasis on the positive results of the work, a plan for the continuation of the work under local management and funding, a public hearing on incentives for conversion away from coal and promotion of energy efficiency, a discussion on the use of computer modeling in the estimation of the current and future effects of Project results on ambient pollution levels, estimation of the savings from the elimination or postponement of construction of new combined heat and power plants because of Project results, wide coverage of the proceedings by the media, and published proceedings in Polish and English.

9. Project Management

Convert the Interagency Agreement to a participating agency services agreement (PASA) to provide greater control to USAID in a restructured Project.

Appoint a resident project manager (Polish speaking preferably) from either USAID/Washington or USAID/Warsaw with authority to manage the details of the restructured Project.

Constitute the Bilateral Steering Committee with representation from USAID/Warsaw, as the agency to which the project manager would report.

Retain meaningful roles for the Department of Energy agencies and the Krakow Development Office in the implementation of the restructured Project.

Provide a meaningful role for the project manager in the rehabilitation of the Skawina project so that the positive results from each of the two projects can be mutually reinforcing.

10. Import Duties and Taxes

Implement the requirement in the Interagency Agreement in which USAID was required to avoid the payment of import duties and taxes on Project equipment by acting to recover such payments connected with past Project activities and to avoid future payments.

I. INTRODUCTION

I. INTRODUCTION

This report addresses an evaluation of the current status (January 1997) of the Krakow Clean Fossil Fuels and Energy Efficiency Project, an activity of the United States Agency for International development (USAID), and referred to hereafter as the USAID Project, or as the Project. USAID's project number is 180-0031. The USAID Project dwells in the Energy and Infrastructure Division of USAID's Office of Energy, Environment and Urban Development. USAID authorized the evaluation work to be undertaken by International Science and Technology, Inc. (ISTI) as Delivery Order No. 4 under its contract number AEP-0085-I-00-6017-00.

ISTI organized a four-person team of individuals having complementary multi-disciplinary experience relevant to the substantive content of the USAID Project. The work began with a briefing in Washington, DC, on October 15th, 1996. The team leader was Charles Bliss, who was supported by Romesh Bandaranaike, Bronek Dutkiewicz, and Roman Semkow. The team performed its field work during late October and throughout most of November 1996. Information on the project activities since its inception was complied from sources in the United States and in Poland. This report represents the joint findings and observations, conclusions, and recommendations of the ISTI team.

The findings, observations, conclusions, and recommendations contained in this report were presented informally and orally to a meeting of the U.S./Polish Bilateral Steering Committee in Tampa, Florida, on January 13, 1997. Nevertheless, the contents of this evaluation report are the official evaluation results and supersede the information presented in the informal presentation. Any changes, which may be detected, should be minor and editorial in nature.

The objectives for the evaluation are

- to examine the progress and achievements of the USAID project to date;
- to identify potential problems in achieving the project objectives; and
- to recommend how to improve the project effectiveness.

The objectives of the USAID project are the following:

- to assist Poland (through the Krakow Municipality) to reduce pollution from low-emission sources in Krakow;

- to include in the assistance, improvement in the efficiency of energy consumption in the equipment producing the pollution;

- to encourage transfer of project results to other municipalities in Poland; and

- to catalyze the formation of private sector firms to seek and undertake business opportunities associated with the results of the project.

The scope of the work the evaluation was to undertake, in order to evaluate the USAID Project under the objectives stated above, was to address eight specific aspects of the project. These aspects are the following: extent of reduction of environmental pollution in the Krakow region; prospects for commercial dissemination of the USAID Project results; local government policy and implementation capacity; development of relevant private sector enterprises; technology transfer and dissemination; public awareness and participation; relationships with other and similar projects; and effectiveness of project management.

The scope of work was also limited to addressing only low emission sources. Low emission sources are identified for the purposes of the USAID Project as emissions originating from the combustion of coal in domestic stoves and in boiler houses which provide energy for domestic uses. The "low" relates to the fact that the emissions are discharged to the atmosphere relatively close to ground level compared with those from the tall stacks in central power stations. At the inception of the Project, the low emissions sources in the Krakow region comprised about 100,000 domestic stoves and 2,927 boilers operating on either gas of oil (673) or on coal or coke (2,254). No other sources were to be examined for evaluation purposes.

The scope of work also excludes the sister project authorized by the same U.S. Congressional legislation. This is the installation of flue-gas desulfurization equipment in a power generation unit of the Skawina Station to the southwest of Krakow.

Clarification of the term "boilers" or "boiler houses" is needed. The term is essentially a misnomer, is probably of Polish origin, and is used freely throughout the Project activities. The equipment to which the term refers actually heats water under pressure, without evaporation, i.e., without "boiling", from the temperature returned the water temperature to be supplied to the central heating systems. In some "boiler houses" actual steam generation, i.e., "boiling" occurs, in order to supply limited local needs. However, this is the exception rather than the rule.

Throughout its work, the team attempted to cross check its information and data from at least two sources. Oftentimes, this was not practical for several reasons. The level of effort available to the team was limited by the terms of the delivery order authorized by USAID. At the same time, securing appointments with sources was not always convenient to the team's limited schedule. Where a finding from the work still represents, in the team's view, some uncertainty regarding the validity of the finding, a suitable qualifier is incorporated.

In contrast, the team finds that much of past activity has been well reported in great depth in public documents. The availability of these documents has saved much time and effort on the part of the team. The documents are listed at the end of Appendix A of this report and are referred to in the report, as appropriate, by numbers in parenthesis corresponding to the listing in Appendix A. Also listed alphabetically, as Appendix B, are the persons interviewed by team members in the course of their work, including their affiliations.

The team found personnel in the Department of Energy and its component agencies fully cooperative in making available their files for review and in discussing aspects of the findings from the files. The team also found personnel of the Krakow Development Office (BRK) fully cooperative in discussing the past events, arranging for appointments with organizations in Krakow, and otherwise providing the valuable logistical support.

The team provided preliminary briefings of then current state of the investigations to personnel of the USAID Mission in Warsaw on November 21st, 1996 at which USAID/Washington and DOE personnel were present; to USAID and DOE personnel in Washington, DC, on November 26th, 1996; and as noted above to the members of the Bilateral Steering Committee for the Project.

The report is organized as five major sections with two appendices, of which this Section I is the Introduction.

Section II is an overview of the USAID project emphasizing the historical aspects, the organization of the activities, the management approach, and the activities up through the award of cooperative agreements to eight firms to continue the work of the Project into a Phase 3. Since the readers having primary interest in the results of the evaluation are familiar with the activities, this Section is brief and refers to details in the comprehensive Appendix A for those readers who may not be familiar with the Project.

The discussion in section II and in the Appendix is intended to be factual and to avoid judgments on the effectiveness of the

activities undertaken. The discussion in Section II and in Appendix A permits this evaluation report to be free-standing. There should be no need for the reader to refer to other referenced reports.

The organization of Section II and Appendix A is based on Figure 1, which is a comprehensive chart identifying by time line 34 discrete events which have occurred so far during the seven year life of the Project. The figure shows the time relationships among the events. The text content of Appendix A essentially describes each event in some depth in order to provide a basis for the evaluation of the Project.

The discussion in Section III focuses on details of the current Project activities, which are largely incomplete at this time. It is organized by reviewing details of activities by the various players, both on the U.S. and on the Polish sides. Again, the discussion in this Section is intended to be factual and to avoid judgments on the effectiveness of the activities in progress. Readers who are not directly involved in the Project affairs can have a convenient opportunity to acquaint themselves with the details of current activities. The text content again is intended to provide a basis for the evaluation of the Project.

Section IV begins the evaluation in the form of findings and observations made by the team as a result of its investigations. The presentation is organized by the topics mentioned above as comprising the scope of work.

Finally, Section V completes the evaluation by presenting the team's conclusions, recommendations, and suggestions regarding the future course of the Project. Each recommendation is accompanied by discussion of factors USAID should consider in reaching its decisions regarding its acceptance of the conclusions and subsequent implementation of the recommendations.

Accordingly, the team believes that USAID management will find the results reported here to be a suitable basis for taking appropriate decisions regarding the future of the Project.

II. PROJECT OVERVIEW

II. PROJECT OVERVIEW

In terms of USAID involvement, the Krakow Clean Fossil Fuels and Energy Efficiency Project has had a seven year life so far. Its origins were about 1990 and the completion of all authorized activities has not yet occurred. In terms of local interest in the City of Krakow to take actions to reduce the pollution arising from the wide use of coal for all purposes, space heating and electric power generation, the history covers a much wider time span. Local interest began in the mid-1980s, several years before U.S. Government interest in supporting pollution reduction began. Local interest is likely to continue beyond the completion of the Project, until the use of coal in low emissions equipment has been totally eliminated.

To enable to reader to comprehend the Project quickly from the events of the past through to the current status of the authorized activities, both on the Polish (City of Krakow) side and the U.S. side, and at the same time to provide a basis for evaluating the Project results, it appears best to present these events in a graphical-schedule form. The fold-out Figure 1, appearing at the end of this Section, is this presentation.

The project was organized to be accomplished in three phases. Phase 1 was designed to establish a technical, engineering, economic, and institutional data base for the characteristics of low emissions in the Krakow metropolitan area, upon which techniques for reduction and elimination of these emissions could be selected and designed. Phase 2 was designed to secure the services of private sector firms in the United States and Poland to undertake activities through cooperative funding agreements with the United States Department of Energy, to reduce low emissions in five distinct areas, which are

- eliminate coal-fired boiler houses by connecting their users to the district heating systems;
- convert boiler houses in the old town area to natural gas;
- convert domestic stoves in the old town area to natural gas;
- modernize outlying boiler houses to be efficient and less polluting; and
- provide an alternative fuel for the domestic stoves which can not be eliminated.

Phase 3 was designed to incorporate the activities undertaken by the cooperating firms.

Each line item in the figure is selected as an event and numbered. Thirty-four discrete events are shown and these cover the entire set of activities belonging to the Project comprising Phases 1 and 2. Information for describing and explaining each item is presented in some depth in Appendix A (Project Activities and Details) of this report. The reader should refer to Figure 1 for the timing for each event. The intent is for a reader, who is otherwise unfamiliar with the Project and wishes to know the details, to read through the information in Appendix A.

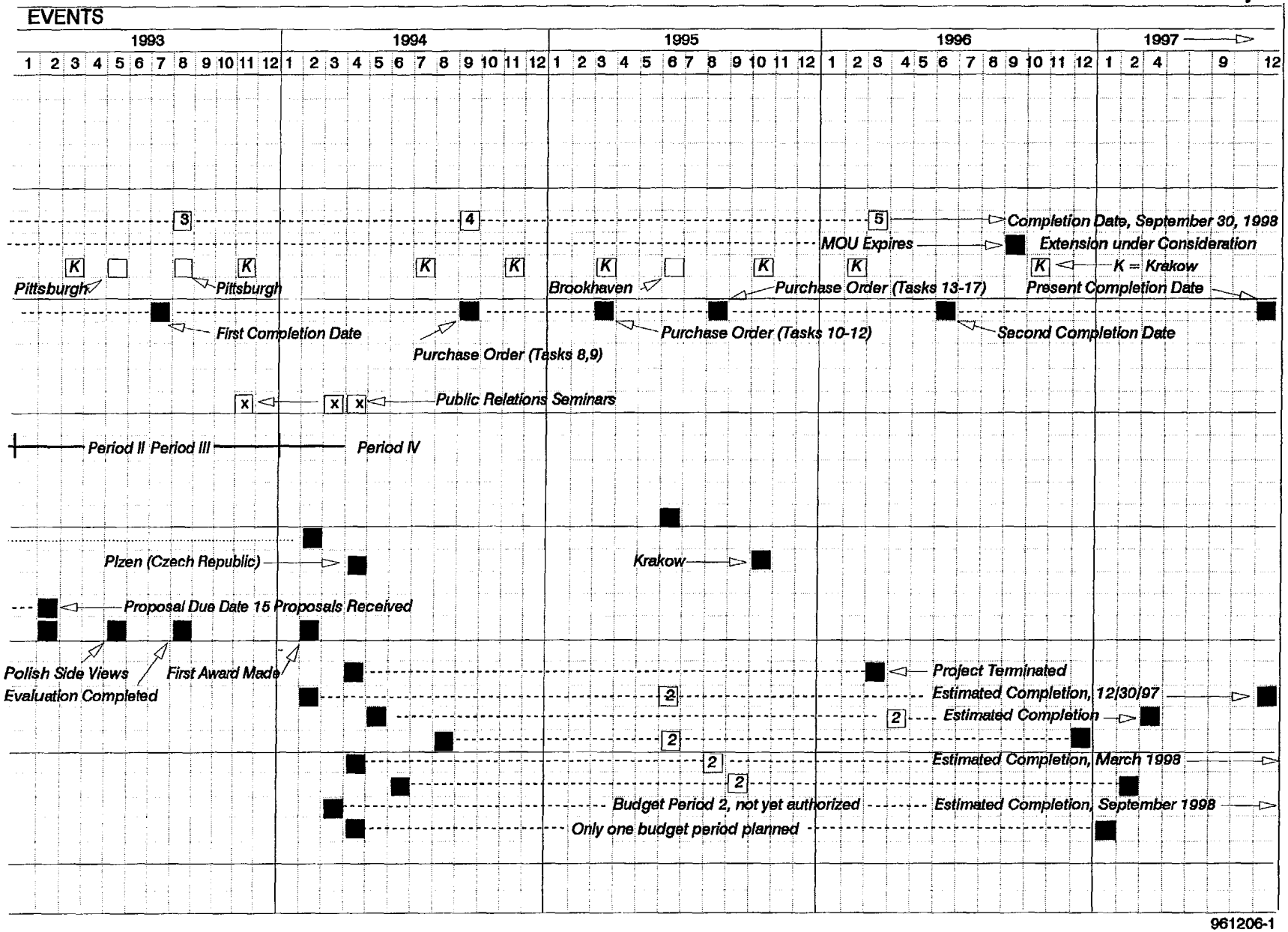
Appendix A also contains a list of the documents reviewed for purposes of Project evaluation.

Appendix B (Persons Interviewed) identifies the sources for the information presented in Appendix A and, as well, for opinions and judgments which have served as inputs to the Project evaluation.

Figure 1. SCHEDULE OF

	ACTIVITY (Detailed Description in Appendix A)	1989	1990	1991	1992
		7 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
1	Origins of Air Pollution		Continues throughout Project duration		
2	Environmental/Economic Awareness		Continues throughout Project duration		
3	Visit of President Bush to Poland	■			
4	The "SEED" Act	Act Passed ■	■ ← Funds Appropriated		
5	Early Problems				
6	USAID Intervention		Visit of USAID Representative →	■ ■ ← Visit of DOE Team	
7	Interagency Agreement			Negotiated → ■ Amendments → 1 2	
8	Memorandum of Understanding			Negotiated → ■	In effect
9	Bilateral Steering Committee		K = Krakow → K	K K K K	K K K
10	DOE Phase 1 Delegations			■ ← DOE selects PNL and BNL	Chicago
11	Krakow Development Office (BRK)		Contract effective date (Tasks 1-7) → □	■ ← Contract award	
12	BNL - Section 2 (Boiler/Stove)			Work Performed between February 1991 and June 1995	
13	BNL - Section 3 (Engineering)			Work Performed between February 1991 and June 1995	
14	BNL - Section 4 (Environmental)			Work Performed between February 1991 and June 1995	
15	BNL - Section 5 (Public Relations)			Focus Group Interviews → X	
16	BNL - Section 6 (Incentives)			Work Performed between February 1991 and June 1995	
17	PNL - Section 7 (Conservation/Buildings)				Period I →
18	BNL - Section 8 (Option Comparisons)			Work Performed between February 1991 and June 1995	
19	BNL - Section 9 (Recommendations)			Work Performed between February 1991 and June 1995	
20	Phase 1 Report	Compilation by Brookhaven National Laboratory of Results of Work of Several Organizations			
21	DOE Phase 2 Activities			Begun → ■	
22	Public Meetings			Chicago, Washington, DC → ■	Krakow → ■
23	Program Opportunity Notice			Issue Date (1); Bidder's Meeting in Krakow (2) →	1 2
24	Receipt of Proposals				
25	Evaluation of Proposals				
26	Selection of Cooperating Firms				
27	Acurex Environmental Corporation				
28	Control Techtronics, Inc.				
29	EFH Coal Company				
30	Honeywell, Inc.				
31	LSR Technologies, Inc.				
32	Shooshanian Engineering Associates				
33	TCS, Inc.				
34	Tecogen, Inc.				

961205-1


EVENTS
1993
1994
1995
1996
1997
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
1 2 4 9 12
3
4
5
Completion Date, September 30, 1998
MOU Expires
Extension under Consideration
K = Krakow
Pittsburgh
Pittsburgh
Brookhaven
Purchase Order (Tasks 13-17)
Present Completion Date
First Completion Date
Purchase Order (Tasks 8,9)
Purchase Order (Tasks 10-12)
Second Completion Date
Public Relations Seminars
Period II
Period III
Period IV
Plzen (Czech Republic)
Krakow
Proposal Due Date 15 Proposals Received
Polish Side Views
Evaluation Completed
First Award Made
Project Terminated
Estimated Completion, 12/30/97
Estimated Completion
Estimated Completion, March 1998
Budget Period 2, not yet authorized
Estimated Completion, September 1998
Only one budget period planned
961206-1

III. COOPERATIVE AGREEMENTS: PROGRESS AND STATUS

III. COOPERATIVE AGREEMENTS: PROGRESS AND STATUS

The purpose in this section is to review the progress and current status of the eight cooperative agreements negotiated by DOE with the eight U.S. firms identified in Figure 1, line items 27 through 34 inclusive. As such, this review will provide the second data base for the evaluation of the project; the project overview in Section II providing the first. As already mentioned, the information in this section is intended to be factual and judgments avoided and deferred until the following Section IV, *Findings and Observations*.

The reader will note throughout the review below that a key player in many projects has been MPEC. MPEC S.A. (Miejskie Przedsiebiorstwo Energetyki Ciepinej S.A.) is a municipal district heating joint stock company. MPEC's core business is distribution and supply of hot water for space heating and for domestic hot water in the City of Krakow. MPEC also delivers process steam to a small number of customers. The majority of the heat distributed by MPEC is purchased from three cogenerating plants. MPEC also owns and operates a number of heat-only plants. Hot water is distributed to customers located throughout the City via network of approximately 700 kilometers (438 miles) of mostly underground pipes. The peak demand output supplied by MPEC exceeds 1,800 MWt.

The firms working under cooperative agreements have been receiving support from the Biuro Rojwoku Krakowa (BRK). This is in addition to the role to that played by BRK in Phases 1 and 2 of the Project (cf. Appendix A). The discussion below addresses this additional role.

A. Acurex Environmental Corporation

This project never reached the Budget Period 2. It was terminated at the close of Budget Period 1. It operated from the date of award, April 1, 1994, through the termination date, March 1, 1996. The total budgeted cost was $2,679,837 of which DOE contributed 49.6% (about $1,329,000).

The reason given by DOE, according to Acurex, was the inability of Acurex to assure investment from the Polish side in the activities for the Budget Period 2. DOE wanted to see written commitments for Polish financing. The position of Acurex was that Polish investors would not provide funds until they could see a run demonstrating the manufacture and market acceptance of the Acurex briquets. Acurex, as a consulting firm dependent on income only from professional services, could not fund the demonstration without Budget Period 2 funds. The amount needed for a demonstration was estimated to be $300,000. Polish invest-

ment funds could only materialize for the purpose of scale up of what was seen by the Polish side as a *sine qua non*, i.e., successful semi-commercial briquette production and marketing of the product.

Accordingly to a view of the Polish side of the bilateral steering committee, a reason for the rejection of budget 2 period funding for Acurex was the inability of Acurex to identify a site for a briquet manufacturing plant. Another reason for the rejection on the Polish side may be recognition that the older generation in Poland exhibits an animosity against the use of briquets because of being forced to use a grossly-inferior and polluting briquet during the last war.

At the time of the Acurex proposal, a briquetting facility operated by the Jankowicz coal mine was available. It had operated since the 1960s, manufacturing a briquet made from carbonized coal with a tar binder. The facility had been closed since the 1980s. In 1994, Jankowicz decided to scrap the plant and sold off the briquetting machines. Acurex believes they can locate them when needed.

Acurex cited one of the marketing problems for briquets. They estimated the briquets could sell for $80 per ton. Good quality coal at the time cost $100 per ton. However, there was no compulsion on the public to buy such coal. Instead, they were able to buy low-grade ("dirty") coal for $50 per ton. According to the results of Phase I, the market for briquets lay entirely in the fueling of the tile room-heating stoves, and in the hand-fed boilers, which market was free of any constraint on the purchase of coal at the lowest cost.

Acurex would use Poland's large stockpiles of unsalable fine coal. Their process derives from experiences in China, where it was observed that emissions from coal burning decreased when the low-income population used coal mixed with clay as the fuel. Through a contract with the U.S. Environmental Protection Agency, Acurex had investigated this phenomenon and developed a process in which a selected ("proprietary") clay would be mixed with the coal prior to briquetting. Part of the strength of the finished briquet was developed through drying after briquetting. Acurex was unable to achieve adequate drying during the pilot work in Poland, and believes that their market study needs to be redone with an adequately dried product.

Acurex had contracted with Brikpol Spotke z.o.o. of Lublin to manufacture 300 to 400 tons of briquets according the Acurex process, using coal from the Bogdanka mine near Lublin. Brikpol possessed the equipment and auxiliary facilities for the purpose and produced the sample. The performance of the sample was

evaluated in the laboratories of the Academy of Mining and Metallurgy in Krakow. The performance in comparison with whole coal showed little differences in emissions with two samples of Wujek coal.

Since the work, Brikpol has changed its technology with an additive of its own, which they say is not clay. The new formulation will reduce the emissions of SO_x and tars, and improve the combustion. Brikpol expects to market its new briquet in the Lublin area early in 1997. Its capacity is 130,000 tons per year, with the initial market expected to be 10-20,000 tons per year. A request by a team member to visit the Brikpol facilities was turned down as inappropriate.

Brikpol has no interest in starting production in the Krakow area, since it is fully occupied in developing its markets nearer home. However, the firm is willing to assist any organization which intends to manufacture briquets for the Krakow market. According to the results of Phase 1 experimentation, a smokeless briquet would be an ideal non-polluting fuel for tile stoves and for hand-fired steel boilers. However, these would be diminishing markets as the results of the low emissions project are implemented.

Acurex reported that they are still in a position to write a Budget Period 2 proposal. They have an agreement to form a joint venture to build a plant and to provide environmental consulting services in general. A business plan exists dated March 14, 1996.

B. Control Techtronics, Inc. (CTI)

This project was awarded on April 1, 1994 and is currently scheduled to be completed on December 30, 1997. The total budget for the two budget periods is $2,314,546, with DOE providing 50% ($1,157,273).

CTI's organized its work in Poland through a joint venture formed in Poland by the name of CTI Polska. The share holders are CTI (80%) and two Polish individuals holding 10% each of the company who serve as its President and Vice-President, the key company executives. The total equity capital of the partners is $2,000. The key persons are John West, CTI, Project Director; Thomasz Szewczyk, President, CTI Polska; and Wieslaw Kalinowski, Vice President, CTI Polska. CTI Polska is a business providing automated combustion control techniques for boilers to reduce particulate and CO emissions and improve the efficiency of boiler operations.

During budget period 1, CTI Polska collaborated with MPEC to introduce automated combustion techniques to improve efficiency of operations and reduce emissions from its Balicka boiler house in the Widok section of Krakow. The intention was for this project to act as a demonstration to other boiler owners of potential benefits from the introduction of automated combustion control techniques. CTI Polska has completed all of its work on the Balicka boiler.

The team understands that CTI Polska may have commissioned independent testing of its work by Krakow University. Meanwhile, testing shows that the boiler house will operate at approximately 15% higher efficiency on average and that there is considerable reduction in emissions. The total charge paid by MPEC for the work, after including the matching funding provided by DOE was about $120,000 and the pay back period for the project is estimated to be approximately 1 year.

During budget period 2, which began in June 1995, CTI Polska is required to introduce automated combustion techniques at four more boiler houses. CTI Polska has examined 13 potential boiler sites and expects to receive orders for introducing its technology at some or all of the following six sites:

- Military barracks in Rzaska Consists of 3 boilers with a total capacity of 20 MW. A contract has been signed and final designs are now being completed.

- Zorza housing co-operative in Myslenice Consists of 4 boilers, each with a capacity of 1.7 MW. A contract has been signed and a technical report should be available at this time. It was not available at the time of the field work.

- Plumbing fixture plant (Krakowskie Zaklady Armatury) Consisting of one 10 MW and two 5 MW boilers. The plant is now in the process of privatization and CTI Polska has submitted a proposal for the work.

- Krakow municipal water company in Dobczyce Consisting of four 2.5 MW boilers. CTI Polska has submitted a proposal for the work.

  Chemical plant in Alwernia (Zakladami Chemicznymi) Consisting of four 25 MW boilers. CTI Polska has submitted a proposal for the work.

  Wielizcka salt mine Consisting of one 25 MW boiler. CTI Polska has submitted a proposal for the work.

The proposals submitted by CTI Polska for these boiler control systems indicate that there will be a 50% reduction in cost available on the basis of matching funds to be provided by DOE under the project, on a first come first served basis till available funds are exhausted.

CTI Polska does the design of the system and procures the hardware from the US. Actual installation is done by Naftokrak-Naftabudowa, under the direction of CTI Polska, in terms of a sub-contract arrangement between the parties.

With respect to environmental benefits, independent testing of the Balicka boiler house by Politechnika, after the CTI Polska work was completed, projected that performance will improve as annually as follows:

Savings in fuel	- 15.2% (2,000 tons of coal)
Decrease in particulate emissions	- By 80% (40-60 tons)
SO_2 reduction	- By 18% (33-50 tons)
NO_x reduction	- By 7%

The expectation is that similar savings (in proportion to capacity) should be available from the other boiler control systems introduced by CTI Polska in budget period 2 as noted above.

MPEC has been working on obtaining graded coal with a minimum size of 5 mm (0.20 inches). At the time of a visit by a team member in November 1996, it appeared from a visual inspection of the coal being fired that MPEC had not yet been successful in maintaining a minimum particle size for the coal it receives.

C. EFH Coal Company

This project was awarded on May 1, 1994 and is currently scheduled to be completed on March 30, 1997. The total budget for the two budget periods is $7,006,989, with DOE providing 38.4% (about $2,690,700).

The organizational structure is a joint venture formed in Poland under the name of *Ecocoal*. The share holders are EFH Coal Company (51%), Gmina Miata, Krakow (the Krakow district government) (25.5%), and Naftokrak-Naftobudowa (23.5%). Originally, the partners were Naftokrak-Naftobudowa and Miejskie Przedsiebiorstwo Energetyki Ciepinej (MPEC), the state owned Krakow district heating company. Subsequently MPEC has been replaced by Gmina Miata, because legal restrictions arising from a recent restructuring of a number of state owned companies (including MPEC) prevent MPEC from owning shares in other ventures.

The total equity capitalization of the venture is presently Zl 10,000 (approximately $3,600).

Peter L. Roselle is the Program Manager and Vice President (EFH Coal Company), Wilkes Barre, PA. Robert Eggleston is the President of Ecocoal. (He lives in Wilkes Barre, PA and travels frequently to Krakow. He has been in Krakow approximately 2-3 weeks per month every month over the past 4 years.) Adam Salitra is the Deputy President of Board of Directors and represents Naftokrak-Naftobudowa. Thomas Szewczyk also represents Naftokrak-Naftobudowa. Jacek Boron is the Managing Director of Ecocoal.

The nature of the project is to set up a plant to produce 300 tons per hour of enriched, washed coal -- 3,600 tons/day (one million tons/year) -- to be used in coal-fired boiler houses in Krakow, by heating utilities and others, including sales to entities outside of Krakow in the future.

The nature of the activities since the date of the award have been the following:

- Identifying the joint venture partners and finalizing the joint venture agreement took one and a half years;

- Selecting a potential site for the project. The site was first identified at the same location as the Szeczakowa Dolomite Mine, close to Jaworzno. Just as an agreement to lease the site was being concluded the dolomite mine was found to be insolvent and the management initiated bankruptcy proceedings. As a result the selected project site had to be abandoned and efforts undertaken to find a new site.

  Ecocoal claims that, although it was aware of the impending bankruptcy, it had expected to purchase the site outright from the Szeczakowa Mine before bankruptcy proceedings were initiated. Ecocoal states that it will be taking legal action against the Szeczakowa Mine in the future.

- Identifying a new site at the location of the Kazimierz-Juliusz Coal Mine in Sosnowicz city. Ecocoal hired engineering firm, EMG, to prepare a draft environmental impact assessment and to carry out all activities required to obtain permits to start construction. During the course of the environmental impact assessment of the chosen site, it was discovered that there could be potential problems with noise pollution at the selected site. One reason was the proximity to a local church.

- Deciding on a further site about 200 meters from the Kazimierz-Juliusz Mine. This move further delayed project implementation. The option of acquiring more of the Kazimierz-Juliusz Mine's area for the project and the use of some of the existing facilities on the site -- such as bunkers, conveyors, racks and other structures -- for the proposed plant are also being considered along with the move. These changes will result in further delays in the project.

- Signing agreements for coal deliveries to the project from the Kazimierz-Juliusz and Myslowice coal mines.

- Entering into letters of intent for purchase of washed coal from the project with MPEC, Nowa Huta cement plant, Krakow Heating Power Plant, Skawina Heat and Power Plant and a number of other organizations for a total consumption of about 700,000 tons/year.

According to EFH's Technical Progress Report 10, covering the period from July through September 1996, plant startup and demonstration is expected to be completed by June 1997 as compared with the current completion date of April 30, 1997. This progress report cites the following work still to be completed:

- collect a representative sample of raw coal from the Kasimierz-Juliusz Mine, ship this sample to Pennsylvania State University , and initiate the washability testing of raw coal and the boiler performance simulations on samples of the coal washed at a number of different specific gravities;

- continue to seek additional washed-coal sales agreements;

- continue with the permitting of the plant site (this effort involves the production of an environmental impact statement needed to obtain a Conditions for Buildings and Land Development permit (WziZT));

- purchase a modular coal-washing plant and deliver it to the plant site; and

- construct the plant and complete the host of ancillary requirements.

The critical path to completion of the project is the obtaining of the necessary environmental permitting from both the local and the national authorities. Optimistically, the expectation is that the local permits could be granted by March 1997. Ecocoal would then have to apply for permits from the national authorities in Warsaw which "could take one and half months if the U.S.

Embassy helps to move the project from the bottom to the top of the heap".

Team discussions with the Director of the coal mine and with the Director of the Environmental Protection Department in Krakow did not paint an optimistic outlook for the early granting of permits either at the local or the national level. Once the permits are available, then the facility could be built in about 22 weeks putting an optimistic startup ahead to August 1997.

With respect to marketing its product, Ecocoal proposes to produce high caloric value, washed coal -- 26,000 to 27,000 kJ/kg compared with 21,000 kJ/kg -- in grain sizes of 6-20 mm to be used in communal, industrial and private boiler houses. The product is expected to be low in sulfur (0.5%) and ash (10% and lower) compared with 'regular' Polish coal of over 20% ash and 1% sulfur. Emission effectiveness of this washed coal should be 15-18% higher than regular coal because of elimination of small size grains. Boiler efficiency is also expected to be about 20% higher. Overall, Ecocoal projects that 1 kg of the washed coal will be equivalent to 1.5 kg of regular coal.

Under the circumstances, Ecocoal claims that it will be able to market its coal washed at a price of $65/ton compared with regular coal at $40/ton. Ecocoal also points out that present government published rates for coal with the sulfur and ash content that will be produced by the plant when operational is around $65/ton.

Ecocoal claims that the letters of intent relating to the purchase of 700,000 tons of its coal during 1997 show that there is a ready market for washed coal of the type it intends to produce. However, the team notes that no prices have been specified in these letters of intent and that the projected price (together with the requirement that coal of the projected quality will in fact be produced by Ecocoal) is a key factor in whether actual sales take place or not.

Ecocoal claims that the one million tons of washed/enriched coal they produce each year, when used as a heat source, will reduce emissions compared with use of regular coal to produce the same quantum of heat, as follows:

Carbon Monoxide	- 1,601 tons
Sulfur Dioxide	- 226 tons
Hydrocarbons	- 22 tons
Particulates	- 258 tons

The team notes that these estimates have not been independently verified. In any event, their validity will depend on successful

implementation of the project. Even if the full projected reductions are realizable, the benefits to the environment in the Krakow area will be smaller than these reductions to the extent that washed/enriched coal produced by Ecocoal is sold outside the Krakow region.

Competition in the market for an upgraded coal is strong. German technologies have been strongly promoted and implemented throughout the Upper Silesian region. A number of Polish coal holdings are also promoting German and other coal washing and enriching technologies.

D. Honeywell, Inc.

This project was awarded on August 2, 1994 and was scheduled to have been completed by December 31, 1996. The total budget for the two budget periods is $5,230,046, with DOE providing 47.4% (about $2,301,300).

Honeywell did not enter into any joint ventures with Krakow companies. Honeywell, as an international company, had settled on the Polish market some time ago, before the arrival of the USAID Project. Instead, it cooperated with a number of Polish companies, offering its products, technologies, and services. MPEC and the Leg Combined Heat and Power Plant became Honeywell's main local partners and customers.

Control Techtronics, Inc. (CTI) became an MPEC partner in the initial phase of the project, providing mostly Honeywell equipment to selected project sites. Together CTI and Honeywell completed the retrofitting of the Balicka boiler house of MPEC and the automation of the nearby cooperative housing estate.

With Leg (EKSA) Honeywell provided equipment for about 50 installations in boiler houses and for connecting to the Leg district heating system. The reduction in emissions from the Leg installations can be estimated as follows:

Particulates	7,357 tons per year
SO_2	5,181 tons per year
NO_x	1,251 tons per year
CO	15,860 tons per year

Honeywell plans to build on the experiences at Balicka. They have shown the installations to a prospective Bulgarian client, and are already implementing a similar installation in Hungary. The experiences may have caused a major reorganization in Honeywell's European organization. The project work had been done through Honeywell's Vienna office to which its Polish office reported. The reorganization resulted in a regional office for

eastern Europe set up in Prague to which all country offices report. The office in Prague in turn reports to Honeywell's European office in Brussels. The Brussel office reports to headquarters in Minneapolis.

The reorganization seems the result of the Krakow experiences to perhaps some significant extent. It also seems that the implementation of the concepts by Honeywell in improving the efficiency of district heating systems would have occurred ultimately, but it is clear that the DOE support given the company has been a catalyst in speeding up the process.

Honeywell offers the Polish (and Krakow) markets equipment for the exchange of heat and its control between the water circulating in the district heating system and the water circulating within the apartment blocks. It also offers equipment for in-room radiators for controlling the heat input to desired temperature levels thereby avoiding the use of open windows in the winter for this purpose.

On the Krakow market, Honeywell competes with Anderson S.A., a Swedish company which offers similar products and services, and as well with Danish Danfoss. There is also some German and French competition. It is reported that both Leg and MPEC express their satisfaction with cooperation with Honeywell. Both companies control the market and play a decisive role in the selection of equipment suppliers.

According to a quarterly progress report for the period May through July 1996, all projected activities should have been completed as of the present time (December 1996). This includes the installation of the SCADA system at Balicka, the installations for the Agricultural Academy and the Public Buildings (testing work was scheduled for the beginning of the heating season in October 1996), the substations for the hospitals, the installations at the Widok housing cooperative, and the installations sponsored by EKSA (Leg).

E. LSR Technologies, Inc.

This project was awarded on April 1, 1994 and is currently scheduled to be completed on March 31, 1998. The total budget for the two budget periods is $1,849,008, with DOE providing 50.0% ($ 924,504).

LSR Technologies did not enter into any joint-investment type of joint venture agreement with Polish companies. They reported inability to identify an equipment manufacturing firm in the Krakow area having both the competence to undertake the production and marketing of the Core Separators and the willingness to

cost-share the efforts. The Krakow area companies contacted were Aeromont, Ekopar, and ERA. In that effort, LSR had contracted with the Polish environmental organization FEWE in Katowice. They did, however, find an existing competent firm in the Poznan area, about 350 kilometers to the northwest of Krakow. They consequently terminated their contract with FEWE. The firm, EcoInstal, exhibited Core Separator equipment at the 1996 Poznan Trade Fair.

EcoInstal collaborates with LSR Technologies, Inc. under a license agreement. During discussions for a joint venture, different approaches emerged. LSR believed that investment would be needed for EcoInstal to employ computer-controlled, automated fabrication of the equipment. EcoInstal believed that Polish labor rates were too low to justify such an investment. Instead, the investments should be made toward marketing the equipment. The nature of the LSR/EcoInstal joint venture is one of licensing, rather than participation by LSR in the equity of a joint-venture firm.

Accordingly, EcoInstal's participation in the project is marketing the Core Separator, sales, manufacturing, and installation. LSR's role is primarily in technology transfer, know-how, and training. The project, which originally was scheduled over 48 months, is now expected to be completed in 40 months.

The LSR/EcoInstal Joint Venture has been able to secure contracts for the installation of 35 units, 22 already in operation and 13 expected to be in operation by March 1997. Table 1 contains a list and description of these installations. Five of these installations are located in the Krakow area. The expectation was for six installations in the Krakow area.

LSR/EcoInstal are currently submitting proposals for the installation of core separator equipment in the Czech and the Slovak republics. LSR reports that the technology has been well received in Central Europe, and they LSR expects to receive long-term royalty income through its licensee, EcoInstal.

The performance of core separators in comparison with competitive particulate emissions control devices - baghouses, cyclones, and electrostatic precipitators - is the following:

- LSR equipment demonstrates a high collection efficiency for 10-micron particles (about 96%) and an efficiency of at least 50% for particles of about 0.1 micron;
- the equipment operates effectively within smaller particle-size ranges which are not amenable to cyclones, multicyclones, and scrubbers;

TABLE 1
LSR/EcoInstal Core-Separator Installations
(Source: LSR Technologies, Inc.)

Core Separator Reference List

Installation	No. of Units	Initial Operation	Capacity (M^3/h)	Application
1. PEC Oborniki	1	4/95	10,000	WR-2.5 Stoker Boiler
2. EXBUD Tarnow	2	5/95, 6/96	5,300	Fluidized Bed Boilers
3. Kombinat RSP Czempin	3	8/95	5,600	WCO-80 Stoker Boilers
4. PEC Knurow	1	10/95	50,000	WR-10 Stoker Boiler
5. Czech Technical University	1	10/95	2,500	Fluidized Bed Boiler
6. MPK Krakow	3	1/96	5,600	WCO-80 Stoker Boiler
7. Armatura Krakow	1	1/96	24,500	WR-5 Stoker Boiler
8. Institute Non Ferrous Metals	1	6/96	12,000	Copper Smelter
9. Matizol Gorlice	2	3/96	10,000	Asphalt Plant Drier
10. Odlewnia Zeliwa	1	3/96	25,000	OKR-5 Stoker Boiler
11. Argentchem Opalenica	1	6/96	800	Smelting Furnace
12. Klimawentex Rzeszow	3	6/96	3,000	Glassmelting/Sanderdust
13. Budostal Krakow	1	6/96	21,600	Rotary Drier/Asphalt
14. Farbiarski Warsaw	1	6/96	9,000	PCO-60 Heating Boilers
Total in Operation	22		184,900	
Under Construction				
15. FIAT Auto Poland	1	1/97	140,000	WR-25 Stoker Boiler
16. Krakodlew-Krakow	1	2/97	8,000	Rotary Drier/Sand
17. Cementownia Strzelce	1	2/97	10,000	Cement Kiln Drier
18. Rzaska Krakow	2	3/97	20,000	WR-2.5 Stoker Boilers
19. Zorza Myslenice	4	3/97	8,000	KRN-1.7 Stoker Boilers
20. Zembiec Zembcu	1	3/97	35,000	Rotary Drier/Bentonite
21. PRD Kutnie	1	3/97	45,000	Rotary Drier/Asphalt
22. PZW Warsaw	2	3/97	100,400	Two Stoker Boilers
Total Under Construction	13		366,400	
Total to Date	35		551,300	

- equipment costs are nominal, operating costs are low, space requirements are low, and operational safety is high;

- the equipment is competitive with baghouses (which are more efficient in dust collection), is less expensive in capital, and is lower in operating and maintenance costs; and

- the reduction of particulate emissions by the core separator is about five times higher than in cyclones, which have been the particulate control equipment conventionally used in Poland.

F. Shooshanian Engineering Associates, Inc. (SEA)

This project was awarded on June 30, 1994 and is currently scheduled to be completed on February 28, 1997. The total budget for the two budget periods is $3,925,698, with DOE providing 50.0% ($1,962,849).

No formal joint venture was formed with any local partner for this project. However, SEA worked closely with MPEC to implement the project. The initial project director was Michael A Selig. On his resignation from SEA, he was replaced by M. Magdalena Lelek. The project directors collaborated with Janusz Mazur, MPEC's managing engineer.

The objectives of the project are

- to reduce atmospheric emissions in the City of Krakow by retiring local coal-fired boiler houses and connecting their loads to the district heating network; and

- to create a new Polish-U.S. commercial enterprise which will promote district heating as a cost-effective, marketable alternative to fossil fuel-fired heating supplied by small local boilers, and energy conservation services.

The expectation at the beginning of the project was that 18 MWt capacity would be retired in the course of the project. Presently, the expectation is that this amount will be significantly exceeded. In both cases, emission reduction and general environmental benefits were to be stressed in marketing the enterprise.

SEA is an engineering consultancy company specializing in efficiency improvements of district heating networks. It undertakes energy audits and provides training to district heat companies to upgrade their services, particularly in the area of marketing. Under the project SEA provided training to MPEC staff on marketing of energy services and worked with MPEC to bring about a

complete restructuring of the latter company. SEA also provided training in the area of implementation of capital projects.

SEA also provided assistance to MPEC by way of preparation of feasibility reports for the sites to be connected to the MPEC district heating network under the project. These feasibility reports were used to convince the boiler owners that it was beneficial for them to undertake the connection and related investments. SEA worked in close collaboration with a local Polish firm -- Polinvest -- in carrying out its project activities. Polinvest had particular knowledge of the legal and regulatory issues associated with boiler houses and district heating in Poland.

MPEC is of the view that the quality of inputs provided by SEA was excellent and it resulted in significant improvements in the operation of MPEC which in turn contributed to MPEC's program of connecting buildings presently using coal fired boiler houses to the district heating network, thereby eliminating the pollution from such boiler houses. The training materials developed by SEA was of the highest quality, according to MPEC, and it has been made available to MPEC to use in future training programs.

MPEC representatives observed that it was not the technical aspects of the connections that were a bottleneck to connecting existing boiler houses to the district heating network. Rather it was the question of convincing customers that it was in their own interest to undertake the conversions. SEA's marketing training inputs, its feasibility studies and the restructuring of MPEC brought about with SEA assistance were critical in improving MPEC's ability in this area.

According to MPEC and Polinvest the matching grant funds available from DOE to reduce the final customer cost of the connections also played an important part in persuading the owners of the boiler houses eliminated to connect to the district heating network. The financial benefits of individual connections vary greatly depending on the specifics of the site and the boiler house, and the sites converted under the project were in general not financially feasible without the matching DOE funds.

One difficulty which has resulted in some delays in implementing the project were delays in MPEC obtaining construction permits for undertaking conversion work at selected sites. It is principally because of such delays that SEA applied for a no-cost extension to the project until the current completion date noted above.

SEA played no direct part in the procuring of equipment or in constructing the connections of boiler houses to the district

heating network undertaken under the project, such work being overseen by MPEC, although such procurement costs were eligible for the DOE cost sharing. As observed above, SEA is primarily in the business of providing training/consultancy inputs to improve the operation of district heating companies such as MPEC, and in undertaking feasibility studies for energy efficiency and pollution improvements such as those arising from elimination of boiler houses by connecting them to district heating networks.

Polinvest informed the evaluation team that they are presently in the process of concluding a co-operative agreement with SEA under which the two parties would work together to continue the types of activities they had undertaken under the DOE sub-contract after this sub-contract is ended. Polinvest argues that the venture can be price competitive in the Polish market even without DOE cost sharing by carefully scheduling the use of the relatively more expensive SEA inputs to provide specific expertise as necessary.

They claim further that having a permanent presence of a US sourced SEA representative in Krakow (or Poland) -- with the attendant high US$ cost of such a representative -- is an approach which would raise costs to prohibitive levels given the potential business opportunities available to the venture at this time. When, and if, there is a significant increase in business it may be justified to have a full time US expert residing in Poland.

G. TCS, Inc.

This project was awarded on March 14, 1994 and is currently scheduled to be completed on September 30, 1998. The total budget for the two budget periods is $2,155,811, with DOE providing 48.7% (about $1,050,000). However, DOE has not yet authorized funding for Budget Period 2, and the total budget so far stands at $1,989,785.

The nature of the project is to install a 12 MW coal-limestone micronization system (on which TCS holds a patent) and a Babcock and Wilcox boiler equipped with a low NO_x burner to partially substitute for the present oil fired boilers operated by PHRO, a Polish greenhouse operating company. PHRO has available an empty warehouse for the equipment and adjacent land for coal storage. The installation will have to involve a new chimney of sufficient height, and connecting to the present hot water circulating system.

Part of the justification for the project has been to provide district heat to the adjacent town of Krescowice, replacing the coal fired boilers there. No action or plans have been put into

effect by the City administration to this effect. The team would expect this to have been done before deciding on the boiler replacement.

TCS operates out of its office in Annapolis, MD without any local partner. Communication with TCS's one potential customer - Produkcja i Hodowla Roslin Ogrodniczych (PHRO), a large company in Krzeszowice growing vegetables and plants using greenhouses - is usually through fax and visits once a quarter or so to Poland by Mr. Richard Shehan, the Vice President of TCS. The managing director of PHRO is Krzysztof Cichy. Although no joint venture has been set up to date, the final proposed arrangement for implementing the project is for PHRO and TCS to undertake new investment as equal partners in a venture setting up a boiler/micronised coal system to provide heat to PHRO (see below).

During the initial phase of the project TCS identified the boilers at the Military Unit at Balice airport as a potential candidate for replacement of its existing boilers with a new boiler and a coal micronisation system. Agreement on cost could not be reached between the Military Unit and TCS and the project site was abandoned.

Since the micronised coal system can only be introduced for very large boilers, TCS was unable to identify any other potential site in Krakow city for introduction of the technology after abandoning the Balice airport site. With the assistance of BRK, TCS then located the PHRO site in Krzeszowice even though it is outside the Krakow city. PHRO presently operates two boiler houses, one with six 4 MW firetube boilers and the other with eight 4 MW firetube boilers. On implementation of the proposed project, the new 12 MW boiler will be used in a "base load" mode with a number of the present oil fired boilers used to meet the peak demands of PHRO.

TCS submitted a preliminary proposal to PHRO in which it was estimated that the total installed cost of the boiler and micronisation plant would be approximately Zl 5 million (around $1.8 million). TCS has indicated that DOE would provide half this amount in the form of a matching grant. A detailed project feasibility has not yet been prepared. PHRO claims that they have made repeated requests from TCS for detailed numbers on which to make an assessment of the viability of the investment and that such numbers have not been forthcoming to date.

TCS has carried out tests of Polish coal and limestone at its plant in Oakland, MD, and found that they are suitable for the micronised coal boiler and that the plant would be able to meet the new Polish environmental standards to be introduced from

January 1998. TCS is presently preparing an engineering design of the plant.

PHRO and BRK informed the evaluation team that Mr. Richard Shehan of TCS had made arrangements to be in Poland in early November for the purpose of finalizing the arrangements between TCS and PHRO. BRK also informed the team that a deadline of end November has been given to TCS by the DOE by which it is required to submit detailed plans for the project including finalizing all arrangements with PHRO. The team has not heard that this deadline has been met.

Preliminary estimates by PHRO based on available information indicate that the savings in fuel and operating costs as a result of installing the plant will be around $200,000 per year. On this basis, the project pay back period after including the 50% DOE cost share would be four and a half years. PHRO has made an application, and received approval in principal, from the Polish Ecofund for a further grant equivalent to 30% of the project capital cost. With this subsidy the pay back period would be reduced to less than 2 years since the net capital cost after considering the DOE and Ecofund contributions would only be $360,000.

The proposed arrangement is for TCS and PHRO to each put in $180,000 of the net capital cost of $360,000 and become equal partners in a new venture setting up a boiler/micronised coal system which would provide heating to PHRO. The remaining funds needed for the total projected investment cost of $1.8 million would come from the DOE and Ecofund grants. PHRO is unable to provide details on how much of the total capital cost of $1.8 million is for direct management and other inputs provided by TCS and how much would be paid to Babcock and Wilcox for its boiler. It could well be that the payments to TCS exceed the $180,000 it proposes to put in for its 50% share of the new boiler/micronised coal venture and the final cash outlay of TCS is zero.

PHRO is unable to provide any schedule for completion of the project, assuming agreement can be reached between TCS and PHRO, since it is unaware of the technical aspects of the proposed boiler/micronised coal system.

Data on environmental benefits of the project are not available at this time. Estimates of these benefits should be available in the TCS report to DOE which is due by the end of November. The actual benefits will, however, be known only when the project is completed.

TCS had difficulty in coming up with the needed cost estimate for the installation, because they had teamed up with a Polish

engineering company in Katowice, which had no prior experience with boiler design or construction. TCS have now teamed up with CTI, who is doing the cost estimate - work which was started about the time of the field work by the evaluation team.

Investment requirements are expected to be in the order of $1.5 million. The financing plan currently envisaged is for USAID/DOE to put up $700,000; PHRO will put up $500,000 ($250,000 in cash and the rest in kind - boilerhouse, land, etc.). The ECO Fund is expected to put up 30% of the project, i.e., $450,000. On the basis of this plan, TCS puts up nothing.

At current fixed fuel prices for oil and coal, PHRO estimates that they will save approximately $250,000 annually by switching from oil to coal. Their current fuel bill is in the region of $1 million on a total revenue from its operations of $5 million, i.e., 20% on sales.

H. Tecogen Inc.

This project was awarded on March 1, 1994 and is currently scheduled to be completed on January 1, 1997. The total budget is $1,013,978, with DOE providing 50.0% ($ 506,989). The project was originally planned to last for one year with only one budget period. The project completion time has been extended. One reason for extensions was the length of time (about one year) taken for the formation of the joint venture company.

The organizational structure for project implementation is through a joint venture formed in Poland by the name of Ecogy. The present share holders are Tecogen Inc. (25%), the Japanese International Development Organization (JAIDO) (65%), and Nafto-krak-Naftobudowa (10%). Originally, MPEC, the state-owned Krakow district heating company, owned 5% of Ecogy's shares. Because legal restrictions arising from a recent restructuring of a number of state-owned companies (including MPEC) prevented MPEC from owning shares in other ventures these shares were purchased by Naftokrak. The total equity capitalization of the venture is approximately $50,000.

Although JAIDO, which is an arm of the Japanese government, is the majority share holder, it has no representation on the Board and Ecogy is effectively controlled by a one man Board consisting of Mr. Ron Breault of Tecogen Inc. The registered office of Ecogy in Krakow is the same as that of Naftokrak.

The key persons involved are Ron Breault, Tecogen Inc., Waltham, MA (based in Massachusetts), Zbignew Lenik, an employee of Naftokrak, who is paid by Naftokrak), Deputy CEO, Ecogy. Adam

Salitra, represents Naftokrak but has no formal position on the Board of Ecogy

The project seeks to increase efficiency and reduce emissions of coal fired boilers through the introduction of automated process control equipment and an increase in the boiler's heat transfer surface by increasing the size of the economizer.

At the start of the project, Ecogy had not yet been formed and Naftokrak-Naftabudowa worked in an informal arrangement with Tecogen Inc. to begin work on modifications to the Krzeslawice boiler house in Krakow. After some time it became apparent that a number of customers purchasing heat and steam from the boiler house were financially insolvent and that the potential financial returns available from introducing automated process control equipment at the boiler house was not justified Consequently, the project was abandoned.

Since that time, Ecogy was formed and with the assistance of BRK the Wieliczka housing co-operative boiler house -- with 4 boilers having a total capacity of 11 MW -- was identified for modernization. An agreement was signed to undertake the work in February 1996 and preliminary analyses of the site and design was undertaken by Ecogy (Naftokrak, in practice) even before formalizing the agreement. According the Naftokrak the work has however been delayed because of delays in decision making on the part of Tecogen, Mr. Ron Breault in particular, who takes all decisions for Ecogy. A decision to go ahead has been taken since that time and work can commence after the present heating season and is expected to be completed some time in 1997.

Mr. Breault makes visits to Poland once every quarter or less frequently. Since all major decisions at Ecogy are taken by him, this "remote management" of the company has had a significant negative impact on operations. The Polish partner, Naftokrak-Naftabudowa representatives, intimated that even the allocation of Mr. Lenik to work full time for Ecogy was approved by Mr. Breault only after great reluctance and much pushing by them. JAIDO has played no active part in Ecogy's operation although it is the majority share holder.

According to Naftokrak control of all finances of Ecogy is in the hands of Mr. Breault. They claim that JAIDO made available $500,000 in funds to Ecogy (outside its equity contribution) and that $68,000 of this was paid to Naftokrak for work it had done on behalf of Ecogy, $200,000 was paid to Tecogen Inc. for "transfer of technology" and it is not clear what has been done with the remaining funds. According to the Polish partner, Mr. Breault has supposedly been asked by JAIDO to come to Japan to

provide an explanation regarding these funds. MPEC states that it is unaware of any of these developments.

The Polish (and Japanese) partners in the joint venture are unaware of the details of the financial arrangements between Tecogen Inc. and the DOE and have not been provided any details in spite of repeated requests by Naftokrak.

Naftokrak representatives who are undertaking the actual work at the Wieliczka housing co-operative claim that the total direct cost of the project will be under $200,000, without including "overhead costs" attributable to Tecogen and Mr. Breault and payments for "technology transfer". They also intimate that all design and other work is being undertaken by them and that the only technological input on the part of Tecogen is the provision of a piece of technical equipment -- known as an "economizer" -- for which Tecogen holds a patent.

At the time of the team's visit to the boiler house on November 16th, 1996, an overnight data collection of performance from one of the boilers had been completed. The data were to be sent to Tecogen for the design of the SCADA. Parts for an economizer addition for the second boiler were in the yard ready to be assembled and installed.

I. Biuro Rojkowa Krakowa (BRK)

BRK, under its contract with the Brookhaven National Laboratory, has been assigned a total of 17 tasks (Section II, item 11 above). Tasks 12 through 17 apply to the work of the cooperating firms in Phase 3 of the Project. The nature of these tasks is summarized below.

- Task 12 - Analysis of Impacts of Phase III Projects This task requires the assessment of the impacts of the projects selected for Phase 3 using the Geographical Information System (GIS) data base previously developed by BRK under Tasks 10 and 11. The expected output for each project includes total emission reductions, investment cost per emission reduction, and annual capital and operating cost per emission reduction.

- Task 13 - Assistance in Emissions Reduction Commercialization This task requires BRK to provide technical, legal and financing assistance to Krakow groups -- most importantly the Phase III US sub-contractors and their Polish partners -- for the purpose of promoting reductions of emissions within the scope of the eight Phase III projects.

- Task 14 - On-site Monitoring of Phase III Projects This task requires BRK to undertake on-site monitoring of the project activities in Poland of the eight Phase III projects.

- Task 15 - Public Relations Support for Phase I Extension and Phase 3 Projects This task involves the provision of public relations/information dissemination relating to Phase 3, including the need for incentives for pollution reduction. Public opinion surveys to support the public relations campaign were also part of this task.

- Task 16 - Long-term Analysis of Phase III Project Impact on Krakow Energy Policy This task requires the assessment of how Krakow government energy policy should use the Phase III projects as a bridge to accomplish its long-term energy goals.

- Task 17 - Project Management Support This task consists of BRK management activities, including participation in review meetings and submission of progress reports to DOE.

IV. FINDINGS AND OBSERVATIONS

IV. FINDINGS AND OBSERVATIONS

In this section, the evaluation team presents its findings and observations on these findings, both of which emerge from the data and information which have been compiled in Sections II and III above and in Appendix A. Since the boundary between a finding and an observation is not a sharp one, and since observations may be made on several findings, the presentation below does not attempt to distinguish between them. Instead, the findings and observations are organized by the topical areas defined in the scope of work given to the evaluation team.

A. Results Achieved to Date

The findings and observations on the results achieved to date are discussed below under separate headings representing the nine topical areas given to the evaluation team to define the scope of its work.

1. Overall Results

On an overall basis, the Project has achieved impressive successes in a number of areas in terms of its primary objective of reducing low emissions in the Krakow area, a primary goal of the Project. At the same time, there have been some failures and perhaps some potential failures. Realistically, one should not expect perfection in the complex efforts represented by the Krakow Clean Fossil Fuels and Energy Efficiency Project

More specifically the successes and non-successes of the Project may be discussed as follows:

- **Primary Objective - Pollution Abatement**

  If the directions established by the Project activities are followed after the completion of the current Project, the use of coal in low-emissions equipment will ultimately have been eliminated completely. The open question is how long it will take to achieve this final result.

  The energy supplies will come instead from the use of natural gas, electricity, and district heat. The use of coal will then have been restricted to high-emissions equipment where emissions are more readily controlled to the desired levels. *Qualitatively* there will have been significant pollution abatement from the low-emission sources, but it will not be practical to measure this *quantitatively*.

  The reason is the clouding effect of emissions from other sources: high emissions, emissions from nearby energy-inten-

sive industries, import of emissions from the west, and the emissions from automotive vehicles. Emissions from this last source have grown enormously since the beginning of Project activities in 1991, and means to control such emissions have not yet been established in Krakow.

The development of a computerized model for estimating emissions reductions during the Phase 1 activities (see below) does provide a powerful tool whereby the emissions-reduction results of the Project activities can be estimated with reasonable accuracy. This model is currently being expanded in scope to operate as a geographical information system (GIS) and to provide for sociological factors which can be quantified.

Given this facility, it should then become feasible to estimate what the ambient pollution levels might have been had the Project never existed. Sufficient data and information now exists, which with reasonable assumptions can be used with computerized ambient-conditions modeling to predict the end result of the Project, the impact on reducing ambient pollution levels when the use of coal in low-emissions equipment will have been eliminated completely.

Nevertheless, City of Krakow officials keep insisting that, while the project was dedicated to the reduction of low emissions sources, the funds allocated to the Project have been employed largely for the purpose of subsidizing U.S. activities with little relevance to the clean-up objectives.

They have pointed out that no, or insufficient, funds were provided to address the single and most important source of low emissions air pollution in Krakow, namely the thousands of chimneys and smokestacks used by coal-burning ceramic tile stoves and small boilers in the city. The City officials are not balancing this view by the fact that the Acurex sub-project (see below) was designed to address this problem. The fact that this sub-project failed is unfortunate. That this failure could have been averted represents a failure of the Project itself.

The fact that none of the cooperative agreements addressed the conversion of the coal-burning ceramic stoves to natural gas or electricity has to be considered as unfortunate. The ponderous and lengthy procurement process and the massive size of the project opportunity notice may have been obstacles. Nevertheless, the procurement process has to be considered as having been free from bias toward any fossil energy form.

- **Secondary Objective - Commercialization and Free Market**

  The secondary objective of the Project was commercial development and fostering free markets. Eight cooperative agreements were awarded to U.S. firms for the purpose of fostering private sector development while contributing to the reduction of low emissions. Not all of the activities under these agreements have yet been completed. Two of the firms have encountered problems which make it likely that they agreements could be terminated. One agreement has already been terminated.

  Two of the firms (LSR and CTI) have established a sustainable commercial presence in Poland with activities consistent with the further reduction of low emissions. One of the firms (Honeywell) had a previous presence in Poland and was able through its cooperative agreement to accelerate its activities to promote energy efficiency in energy consumption from low-emission energy sources.

  The activities of the eight firms are discussed further below in Section 4 under the heading "Phase 3 Activities" .

2. Phase 1 Activities.

Phase 1 activities essentially began in February 1991 with the selection by the Department of Energy of its Brookhaven National Laboratory and Pacific Northwest Laboratory to undertake activities addressing the five areas agreed to between the Department of Energy and the Bilateral Steering Committee. Phase 1 activities essentially were complete with the issuance of the Phase 1 report by Brookhaven National Laboratory in June 1995. Much of the work was experimental, largely conducted in the Krakow area with local institutions on actual installations or mock ups.

With one exception, the results were achieved by the Krakow Development Office (BRK). BRK is now a private sector firm, but during much of the period it was a local government organization working with local subcontractors under Brookhaven supervision through its contract with BRK. The exception is the energy conservation topic which was undertaken by a contractor (Electrotek Concepts, Inc.) to DOE's Pacific Northwest Laboratory working with BRK collaboration.

The energy conservation work, which addressed heat savings in apartment buildings started what could be termed an avalanche of interest in continuing such activities into other parts of Krakow. The team was told in an interview with City of Krakow officials that the savings in energy consumption may have avoided the construction of another 500 MW of combined heat and power

capacity for the City of Krakow and avoidance of the emissions which would have resulted. Such a power plant could have cost as much as U.S. $750 million to construct.

The team finds that the Phase 1 activities resulted in the establishment of a data base which should have been, and likely was, fundamental to the work of the eight cooperating firms, selected as a result of the Phase 2 efforts. This data base addressed the five areas of investigation which had been agreed to between the U.S. side and the Polish side. Perhaps because of the desire for speed, the Phase 2 Project Opportunity Notice, which led to the selection of the eight cooperative agreements with U.S. firms, was issued before the Phase 1 report became available. Prospective responders to the PON then did not have the full benefit of all of the Phase 1 findings for consideration in their responses. The PON contained only the partial results which were available at the time.

An especially noteworthy result of the Phase 1 activities has been the development by DOE, from various sources, of a spreadsheet model which calculates annual costs, capital costs, and emission levels for the low emissions sources in the City of Krakow. This model operates on a personal computer with a Lotus 1-2-3 program, version as early as 2.2. A description of this program was included in the PON. It enabled the responders to forecast the emissions reductions effect of the approach incorporated in their proposals for use in the evaluation process.

Development of the spreadsheet model still continues at present. BRK has been tasked with incorporating this model into a geographic information system (GIS) so that its outputs can be displayed graphically as a map locating sources addressed in a model run. The City of Krakow has undertaken to add to the model sociological factors as far as these can be quantified or assumed. There are no details but the team believes that such consumer attitudes as balancing the value of hauling solid fuels from storage to furnace against paying higher costs for a more convenient energy source such as natural gas or electricity, could be accommodated in the model expansion.

Perhaps the most important benefit the model offers is that it appears to be the only practical way to estimate the emissions reduction effects of the Project activities. As already noted, emission levels in the Krakow area arise not only from low emissions but also from high emissions from industrial plants and power stations, from automobile and truck emissions, and through import of pollution from coal consuming areas to the west of Krakow, Katowice in Silesia for example. By inputting data from installations which have already been retrofitted with emissions reduction equipment, or have been eliminated, a calculation of

the reduction of low emissions is quickly obtained. The result can then be compared with knowledge of levels of emissions from other sources producing the ambient pollution concentrations in Krakow.

The team was also told that a genuine free market competition seems to have emerged in which the electric utility, the gas utility, and the district heating utility are competing with each to secure new customers for their services. This could serve to accelerate the elimination of coal-fired tile stoves, especially if the competition results in price reductions for the energy supplies. This competitive situation is a likely result of the project activities, i.e., it likely would not have happened without the Project.

3. Phase 2 Activities.

Phase 2 activities essentially began in February 1992, one year after the beginning of the Phase 1 activities with the planning for the first public meetings aimed at generating interest in the project opportunities represented for the U.S. private sector in commercial activities to control low emissions in the City of Krakow. These activities ended in February 1994 with the first award of a cooperative agreement to Control Techtronics Inc.

The activities were essentially directed toward procuring cooperative agreements in which DOE would cost share activities with private U.S. firms up to 50%. The objective was to secure such agreements to cover the five low emissions reduction areas which had been agreed to between the Bilateral Steering Committee and the Department of Energy. The activities were organizing and conducting two public meetings in Chicago and Washington, DC, for U.S. firms to learn the details of the Project, and in Krakow for Polish firms and organizations to learn the details, meet representatives of U.S. firms, and consequently determine their interests in participating.

The substantive content of these meetings were a draft project opportunity notice (PON) which would call for proposals for cooperative agreements to undertake subprojects in the five areas of concern for controlling low emissions. The formal PON was issued before the Krakow meeting, which added a purpose to meeting, i.e., it became also a bidders' meeting. The questions and answers generated were then issued as an amendment to the PON. Fifteen proposals were received from which eight awards were made.

The Polish side criticized the procedures employed in that there were no proposals awarded which addressed the conversion of equipment to the use of either natural gas or electricity. The

implication was that a possible bias may have existed on the part of DOE since its implementing agency, the Pittsburgh Energy Technology Center (now the Federal Energy Technology Center) was essentially a coal-oriented organization.

Inspection by the evaluation team shows that the information over the five areas was presented fairly and equitably. Procedures followed by PETC were "by the book", no discrimination was employed during the solicitation of proposals. Also, the Phase 1 report treated all five areas equitably. But, this report became available only after all awards had been made and work was well under way. The fact that no proposals were acceptable involving natural gas or electricity has to be taken as unfortunate.

The information the evaluation team has is that the Polish side of the Bilateral Steering Committee was frustrated in that the procedure between solicitation and a first award of a cooperative agreement took about a year. Thus, for the solicitation to have been reissued the project would have been delayed for an additional year. In the end, the Polish side agreed with the formal selection of the eight awards.

A possible reason for the non-presence of natural gas and electricity proposals may lie in the fact that the PON document was about 2-inches (50.8 mm) thick. It contained not only the work scopes but also the "boiler plate" and documents which reported the progress of the activities in Phase 1 for use in proposal preparation. One should expect that any firm at a given time has a number of opportunities for the development of new business through submission of proposals. The proposer usually bears the full cost of proposal preparation and submission. There is a cost associated with absorbing the contents of a massive document in order to identify a strategy for successful proposal preparation.

Proposals solicited by private sector firms generally are very simple proposal request documents. It is conceivable that many firms receiving the PON would have decided on "no-bid" after paying very little attention to the PON contents. In retrospect, it should have been helpful if the PON had been issued as two documents, one containing all reference material and the other the solicitation itself. Alternatively, the reference document could have been given afterward to those firms expressing interest in submitting a proposal. This method could have forecasted early the potential lack of gas and electricity proposals.

4. Phase 3 Activities

The activities in this Phase are more or less still incomplete. Achievement of success varies over the spectrum between total

success and total failure. The following summary of results illustrate the present status in terms of degree of successful outcomes.

Honeywell, Inc./Control Techtronics, Inc.

The two firms have completed installations at the Balicka boiler house of MPEC. Honeywell has addressed the "downstream" functions of the district heating system supported by this boiler house, i.e., improving the efficiency and effectiveness of the "demand" side of the system, while CTI has addressed the effectiveness and efficiency of the supply side through the automation of the combustion controls.

The first heating season for this boiler house in now underway. The expectation is that demand for equivalent comfort heating will decrease because of the Honeywell installations of heat exchangers in the apartment buildings, room thermostats on the radiators, and centralized measurement of heat consumption in each building. This should reduce the total quantity of coal burned at Balicka, with consequent reductions of emissions. A double benefit should be expected: one from the reduction of fuel consumed and the other from the more efficient combustion of the fuel.

Honeywell has gone on to collaborate with EKSA in its program of modernizing district heat connections to its system, which is fed by the Leg power station. Honeywell has also gone on to promote its installations elsewhere. It has a similar project in Hungary and has shown the Balicka installations to a visiting group from Bulgaria. It has also reorganized its European operations to provide a higher profile within its overall organization to the market in Poland.

CTI's completion date is December 30, 1997. It expects orders for an additional six installations in the Krakow area. CTI is also cooperating with TCS, Inc. for the conversion of the PHRO boiler houses at Krzeszowice to coal from oil. The progress of the project has been satisfactory and CTI Polska is likely to be sustainable after DOE matching funds are exhausted, particularly if it begins to search further afield than the Krakow region for its customers. CTI claims that it is developing business in Poland, other eastern European countries, and in countries of the former Soviet Union as result of its involvement in the Krakow program.

There has been a transfer of technology to CTI Polska from CTI as far as design of the automated boiler combustion control systems for specific boilers are concerned, but not in the area of manufacture of process control hardware.

This subproject has in general been successful and achieved the broad objectives of the Krakow Low Emission Project of improving air quality in Krakow and of bringing in US technology in this improvement. No specific actions need be taken in the case of this project.

On the negative side, there is one factor which is not connected with the activities and observations reported above. This is the fact that the boilerhouse at Balicka receives coal containing particles less than the minimum size of 5 mm (0.2 inch). These smaller particles appear in significant quantities. They are the most likely to be ejected from the fuel bed on the stoker grates and entrained into the gas leaving the boiler without complete combustion of the coal. This is a matter of controlling specifications in the coal fuel purchased by MPEC for this boiler house. The effect will be to increase low emissions.

LSR Technologies, Inc.

This firm has successfully completed a licensing arrangement for the manufacture of its core separator equipment with the firm of EcoInstal in Poznan, Poland. This licensing agreement has already resulted in the supply by EcoInstal and operation of 22 installations mostly in Poland and one in the Czech Republic. Two of these installations are in the Krakow area. EcoInstal currently has another 13 units on order for Polish locations, two in the Krakow area.

LSR's collaboration with EcoInstal as a licensee for its technology rather than entering into a joint venture is the result of a difference in business philosophy between the two firms. LSR had advocated an investment in computer-controlled, automated equipment manufacture at the EcoInstal facility, while EcoInstal management felt that the low Polish labor rates could not justify the investment. Rather, investment should be put into marketing.

EcoInstal exhibited the LSR core separator at the 1996 Poznan Trade Fair in a prominent fashion, with a small-sized equipment model and numerous photographs of installations. During the last day of the Fair, EcoInstal received another order for an installation.

The subproject has resulted in the introduction of a new technology for the control of particulate emissions, which is competitive with baghouse filtration technology. Each technology offers advantages with respect to lower maintenance costs and space requirement for the core separator against a marginally lower capture of the very fine particles in this equipment compared with the baghouse.

This subproject appears to have achieved total success, but still has until March 1998 for completion. A question arises as to why the completion date is scheduled so far in the future.

Shooshanian Engineering Associates, Inc. (SEA)

This firm has worked closely with Krakow's main district heating system owner, MPEC. The training provided by Shooshanian in marketing district heating, performing energy audits, and effective project management changed materially the organizational structure of MPEC.

The project inputs provided by SEA appear to have had a positive impact in accelerating MPEC's program of connecting existing boiler houses to the district heating network and in bringing about the connection of the specific sites included under SEA's cooperative agreement with DOE. MPEC is fully satisfied with the quality of SEA's inputs. The project has, however, slipped in timing because of problems with obtaining construction permits for site conversions.

SEA's consultancy services are much more costly than those of Polish consultants. As long as funds were/are available from DOE for cost sharing in boiler conversions, the cost of these consultancy services are part of the conversion costs and eligible for cost sharing. The unshared component of the costs were ultimately met by the conversion customers. If SEA is to continue in the Polish market once DOE cost sharing is no longer available, it will have to be able to find customers for its consultancy/ training services at full cost. Whether this is possible remains to be seen.

Polinvest informed the evaluation team that they are presently in the process of concluding a co-operative agreement with SEA under which the two parties would work together to continue the types of activities they had undertaken under the DOE sub-contract, after this sub-contract is ended. Polinvest argues that the venture can be price competitive in the Polish market even without DOE cost sharing by carefully scheduling the use of the relatively more expensive SEA inputs to provide specific expertise as necessary. They claim further that having a permanent presence of a US-sourced SEA representative in Krakow (or Poland) - with attendant high US dollar cost of such a representative - is an approach which would raise costs to prohibitive levels given the potential business opportunities available to the venture at this time. When, and if, there is a significant increase in business it may be justified to have a full time US expert residing in Poland.

This project has in general been successful and achieved the broad objectives of the Krakow Low Emission Project of improving air quality in Krakow and of bringing in US technology in this improvement. While there is some question of whether SEA will be price competitive in the Polish market in providing training services of the type it provided to MPEC once the matching grants from DOE are no longer available, the co-operative agreement between Polinvest and SEA could well become successful and be sustainable in the long run.

No specific actions need be taken in the case of this project.

Tecogen, Inc.

The work by this firm is at a relatively early stage. One boiler at the Wieliczka boiler house, at the time of the visit by the evaluation team, had been outfitted with additional economizer heat transfer surface and an operational test to provide data for the design of the combustion control equipment had just been performed the previous night. The parts for a second economizer were in the yard awaiting assembly and installation. The project is scheduled for completion in January 1997. It is likely that an extension will be requested. The project has received an infusion of funds from the Japanese Industrial Development Organization (JAIDO) and a joint venture formed named "Ecogy". The partners are JAIDO, Naftakrak-Budowa, and Tecogen, Inc.

The joint venture appears to be an arrangement only in name. JAIDO has taken no active role even though it owns a majority of the shares. If the claims of Naftokrak are true, the $500,000 in additional funds provided to the project by JAIDO may have been used without proper accounting and with little in terms of boiler improvements to show for it. Naftokrak is extremely dissatisfied with the present arrangements where the Tecogen member essentially operates a "one man show". It is simply a matter of time before the present arrangements could disintegrate completely.

The evaluation team has doubts regarding Tecogen Inc.'s commitment to set up any sustainable business venture to undertake process control improvements to boilers in Krakow, or elsewhere in Poland. Once all funds allocated to the project by DOE have been received by Tecogen Inc. (this project does not have a second budget period), it is likely that even the present sporadic visits to Poland by the Tecogen representative will cease.

In light of Naftokrak's claim that the total cost of the system to be introduced at Wieliczka is under $200,000, and this is the only significant activity that will be carried out under this project, it is difficult to understand the rationale for the total budget of over $1 million for the project, made up in equal

parts of $506,989 from Tecogen and DOE. Since assessment of the payments paid to date to Phase 3 sub-contractors by DOE is outside the scope of the present evaluation, it is not possible to make any judgments in this area.

It appears that a detailed DOE/USAID review of the project should be undertaken without delay. This review should include a comprehensive audit of all project related expenditures to date, particularly when such expenditures, if any, have been reimbursed by DOE or have been the reason for payment of matching DOE funds. If the review bears out the evaluation team's broad findings regarding the Ecogy joint venture and the lack of future commitment on the part of Tecogen Inc., USAID/DOE may find a need to terminate the project forthwith, or restructure it financially.

EFH Coal Company

Despite an initiation date for this subproject in May 1994, the work is still in an early stage of seeking the necessary environmental permits to enable the procurement of equipment and the construction of the facilities. The intent is to provide the markets with a washed and graded coal, sized to specifications required by the consumers. Included would be sized coal suited to the MPEC boilerhouses in Krakow's district heating systems, but the quantities required for this purpose (8% - about 80,000 tonnes) is a small fraction of the projected one-million ton capacity per year for the facilities.

Because of the small market for the output in the MPEC system, the project as now constituted does not fall within the current objectives for the Project. Moreover, discussions with EFH, the director of the coal mine to supply the EFH project, and with the Director of the Environmental Protection Department in Krakow did not paint an optimistic picture for early granting of the permits either at the local or the national level.

The current configuration of the EFH subproject does not fit into the original objectives of the Krakow low-emissions reduction program. Given that the subproject has shown so little progress since the time of its inception and that the subproject promoters do not appear to have spent much time or money on the project, the evaluation team has serious doubts about the commitment of the joint venture partners to invest substantial quanta of their own funds to the project. The are serious doubts also as to whether the subproject can ever be successfully implemented.

This subproject, therefore, appears to require a costly, large-capacity installation to provide a small quantity of specification coal to meet Krakow requirements. At the same time, it poses a large downstream risk and, based on its performance to

date, a possible embarrassment to the U.S. government of ultimate failure.

TCS Inc.

This subproject plans to install a new coal-fired boiler installation to provide heat to a major greenhouse installation outside of Krakow at Krzeszowice, about 50 km to the west. The greenhouse is owned by PHRO (Production and Breeding of Horticultural Plants, Ltd.), whose interest in the subproject is based on the savings they see from conversion to coal from their present reliance on fuel oil to fire a group of ten firetube boilers located in two boiler houses on the property. At current arbitrarily-fixed fuel prices for oil and coal, PHRO estimates that they will save approximately $250,000 annually by switching from oil to coal. Their present fuel bill is 20% of total revenues.

Something appears wrong with the concept of switching from oil to coal. KRPP "Koludnie" at Kedierzyn-Kozle, about 80 kilometers to the west of the greenhouse location, is planning to build a grass-roots oil refinery whose feasibility study was funded by the U.S. Trade Development Agency, to produce fuel oil for this regional market. It appears that no basis exists to believe that the present relationships between fixed fuel oil and coal prices will remain. Instead, it appears because of difficult mining conditions in Poland, that in a totally free market the price advantage of coal over oil can gradually disappear.

Part of the justification for the subproject is to provide district heat to the adjacent town of Krzeszowice, replacing coal fired boilers in that system. No actions or plans have yet been put into effect as of now (December 1996) by the City Administration to this effect. The team would expect that such plans would have been established before deciding on boiler replacement.

The following overall observations can be made in respect of this project:

- DOE/USAID has assigned almost $1 million to this project.
- When, and if, it is implemented it will result in the introduction of a boiler/micronised coal system which will reduce air pollution by some amount not possible to estimate at this time plus a saving in annual fuel cost.
- The total cost of the system has been estimated by TCS to be $1.8 million with a basis for estimating costs which is not known, although it is clear that the estimate has not been based on competitive bids.

- No assessment of the relative costs and benefits of alternative technologies which could have achieved the same environmental benefits has been undertaken.

- TCS has managed the project out of the US even though a presence in Poland on a continuing basis is clearly necessary. The long delays in the project can be attributed in part to this management structure. Because of these delays and lack of concrete progress, funding for TCS has not yet been approved by DOE for Budget Period 2.

- It is unlikely that even with successful implementation of the project that TCS's micronised coal technology will be a future player in the Polish market for efficiency improvement/pollution reduction in boilers.

- In view of the foregoing observations, it is difficult for the team to understand the continuing support for the project in the face of long delays in implementation.

Acurex Environmental Corporation

Of the eight subprojects in Phase 3, this one is only one not to receive funding for budget period 2. It was terminated as of March 1996. The observations related to the failure may be the following:

- The Polish side of the bilateral steering committee believed the project inappropriate because it required experimental work and was not a developed technology. Somehow Acurex failed to make it clear that the technology required the experimental formulation of a recipe suited to the particular coal to be employed, a normal empirical procedure.

- The briquets produced by Brikpol apparently were not adequately dried and the briquets failed to generate the strength needed to withstand shipping and handling before use.

- The use of a washed coal for briquet manufacture would in fact reduce the sulfur content in the briquet relevant to the coal, but well known technology exists that could have prevented a major part of SO_2 emissions during combustion, namely the incorporation of slaked lime in the recipe.

- With the emphasis on conversions to natural gas and electricity for the tile room-heating stoves in Krakow, and because of consumers reluctance to haul solid fuels from storage to stove, the market for briquets in Krakow would be a decreasing one, but over an unknown time period.

- There are no restrictions in Krakow on the quality of coal which consumers could purchase, with the result that low-cost polluting "dirty coal" is available at prices considerable below the pricing for briquets. The briquets could easily compete with the prices for high-grade coal. It appears that the City of Krakow has no legal authority to control the quality of the coal entering the Krakow market.

- the Phase 1 results show that a market for briquets would exist in fueling hand-fired boilerhouses of steel construction and the domestic tile stoves.

- USAID/DOE could have made available to Acurex the results of the briquetting work funded by USAID in Pakistan in the late 1980s which employed the same "proprietary" technology claimed by Acurex, and which incorporated lime for control of SO_2 emissions.

- Finally, Acurex appears to have had a poor public relations image. The team was told by an official in the U.S. Consulate in Krakow that his understanding was in effect that Acurex had come to Krakow and taken a good coal, added sulfur to it, and produced a dirty briquet.

Perhaps, if there had been a more-effective implementation, the subproject need not have been terminated. Brikpol plans to market briquets in the Lublin area and the Institute for the Chemical Processing of Coal at Zabzre appears ready to launch a briquet manufacturing enterprise.

Krakow Development Office (BRK)

BRK has had a continuing involvement in the Project since September 1991, is currently working on yet-to-be-completed assignments, and still has unassigned tasks scheduled for definition and release in early 1997. Thus, it had been involved and still is involved in all three Phases of the Project.

Phase 1

The work performed by BRK under Phase 1 of the Project was undertaken with the assistance of sub-contractors hired by BRK for the purposes as shown in Table 2. BRK operated under a contract with Brookhaven National Laboratory (BNL).

Over 50 separate reports were prepared by BRK and the sub-contractors covering the large number of sub-task areas. In general, BRK satisfied all of the requirements in the Phase 1 tasks listed above (and related sub-tasks). In some cases, modifications to specific sub-tasks were agreed between BRK and BNL to

reflect changes occurring during implementation of Phase 1. Table A-1 in Section 11 of Appendix A lists the tasks assigned to BRK.

Phase 1 Extension

BRK has satisfactorily performed the Task 8 activity of organizing the Krakow conference and publishing its proceedings. An implementation plan for the control of low emission pollution in Krakow city center (within the first circular ring) has been prepared. A similar plan for the area between the first and second circular rings is presently under way while a plan for the area of the city outside the second circular ring will be developed in 1997.

TABLE 2
SUBCONTRACTORS TO THE KRAKOW DEVELOPMENT OFFICE

Sub-Contractor	Area of Responsibility
Ekopol	Analysis of emissions, air quality, and associated fees and penalties.
Polinvest Ltd.	Legal and economic analyses of options and incentives
Academy of Mining and Metallurgy	Home stove combustion tests.
Energoekspert	Boiler combustion tests.
NBS	Public relations/public information campaign.
FEWE - Krakow	Installation of energy efficiency measures
Krakow Design and Research Office of Industrial Construction	Engineering analyses of options for boiler modernization.

BRK has conducted workshops in Katowice (for 400 people), Lublin (for 300 people), Nowy Socz (for 80 people) and Jaroslaw (for 30 people). in terms of its Task 9 requirements. It has also conducted 2 conferences in Rytro and another in Krakow (together with FEWE). BRK intends to conduct additional workshops/conferences in other cities in the coming months.

The data base update required under Task 10 has been completed in the case of boiler data and is being done at present 19 (November

1996) for room heating stoves. The transfer of this data base to a GIS under Task 11 is also being completed. Data are being collected for the analysis of the impact of Phase 3 projects under Task 12. Since the activities under these tasks are still under way it is not possible to comment on the work at this interim stage.

Phase 3

Under Tasks 13 and 14 BRK is basically required to provide assistance to the Phase 3 sub-contractors in various technical areas and also to monitor the performance of these sub-contractors. BRK has been providing ad-hoc assistance to these sub-contractors as and when requested by them. BRK has no formal authority to make inquiries from the Phase 3 sub-contractors whose on-site activities it is supposed to monitor in terms of Task 14. It cannot request progress reports from these sub-contractors or assess if they are on schedule or not.

In fact, BRK has no real role in monitoring, except to send a bi-monthly report to BNL reporting on what activities/assistance it has provided to the Phase 3 sub-contractors and whatever other information relating to sub-contractor activities it may have obtained. BRK's role is simply a re-active one of responding to specific requests for assistance from the sub-contractors rather than a pro-active one of trying to move the projects forward. Furthermore, it has no basis to judge if a request by a sub-contractor is reasonable or not, it must simply carry out the request to the best of its ability.

As observed elsewhere in this report, the performance of some of the sub-contractors under Phase 3 leaves much to be desired and progress in some areas has been very slow. However, BRK cannot be blamed for this. It has carried out its limited role of assistance and monitoring to the best of its ability within the framework established in its sub-tasks. The ultimate responsibility for implementing of the Phase 3 projects rests with the DOE selected US sub-contractors and their Polish partners, if any, and DOE should be the moving force to push these activities forward.

BRK informed the evaluation team that funding for Task 15 (public relations support has not yet been authorized by DOE. Given the relatively slow progress of the Phase 3 sub-contractors, the requirement under BRK's Task 16 to conduct long-term analyses on how these projects can be used as a bridge to accomplish Krakow's long-term energy goals is not relevant. Finally, Task 17 simply relates to general management and reporting relating to BRK's activities under Phase 3 of the project and this is an ongoing activity.

Bilateral Steering Committee (BSC)

The Polish side of the BSC made the following observations relating to the operations of the Bilateral Steering Committee:

- The Polish-side members are of the view that the BSC has not really been a decision making body. Instead, it merely has acted in an advisory capacity with the Pittsburgh Energy Technology Center and the Department of Energy taking all the final decisions.

  One exception to the above occurred at the start, before the Project parameters had been decided. DOE representatives were pushing for the total Project funding of $20 million to be used entirely for conducting a feasibility study of a $500 million power plant for Krakow. The Krakow mayor wrote directly to the US Ambassador indicating the objections of the Polish side to this proposal and seeking assistance to put its view across. USAID intervened in the process and the idea was abandoned.

- No formal minutes have been kept for the BSC meetings in spite of an initial request to do so by the Polish side. The DOE official, who was on the BSC and in charge of the Project, used to take drafts of minutes to the U.S. But no completed minutes (or draft minutes) were subsequently given to the members. (However, it should be noted that on occasion DOE did send memoranda which recorded actions taken by the BSC, but these did not constitute formal minutes.) The Polish side had suggested that important decisions taken at the BSC be recorded at the time and initialled by both sides. This was not agreed to by the U.S. side.

- The Polish side agreed in general with the thrust of Phase 1 of the Project.

The Polish members of the BSC made the following observations with respect to the solicitation and proposal evaluation process for selecting and awarding the Phase 3 cooperative agreements:

- The Polish side had no role in the process leading up to the bids. They were simply shown the proposals received, and that respect, only the technical content.

- When they inquired why there were no potential contractors in two of the five agreed upon areas for reducing low emissions in Krakow covered during Phase 1 -- relating to gas and electric conversions -- they were informed that there were no acceptable bids in these areas. They wondered whether the solicitation process paid sufficient attention

to attempting to attract bids in these areas. Overall, they got the impression that there was a preference on the part of the DOE for 'coal solutions' for low emission reductions.

In this respect, as discussed elsewhere in the Report, the team believes that DOE acted impartially and without bias in the procurement process. The lack of bids in the natural gas and electricity areas must be considered as unfortunate. Perhaps in retrospect, if the solicitation had been delayed until the issuance of the Phase 1 report by Brookhaven National Laboratory, and if the supporting documents in the PON had been issued as a separate volume, the outcome could have been different.

- The Polish side wanted only proven technologies to be selected for transfer to Poland during Phase 3. They observed that some of the short listed bids involved unproven technologies.

  - They observed that there would be problems with the Acurex proposal to set up a briquetting plant, particularly with environmental approvals for construction of a plant. This was ignored. (It is not clear what is meant by environmental approvals. Is this approval for the expected performance of the briquets, or approval for the briquets manufacturing plant? If the former, there appears to be justification for this view based on the results of the Acurex efforts.)

  - They wanted to make it mandatory that every US bidder must have a Polish partner at the time of submission of the bids. They were told that this was difficult to do at the bidding point and there was no such mandatory requirement in the solicitation. (The reader should refer to relevant discussion on this topic below, Section I, "USAID/DOE and Polish Issues.)

B. Project Management

The management of the Project has certainly been diffuse, at least on the surface. Throughout the six year period of the project, there has been no permanent project manager in the field, responsible for the day to day management of activities in accordance with the decisions taken by the Bilateral Steering Committee. The officials on the U.S. side, who no doubt were instrumental in shaping the nature of the Project, no longer have an involvement in the Project and were not interviewed by the evaluation team. In contrast, involvement of Polish side officials, as members of the Bilateral Steering Committee, appears to have been continuous since the inception of the Project.

Polish reactions to progress, good or bad, can be perceived almost immediately by USAID/Warsaw from reports it may have from the U.S. Consulate in Krakow or through its own efforts. In fact, USAID/Warsaw found it necessary in May 1996 to have one of its senior officers travel to Krakow and investigate the progress and results of the firms operating under the eight cooperative agreements with the Department of Energy, who produced a comprehensive written report of the situation at that time. USAID/Warsaw also found it necessary to request an evaluation of the Project, which after more than a year this report now represents.

Bureaucratically, to reach the field management, USAID/Warsaw reports to senior management in AID/Washington, which in turn theoretically passes USAID/Warsaw reactions to the Energy and Infrastructure Division in its Office of Energy, Environment and Urban Development, which then passes them to DOE/Washington, then to the Pittsburgh Energy Technology Center, then to Brookhaven National Laboratory, then perhaps (if need be) to the Krakow Development Office (BRK), the contractor to Brookhaven.

It is a compliment to this chain of command that the Project has achieved the successes that it has. Yet this chain did not prevent what the evaluation team detects as a continuing frustration on the part of City of Krakow officials, which began during Phase 2, that Phase 3 activities would not address topics in natural gas and electricity conversions of coal-burning equipment. But, in fairness to the Project efforts, the team should note here that, despite the lack of such topics in the Phase 3 activities, a healthy free market competition appears to be developing among the electric, natural gas, and district heating utilities for new customers for their respective services.

The diffuse chain of management may also account for the lack of progress in the two current cooperative agreement subprojects: that of EFH coal company; and that of TCS, Inc. Considerable budget period 1 funds may have been expended without fruitful results. Perhaps, a more direct field management may have avoided the unnecessary expenditure of funds for the Acurex subproject, or perhaps even avoided the inability of this firm to justify funding for the second budget period. The involvement of significant Japanese investment in the Tecogen, Inc. subproject, and the financial management questions which have arisen in the management of this project, is a puzzle. It seems inconsistent for this to occur within a U.S. assistance project.

The lack of permanent field management makes it even more difficult to manage the inflexibility toward meeting change which the eight cooperative agreements represent. No doubt DOE's experience with this type of agreement for activities within the United

States (the use of this type of cooperative agreement in the DOE Clean Coal Program is a good example of effective results) has been favorable. But, in a rapidly changing environment such as has existed in Poland over the past six years, the contracting vehicle must be sufficiently flexible to response to exogenous changes. The private-sector, cost-sharing approach appears to lack the flexibility to readjust the direction in mid-project as major changes in the Project environment are foreseen. It could be extraordinarily difficult to restructure the failing subprojects should USAID decide to take this course.

Although BRK is tasked with providing support to the cooperative firms, the cooperative agreements exist between the Pittsburgh Energy Technology Center and the firm, whereas BRK operates through a contract with Brookhaven National Laboratory, which in turn operates under a field work order from the Pittsburgh Energy Technology Center. It is fortunate that the personnel involved in the three organizations have worked well together, which has largely compensated for problems generated by diffuse project management.

As indicated above, BRK's role in supporting the work of the cooperative firms and their partners in the field lacks sufficient authority for it to be effective. With a centralization of the project management in the field, BRK could be effective in detecting and avoiding problems which consume the funds available to the subprojects without a product resulting.

The evaluation team was unable to find a record of minutes which were formally adopted by the Bilateral Steering Committee to represent the decisions taken during the nineteen meetings held so far since the inception of the Project. Instead, the team understands that periodically the U.S. side sent memoranda reporting decisions which were taken. The team would expect that in a project of long duration, such as this one has, a formal record of minutes from the policy-determining steering committee should have been a "must".

The Interagency Agreement left the responsibility for securing exemptions from import duties, value added taxes, and other taxes with USAID to implement. Yet the team was informed by Honeywell that they were required to pay import duties on the equipment brought under their subproject. It may still be possible for USAID or the US Embassy to recover these payments and add them to the available Project funds. Other cooperating firms under the Project may have had the same experiences.

C. Krakow Area Emission Reductions

The project clearly has reduced the low emissions in the Krakow area from installations already completed (and from installations yet to be completed through the momentum which the Project activities has generated). However, the only practical method for quantifying this reduction is through application of the computer spreadsheet model, developed as a Project result, as mentioned above. Also as already mentioned, the reason is the emissions produced from other sources, high chimneys, motor vehicle exhausts, and the pollution imported from the coal-burning areas to the west of the city.

Emissions from industrial sources decreased during the period of the Project because of the economic recession which occurred during the early years and perhaps also from installation of pollution control equipment in these industries. On the other hand, pollution from motor vehicles has increased remarkably because of the rapid increase of both automobiles and trucks in the city streets. The readings from the environmental monitoring stations in the area show the composite ambient effects from the various polluting sources.

A quantification of the polluting reduction effects from the project is certainly possible through the use of the model, but such a quantification at this time is likely to be premature. It would be necessary first to take a census of all installations which have resulted (a) from the Project activities, (b) from those installations now underway, which result from the momentum established by the Project activities, and perhaps (c) from a forecast of potential installations that can occur over time. It will also be necessary to characterize the amount of reductions in low emissions by type of installation and by the capacity of the installation. Quantification of the reduction effects is outside the scope of this Project evaluation, but such an effort is likely to be needed should it be necessary to establish the quantity of low-emissions reduction as a measure of the success of the Project.

Table 3 is a record of levels of SO_x and particulate pollution in Krakow over the period 1989 to 1996. The data are from readings taken from the City air pollution monitoring stations (installed by the U.S. Environmental Protection Agency under a different grant) and compare the results for two periods 1989-1994 and 1994-1996, which roughly correspond to the Phase 1 and Phases 2/3 periods of the Project respectively.

In the period 1989-94, before Phase 3 started, the City of Krakow reduced the emissions of particulates 74% and that of SO_2 by 61%. These reductions were primarily due to the extension of the

district heating network by MPEC eliminating hundreds of coal fired boilers and the conversion of other boilers from coal to gas.

In the second period (1994-1996) particulates were reduced by a further 9% and SO_2 by 25% of their original 1989 values, to where existing levels fall on average within allowable standards.

Table 3
Air Pollution Levels in Krakow

Date	Particulate Levels, $\mu g/m^3$	Index	SO_2 Level $\mu g/m^3$	Index
October 1989	180	100	160	100
October 1994	46	26	62	39
October 1996	30	17	22	14
Allowable	50		32	

During the meeting of the Bilateral Steering Committee in January 1997, one participant reported that visibility in Krakow had been reduced to several meters because of smoke pollution during the then current severe cold wave in Europe. This fact indicates that ambient levels of pollution depart seriously from average values and that periodic severe particulate pollution requires the elimination of coal completely from low emission sources. It also indicates the need for attention to the quality of coal entering the Krakow market.

D. Commercial Markets/Private Sector Development

These two topics are combined because of their interrelationships.

One of the objectives of the Project has been to catalyze the formation of private sector firms to seek to undertake business opportunities associated with the results of the Project. Not stated in the objective, but inherent in the policies followed by USAID since the early 1980s, is that such business opportunities would be undertaken in a free market environment. The first aspect then is the existence of markets and how free they are of constraints in serving them.

Purchase of coal by retail consumers is totally free of constraints. Low-grade, "dirty" coal is available at prices so attractive that Acurex found its briquets could not compete. The

techniques introduced there of weatherstripping, building insulation, and control of the individual heating of rooms, although not unique and strange in eastern Europe, represent at least a dissemination of technology, if not an actual technology transfer.

- The associated automation of the equipment at Balicka on the energy supply side by Control Techtronics, Inc. to provide a SCADA system represents a technology transfer. Based on the communist philosophy in a centrally-planned economy of production at all cost, managers had never placed importance on the efficiency by which the production was attained. Energy efficiency and environmental emissions had never been of any concern. The Balicka installations by CTI offer the tool whereby managers now can operate efficiently and environmentally-friendly in a competitive market-oriented economy. A similar technology transfer is like to occur when, or if, the TCS, Inc. improvement project at the Wieliczka boiler house is completed.

- The licensing of EcoInstal to manufacture the LSR core separator equipment is a dissemination of technology developed in the United States for the control of particulate emissions. Should the licensing arrangement between LSR and EcoInstal ever permit the design of an installation to be made by EcoInstal instead of LSR, a transfer of technology will have resulted. With 32 installations now on EcoInstal's books in the space of about two years, this rapid expansion of applications has to be considered as impressive.

- Shooshanian's work with MPEC was primarily in organization and administration methods, which in a way may also be considered as technology transfer, especially to the extent that computerized analysis and new computer programs have been employed. In a similar vein, the projected work by BRK to expand the computerized spreadsheet model for low emissions calculations to express output by GIS, and by the City itself to introduce sociological factors into the operation of the spreadsheet model may also be considered as a transfer of technology and dissemination of information.

The team learned from an interview with a faculty member knowledgeable of Poland's coal mining industry that coal washing and cleaning is widely practiced in Poland. Given a successful outcome of the EFH subproject, it appears unlikely that any technology transfer will have been involved.

If there is a successful outcome of the TCS, Inc. project, the micronized coal burner could represent technology transfer in

terms of burner technology in which emissions of SO_2 and NO_x are suppressed.

Some technology transfer may have occurred from the Acurex subproject. The team suspects that Brikpol's intention to market an improved smokeless fuel briquet in the Lublin area in early 1997 may involve some knowledge gleaned from its work for Acurex employing Acurex technology, but there is no proof of this suspicion.

F. Public Awareness and Participation

It should be noted that, since both the current project and the Skawina project belong to the same USAID package, to the same SEED Act, and to the same U.S. Government Agency, Polish public awareness and opinion do not differentiate between them.

Given this lack of differentiation, it should also be noted that (1) the Skawina project (whose evaluation is outside the scope of the present work by the team) started earlier with $10 million in U.S. funds, (2) the SEED Act does not restrict the allocation of the total appropriate of $30 million between the two Projects, and (3) the objective of the Skawina project has been to install a flue gas desulfurization unit in one of the units at the Skawina Station. The public is aware that the Skawina project failed to operate successfully.

In the meantime, a German firm successfully completed a similar flue gas desulfurization project at a nearby power plant at Jaworzno in record time and is using a comparison with Skawina as a marketing tool to solicit other projects. It would be ostrich-like behavior to discount the effect of the Skawina project on public awareness of success of the low emissions project.

General public knowledge of the results of the Krakow Clean Fossil Fuels and Energy Efficiency Project most likely has come from publicity in newspapers, radio, and television. The two public meetings in the United States and the public meeting in Krakow, which were aimed at the solicitation of Phase 3 proposals, and the public meetings in Krakow and Plzen (the Czech Republic) in which the Project elements were presented, informed commercial firms, ecology-oriented non-government organizations, and government organizations of the Project, its progress, and results.

From the point of view of the general public, specific public awareness programs are targeted on the younger generation. A prominent role here is played by the underfunded "Blue Thumbs" organization which sponsors educational programs in public schools and organizes various ecology-oriented public events.

The display of the measurements of the environmental monitoring station located in the public square in Old Town Krakow provides reality to what the younger generation encounters in the school.

The older generation, which lived for two generations during the almost 50-year period of communist rule, was accustomed to an economy of waste. At the time, Poland was one of the leading nations in per capita energy consumption. The consumption included huge waste hidden from public view by state subsidies.

Awareness of waste does not start with good intentions toward relieving environmental pollution, but with the pocketbook. When a household has to buy energy at market prices, it does not open windows in winter time to lower the house temperature. It turns down the thermostat instead. Before the introduction of a market economy, an average Polish household was spending no more than about 1.5% of its budget on heating, electricity, and gas. Now, six years later, the cost of this budget component has increased tenfold to about 15%.

KAPEK, the Polish National Agency for Energy Conservation, plays a leading role in energy conservation in Poland. The most visible effect of its energy conservation programs. combined with the introduction of market pricing for the cost of fuels, is a chain reaction. Less demand for energy equals less demand for fuels. Less demand for fuels equals less air pollution.

The readout from the monitoring station located in the Old Town square is in Polish and no doubt has contributed to the public awareness of pollution levels in Krakow, but as mentioned above the awareness is not specifically directed at the Project results, since these are clouded by emissions from other sources than low emissions.

Three observations on public awareness of the U.S. funding of the Project are worth noting.

- The installations at the Balicka boiler house are impressive. In an otherwise dull-gray, dim interior, the visitor sees a number of brightly colored new cabinets placed in different locations. He also see the computer monitor with its screens of various data. But nowhere is there any indication that these installations are the result of U.S. assistance.

- Honeywell has produced a video of the Balicka-related installations. The commentary accompanying the video will recognize the U.S. contribution.

- In the EcoInstal booth at the 1996 Poznan Trade Fair, the U.S. flag was prominently displayed and the participation of the U.S. firm, LSR Technologies, noted in the wall posters. The visitor from the team did not notice any obvious reference to the U.S. assistance.

G. Other-Donor Project Relationships

Other than awareness of the contribution of World Bank funds to help finance the implementation of the subprojects directed to the district heating system and the involvement of the Japanese Industrial Development Organization (JAIDO) in the Tecogen subproject, the evaluation team is not aware of any impact on Project results because of activities by other donors.

In fact, the reality is more that the coordination among various donors and lending institutions does not deviate in Poland from "traditional" cooperation standards, which could be summed up briefly as "much talk about, very little concrete action".

H. Local Government Policy and Capacity

The team believes that the local government and the voyevodship will need to address the regulations and incentives which will be needed to catalyze conversions of energy consuming facilities away from dependence on coal. Somehow legal authority needs to be obtained to regulate the quality of coal entering the Krakow market. Limiting availability to the higher priced, washed and cleaned lump coal should accelerate the conversion of tile stoves to the three optional modes for space heating: connections to the district heating system; conversions to natural gas; and conversions to electric heating.

To limit the growth of demand because of these conversions, local government and the voyevodship will need to provide incentives to encourage increases in the efficiency whereby energy is consumed, particularly for space heating. The contents of the Brookhaven Phase 1 report provide a comprehensive data base upon which the details for regulation and the nature of the incentives can be developed.

The evaluation team views the actual development and adoption of regulations and incentives as subjective to the local government authorities. These authorities would need to take account of the political and sociological factors which should be addressed during the development process. Such factors are outside the scope of this evaluation. The project has performed excellently in providing a comprehensive data base for eventual development of regulations and incentives.

The fact that the City is taking on the responsibility to apply the computerized spreadsheet model for further analysis of sociological factors in low emissions control is a good first step. The team would also suggest to the local government authorities that the Krakow Development Office (BRK), because of its deep involvement in the three phases of the Project) represents a private-sector organization with excellent support capability to the government agencies which would undertake the development. BRK also represents the institutional memory for the beneficial results so far obtained from the Project activities, especially after the Project activities have been completed.

I. USAID/DOE and Polish Issues

The evaluation team can identify issues which should be addressed and, if possible, resolved between the U.S. side and Polish side regardless of the future course of the Project.

- *Can the present bureaucratic arrangements be modified to provide a close-up project management effort in the field?*

  This is an issue whose resolution must be internal between USAID and the Department of Energy. It becomes an important issue should project activities continue or be restructured as discussed in Section IV on Conclusions and Recommendations. The only view the evaluation team can offer in this respect, is that there must be continuous close-up management in the field if the results are to be beneficial and maximized.

- *Can there exist a more patient attitude on both sides to understand from where each side is coming?*

  This is an issue whose resolution depends on taking the time for both sides to understand the constraints governing the actions of the other. It is clear to the evaluation team, for example, that DOE acted by the "book" and without bias in the selection of the eight cooperating firms. It is not clear how much effort DOE exercised to be sure this objectivity was understood and accepted without reservation by the Polish side. Given that Project activities are to continue, the exercise of patience when views differ will remain a necessity on both sides.

- *Should there be a role for USAID/Warsaw in the determination of the future of the Krakow Clean Fossil Fuels and Energy Efficiency Project?*

This is an issue whose resolution is likely to be subjective to USAID/Warsaw and AID/Washington. Nevertheless, it is clear to the evaluation team that local representatives of the U.S. Government - USAID/Warsaw and U.S. Embassy - take the brunt of recriminations which have and could continue to arise in the future concerned with the course of the Project activities. In this respect, the resolution of this issue should result in some optimum level of responsibility and authority for project management residing with USAID/Warsaw.

- *Has there been a conflict of interest in the selection of objectives for the Krakow Clean Fossil Fuels and Energy Efficiency Project?*

The evaluation team believes there has been some degree of conflict of interest between first and fourth objectives of the Project, stated in the Introduction Section of this Report as the objective of reducing pollution from low emission sources in the City of Krakow and the objective catalyzing the formation of private-sector firms to seek and undertake business opportunities in connection with low emissions reduction.

Certainly EFH is a good example of many interests existing at the same time within one organization which conflict with the main objective of low-emissions reduction and where one could question how the Project funds are employed in addressing the many interests. In this subproject, there has been a total disregard for the fact that the coal-washing technology proposed is already employed in Poland, even in the vicinity of Krakow. The cooperating firm appears to be serving its own interests by "reinventing the wheel".

Another example may be Tecogen in which the U.S. desire to be helpful in its own interest may be diluted by the infusion of Japanese capital in the efforts. Finally, by way of example, the TCS project may be implemented outside the Krakow metropolitan area for the benefit of other local interests in reducing fuel costs by converting to coal (!) rather than reducing low emissions in Krakow. Also, TCS, Inc.'s business relationships with Babcock and Wilcox seem to be the determining factor as to how the subproject would be implemented rather than an effective approach to reducing low emissions in Krakow itself.

In retrospect, and from conversations with PETC, the evaluation team believes Phase 3 could have been more effectively developed in terms of results, the satisfaction of the Polish side of the BSC, and the avoidance of an apparent conflict of interests, if the awards had been made to Polish

firms showing a sole dedication to the low-emissions reduction objective, with the funds allocated being employed solely for the purpose of hiring U.S. firms to support the efforts. This approach conceivably could have resulted in involving U.S. firms to support efforts in the natural gas and electricity topics, a lack which the Polish side has criticized.

- *Does Polish public perception that the Skawina Flue Gas Desulfurization Project and the Krakow Clean Fossil Fuels and Energy Efficiency Project may be one and the same U.S. Government assistance effort, require a closer U.S. side administration for the two projects?*

  The evaluation team was exposed to this issue during its field work, even though the Skawina project is outside the terms of reference for the evaluation of the low-emissions project. The SEED act did not distinguish between the two and, in fact, legal opinion within DOE exists that funds allocated by USAID to the low-emissions project can be transferred to the Skawina project. In fact a transfer of $646,000 has already occurred (see Section 7, Appendix A).

  Resolution of this issue should consider that, if both projects are considered as a package, the planned refurbishing of the installations at Skawina and the positive results which have been achieved for low-emissions reduction taken together could help materially to reduce prevailing negative public perceptions of the U.S. sponsored emissions reductions activities authorized by the SEED Act.

V. CONCLUSIONS AND RECOMMENDATIONS

V. CONCLUSIONS AND RECOMMENDATIONS

In this Section, the evaluation team presents its conclusions and recommendations based on its investigations and the summary of findings and observations presented in the previous Section.

A. Conclusions

There are three possible conclusions which can be drawn from the foregoing findings and observations. Each of these conclusions has positive and negative implications with respect to their practicality for subsequent actions. They are

- the Krakow Clean Fossil Fuels and Energy Efficiency Project has run its course and, although significant beneficial results for reducing low emissions have been obtained, all current activities should be terminated;

- the Krakow Clean Fossil Fuels and Energy Efficiency Project has produced beneficial results for reducing low emissions and should continue to the conclusion of the current activities within the project anticipated completion date; or

- the Krakow Clean Fossil Fuels and Energy Efficiency Project has produced beneficial results for reducing low emissions, but these results could be enhanced by restructuring, in an appropriate manner, the activities still underway and yet to be completed.

Terminate all Current Activities

On the positive side for this conclusion, the funds thereby deobligated could be combined and used for supporting the solution to the problems encountered in the sister project in Krakow, which is the reduction of SO_2 emissions from the steam generators at the Skawina power plant. The SEED Act appears to permit such transfer of funds between the two projects. The team learned during its field work that the failure of the initial installations at this station to operate reliably has been an embarrassment to the United States in Polish eyes, has focused the attention of the U.S. Embassy on this problem, and will require a significantly-large new infusion of funds to provide the remedy. It appears that U.S. Government policy is not to let this failure go without remedy.

On the positive side also, such a conclusion would avoid the expenditure of funds in the two cooperative agreements, i.e., DOE and TCS, Inc. and DOE with EFH Coal Company, which have not yet produced beneficial results after a considerable period of time and where it is not clear that these two subprojects will in fact

produce sufficient benefits from the cost to USAID. With such an action, additional funds could be released from a reduction of the scope of work which has been assigned to BRK in connection with providing field support to these two subprojects.

On the negative side, there appears to be contractual problems as to whether or not the two agreements can in fact be terminated (see Figure 1, item 23 and the discussion in Section 23 of Appendix A). It could be difficult for DOE to show that there has been non-compliance on the part of the participating firms. Moreover, the participating firms have the right of appeal from such a determination. It appears that termination may be easier in the case of EFH in early 1997 than it may be in the case of TCS. Both firms have encountered obstacles which have been beyond their control to avoid, although it could be argued that they may not have been reasonably effective in attempting to overcome those obstacles.

Finally, an abrupt termination, coming at the heels of the problems at Skawina, could compound negative views on the part of the City of Krakow and the public on the reliability and effectiveness of U.S. assistance efforts.

Continue to the Conclusion of the Current Activities

On the positive side, such a conclusion provides the least difficulty in the management of the Project by DOE and USAID. DOE could grant extensions of time, on request, until the project anticipated completion date of September 30, 1998 is reached.

On the negative side, presently obligated funds will have been spent on results which at the best are likely to be marginal with respect to reduction low emissions in the Krakow region. In addition, these funds will have been spent with advance knowledge, recognized by others, that any results of such a completion are likely to be marginal at best in effect.

Restructure the Project

On the positive side for this conclusion, the funds obligated but not yet spent are significant in amount. Restructuring the Project in the light of the experiences accumulated within the Project activities over the past six years, should enable the activities now under way to be reoriented to assure maximum benefits from the funds still remaining to be spent. Consideration could be given to deficiencies which have been noted in Section IV above. The restructuring effort could focus in part on eliminating these deficiencies to the maximum practical extent.

There is little to note on the negative side. Amending the scopes of work in the two cooperative agreements under question should pose no contractual problem since it is reasonable to expect the two firms will be cooperative given that restructuring should largely eliminate obstacles they still face. A problem could remain if the restructuring should include the cancellation of the two cooperative agreements with EFH and TCS.

Choice of Conclusion

The evaluation team recognizes that factors exist within the USAID organization which are beyond the scope given to the evaluation efforts, and which could well determine the choice which USAID decides to take. These are factors existing within the USAID administration both in Washington and in Warsaw involving policies and internal administration. There can also be influences on the choice of conclusion arising from the views and positions of the U.S. Embassy in Warsaw.

Nevertheless, the evaluation team believes that it could best serve both U.S. and Polish interests to restructure the project, and that this is the conclusion which should be drawn. Given such a conclusion, the team can offer a number of recommendations and suggestions as to how the restructuring effort should be designed and implemented.

B. Recommendations

Currently, four classes of activities are underway in the Project. These are the two sets of activities by the two cooperating firms EFH Coal Company and TCS, Inc., the activities of the Biuro Rozwoju Krakowa (BRK - Krakow Development Office), and the activities of the Bilateral Steering Committee. The evaluation team focuses its recommendations first on these four classes. Part of the intent of the recommendations is to liberate as far as practical funds already obligated for reobligation in the restructured project. One important recommendation, however, precedes.

1. Coal Quality in the Krakow Markets

Act immediately to provide the legal basis upon which the Municipality can control the quality of coal available in the Krakow markets. The action here is obviously one for the Polish side, but the restructured Project activities recommended below should provide the technical inputs required to establish acceptable coal qualities, the means to assure compliance, and the incentives to encourage purchase of high quality coal to overcome short-term disruptions in the supply of coal.

2. EFH Coal Company

The activities of this subproject should be terminated at the earliest possible date. The window appears to be the present completion date of March 1997. The certainty appears to be that this firm will apply for an extension of time. This should not be granted. This project has little, if anything, to contribute while offering a large downstream risk of possible embarrassment to the U.S. government based on its performance to date. Field activities by this firm indicate that the expenses incurred under USAID/DOE funding should be audited.

Termination of the EFH subproject will not eliminate a residual need in the Krakow Clean Fossil Fuels and Energy Efficiency Project, which is for an assured supply of specification coal to the existing boiler houses which are likely to remain in service for an indefinite period. The specifications should cover washing and cleaning to reduce the pyrite (and hence sulfur) content of the coal and the careful control of particle size between 5 mm (0.20-inch minimum and 20 mm (0.80-inch) maximum.

Steps should be taken and legal means found to establish regulations to control the supply of coal to the boiler houses to meet desired specifications. The main benefit would be a reduction in coal consumption in the generation of the heat supply because of reducing the loss of unburned carbon in the ash escaping from the boiler.

The team recommends that the Krakow Development Office (BRK) be tasked to develop a plan for the supply of such coal. Toward such an end, the evaluation team offers some suggestions for consideration in the development of such a plan.

- In a discussions with a knowledgeable faculty member at the Academy of Mining and Metallurgy, the team understands that washing and clean coal is not a strange technology in Poland. Coal washing down to 16 mm size particles is practiced by a majority of Poland's coal mining establishments. A technical problem exists with coal below 16 mm, which is difficulty to screen out the smallest particles because of high moisture content in the coal. A local coal mine, which (in translation of its Polish name) is the Coal Mining Company on the Vistula, is reported to be practicing coal washing and grading. Logic would dictate that efforts should be taken to build a specification coal supply on such an existing effort, rather than on a new one involving an order of magnitude higher production capacity than the Krakow market requires. The validity of this suggestion should be checked.

- The Krakow market for specification coal appears to be in the range of up to 100,000 tonnes annually among the boiler houses and the tile stove owners who are likely not to convert to electricity, gas, or district heating for the foreseeable future. The BRK effort should involve a market assessment, the principles for penetrating this market (including distribution options), potential pricing (which should reflect incentives which the City of Krakow might adopt in the future), the identification of suppliers willing to invest on the assurance of long term supply contracts, and the feasibility of legally controlling the quality of the coal supplied to the Krakow market.

- A coherent and well-documented outcome, coupled with funding resources identified in Section IV, subsection D, of this Report should assure implementation of the results.

3. **TCS, Inc.**

The activities in this project should be reorganized to eliminate the large investment needed just to demonstrate the TCS micronizer burner in a venue where the justification depends on savings in fuel costs by converting to coal from oil in a regime of arbitrary, rather than market, pricing of the two fuels. The requirement to build a new boiler and tall chimney, together with connections to an existing centralized heating system, and then to promote coal use rather than oil just makes no sense with respect to reducing low emissions in the Krakow area. An analogy to this situation could be, in order to demonstrate a new automotive carburetor, one must buy a new Cadillac (or Mercedes) for the purpose.

TCS, Inc. seems to have taken the course it has because of an existing business arrangement with the boiler manufacturer, Babcock and Wilcox; an illustration of the apparent conflict of objectives in the Project. Nevertheless, the equipment TCS, Inc. is offering does have merit toward the reduction of low emissions and the evaluation team offers some suggestions as to how this subproject could be restructured.

- In its paper presented at the Plzen conference (1), the TCS vice-president made some technical claims for its equipment which the evaluation team believes do have technical merit. It is useful to list these claims below for convenient reference.

  - The technology is apparently well developed and in commercial use. The paper reports about 100 units have been successfully marketed, manufactured and installed

in the United States, Canada, Europe, South America, and Israel.

- The technology comprises two equipment items: the micronizer itself which is equipped with an internal fan to provide air for conveying the micronized coal to the burner; and the burner itself. Unit sizes are shown in the paper ranging from 5 to 15 million Btu/hr (1.46 to 4.39 MWt) to 100 to 150 million Btu/hr (29.3 to 43.9 MWt). Power consumption for micronizer coal is shown as 30 HP for the smallest sizes and 300 HP for the largest sizes.

- The technology is claimed to be adaptable to a variety of different coals and to cofire with gas and oil and waste wood. Limestone is micronized together with the coal to reduce SO_2 emissions. The burner is designed to minimize excess air and reduce flame temperatures in order to minimize NO_x formation. Particulate emissions are controlled by the installation of baghouses (the core separator of LSR Technologies might find application here).

- The burner produces a shorter, more intense flame, about half the length of flames from conventional coal burners; slag and ash deposition rate on convective tube passes is significantly reduced; and the fuel ignites at a lower temperature and combustion is completed sooner.

- The advantages claimed point to an obvious conclusion for the TCS, Inc. subproject, and this is that the technology should be applicable to replace the hand-fired stokers in the boiler houses of Krakow, which are not slated for obsolescence in the near term, and which are of steel construction.

- Such a conclusion points to the prospect that the proposed installation of a new boiler and chimney at the PHRO greenhouse facility in Krzeszowice be abandoned in favor of a program to retrofit the 10 existing firetube boilers there with TCS, Inc. micronized burner equipment.

- Such a prospect would require experimentation to develop design data and generate equipment reliability experience, not too different from the boiler experimentation which was accomplished in Phase 1. It could also require the design of equipment for a slightly smaller capacity than those indicated in the TCS, Inc. paper. From inspection during the site visit, the team expects that each of the two boiler

houses could be provided with one baghouse (or core separator?) installation manifolded to the flue gas streams from the boilers.

- The above observations lead to a suggestion that restructuring the project considers the design of a program along the above lines, which should involve Brookhaven National Laboratory and the local organizations which were involved in the Phase 1 test work. The design could isolate one of the PHRO fire-tube boilers for experimentation and testing before taking a decision to retrofit the entire installation.

- The expectations are that the total cost of such a program would be considerably below that presently contemplated, that the completion time would be much shorter, and that the results would be applicable to the hand-fired boiler houses in the Krakow metropolitan area which are of steel construction.

Should the above suggestion not fly, the evaluation team would recommend that ways be found to terminate the TCS, Inc. subproject.

4. Other Subprojects

Except for LSR Technologies, the remaining subprojects (Tecogen, Inc. and Shooshanian Engineering Associates, Inc.) are scheduled for completion early in 1997; Control Techtronics, Inc. at the end of 1997. The evaluation team sees no need for any changes in these schedules. However, the team recommends that the Tecogen subproject be audited for tracking the costs associated with the use of USAID/DOE cost share of the cooperative agreement. It appears that some funds could be liberated for other purposes as a result.

In the case of LSR Technologies, Inc., this subproject has met with a large measure of success and appears to be progressing on its own momentum. The completion date is scheduled for March 1998. The evaluation team recommends that this date be reexamined with LSR Technologies to determine whether termination could come earlier.

5. Brookhaven National Laboratory (BNL) and the Krakow Development Office (BRK)

BNL and BRK represents the potential of being the institutional memory for the project activities and for the results achieved in all the three Phases. They also represents competence and experience within their staffs which have been involved in low

emissions reduction since the beginning of environmental awareness among the local population and organizations.

The evaluation team recommends that the restructuring of project activities be designed to provide key roles for BNL and BRK in backstopping and monitoring the activities planned. The BRK tasks still outstanding are likely to be required, perhaps in modified form, and new tasks could be added to extent that the recommendations and suggestions made in this section of the Report are adopted.

This recommendation should not be taken as discounting the positive managerial and technical role which has been played by the DOE Pittsburgh Energy Technology Center during the course of the Project activities.

6. Bilateral Steering Committee (BSC)

The role of the BSC should be retained, but strengthened to represent literally the "steering" function in its title. This topic is addressed below under the heading "Project Management" The evaluation team recommends that the BSC continue its consistent efforts to eliminate the use of coal in equipment representing low emissions, but at the same time recognize, as it probably already has, that this is the primary objective of the Project. The Project objective concerned with commercial business opportunities arising out of the elimination of coal-based low emissions should play an important, but definitely a secondary role, subject in all respects to the primary Project objective.

The team suggests further that the BSC, if it has not already, look forward to the period after the termination of the Project. Then, it should take advantage of the momentum and experiences generated by the project to carry forward efforts toward ultimate elimination of low-emissions coal firing. At that time, the composition of the BSC is likely to change, in name, function, and membership.

7. Conversion of Coal-Fired Equipment to Natural Gas or Electricity.

A portion of the liberated funds should be devoted to these two topics which were not reflected in the eight cooperative agreement awards. Rather than repeating the laborious PON process, which previously required a year to complete, consideration could be given to tasking Brookhaven National Laboratory and the Krakow Development Office to implement these two topics. It appears that sufficient local talent and experience should exist in Krakow by this time to avoid the need to find U.S. firms to participate. Guidance and monitoring by BRK of its subcontrac-

tors in these areas should be sufficient. If necessary, the services of U.S. firms could be procured through a grant to the municipality to fund such services.

8. Termination Conference

The team recommends that the restructured Project eventually terminate with a public conference in which the accomplishments of the project would be emphasized, as well as tasks yet to be undertaken. The team can offer suggestions as to how this conference should be organized and its substantive content.

- The tenor of proceedings should reflect the successes achieved and how they influence further efforts. For example, when the project began, the funding offered was a major contribution to the City of Krakow for environmental emissions mitigation. The present availability of funds appears to be limited more by identification of useful projects than by funding. The USAID funding may have been the stone which started the avalanche.

  Another example is the introduction to the general public of efficiency in the consumption of energy and awareness of its positive effects in meeting the rising energy prices caused by conversion to a market economy. It represents the means to avoid major sociological upsets in the population which has experienced two generations of wasteful energy consumption under the centrally planned economy of the communist governments in Poland.

- The conference management should encourage coverage of the proceedings by the press, radio, and television from all parts of Poland and neighboring coal-consuming countries as well.

- Polish ecological organizations should be encouraged to participate with papers and to state their views on the accomplishments of the Project.

- The cooperating firms completing subprojects should present non-technical and illustrated papers summarizing their activities and accomplishments.

- Krakow City and Voyevodship authorities should be prepared to, in effect, hold "public hearings" on their plans for providing incentives and establishing regulations to phase out low emissions coal consumption.

- A paper should describe the work plan to be followed upon the completion of the Project activities with the ultimate

objective of eliminating coal firing from the low emissions equipment. The paper should identify the potential players and their prospective tasks and objectives, and the project management.

- One of the major papers in the Conference should describe the role of the computer spreadsheet model in estimating the decrease in low emissions caused by the Project activities. The paper should make it clear that this method is the only way available to measure the decrease and its effects on ambient levels of pollutants because of the clouding effects of other emissions sources (high emissions, automotive vehicles, and imports from the western industrialized areas).

- BRK should be tasked to prepare a paper quantifying the then current effect of Project results on reducing ambient pollution levels and also the ambient pollution levels given the complete elimination of coal from low emission sources.

- BRK should also be tasked to quantify the reduction in demand for new energy supply from central combined heat and power stations represented by the increase in energy consumption efficiency (reduction in energy demand) resulting from the demonstration by Pacific Northwest Laboratory/Electrotek Concepts, Inc. The purpose should be to confirm the belief that such efficiency increases have avoided the construction of a new 500 MWe combined heat and power plant at a cost of perhaps U.S.$ 750 million.

- It may be prudent in this Conference to summarize the situation at the Skawina power plant in a way that avoids the floating of rumors and distortions of the actual situation at the time, especially since the public will not appreciate the fact that USAID/DOE has considered Skawina and low-emissions elimination as two separate projects.

The evaluation team believes that an effective mounting and completion of such a conference, along with publishing the Proceedings in Polish, will go a long way toward tempering negative perceptions which currently exist in Krakow of the U.S. Government assistance activities.

8. Project Management

The evaluation team recommends that USAID reconsider the methodology for managing the Project in a way to put authority where the Polish side sees responsibility for effective accomplishment of Project activities, namely with USAID/Warsaw. In this re-

spect, the team offers suggestions while recognizing that some of them could be bureaucratically difficult to accept.

- Reconsider the Interagency Agreement by converting this to a Participating Agency Services Agreement (PASA) in which the responsibility and authority for the restructured Project would lie in USAID/Warsaw. The PASA would state a termination date and the activities specified in the PASA would be designed to permit termination by that date.

- Appoint a resident project manager from either AID/Washington or USAID/Warsaw staff to undertake responsibilities and corresponding authority for the successful achievement of the remaining Project activities. A Polish speaking project manager would have a unique advantage in performing his duties.

- Arrange that the project manager reports to a reconstituted Bilateral Steering Committee and at the same time serves as its executive secretary, in which post he would be responsible for preparing minutes of meetings and arranging for the their formal adoption by the BSC. Reconstitute the BSC to have membership from USAID/Warsaw.

- Retain technical roles for implementation of the roster of activities remaining in the restructured Project by the Pittsburgh (now Federal) Energy Technology Center, Brookhaven National Laboratory, and the Krakow Development Office. There should be no need to change the contractual relationships among these organizations. Instead, only scopes of work and budgets would need to be reworked.

- To avoid counterproductive efforts, it appears useful to provide a meaningful role for the Project Manager in the Skawina Project as this may be reconstituted. The purpose would be to ascertain that ultimately the "package" of the two projects will terminate with a positive flavor.

9. Import Duties and Taxes

The team suggests that USAID/Warsaw and/or the U.S. Embassy take steps to recover as Project funds the import duties, value added taxes, and other taxes which have been paid by any of the participants during the entire course of the Project. An effort would be required here to compile the necessary documentation from all of the participants in the Project. Steps should be taken to avoid such payments in the future.

APPENDIX A. PROJECT ACTIVITIES AND DETAILS

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Table of Contents

List of Tables

The numbering of the sections below corresponds to the numbering of Figure 1 in the main body of the report. The documents consulted in the compilation of the information below are listed in Section 35.

1. Origins of Air Pollution

The origins lie in the local geography, climate, economic activity, and social customs.

The City of Krakow, which has a population of 750,000, lies in a shallow Vistula River basin, a tectonic depression, surrounded by low hills. The prevailing westerly winds have difficulty in penetrating the basin. As a consequence the interfacing thermal layers create an ideal trap for air pollutants.

The City itself consists of a medieval town surrounded by a park, which replaced the defense walls, moats, and other fortifications. It contains a first ring of post-renaissance but pre-World War I palaces, tenements, churches, and administrative buildings. Further out, a second ring contains post-World War I private housing estates and post-World War II cooperative estates. Because of the number of historical buildings and sites, UNESCO has included Krakow in its list of the world's cultural heritages.

In the early 16th century, coal-burning ceramic-tile stoves replaced the fireplace for space heating and brick or cast-iron stoves replaced the fireplace for cooking. The early 19th century witnessed the introduction of boilers (actually water heaters) for centralized, or district, space heating and manufactured town gas for cooking.

By the late 19th century, the medieval section of Krakow was covered by a network of gas pipes from the municipal manufactured gas works. After World War II, the City invested in an extensive municipal hot water distribution system, covering the outer city rings from two local power stations: Skawina at a capacity of 200 MWe and Leg at 1,400 MWe. Narrow streets made it impractical to extend the district heating system to the Old Town.

By 1970, the following energy consumption pattern had emerged:

- *Medieval City* - Coal-burning boilers for central heating; ceramic tile stoves for space heating; gas, coal, or electric ranges for cooking.
- *First Ring* - Coal burning house boilers for central heating; connections to the district heating system; some ceramic

tile stoves for space heating; coal or electric ranges for cooking.

- *Second Ring* - Small, coal burning boilers for individual houses in private estates; large boiler houses for cooperative estates; connections to the district heating system; electric ranges for cooking.

An informal 1986 census of all coal-burning boilers, stoves, and ranges showed about 4,500 boilers in 1,133 boiler houses. The medieval city contained 48; the first ring 413; and the second ring 672. In addition, the census estimated that there were about 17,000 ceramic tile stoves and another 100,000 cooking ranges.

By 1980, the City of Krakow was using about 500,000 tonnes of coal per year, most of the consumption occurring during the "official" heating season, decreed as 222 days. By 1986, the average count of particulates in the atmosphere exceeded 180 $\mu g/m^3$ compared to 50 allowed. For SO_2, the count exceeded 160 $\mu g/m^3$ compared to 32 allowed.

The quality of the air is also affected by industry (Sendzimir Steelworks, energy industry, and chemical plants), influx from the Silesian industrial region (power plants, metallurgy), and trans-boundary pollution (Ostrava - Czech Republic).

2. Environmental and Economic Awareness

While most of heavy pollution is caused by excessive concentrations of coal-burning heavy industries and environmentally-hostile large factories, environmental depredation in the Krakow region itself has been caused primarily by coal-burning domestic polluters. The pollution has taken a heavy toll on Krakow's historic limestone-based buildings and monuments and on the health of its citizens. Compared with other regions in Poland, the City residents have significantly higher levels of respiratory diseases as well as other illnesses associated with the specific pollution in the City.

The general public outcry against uncontrolled environmental depredation was picked up in 1980 by the Solidarity movement, which included a strong pro-ecological platform in its charter. In 1990, this platform was on the agenda of the Round Table talks between Solidarity and the last communist government in Poland. The outcry and protests were strong enough to stop, for example, a well-advanced construction of a nuclear power plant at Zarnowiec, near Gdansk.

In 1986, the City of Krakow established the Krakow Development Office (Biuro Rozwoju Krakowa - BRK) as a government agency, and mandated it to evaluate all known alternatives to reduce the emissions of air pollutants.

By 1989, after extensive studies, BRK had proposed the following solutions:

- Eliminate domestic boilers and boiler houses by connecting their users to the district heating system;
- Convert boilers and boiler houses outside the economic reach of the district heating system from solid fuel to natural gas or electricity;
- Convert ceramic tile stoves to electricity and adapt the municipal power grid to this purpose; and
- Promote end-use efficiency to reduce fuel consumption and to allow existing energy sources to serve more customers.

By the time this program was ready for implementation, Poland had rejected its communist government and elected the first democratic government in 50 years. The consequent impetus to convert from a centrally-planned, highly-subsidized economy to a market-driven economy led to a marked reduction in industrial activity and lack of funds for ecological purposes. The economic depression that resulted was most severe during the 1989-91 time frame.

The conversion to a market-driven economy was governed by the "Plan Barcelowicz". The economy at that time could be described as going into a tailspin. Inflation approached three digit figures and unemployment the 20% mark. Consensus by foreign businessmen, consultants and economists was that the road to recovery would be very slow and that what was needed was some transitional strategy based on western know-how.

Another characteristic of the climate at that time was the universal condescending attitude of foreign experts toward local experts. These experts came to Poland mostly with experience developed from third-world activities which could be irrelevant to a country just emerging from 50 years of a command economy. The normal result in many cases was for the foreign expert to do the job himself and to keep the Polish expert's presence and opinions at a distance. The net result in most cases could be badly formulated projects. The expression "brygada Mariotta" (Marriott's brigade) entered the Polish lexicon to describe a particularly inept consulting team.

It was in this economic climate that the initial environmental assistance efforts began following the visit of the then U.S. President Bush.

3. Visit of President Bush

This visit occurred in July 1989 and included a visit to the City of Krakow. Subsequently, in an address before the Polish Parliament (the Sejm and Senat) on July 10, 1989, President Bush committed a US aid package to assist the City of Krakow to reduce air pollution.

4. The SEED Act

The Support for Eastern European Democracy (SEED) Act, passed by the U.S. Congress in November 1989, authorized two activities for Poland related to fossil fuels and directed the Secretary of Energy to cooperate with Polish officials accordingly:

- to retrofit a coal-fired commercial power plant in the Krakow, Poland, region with advanced clean-coal technology that has been successfully demonstrated at a comparably-sized power plant in the United States;

- to cooperate with Polish officials and experts and companies within the United States to assess and develop the capability within Poland to manufacture or modify boilers, furnaces, smelters, or other equipment that will enable industrial facilities within Poland to use fossil fuels cleanly.

The Act authorized a total of $30 million for the three-year period beginning October 1, 1989

The Foreign Operations Appropriation Bill of 1990 made the funds available. Of the total amount, USAID allocated $10 million for the retrofitting of the coal-fired Skawina station near Krakow and $20 million for activities to assist in the reduction of low emissions in the City of Krakow. The latter activity later became the Clean Fossil Fuels and Energy Efficiency Project.

The SEED Act also provided an additional $5 million for parallel projects involving the establishment of environmental monitoring stations, one of which in the Krakow Old Town Square provides the public with a continuous read out of levels of a number of pollutants. The funds were also used for water treatment facilities.

In Krakow, the technical infrastructure influencing environment was decrepit. There was no money available for any pro-ecological projects. Ecology had to take a back seat. In this context,

the U.S. Presidential initiative dedicating $35 million for two ecology-oriented projects in Krakow appeared at the time like the proverbial answer to prayers.

5. Early Problems

Joint U.S.-Polish cooperation and collaboration began with a visit of a U.S. delegation to Krakow. During the discussions, two "extreme" projects arose. On the Polish side, most likely the politically-active Ecological Club, started lobbying to dedicate the entire amount of the funds to free distribution of electric heaters and ranges to Krakow's residents. On the U.S. side, the push was for a $20 million engineering study to erect a new power station to cost an estimated $500 million, a so-called third energy source which Krakow did not need.

When the situation got out of hand, the Vojevoda (Governor) of the Province sent on January 14th, 1991, a letter to the Polish Minister of Environmental Protection requesting his intervention since "the preliminary discussions with the American side are not without emotions and diverging points of view". On January 23rd, 1991, the Governor sent another letter to the U.S. Ambassador in Warsaw, requesting his assistance in resolving the issue as to how the AID-Package money should be spent.

6. USAID Intervention

Early in February 1991, the USAID Representative in Warsaw visited Krakow to arbitrate. He suggested that the Krakow Development Office (BRK) prepare for review a memorandum summarizing the Polish position. BRK had the memorandum ready by mid-February 1991. BRK identified six areas to be addressed by the U.S. funds.

- Convert boiler houses in old town area to gas.

  Old Town streets are too narrow to permit installation of district heating mains. Old Town had the piping from an old town-gas distribution system, which could be rehabilitated and have twice the distribution capacity with natural gas. The construction of a second major natural gas pipeline across Poland in the north from Russia to western Europe would provide additional royalty gas to Poland. Forty boiler houses could be converted to gas and a portion of the funds could be used to cover the costs.

- Replace coal-fueled boiler houses by connection to the district heating system.

  Of the then 1,133 solid-fuel boiler houses, about 50% were close enough to the district heating network, that they could be replaced by heat exchangers.

- Convert domestic stoves in the Old Town area to electricity.

  The substation in the Old Town area had sufficient excess capacity to convert about 9,000 domestic stoves to electricity. (According to BRK, at the time the US side had no knowledge of the nature of these domestic stoves.) It was not practical to connect these stoves to district heating. Special electricity tariffs would be organized to avoid peak use periods and two meters would be provided for each rate payer.

- Modernize outlying boiler houses to be efficient and less polluting.

  There are about 229 stoker-fired boilers from 1 to 45 MWt capacity. One of these would be modernized as a demonstration.

- An alternative fuel for those Domestic Stoves which could not be eliminated by the above actions.

  U.S. side commented that stoves in the U.S. could be environmentally-sound and efficient.

- The sixth area addressed pollution from automotive vehicles, which at the time were about 50% of the number that exist now in 1996, and 2,000 buses. U.S. side was to help reduce emissions.

After one or two months, the US side agreed to the first five activities and the Polish side agreed to drop the sixth activity.

Both sides agreed to organize the activities to result in three phases.

Phase 1. Conceptual Design

US Side would undertake technical and economic analyses for the five selected areas and perform all experimental work needed to provide the data inputs. Demonstrations in Poland would be conducted as appropriate.

Phase 2. Solicitation of U.S. firms to undertake projects related to the results of Phase 1 under cost-shared cooperative agreements.

US Side would undertake a series of public meetings to disseminate the results of Phase 1 (later held in Chicago, Washington, and Krakow), advertise the project opportunities in Poland, plan on a cost sharing effort to introduce American firms to Poland, encourage joint ventures, undertake commercially viable activities which would be sustainable after the Project was completed, and which would address all of the five areas.

Evaluation of proposals and selection of firms for negotiating cooperative agreements would be included.

Phase 3. Implementation of the Cooperative Agreements

Both side were satisfied with progress at the time. The environmental groups, however, were not satisfied with the three phases. They preferred receiving the money for hardware. The City supported the three-phase proposal as a basis to continue.

DOE requested the selection of an organization in Krakow to coordinate the implementation of the tasks which had been identified for phase 1. In April 1991, the Biuro Rojwoku Krakowa, the Krakow Development Office (BRK), was selected to work with Brookhaven National Laboratory and Pacific Northwest Laboratory, both units of the Department of Energy.

The five areas became pilot subprojects in the statement of work for the Krakow Clean Fossil Fuels and Energy Efficiency Project (USAID designation 180-0031).

In April 1991, a six-person U.S. team arrived in Krakow to establish activities, staffing, cost estimates, and schedules for what later became Phase 1 of the Project. The results of this field work were to be submitted for approval by the Bilateral Steering Committee.

7. Interagency Agreement

The SEED Act allocated the funds to the U.S. Agency for International Development (USAID) with instructions for the efforts to be implemented by the U.S. Department of Energy (DOE). Accordingly, USAID on August 5, 1991 negotiated an Interagency Agreement (IAA) with DOE, whose purpose was to define procedures under which USAID would reimburse funds to DOE "for the purpose of implementing the Krakow Clean Fossil Fuels and Energy Efficiency Project in Poland". This IAA provided for the following:

- a scope of work which encompassed the five areas defined in the activities of Item 6 above;
- recognition that the work will be performed in distinct phases of effort, Phase 1 to emphasize engineering analysis, pilot tests, and incentive analyses;
- equipment and services to be purchases from U.S./Polish joint venture organizations;
- DOE's Office of Conservation to be responsible for the area of energy efficiency and extension of the district heating system and DOE's Office of Fossil Energy to be responsible for the remaining areas;
- specified components for the work which are to be addressed as follows:
  - Engineering Analysis and Pilot Installations;
  - Policy, Regulatory and Financial Incentive Framework;
  - Private Enterprise Development;
  - Energy Efficiency Program
  - Longer-Term Options
- provided a tentative budget of $3 million for the Phase 1 work.
- stated the understanding that the funds will be used in a manner consistent with the purposes of the program;
- required DOE to enter into a Memorandum of Understanding with the Polish Ministry of Environment and with other relevant Krakow authorities, which among other things will establish a bilateral steering committee as well as the terms of the technical cooperation and the framework for overseeing the program;
- required a work plan within 45 days of the signing and quarterly progress reports relating expenditures to accomplishments;
- required USAID to seek to negotiate arrangements to avoid imposition of Polish taxes and duties on goods and services covered by the IAA; and
- specified a completion date of September 30, 1995.

The IAA was subsequently amended as follows:

Amendment No. 1	April 24, 1992	$2,500,000 new funds
Amendment No. 2	July 8, 1992	$3,000,000 new funds
Amendment No. 3	August 31, 1993	$7,000,000 new funds
Amendment No. 4	September 30, 1994	$4,500,000 new funds

The four amendments plus the original obligation in the IAA account for the total of $20 million authorized by the SEED Act.

On March 20, 1996, Amendment No. 5 was negotiated. This amendment provided for extending the completion date for the work covered by the IAA to September 30, 1998. It also recognized the obligations of USAID funds for cost sharing the eight cooperative agreements between private-sector firms and DOE as follows:

- Acurex Environmental Corporation (Durham, NC)

DOE/USAID	$ 1,210,029
Acurex	1,469,808
Total	$ 2,679,837

- Control Techtronics, Inc. (Harrisburg, PA)

DOE/USAID	$ 1,162,273
Control Techtronics	1,162,273
Total	$ 2,324,546

- EFH Coal Company (Wilkes-Barre, PA)

DOE/USAID	$ 2,700,612
EFH Coal Company	3,365,911
Total	6,066,523

- Honeywell, Inc. (Minneapolis, MN)

DOE/USAID	$ 2,462,002
Honeywell, Inc.	2,462,003
Total	$ 4,924,005

- LSR Technologies, Inc. (Acton, MA)

DOE/USAID	$ 924,504
LSR Technologies	924,504
Total	$ 1,849,008

- Shooshanian Engineering Associates, Inc. (Boston, MA)

DOE/USAID	$ 1,962,849
Shooshanian	1,962,849

- TCS, Inc. (Annapolis, MD)

DOE/USAID	$ 969,939
TCS, Inc.	1,184,872
Total	$ 2,154,811

- Tecogen, Inc. (Waltham, MA)

DOE/USAID	$ 506,989
Tecogen, Inc.	506,988
Total	$ 1,013,977

The obligations represented above total $ 11,899,196, or 59.5 percent of total USAID funding.

Amendment No. 5 also recognized other budgeting as follows:

- Phase 1 activities $ 5,500,000

- Brookhaven National Laboratory including the allocation to the Krakow Development Office (BRK) $ 1,095,000

- Initial Scoping Analysis, prior to the negotiation of the IAA $ 400,000

- Reserve for travel and management $ 459,804

- Undefined allocation to the Skawina Program, which apparently the authorizing legislation (Section 4 above) permits $ 646,000

The above obligations and budget allocations account for the entire sum of $20,000,000 at the time Amendment No. 5 was negotiated.

8. Memorandum of Understanding (MOU)

On October 16th, 1991, the U.S. Secretary of the Department of Energy and the Polish Minister of the Ministry of Environmental Protection, Natural Resources, and Forestry signed a Memorandum of Understanding (MOU). The objective of the MOU was to establish a framework for collaboration between the parties in order to promote the implementation of the five pilot projects to demonstrate a free-market approach to decreasing the levels of air pollution in Krakow. The MOU provided for the following:

- recognized the three phases of activities as a basis for proceeding with the project;

- specified the supply of equipment and services on a free-market basis;

- established a bilateral steering committee of eight members, four from each side, to oversee the work;

- included the participation of Vojevodship of Krakow and the City of Krakow in the activities; and

- protected intellectual property rights.

9. The Bilateral Steering Committee (BSC)

The MOU established the Bilateral Steering Committee as comprising eight members; four from the Polish side and four from the U.S. side. The BSC was to oversee all three Phases of the Project and to coordinate with related projects funded from other sources. Four of the members were to be designated by the Ministry of Environmental Protection, Natural Resources and Forestry (MOEP) and four by the Department of Energy.

The Polish representatives were selected from the MOEP, the Office for Environmental Protection for the Krakow Province, and from the City of Krakow itself. The U.S. representatives were selected from the Department of Energy and from USAID. The BSC was to meet as required and to alternate meeting sites between the U.S. and Poland. The chronological history of meeting dates is shown in Figure 1 in Section II of the main body of the evaluation report, to the extent that information was available in the sources investigated. It is clear that the BSC existed before the MOU. It appears that three BSC meetings were held before the date of the MOU. The membership of the BSC most likely was different before the MOU was negotiated.

There is no record of formal minutes of BSC meetings. However, there is correspondence from DOE to the BSC summarizing decisions taken at meetings. Such correspondence occurred in many cases, but is not clear that this practice was followed completely nor that they constitute formal minutes for the record.

10. DOE Responsibilities Delegated (Phase 1)

The statement of work in the MOU recognized the five areas to be addressed for reduction of emissions and stated them as follows:

- Energy Conservation and the Extension of the District Heating System;

- Replacement of Coal and Coke Fired Boilers with Natural-Gas fired Boilers;

  This replacement would primarily occur in the Old Town.

- Replacement of Coal-Fired Home Stoves with Electric Heating Appliances;

- Reduction of Emissions from Stoker-Fired Boiler Houses; and
- Reduction of Emissions from Coal-Fired Home Heating Stoves.

DOE delegated most of its responsibilities under the MOU to its Pittsburgh Energy Technology Center (PETC - Now the Federal Energy Technology Center, incorporating the Pittsburgh and Morgantown Centers) to serve essentially as the project management under the terms of the MOU. PETC in turn arranged for the work in four of the five areas comprising Phase 1 to be performed by the privately-managed Brookhaven National Laboratory, under field work proposal by BNL dated April 22, 1991.

DOE delegated its responsibility for the Energy Conservation and Extension of the District Heating System area to its Office of Conservation. This office in turn delegated the work to the Pacific Northwest Laboratories (PNL). PNL, in turn, delegated the responsibility to Electrotek Concepts, Inc.

11. Krakow Development Office (BRK)

Brookhaven National Laboratory's Division of Contracts and Procurement awarded a sole-source contract to the Krakow Development Office on February 11, 1992 to undertake specific tasks related to the five areas agreed to in the MOE/MOEP Memorandum of Understanding (Section 8 above). These tasks were organized as seven subprojects, comprising the Phase 1 effort defined in the MOU (Section 8 above), as follows:

1. Extensions to the heat distribution network and replacing locally operating boilerhouses.

   This subproject was excluded from the BRK contract, since the responsibility had been delegated to Pacific Northwest Laboratory. (See Section 12 below.) However, BRK was to provide full support as appropriate.

2. Elimination of solid-fuel boiler houses situated within the Old Town by converting them to Natural Gas.

3. Necessary construction works to implement conversion of heating in selected parts of town to electric energy from the main power supply station "Lobzow".

4. Modernization of present technological boilerhouse at the Main Supply Base in Krakow-Nowa Huta at Makuszynskiego Street.

5. Introducing efficient, modern coal stoves instead of traditional ceramic stoves.

6. Public Relations

Inform the public about the project, showing advantages of low emission sources and improved fuels.

7. Cooperation with U.S. Department of Energy

Cooperate with DOE in accomplishing and managing work performed in this project.

The justification for the sole source contract was the fact that BRK had been delegated by the City of Krakow to undertake relevant work previously and, as a Polish government organization at the time, had predominant capability and field presence for the tasks to come.

Authorization to begin the work was made retroactive to September 20, 1991. Completion of the work was scheduled for July 31, 1993. Brookhaven was required to provide specified test equipment and to undertake and complete a boiler modernization study by September 30, 1992.

Through a purchase order dated September 2, 1994, Brookhaven National Laboratory awarded two additional tasks (8 and 9) to BRK and extended the completion date to June 30, 1996.

8. Conference on the results of Phase 1.

The Conference was planned for October 1995 to be conducted in Krakow. The objectives were to communicate the results of the Phase 1 work, to identify institutional issues for the future, and to identify technical issues where appropriate. Papers were to present positions of the participants as well as the results from the Phase 1 work. The proceeding were to be published both in Polish and in English as a deliverable.

The task also included the preparation of an implementation plan for the control of pollution from low emission sources. The plan would include the results of the Phase 3 projects in terms of reduction of emissions and identify incentives needed to accomplish the reduction. Activities to be implemented were to encompass infrastructure improvements, technical solutions appropriate to the different sections of Krakow; needed support for subsidies; tax relief; new taxes; new emission control regulations; development of a time table; and development of a schedule of costs to the city and to the utilities. The user-friendly spreadsheet model developed in Phase 1 was to be combined with a geographical information system (GIS) and the combination used to display

the results of the planning effort. The detailed plan for addressing the low emission sources was to be a deliverable.

9. Workshops for other Cities.

The objective of this task was to transfer the results and the experiences in the Krakow project to selected cities (up to 10) in Poland and to report on the applicability of the results and experiences to these cities. The mode of accomplishment was to be a workshop in each case with the appropriate officials. A report for the results in each city was to be a deliverable.

Through a purchase order dated March 8, 1995, Brookhaven National Laboratory awarded three additional tasks (10, 11, and 12) to BRK. The completion date remained June 30, 1996.

10. Data Base Update

The objectives for this task were to update the original data base on the population of low emission sources to reflect the changes resulting from the project activities in terms of fuel type, annual fuel consumption, capacity, equipment type and age, pollution control equipment, emissions based on Phase 1 test results, ownership, and other parameters; and to develop a method for updating the data base on a continuing basis. The work was to include a proposal for a mechanism for continuing the effort past the completion of the Project. The deliverable was to be the completed surveys in data base format and a report summarizing the characteristics of the population of boilers and stoves.

11. Transfer Data Bases to Geographic Information System.

The objective of this task was to transfer the data bases to a geographical information system which could rapidly produce maps spatially illustrating fuel use, emissions, source type, and other relevant details. The deliverable was to be the completed computer files and a report demonstrating the capability of the completed system.

12. Analysis of Pilot Activities

The objectives for this task are the identification of candidate options for reduction of low emissions based on the pilot results from Phase 1 and their evaluation for decision makers in terms of showing, for each candidate, the distribution of reduced emissions and possibly the corresponding investment cost distribution. For each candidate

further, output spreadsheets were to determine (i) total emission reductions, (ii) investment cost per emission reduction, and (iii) total capital and annual operating cost per emission reduction achieved. The deliverable was to be a report on the results.

Through a purchase order dated August 9, 1995, Brookhaven National Laboratory awarded five additional tasks (13 through 17 inclusive) to BRK. The completion date was extended to December 31, 1997. The objectives for these tasks were the following:

- provide information and analytical support for the purpose of assisting the eight commercial ventures in Phase 3 (i.e., the eight DOE cooperative agreements) to be realized;
- identify attractive sites for replicating Phase 3 projects (undertaken by the eight firms) and assist U.S. firms with implementation;
- serve as a repository of information on the techniques and data acquired by the project so that it can be made available (through reports and participation in seminars) to other cities;
- conduct analyses to provide a basis for integrating the Krakow program into the long term energy policy of the City; and
- perform monitoring of activities for each of the eight projects.

The five tasks were the following:

13. Develop and Implement an Emissions Reduction Commercialization Assistance Program

    Under this task, BRK was to provide technical, legal, and financing assistance to Krakow groups for the purpose of promoting the reduction of emissions within the scopes for the eight cooperative agreement projects negotiated by DOE. Activities undertaken under this task were to be designed as "models", showcased to promote other conversions. BRK was to retain the services of (i) a lawyer who can write and interpret appropriate statutes and regulations; (ii) an economist to conduct cost/benefit analysis; (iii) an investment specialist in municipal financing; and (iv) a housing policy/management specialist.

14. On-Site Monitoring

Under this task, BRK was to provide on-site monitoring of project activities in Poland for all eight cooperative agreements and report to the DOE project officer through BNL.

15. Public Relations Support for Phase 1 Extension and Phase 3 Projects

Under this task, BRK was to disseminate information on the progress of the Phase 3 activities; undertake public opinion surveys; and publicize the results of incentives analyses to relevant political bodies in the Krakow region.

16. Long-Term Energy Policy Analyses

Under this task, BRK was to conduct long-term energy policy analyses based on the results of the eight cooperative agreement projects in terms of long term energy goals.

17. Project Management

This task covers BRK's project management activities in conjunction with the tasks outlined above, participation in review meetings with BNL/PETC, submission of monthly progress reports, conducting relations with subcontractors, and general planning activities.

Budget allocations given to BRK, and the status of the work as of the March 8th, 1995 BNL purchase order, in connection with the implementation of the above tasks are shown in Table A-1. As shown in the Table, the total obligated by Brookhaven National Laboratory to BRK for the sixteen defined tasks as of the time of the purchase order, dated August 8, 1995, is accordingly $1,591,920.

As of the date of this evaluation report, December 1996, the status of the tasks shown in Table A-1 as pending or to be determined, and corresponding additional financial commitments are as follows:

13. Develop and Implement an Emissions Reduction Commercialization Assistance Program

The applicable components are Subtask 13.1 (Modify the recently modified spreadsheet by Gibert Commonwealth, to make it specific to Krakow data and available information); Subtask 13.2, Part 2 (Develop model conversion

TABLE A-1
BRK BUDGET AND WORK STATUS DATA
(Source: BNL Purchase Order dated August 8, 1995)

Task	Budget	Status
2	235,500	All work completed
3	132,950	Expected total completion, 12/94
4	286,545	Expected total completion, 12/94
5	138,725	Expected total completion, 12/94
6	47,500	Expected total completion, 12/94
7	248,000	Expected total completion except for project management functions related to other tasks, 12/94
8	215,000	Expected total completion, 6/96
9	28,600	Expected total completion, 6/96
10	39,100	Expected total completion, 6/96
11	35,000	Expected total completion, 6/96
12	35,000	Expected total completion, 6/96
13	*120,000	Some components awaiting funding, expected completion funded work, 6/96
14	*17,000	One component awaiting funding, expected completion funded work, 2/96
15	**	All components awaiting funding
16	**	Awaiting funding
17	13,000	One component awaiting funding, completion of other component, 2/96

* Task is pending, awaiting funding
** Nature of Task to be determined.

projects); and Subtask 13.3, Part 2 (Support to assure compliance with Polish building codes)

Subtask 13.1 BRK has not yet been authorized to start this subtask. BNL expects to authorize the work in the first quarter of 1997. The update of the boiler population survey is now being completed and this will be used as an input to this subtask.

Subtask 13.2, Part 2 BRK has not yet been authorized to start this subtask. BRK expects to authorize this task in the first quarter of 1997 in a modified form with a reduced budget, which is expected to be in the range of $80,000 to $100,000. The reduction actually will apply over tasks 13 through 17. The scope of work will be redefined as necessary.

Subtask 13.3, Part 2 BRK has not yet been authorized to start this subtask. BNL expects to authorize this work in the first quarter of 1997. The subtask includes support to Phase 3 contractors on issues relating to building codes. The TCS project would be an important example of the utility of this task.

14. On-Site Monitoring

The applicable component is Part 2 (The division of this task into two parts is not specified in the BNL Purchase Order dated August 8, 1995. This Part is subject to redefinition at the time the work is authorized, expected to be in the first quarter of 1997. This is a very general task in which BRK is to keep BNL and DOE informed of progress and issues related to phase 3 projects.

15. Public Relations Support for Phase 1 Extension and Phase 3 Projects

The three components of this task are Subtask 15.1 (General Public Relations); Subtask 15.2 (Public Opinion Surveys); and Subtask 15.3 (Coordination with the eight cooperative agreement firms to identify incentives). All three components are pending in the Purchase order document.

All three components are expected to be authorized in the first quarter of 1997. Prior to authorization the work will be redefined. The intention is to publicize successes which have been achieved to date in the program and evaluate changes which have occurred in public opinion relative to air pollution sources since the survey conducted in Phase 2 (see Item 15 below). A part of the work (subtask 15.3) is

intended to promote actions on incentives which would advance the project goals.

16. Long-Term Analysis of Krakow Energy Policy

BNL has not yet authorized BRK to undertake his task. BNL intends to authorize this task in the first quarter of 1997. The output of this task will be a final report, prepared jointly by BRK and BNL, summarizing the results of all current work and the positive benefits of the Phase 3 projects.

17. Project Management

The purchase order document does not define the two parts for this task, and shows Part 2 "to be defined". These two subtasks are general and include participation in review meeting, submission of monthly progress reports, management of subcontractors, and general planning activities. The structure of the BNL/BRK contract provides for setting aside a portion of the total funds for these purposes.

Accordingly, the additional funding provided to BRK for completion of the remaining subtasks is not yet clear.

12. BNL Section 2.0 Activities (Boiler-Stove Performance)

Reference to "BNL Section" here and below means reference to the Phase 1 Report issued by Brookhaven National Laboratory. As explained in Section 20 below, the Phase 1 Report represents the results of team efforts.

The scope of the work in Section 2.0 activities covers the performances of traditional Polish heat-storage stoves, manually coal-fired, fixed grate boilers, and stoker-fired, moving-grate boilers.

Heat Storage Stoves

This area dealt with the performance of traditional Polish heat-storage stoves built of brick and covered with ornate ceramic tiles. These stoves are fired once or twice daily during the winter. The room is heated as the masonry in the stove slowly cools.

The specific objectives of the test work were the following:

- to determine the efficiency of the stove with various fuels;
- to establish pollution-emission factors for various fuels;

- to determine the optimum procedure for firing the stoves to increase their efficiency (and reduce emissions) without modifying the stoves construction; and

- to evaluate whether small changes in construction could improve the combustion process.

The work was performed on a fully instrumented stove built in the laboratory of the Academy of Mining and Metallurgy in Krakow. U.S. practices were used in the testing procedures. The operating procedure was designed to reflect closely the typical firing of a home stove during a 24-hour period.

Seven different fuels were employed in the test program, ranging through high-quality Wujek hard coal, low-quality Boleslaw Smialy hard coal, dry-quenched coke from the Przyjazn Cokery, smokeless briquettes manufactured by the Institute for the Chemical Processing of Coal at Zabrze, and briquettes made of wood waste. Sulfur content of the coals were as high as 0.59% and as low as 0.29%. The two samples of Zabrze briquettes showed 0.34% and 0.22% sulfur. The coke showed 0.50% sulfur, while the wood-waste briquets, of course, were sulfur free.

The general conclusion which could be drawn from the results of the test work was that the low-volatile fuels (the coke and briquettes) had the lesser emissions, or better environmental performance, with the briquette performance depending on operating procedure. The potential reduction in emissions from the population of coal stoves was found to be significant either from the use of briquettes or from coal with improved operating procedures.

Fixed-Grate Coal-Fired Boilers

Two different types of boilers were tested; one of steel and the other of cast iron construction.

Steel boilers are periodically, manually-charged with coal onto a fixed grate in the furnace. The water being heated flows outside of a bank of tubes through which the hot combustion gases pass, the usual configuration for a fire-tube boiler. The cast-iron boilers are built in cast sections with the water contained in the section and the combustion gases flowing around the sections. The outer surfaces of the cast sections have pins or fins included in the castings to improve heat transfer. The capacity of such a boiler can be adjusted in the factory simply by adding or removing sections.

The steel boilers were designed to burn coal with particle sizes from 16-125 mm. Operations are visual and entirely under the

control of the operator. The cast iron boiler was designed to burn coke of particle sizes from 25-125 mm. The instrumentation provides only for temperature measurements of the water circulating through the boiler and for indications of pressures.

The objective of the test work was to determine the boiler system efficiency and particulate and gaseous emissions depending on the kind of fuel burned; manner of combustion; thermal load; and quantity of air supplied during combustion. For the cast-iron boilers, the fuels tested were coke from the Sendzimir Steelworks, 50/50 mixtures of coke with coal from the Ziemowit coal mine; and briquettes manufactured by the Institute for Chemical processing of Coal at Zabrze. For the steel boilers, the fuels tested were the normal Halemba coal from Katowice; a 70/30 mixture of coke with coal from the Ziemowit coal mine, and Zabrze briquettes.

Two methods of operation were employed. One was the normal periodic feeding and the other was a measured rate of manual feeding with layering of the coal in the furnace accompanied by control of the secondary combustion air admitted over the burning bed. This method requires more frequent additions of coal.

The results indicated the following:

- Coke is the best fuel for the cast-iron boilers of the design tested. Emissions can be significantly reduced by regulating the input of secondary, overfire air, particularly at the beginning of the firing cycle;

- Burning fuel in layers did not yield good results, neither in terms of efficiency nor in emissions of pollutants;

- While coke has a large advantage in terms of particulate emissions, it has the disadvantage of a high sulfur content which caused high sulfur dioxide emissions; and

- Briquettes appeared to be the best fuel for the steel boilers, showing the highest efficiencies with the lowest emissions of gaseous pollutants and particulates; and could be a better option for the cast-iron boilers providing special attention is given to the operational procedure.

In comparison with the operations of stoker-fired, moving grate boilers (see below), emission reductions and fuel-related costs, in relation to a baseline of 100% for the Balicka boiler tested, were found to be higher regardless of the fuel type supplied.

Stoker-Fired, Moving-Grate Boilers

These boilers are continually fed with fuel at a measured rate. The coal discharges onto a grate which moves slowly across the length of the furnace, where the burned coal, now ash, is discharged. Openings are provided in the grate for the flow of combustion air through the burning coal bed. Secondary (overfire) air can be admitted over the bed. The combustion gases pass through the spaces between banks of tubes, within which the water being heated passes, the usual configuration for a water-tube boiler. The boilers are backed up by a battery of cyclones for limiting particulate emissions in the combustion gases.

The work included testing the boilers in two boiler houses; Balicka and Krzeslawice. The capacity of the Balicka boiler is 10 Gcal/hr (396.8 million Btu/hr); and that for the Krzeslawice boiler, 2.5 Gcal/hr (99.2 million Btu/hr).

The objectives for the testing program were to establish the baseline performance of the boilers and to determine how their efficiency and the emission of particulates and gases change depending on the type of fuel fired, the heat load on the boiler, and the excess air.

The boilers were tested with a variety of coal-supplies ranging from a "coal duf" having particle sizes down to less than 0.385 mm to a pea-sized coal whose minimum particle size was 3 mm. Two samples of a semi-coke were also employed. Unlike the hand-fired boilers, the stoker-fired boilers operate under steady conditions with distinctly different combustion reactions occurring in five zones along the moving grate until the coal is completely burned out. Since combustion air is supplied through the moving grate in zones, distribution of combustion air over the coal bed occurs by control of the combustion air supplied in each zone. None of the boilers tested had monitors for flue gas composition or for pollutant emission rates.

The results of the test work showed difficulty in controlling excess air which reduces thermal efficiency and increased the consumption of fuel. Gaseous pollutants depended on the type of coal supplied. Grate speed had an effect on the combustion pattern along the grate. An obstacle to the test work at Balicka was inability to control the inlet damper to the induced draft fan. This caused high, uncontrollable draft levels in the furnace, excess air leakage into the furnace, and low efficiency.

With the operational cost for fuel-supply-related items for the Balicka unit taken as the baseline of 100%, the test results showed that selection of the coal source and type could reduce costs to as low as 79% and emissions to one half. In another

case of fuel sourcing, the cost could be reduced to 85% with emissions reduced again to about one half. For the Krzeslowice boiler the nature of the findings was analogous.

13. BNL Section 3.0 Activities (Engineering Investigations)

This work is reported in Section 3.0 of the Phase 1 report (see Section 20 below). The scope of this work, under the generic heading "Engineering" covers investigations in six different areas as follows:

- Extension of the District Heating System (which was led by PNL with work done by BRK);
- Conversion of Solid Fuel-Fired Boilers to Natural Gas;
- Conversion of Coal-Fired Home Stoves to Electric Heating;
- Conversion of Coal-Fired Stove Heating to Natural Gas-Firing;
- Modernization of the Krzeslawice Boiler House; and
- Solid Fuel Supplies in Krakow.

Extension of the District Heating System

Krakow's district heating system is extensive and has been in operation since the late 1950s. It is supplied by thermal energy from three sources: the Leg Combined Heat and Power (CHP) plant with a heat supply capacity of 1,460 MWt; the Skawina CHP with a heat supply capacity of 220 MWt; and the CHP plant of the T. Sendzimir Steelworks with a heat supply capacity of 36 MWt. The total is 1,716 MWt. The network of pipes is about 630 km in length.

In addition, there have been 789 boiler houses within the range of the municipal district heating system. These have had a total combined capacity of 769 MWt. Of the total, 635 boiler houses could be eliminated by connecting their systems to the municipal network, and, during the period of this analysis, 20 of these boiler houses, capable of 30.8 MWt, were connected to the network.

As of 1992, the expected demand for district heat from an expanded system was estimated to total 2,291 MWt. BNL investigated three options for the expansion of the system which could bring the total supply up to about 2,050 MWt. These options included laying new pipelines, constructing new pumping stations, and adding new heat turbine to the power stations. Two options

showed an investment cost of about U.S.$ 59 million and one option of about U.S.$ 90 million. Five regions were identified as priority regions for eliminating boiler houses by connection to the municipal district heating system.

One significant result was that reducing the heating requirements for district heat-supplied buildings will enable the existing district heat system both to serve additional customers without constructing new heat sources and to eliminate local boiler houses on the district heat system.

Conversion of Solid Fuel-Fired Boilers to Natural Gas

Natural gas has only been readily available in the Krakow area since the late 1980s. With introduction of a market economy in the early 1990s, energy prices were increased and limitations ended on the use of natural gas for individual heating systems in apartments. Natural gas is supplied to Krakow via four high-pressure pipelines running east to west, flanking the peripheral parts of town and feeding pressure reducing stations.

The Gas Utility Enterprise of Krakow is the distribution utility. It is a public enterprise subordinated to the Minister of Industry. The prices for gas are fixed by the Ministry of Finance.

Three technical studies were undertaken for converting solid fuel boiler houses to natural gas:

- the conversion of solid fuel-fired boiler houses to natural gas in the Old Town part of Krakow;
- the conversion of boiler houses and home stove-based heating systems to gas within the "second ring" road; and
- the possible adaptation of the distribution network for natural gas in the City of Krakow to meet an increased demand for gas for heating purposes.

The studies showed that there were 48 solid-fuel boiler houses within the Old Town area, with a total output of 18.6 MWt consuming 4,562 tonnes of fuel per year. Five of these were eliminated during 1990 and 1991. BRK developed detailed designs to convert 20 of these boiler houses with a total of 16.3 MWt capacity, and estimated costs which covered the conversions itself, the construction of needed pipelines, and modernizing an existing pressure reduction station.

The conversions costs were estimated at U.S.$ 1.9 million and the balance of pipeline construction and pressure reduction station

modernization at U.S.$ 0.9 million. Natural gas demand would increase by 1,500 Nm^3 per hour (53,000 scf/hr).

The area between the first and second ring roads had a large concentration of boiler houses, 339 with a total capacity of 137.5 MWt; and about 47,000 home heating stoves. Assuming that the boilers out of reach of the municipal district heating system would be converted to natural gas, 195 candidates were identified with an aggregate capacity of 95 MWt. Natural gas consumption would increase from 7,000 Nm^3 per hour to 19,000 Nm^3 per hour (247,000 to 670,000 scf/hr).

To feed such a system, the system of medium and low pressure pipelines would have to be extended, new pressure reduction stages would have to constructed, and existing stations modernized. The capital cost was estimated at U.S.$ 12.5 million.

The third natural gas topic concerned adapting the municipal gas distribution network in Krakow to satisfy the increased demand for gas for heating. The work considered two options:

- Option I. Expansion to be limited to 744,000 residents and selected technological boiler houses (i.e., not those which supply steam to industry and cannot be converted) outside the second ring road.

- Option II. Expansion to be limited to 928,000 residents (as estimated in the 1990 urban development plan for Krakow), and all technological and peripheral boiler houses.

Under Option I, the natural gas demand was estimated to be 321,700 Nm^3 per hour (11.352 million scf/hr). Under Option II, the demand was estimated to be 456,000 Nm^3 per hour (16.091 million scf/hr). For Option I, the total estimated cost for the network construction and the construction and upgrading of pressure reduction stations was U.S.$ 5.24 million. For Option II, the total estimated cost was U.S.$ 6.03 million.

Conversion of Coal-Fired Stoves to Electric Heating

The objectives of the study were to show the feasibility of replacing all coal-fired apartment stoves with electric heaters, or by inserting electric heating elements in them, and the effects such replacements would have on the existing electricity system.

The most recent data in 1993 showed 13,954 apartments and 5,831 commercial units heated by electricity. These installations consumed 90-100 MW. Analysis by BRK showed that almost half of the 100,000 coal-fired home stoves were located in the central

part of the town and at the same time most of the electric storage systems were also located in this area. The residents in this area showed the highest interest in electric heating.

The Electricity Supply Company applied a special tariff for electric heating, which was 50% of the regular rate for domestic use. However, the use of electricity for this purposes was limited to eight hours during the night and two hours during the day. The conversion efforts focused on the district "Lobzow", which had a large reserve capacity (50 MW) and a population of about 8,500 coal stoves.

The analysis showed that the estimated cost of the additional transformers and the construction of additional medium and low voltage lines was U.S.$ 1.7 million. A similar analysis for the Old Town showed a cost of U.S.$ 0.58 million.

Conversion of Coal-Fired Stoves to Natural Gas

This area turned out to be a complex alternative to the conversion to electricity. It became necessary to observe requirements of existing building codes, particularly for old buildings with respect to proper ventilation where the gas unit was to be installed and as well as adequately venting the combustion products through the installation of new chimneys or the remodeling of existing chimneys. The cost per installation was estimated to be about U.S.$ 3,100.

Modernization of the Krzeslawice Boiler House

This study addressed the boiler houses which are too distant to be connected to the municipal district heating system. The Krzeslawice boiler house was selected because it operates all-year round and needed either a major overhaul or replacement; in its then state, it could not meet demand; and it could not meet present or future emission standards. The boiler house has a capacity of 11 MWt in four stoker-fired, water-tube units, provided with cyclones for particulate removal from the chimney gases.

The objectives for modernizing the boiler house were the following:

- to install modern equipment for combustion and pollution control, and hence turn the facility into a nationwide pilot site;
- to improve the thermal efficiency significantly so as to reduce the cost of fuel and other operational expenses; and

- to bring the boiler house into compliance with emission standards to come into effect in 1997.

The boiler house facility was commissioned in 1958. It provides pressurized steam to eight nearby industrial plants. Minimum supply demands occur in the summer and during vacation periods. In 1992, the boiler house consumed 13,116 tonnes of coal fines. Maximum permitted emissions from existing traveling-grate, stoker installations by December 31, 1997 are (in grams per gigajoule of heat input) 990 for SO_2, 150 for NO_2, and 800 for particulates. After January 1, 1998, the values drop to 640, 95, and 600 respectively.

Engineering analyses were carried out by two teams, one Polish and the other American. The Polish options were two versions of Polish-manufactured fluid-bed combustion boiler equipment and an imported oil-fired boiler installation. The American options were the installation of a new vibrating grate stoker of U.S. manufacture, a circulating fluid-bed combustion equipment, and a near-commercial advanced coal-combustion technology supplied by Tecogen, Inc of Waltham, Massachusetts.

The options were evaluated to the following criteria:

- compliance with environmental regulations;
- staging the modernization to the actual heat demand from the consumers;
- owner's capability to allocate money to capital projects;
- the level of operational costs after modernization; and
- technical quality of the boiler units and auxiliary equipment.

The analyses of the problems at the boiler house led to identification of areas where improvements were needed and where Tecogen one of the firms having a Phase 3 cooperative agreement) is working (see Sections 21-24 below).

Solid Fuel Supplies to Krakow

The work in this area surveyed the solid fuels consumption pattern in the Krakow area in 1991 and the efforts underway to improve quantity. The results showed that the boiler houses consumed 237,700 tonnes of fine coal in stoker fired boilers; 52,400 tonnes of lump coal in hand-fired boilers; and 83,700 tonnes of coke in hand-fired boilers. The coal fines, which are

neither washed nor graded, generated large amounts of pollutants, despite control devices, and emissions of particulates.

A BRK estimated that there were 99,986 stoves and small boilers in apartments which used about 100,000 tonnes of coal per year. The coal was supplied in chunks with low sulfur and ash. Later, lower grade coals came on the market with lower prices, and began to replace the higher quality coals.

The work studied the costs associated with providing better quality fuels to the market. The techniques studied were washing and grading coal fines for boilers with traveling grates and the manufacture of smokeless briquettes for steel boilers with fixed grates and also for home stoves.

Many mines in Poland began washing coals for marketing and one of the firms selected by DOE for Phase 3 (see Section 27 below) is focusing on washing and marketing an upgraded coal under the name ECOCOAL.

Poland does not yet have a briquette manufacturing industry, although a number of organizations have commercialization plans. Among them are the Institute for Chemical Processing of Coal in Zabrze, Brikpol, Ltd. near Lublin, and a group in Silesia, near Blachownia.

Coal selling prices can vary widely with the source from a low of $24 per tonne to a high of $42.60. The price of washed and graded coal can also vary, and not necessarily in proportion to the cost of the base coal, from a low of $51.50 per tonne to a high of $73.50 per tonne. The price of Zabrze briquettes in 1994 was $80.50 per tonne. Prices in 1996 are higher.

14. BNL Section 4.0 Activities (Environmental Aspects)

Environmental regulations comprising allowable emission standards and method of enforcement are reviewed. Until December 31, 1997, the permissible levels for particulates and SO_2 in the Krakow area is 32 and 50 $\mu gm/m^3$ respectively. At the time of the inception of the project (1990) the atmospheric levels were 53 and 54 respectively. After December 31, 1997, the permissible levels are expected to become more stringent.

The objective in this section was to predict the reduction in pollutant levels resulting from the implementation of the options defined in Section 3.0 of the Phase 1 report (Section 13 above). To enable a quantitative evaluation, the term equivalent emissions was defined as the sum of the products obtained by multiplying the emission quantity of each pollutant by its toxicity coefficient as defined by the Ministry of Environmental Protec-

tion. Four basic pollutants are incorporated in the calculation of equivalent emissions: particulates; sulfur dioxide; nitrogen oxides; and carbon monoxide.

The results found were the following:

- For the conversion of Old Town boiler houses to natural gas firing,

  then present equivalent emissions = 339,760 kg/season
  expected equivalent emissions = 41,293
  reduction = 298,467 kg/season

- For the modernization of the Krzeslawice Boiler House

  then present equivalent emissions = 484,648 kg/season
  expected equivalent emissions = 81,823
  reduction = 402,836 kg/season

- For converting home coal-fired stoves to electricity

  then present equivalent emissions = 563,167 kg/season
  expected equivalent emissions = 88,930
  reduction = 474,237 kg/season

- Eliminating home stoves or using briquettes in home stoves (Scenario II)

  then present equivalent emissions = 16,188,000 kg/yr
  remaining low emissions = 3,819,000
  increase in high emissions = 127,000
  reduction = 12,243,000 kg/yr

  Note: increase in high emissions applies to emissions occurring during briquet manufacture.

- Replacing coal with electricity or natural gas

  then present equivalent emissions = 16,188,000 kg/yr
  remaining low emissions = 643,000
  increase in high emissions = 1,136,000
  reduction = 14,409,000 kg/yr

  Note: remaining low emissions apply to emissions from natural gas use; increase in high emissions applies to the increase in electricity production.

- Basic effect of introducing all the options of abating low emissions

  expected reduction in low emissions = 38,126,000 kg/yr
  expected equivalent emissions = 1,412,000
  improvement = 36,714,000 kg/yr

  Note: emissions stated above are equivalent emissions.

A remarkable decrease in the concentration of sulfur dioxide in winter can be expected, bringing it to levels only slightly higher than summer values.

15. BNL Section 5.0 Activities (Public Opinion and Relations)

This area addressed public opinion and the source of low emissions. The objective was to acquaint the public with the scale of pollution from the sources already identified above and with the entire planned program for reduction of low emissions.

The activities included

- surveying public opinion;
- distributing publications, brochures, and leaflets;
- organizing public seminars;
- issuing press releases and holding press conferences; and
- producing documentary films.

Intensive discussions with four focus groups were conducted by VRG Strategy Company, Ltd. in September 1992. The four groups represented apartment building landlords in the Old Town; tenants who had applied to the electricity department for electricity allocations for "night-store" space heating and have already made some investment; Old Town residents who were not considering changing their heating mode; and tenants just outside the Old Town who had not considered changing their heating mode. Questions put to the group generated emotional reactions reflecting on the policies toward the environment by the previous communist government.

Nine major issues emerged from the interviews, incorporating such aspects as not easily distinguishing among the various sources of pollution other than low emissions; need for the public to be better informed to avoid arguments based on hearsay information; interest in having a more convenient form of heating regardless of reducing the effects of pollution from the present systems; a

division of opinion as to who should pay for emission reduction improvements; unsatisfactory state of the existing infrastructure; criticisms of the authorities including the staff of the Electricity Department; willingness to accept change if convinced that something positive is being done; willingness to pay depending on income and length of leases; and little recognition of the U.S. fund plus recognition that foreign experts could best control the appropriate use of foreign credits.

The above findings became the basis for further efforts to be extended to a greater cross section of the population. The degree of support the residents of Krakow were willing to give to concrete options aimed at abating, or eliminating, air pollution is shown in the results of these efforts. The results show the support by option:

- Introduce a system of refunds and tax deductions to assist in purchase and installation of environmentally-sound equipment 92.3%

- Introduce strict controls on emissions by industrial polluters 91.0%

- Reduce heat losses by insulating buildings, installing thermostats and radiator control valves 90.0%

- Introduce regulatory restrictions on car exhausts 88.0%

  Introduce high fees and fines for local boiler houses 76.3%

- Prohibit the use of low-quality coal 71.0%

- Eliminate low emissions by converting 100,000 coal stoves and 1,000 boiler houses, even if the cost for converting a single coal stove is in the range of PLN 300-1500 (U.S.$ 107-537) 43.3%

- Make use of briquettes obligatory in coal stoves and boiler houses, which costs twice as much as coal but causes one-fifth of the pollution 32.0%

- Eliminate low emissions by converting 100,000 coal stoves and 1,000 boiler houses, even if the new sources of energy would require 5-10 times more capital investment, and the energy

prices in the 1990s would be brought to world levels 22.7%

The above figures led to the conclusion that residents of Krakow are willing to accept the great majority of modernization and administrative measures aimed at abating pollution, and also are willing to pay more for operating cleaner heating systems.

Other findings from the expanded effort to survey public opinion were the following:

- an overwhelming majority of opinion on specific legal solutions favored tariff reform and specific tax incentives and subsidies to implement the changes which would result;
- 61.7% responses considered the City Council of Krakow as the most qualified to work on pollution abatement, but about 44% of the responses viewed the Council's past actions as ineffective and achieving little and one third of the responses believed the Council would be more effective in the future;
- The respondents generally supported central, district heating. None of the respondents wanted coal-fired stoves in their apartments.
- 64.3% of the respondents reported having weatherstripping installed in windows and 89.3% reported having double frame windows, but 73.3% reported winter drafts from windows and doors. The same percentage reported opening windows in the winter time to control inside temperatures.
- Only about 20% of the respondents indicated that they plan a change in their heating installations.
- Opinions of the respondents on who should cover the costs of conversion were the following:

  - the private owner of the building 42.5%
  - the state, in state-owned buildings 65.0%
  - the tenant, with a guarantee of long-term occupancy 30.0%
  - the owner, but with some form of help (tax deductions, grants) 52.5%

Public relations activities were conducted by National Business Services (NBS) Holding Poland Ltd, with the following objectives:

- to inform Krakow residents about effects of low emissions;

- to inform Krakow residents about the Program to eliminate sources of low emissions, its objectives, and the results achieved;

- to inform Krakow residents about modern methods of energy generation, and ways to save energy; and

- to encourage municipal institutions, enterprises, and the residents of the areas included in the program to adopt and apply the planned options.

Press releases covered the following topics:

- the results of the questionnaire given to the residents of Krakow;

- the improvement in air quality due to implementing some options developed under the program;

- the possibilities of eliminating low-emission sources by converting coal-fired heating devices to gas-fired systems; and

- the possibilities of eliminating low emissions sources by connecting them to the municipal district heating system.

In addition three seminars were organized an conducted in Krakow with press and radio coverage. The third seminar presented the eight firms which had negotiated cooperative agreements with the Department of Energy to undertake specific efforts under Phase 3 of the project. A concurrent conference with the last was held at Plzen in the Czech Republic to "export" the results being achieved in Krakow. A video tape was produced and aired on television and shown at various conferences.

16. BNL Section 6.0 Activities (Incentives Analysis)

This area dealt with analysis of the incentives to implement the options for reducing low emissions so far identified. The work was performed by Polinvest, Ltd. The objectives for the work were the following:

- to determine the feasibility of the capital projects intended to reduce low emissions in various parts of Krakow, using various fuels and technologies;

- to determine the amount of money the City of Krakow would have to allocate to the incentive program promoting these capital projects; and

- to identify the mechanisms the City must create to ensure the program is carried out.

The scope of work undertaken by Polinvest to achieve these objectives was the following:

- forecasting the growth in Poland through the year 2020 in the prices of gas, power, coal, coke, briquettes, heating oil, and district heating;

- performing feasibility studies on four types of capital projects intended to reduce low emissions: connecting district heating to areas where the local boiler houses are shut down; converting coal/coke-fired boiler houses to gas firing; replacing coal-fired stoves in the "Lobzow" substation area with electric heating; and using briquettes in coal-fired tile stoves.

- performing comparative studies of current and future operating costs of various heating systems and equipment using various types of fuels;

- undertaking legal studies of program-related issues such as methods for generating energy prices; effects of controlling prices; ownership of facilities; environmental regulations; financial and tax regulations; administrative law and local ordinances; and statutes regulating local government; and

- undertake a study of incentives for possible actions to be undertaken by the municipal authority to promote the program's capital projects among the users of current heating systems and equipment.

The results of the Polinvest work showed the following:

- Energy Prices

  Night-time electricity rates should rise from U.S.$ 0.0240/kwh in 1995 to U.S.$ 0.0321 in 2020.

  Natural gas prices for boiler houses should rise from U.S.$201.07 per 1,000m³ in 1995 to U.S.$551.34 per 1,000m³ in 2020. These levels should be about the same for individual customers.

  Heating oil prices should rise from U.S.$336.55 per ton in 1995 to U.S.$416.26 per ton in 2020.

District heating prices should rise from new Zl 6.11 per GJ ($2.19 per million Btu) in 1995 to Zl 8.59 per GJ ($3.08 per million Btu in 2020).

- Regarding strategies for the development/enlargement of Krakow's district heating network, the results of feasibility study identified twelve areas in which intervention by authorities outside the management of the district heating company (MPEC) would be necessary. These interventions would be needed for new capital investments to be financially attractive.

- Similar results were obtained with respect to converting coke-coal-fired boiler in the old town to gas firing. Polinvest identified five interventions which would be needed for new capital investments to be financially attractive.

- For replacing coal firing with electrical power for an average ceramic stove, Polinvest's analysis found that such a conversion would be cheaper if such a stove is operated for a minimum of eleven years, providing that a cost is associated with the labor of managing the coal fuel and ash disposal is included. Otherwise the conversion would not be viable. Financial attractiveness to the power utility would depend on increases in the prices for the electricity consumed.

- On the feasibility of using briquettes instead of coal in heating with ceramic home-heating stoves, Polinvest's analysis found that without a commercial briquette manufacturing industry in Poland, the pricing of briquettes in the market is uncertain and assumptions on pricing were needed for analysis. The analysis found (a) that subsidies would be needed on the sales of briquettes and (b) in comparison with other alternatives to reduce low emissions in the City, such subsidies would represent an effective use of funds.

- In summary, Polinvest identified for each of the four options listed above that the net present value of the investments needed would be negative, and that subsidies would be needed to bring the present values to a zero value. For the net present value of each subsidy there would be a return in the form of reductions in low emissions. These results are shown in summary form in Table A-2.

Table A-2
Summary of Subsidies for Low-Emissions Reduction Options

Option	Subsidy, U.S.$	Low Emissions Reduction, tons
Expanding the District Heating Network	198,005	11,056
Converting Boiler Houses to Gas Firing	759,858	3,543
Converting to Electrically-heated Coal Stoves	975,571	4,912
Smokeless Briquettes in Coal Stoves		
Rapid withdrawal of Subsidies	600,743	33,501
Gradual withdrawal of subsidies	1,360,000	33,496

Note: Low emissions reductions are as equivalent emissions as defined above.

The Polinvest study also addressed an 87 m^2 apartment representative of the Old Town area and compared current and forecast expenditures for the hypothetical installation of various types of heating equipment. Eight options were considered including the unlikely extension of district heating into the Old Town area. The study was based on the current and forecasted prices as reported above. Low grade coal showed the lowest cost for both current and future prices. In the year 2020, low-grade coal still remained the lowest cost fuel with natural gas showing the highest cost.

Finally, the Polinvest study produced a series of recommendations. A set of recommendations concerned with needed incentives and stimuli were offered for each option for reducing low emissions, as follows:

- Expansion of the district heating system.
  - issue administrative prohibition orders against the continuing operation of coal/coke fired boiler houses;
  - provide funding from the Municipal Environmental Protection Fund;
  - provide funding by EKO-INVEST, a non-profit corporation.

- Conversion of coal/coke-fired boiler houses in the very center of town to gas firing.
  - issue administrative prohibition orders against the continuing operation of coal/coke fired boiler houses;
  - grant property tax exemptions;
  - make the issuance of building permits for residential investment property major remodeling contingent on the replacement of the current heating systems;
  - provide funding by the Municipal Environmental Protection Fund;
  - provide funding by EKO-INVEST, a non-profit corporation.
- Equipping coal-fired ceramic stoves with electric heating elements.
  - create and support grass-roots committees for the construction and enlargement of power supply equipment;
  - grant property tax exemptions;
  - make the issuance of building permits for residential investment property major remodeling contingent on the replacement of the current heating systems;
  - provide funding by the Municipal Environmental Protection Fund;
  - provide funding by EKO-INVEST, a non-profit corporation.
- Modernize boiler houses not scheduled for conversion to gas firing or for connection to the district heating system.
  - issue administrative orders to reduce emissions from the currently operated coal/coke-fired boiler houses;
  - provide funding by the Municipal Environmental Protection Fund;
  - provide funding by EKO-INVEST, a non-profit corporation.

- Replace coal, the fuel currently used for heating with home stoves, with a less environmentally-damaging fuel.
  - issue administrative orders prohibiting the sale of poor quality coal;
  - support the manufacture and sale of cleaned (washed) coal in Krakow;
  - support the manufacture and sale of smokeless briquettes in Krakow.

17. PNL Section 7.0 Activities (Energy Conservation/Buildings)

This work is reported in Section 7 of the Phase 1 Report (Section 20 below).

This area dealt with a demonstration of energy conservation in the Krakow building stock. The work was undertaken by Pacific Northwest Laboratory, which employed a contractor, Electrotek Concepts, Inc. Conservation was considered as a potential pollution reduction strategy since

- less fuel can be burned by the coal- or coke-fired heating systems;
- by reducing building heat requirements, it becomes less costly for the residents to burn alternative, less-polluting fuels, which may be more costly, and encourages them to switch; and
- by reducing the heating requirements for the buildings served by district heating systems, these systems can serve new customers without constructing new heat sources and can eliminate local boiler houses.

The objectives of the conservation demonstration were

- to identify affordable, cost-effective residential energy efficiency measures;
- to evaluate the costs and energy reductions due to selected measures; and
- to identify institutional and infrastructure impediments to the adoption of economically attractive energy efficiency measures and means to overcome these obstacles.

The work occurred during four wintertime periods from 1992 to 1994 as shown in Figure 1 in Section II of the main report for

this topic, and involved retrofitting four practically identical, adjacent, eleven-story residential buildings in Krakow. Each building contained six apartments per floor and a basement storage area. The parameters to be investigated ranged from weatherization and external building insulation through reducing heat delivered to the buildings during mild weather to thermostatic controls on individual radiators with incentives for the residents to use them.

The experimental design addressed the performance of hydroelevators (i.e., jet-injected lifting of hot water to the building height using recirculated, pumped cooled (used) water); installation of flat-plate heat exchangers; weatherization measures; thermostatic valves; and external insulation.

As incentives to proper use of the installed equipment, building residents were given two different rebates based on measurements during the experimental work. One rebated to each resident equally on the basis of total heat reduction in the building. The other was given to an individual based on his own measured reduction in heat demand.

Evaluation of the results showed that it possible to save over 20% of a building's space heating energy. The implications for reducing low-emissions in the Krakow area are

- connecting more customers to the district heating network and eliminating local boilers without requiring construction of new combined heat and power plants;
- reducing heat costs for customers converting from solid-fuel sources to less-polluting sources; and
- reducing heat demand so more customers can be served by existing gas and electric distribution systems.

The work in this section is reported in depth in Brookhaven (2), pages 7-1 through 7-16; in Plzen (1), pages 137 through 146; and Krakow (3), pages II-1 through II-18.

18. BNL Section 8.0 Activities (Comparison of Options)

This area addressed a comparison of the options for low emissions reduction so far identified in the Phase 1 work, in terms of the use of a spreadsheet computer model. The model permits many options to be screened rapidly in terms of costs and degree of low-emissions reduction to aid policy decisions on a city-wide scale. Because of simplifying assumptions, the model is not appropriate for making investment decisions. Such decisions would need to be made on a case-by-case basis.

The spreadsheet model was used in two ways. In the first, nineteen different options for reducing low emissions were considered and ranked in terms of the user cost per unit of low emissions reduction. However, this is not a complete use of the model because the ranking does not allow for the total amount of low emissions reduction.

In the second, this limitation was addressed by taking combinations of options by scenarios for low emissions reduction in the City of Krakow. Three scenarios are reported as an illustration of the potential of the spreadsheet model. In Scenario I, which offered full elimination of all low emissions, the capital cost was estimated at U.S.$ 187 million and equivalent emissions were reduced by 90%. Scenario III, which required no capital investment showed a reduction of 56%.

19. BNL Section 9.0 Activities (Conclusions and Recommendations)

This section addressed the twenty conclusions and recommendations which derive from the activities reported above. These are reported below in summary form:

- Low emissions sources, according to calculations, demonstrate that these sources contribute about 35-40% of the total pollution. The remainder is contributed by vehicular traffic, emissions from high sources, and inflow from other regions. Therefore, elimination of low-emission sources will improve, but not eliminate, air pollution in Krakow.

- The most harmful sources of low emissions are the home stoves, which account for over 40% of the total particulate emissions. This harmful effect has recently increased because of the availability of lower priced, lower grade coals. In addition various plastic, rubber, and other wastes are burning in the stoves.

- It is technically possible to consider various options to eliminate stove heating in houses. These options vary in attractiveness for emissions reduction by capital costs, tariff structures, and feasibility. They include connections to the district heating system and conversions to electrical and natural-gas heating.

- Some form of incentive would have to be provided by the City of Krakow to replace the tile stoves with gas or electric heating. The provision of incentives could require changes in current regulations. Many tile-stove users are willing to replace the stoves with electric or gas heating, if the cost is not excessive.

- However, it does not appear possible to eliminate coal-stove heating in the near term, and temporary solutions are required. Measures which could be considered involve controlling the quality of coal sold in the Krakow market; popularizing improvements in the method of firing the stoves; and making available environmentally-friendly fuels such as briquettes.

- The greatest amount of pollutants is generated by burning solid fuels in boilers. Two groups of boilers appear to be the worst offenders: hand-fired boilers made of steel and designed to be fired with coal or made of cast iron designed to be fired with coke; and stoker-fired boilers designed to be fired with pea-sized, graded coal which are usually fired with raw coal of a broad size-consist. These boilers in the Old Town area should be eliminated. Remedies need to be found for the remainder.

- Hand-fired, cast-iron boilers should be fired only with coke. Otherwise, with coal, emissions increase about 36%.

- Hand-fired, steel boilers, which are designed to be fired with coal, show equivalent emissions 60% higher than the cast-iron boilers fired with coke. Replacing coal in these boilers with briquettes could reduce equivalent emissions by 63% and particulate emissions from 650 g/GJ to 69 g/GJ heat input.

- Stoker-fired boilers could operate at higher efficiencies (up to 75% from the present 50-60%) thereby reducing the consumption of coal. Tests showed such efficiency increases are possible and that equivalent emissions could be reduced from 2,000 g/GJ to 1,000 g/GJ, about 50% by improving operating procedures and using washed and graded coal. Efficiency could be improved by controlling and optimizing the combustion process.

- Energy can be conserved in all parts of the heating system as well as at the end users. Efforts such as are described in Section 7.0 above (Section 17) demonstrated that such savings could be as high as 30%, which reflects on savings of 300-400 MWt in the municipal district heating system supplied from the combined heat and power plants.

- The district heating system has surplus capacity to the extent that more than half of the boiler houses could be eliminated by connection to the system. 635 boiler houses with a total capacity of 450 MWt could be eliminated throughout the whole city.

- Within several years the natural gas supply system could be modernized to allow replacing coal and coke-fired boiler houses with gas fired boiler houses within the Old Town and between the first and second rings. The cost of such modernization is within the financial capacity of the gas utility.

- The attractiveness of various options to reduce low emissions strongly depends on the location within the city. Site-specific studies must be done to support local decisions.

- The unit capital costs for the various option vary from a low of U.S.$ 90 per kWt to a high of U.S.$ 320 per KWt.

- The spreadsheet model can contribute to decisions about energy policy at the City level. Using criteria related to costs and environmental effectiveness, the model produced the following ranking of options for low-emissions reduction, the more attractive being at the top.

  - Using improved fuel
  - Connecting to the municipal district heating network
  - Converting solid fuel-fired stoves to electric heating
  - Converting solid fuel-fired stoves to gas heating
  - Completely modernizing stoker fired boilers

- The model was used to study the long-term improvement in low emissions involving six major options. It would take many years and large capital investment to reach these goals. Therefore, in the near term, options should be selected which involve no capital costs. These are firing stoves and hand-fired steel boilers with smokeless briquettes; firing hand-fired cast iron boilers with coke; and firing stoker-fired boilers with washed and graded coal.

- The model was used to analyze a concept for totally eliminating low emissions. The capital cost was found to be U.S.$ 190 million. Equivalent emissions could be reduced by about 90%, particulates by 97%, and SO_2 by 93%. Only eliminating stoves and coal fired boilers for heating apartments would reduce equivalent emissions by about 26% and particulates about 50%. The model also showed that simply by using better-quality fuels at no additional capital cost, equivalent emissions could be reduced by about 26% and particulates by 80%.

- Other experiences during the course of the work showed beneficial effects on reducing low emissions through a decision to operate the district heating system all year round which would serve domestic hot water needs; the part of the Old Town accessible to the district heating network is increasing; natural gas available outside of the city center could result in converting some boiler houses to gas, instead of modernizing them thereby avoiding capital investment; and Phase 3 activities involving the introduction of complete control and automation of the combustion process, recovery of flue gas heat, and efficient air protection equipment can permit boiler house modernization at greatly reduced capital cost.

- The City will need some type of incentives program to encourage conversions and reduce low emissions, which could involve direct financial assistance. Some legal regulations may require change. Delay in establishing an incentives program, while energy prices in Poland rise to world levels, could materially increase subsidies needed in an incentive program.

- Further decreases in low emissions in Krakow are feasible. In ten to twenty years, the issue of low emissions should no longer be one of the more serious environmental problems facing the city.

20. Phase 1 Report

This report was issued, dated June 1995. Although BNL organized the report and wrote some sections, and edited it, it represents the results of input from several groups. BRK wrote a good part; Electrotek (mostly for Section 7.0) and PNL (a little for Section 7.0) wrote some. Thus the Phase 1 Report, issued by BNL, represents a team effort.

The report is the source document for most of the content in Sections 12 through 19 above. BNL's and BRK's roles in the participation, planning, and management of the efforts involved in developing, organizing, and compiling the report has already been noted above. In addition, BNL provided from U.S. sources all of the test equipment which was not available in Poland. A number of firms and organizations, U.S. and Polish, participated in the work efforts under subcontracts, and they were the following:

- Burns and Roe Services Corporation, through a contract with PETC, played a significant role in planning the original task structure, getting air quality analysis, public relations, and overall participation in the U.S. team;

- Krakow Industrial Design Office, as subcontractor to BRK, completed a modernization design study involving alternative furnaces for the Krzreslawice boiler house owned by MPEC in joint effort with Burns and Roe Services Corporation and Burns and Roe Engineering Company; which is reported in Section 13 above;

- Battelle Pacific Northwest Laboratories, through its subcontractor, Electrotech Concepts, Inc., performed the work with local subcontractors in energy conservation for the Krakow building stock, which is reported in Section 17 above;

- Energoekspert, a Polish firm as subcontractor to BRK, performed the work to test the efficiency and emissions characteristics of the two types of hand-fired boilers;

  Energoekspert performed the test programs at the two stoker fired boiler houses, including emissions with normal and alternative fuels;

  The results are reported in Section 12 above.

- Ekopol, as subcontractor to BRK, collaborated and supported BRK in completing several engineering studies including a design and cost study for the conversion of hand-fired boilers in the Old Town to natural gas, analysis of the gas distribution system to meet demand in Old Town; analysis of conversion in the second ring of the City of Krakow; analysis of air quality impacts of gas conversion; and analysis of leakage in the gas distribution system;

  Ekopol supported BRK in a conceptual design study for the conversion of the coal stoves in the Lobzow region to electric heating, studied the average user conversion costs, analyzed the air quality impacts of electric conversion; and studied the conversion to electric heating in the Old Town area;

  The results are reported in Section 13 above.

- Polivest, a Polish firm with the support of Ekopol, projected future natural gas prices in support of economic analysis, analyzed the costs of gas conversion from the user's perspective; analyzed the need for incentives, and reviewed the options available to the City for incentives;

  Polivest also projected future electricity prices in support of economic analyses; analyzed the costs of electric conversion from the user's perspective; analyzed the need for incentives; analyzed electricity prices required to make

investments by the electric utility profitable; and reviewed the options the City has for incentives;

Polivest forecasted coal prices for supplying stoker-fired furnaces, while Separator (Central office for Coal Processing and Design in Katowice) completed a study of the availability of washed and graded coal;

Polivest projected the future prices of coal used for home stoves; analyzed the costs of different methods of heating apartments, reviewed the legal possibility of controlling fuel quality within Krakow, and recommended possible actions by the authorities; much of which is reported in Section 16 above;

The results are reported in Item 16 above.

- The Academy for Mining and Metallurgy in Krakow provided space and facilities for installing a ceramic tile coal stove for comprehensive testing and cooperated with BNL in the performance test work, which is reported in Section 12 above;

- Ekopol and Tawimex (a consulting group related to the Academy for Mining and Metallurgy) supported BRK to complete a study of the costs of replacing tile stoves with gas-fired boilers, including the air quality impacts of the home stoves, which is reported in Section 13 above; and

- NBS and VRG Strategies, as subcontractors to BRK, undertook the public relations activities related to low emissions; interacted with the focus groups and surveyed public opinion; prepared and distributed information about the Project including press releases, brochures, seminars, press conferences and a film (which was funded separately by the Krakow office of Environmental Protection), which is reported in Section 15 above.

21. DOE Phase 2 Activities

DOE Phase 2 activities, which were designed to obtain a number of cooperative agreements with U.S. firms to address the five pollution reduction areas of the Project began early in 1992 and extended until the award of the eight cooperative agreements during mid-1993. (Section Item 26 below).

22. Public Meetings

DOE conducted similar public meetings in Chicago (June 18, 1992) and in Washington, DC (June 22, 1992) for the following purposes:

- to provide background information about the Project;
- to describe the planned approach for the upcoming competitive solicitation that offers a significant opportunity for U.S. companies interested in business opportunities in Poland; and
- to obtain comments and answer questions before DOE procurement plans are finalized.

The participants at the public meetings were given documents supporting the program of each meeting; the then current situation in Krakow (including a draft document); the Phase 1 activities; the planned solicitation (Project Opportunity Notice (PON)); planned World Bank loans for pollution control in Krakow; and planned public meetings in Krakow. All members of the Bilateral Steering Committee attended these meetings.

The U.S. meeting was followed in October 1992 by a meeting in Krakow, which had the following objectives:

- to provide an opportunity for U.S. firms to meet with Polish firms and learn their capabilities;
- to obtain further information on the results of the Phase 1 program;
- to enable each U.S. firm to have an opportunity to provide a presentation of its technical capabilities; and
- to provide, separately, the pre-proposal conference to be conducted in association with bidding on the Program Opportunity Notice.

23. Program Opportunity Notice

DOE's Program Opportunity Notice (PON) is dated September 21, 1992 with the closing date for cost shared proposals announced as January 29, 1993. It is based on the Phase 1 results then available. The PON specified five project areas against which proposals can be submitted:

- Extend Central District Heating;
- Replace Coal and Coke-Fired Boilers with Natural Gas Fired Boilers;
- Replace Coal-Fired Home Heating Stoves with Electric Heating Appliances;

- Reduce Emissions from Boiler Houses using Coal and Coke; and
- Reduce Emissions from Coal-Fired Home Heating Stoves.

Proposals were limited to U.S. individuals and firms to conduct projects that lead to cost-effective, air pollution reduction in the City of Krakow. Proposals were to remain valid for a period of 365 days.

The intent of the PON was to encourage the formation of commercial ventures between U.S. and Polish firms to provide equipment and/or services to reduce pollution from low emission sources in Krakow, Poland. These commercial ventures could be in the form of contracts, joint ventures, partnerships, or any other commercially feasible arrangement that accomplishes the purposes of the Project. The support was intended to cover all activities up to the time any of the enterprises receives revenues from its activities in Krakow. The cost sharing by the proposer was to be a minimum of 50%. Proposed efforts were to address one or more of the five project areas specified above.

The period of performance was to be specified by the proposer but was not to exceed four years. The proposer could address one or more of the five projects. The proposer was free to offer a broader scope for each of the five projects, or to offer variations in the scope, if these were necessary to assure a viable commercial project.

The proposals were to specify the scope of work so that two budget periods could be identified as logical breakpoints for evaluations and decisions. Construction of major facilities or other major expenditures were to be deferred to the second budget period. At the end of the first budget period, the proposer was to submit an evaluation report and a continuation application to enable a decision regarding funding for the second budget period.

The PON contained eight examples of the types of proposals being solicited, which cover the five areas the PON addressed.

The PON, page 22, states "The prime consideration in the evaluation of proposals is to assess their likelihood of providing a lasting business venture to address the scope of one or more of the five projects in the Krakow Clean Fossil Fuels and Energy Efficiency Project."

The DOE model cooperative agreement provides for the following termination clause:

"Termination for Cause and Force Majeur"

DOE may terminate the Cooperative Agreement, in whole or in part, for cause (i.e., on the basis of a non-compliance determination). DOE shall provide advance written notice, as required by 10 CFE paragraph 600.28, of any non-compliance determination (with a minimum 30-day opportunity to cure the non-compliance) and of any subsequent decision to terminate for cause. DOE may exercise its rights under 10 CFE 00.12 including but not limited to the recovery of funds and tangible property up to the amount of the award. The Cooperative Agreement may not be terminated for delays in performance caused by fires, floods, strikes, acts or omissions of the government, acts of God, or similar causes which are beyond the control of the Participant."

The Participant has the right to appeal such actions as specified in 10 CFR paragraph 600.26.

The PON contained technical information available at the time of its issuance: a detailed description of the spreadsheet model for analyzing emissions reduction choices for the City of Krakow; a July 1992 survey of boiler sites in the Krakow region and an evaluation of these low-emissions sources; and an interim report prepared by Brookhaven National Laboratory on the information gathering Phase 1 of the Project.

Subsequent amendments to the PON provided for the following:

- extension of proposal due date to February 13, 1993;
- adding to the PON new data relevant to testing the boilers at the Krzeslawice boiler house, new information on the expansion of the district heating system, and an equipment list of measuring instruments and accessories in the possession of the voyevodship, which could used by participants identified as a result of proposals submitted for the PON; and
- the questions and answers emerging from the pre-proposal conference in Krakow. BRK was designated as the contact in Krakow to facilitate emerging relationships between U.S. and Polish firms. One response made it clear that only U.S. technologies were to be considered in the evaluation of proposals. These are technologies either owned, 50% or more, by a U.S. firm, licensed from another U.S. firm, or which is in the public domain
- DOE presented examples of the kinds of costs involved in all activities that must be accomplished by U.S. organizations and their proposed team members before the enterprise can

expect to receive revenues from its activities in Krakow, as follows:

- efforts to determine how to establish a U.S.-owned business in Poland;
- identification of regulations relevant to the proposed project;
- market studies;
- identification of facilities and a labor force;
- acquisition of a manufacturing plant; and
- construction and testing of equipment or production of fuel.

- DOE presented examples of sample projects, as follows:
  - briquettes from coal fines;
  - building insulation;
  - boiler operator training/boiler performance optimization;
  - ceramic home stove insert;
  - improve, or expand, local distribution system for natural gas, electricity, or district heat; and
  - upgrade a local combined heat and power station to provide additional heat for the district heating system.

- DOE estimated that awards of cooperative agreements could be made by December 1993. Five discrete steps were to be involved before awards.

- 72 Polish firms or organizations were listed with information on their individual interests with whom prospective proposers could interact.

24. Receipt of Proposals

DOE mailed approximately 320 copies of the solicitation to potential proposers and interested parties. Fifteen offers, addressing three of the five areas of interest, were received in response to the solicitation.

25. Evaluation of Proposals

The evaluation of the proposals was completed on August 27, 1993 with the identification of nine firms to receive cooperative agreement awards. The evaluation proceeded in steps as follows:

- On receipt of proposals, DOE established a Source Evaluation Board, which took the steps specified in the PON to establish the competitive range.

- On May 4th, 1993, BRK submitted a report to DOE commenting on 13 of the 15 proposals received. The report was based on a review of all proposals by a delegation which had been appointed by the BSC for the purpose. The report recommended rejection of four of the proposals, was non-committal on four of the proposals, and was favorably inclined toward five.

- In a report dated May 10th, 1993, the Polish members of the BSC stated their views on the proposals which led to the need for securing more information and clarifications from the proposers.

- As the result, DOE issued a questionnaire to the proposers as required and received revised proposals which were re-evaluated in the same manner as for the original proposals.

- The Polish members of the BSC reviewed the revised proposals and reported on August 9, 1993. They viewed the rebidding effort as having improved the responsiveness of the proposals. They also suggested activities for some of the Proposers. Finally, they stressed the need for quick implementation.

- Accordingly, DOE selected nine of the proposals for award of cooperative agreements.

26. Selection of Cooperating Firms

DOE awarded cooperative agreements to nine U.S. firms as follows, one of which Hart Associates, Inc. later dropped out (see below). Total cost estimates shown cover both budget periods, with funding for the second period authorized based on submission of justification and acceptance by DOE.

Firm Cost Shared %	Original Total Budget Current Total Budget	Start	Current Completion
Acurex Environmental Corp. (49.6%)	$5,278,667 2,679,837	4/01/94	3/01/96*
Control Techtronics, Inc. (50.0%)	$2,324,546 2,324,546	2/14/94	12/30/97
EFH Coal Mining Company (61.46%)	$7,006,989 7,006,989	5/01/94	4/30/97
Honeywell, Inc. (47.4%)	$4,111,024 5,230,046	8/02/94	12/31/96
LSR Technologies, Inc. (50.0%)	$1,849,008 1,849,008	4/01/94	3/31/98
Shooshanian Engr. Assoc. (50.0%)	$3,925,698 3,925,698	6/30/94	2/28/97
TCS, Inc. (51.3%)	$2,155,811 1,989,785	3/14/94	9/30/98**
Tecogen Division/TPC (50.0%)	$1,013,978 1,013,978	4/01/94	1/31/97

* Project has been terminated on March 1, 1996, the end of the Budget 1 period, by mutual agreement.

** Funding has not yet been authorized for Budget Period 2.

Hart Associates, Inc., which had been active for some time in Poland in connection with the country's district heating systems and well acquainted with the situation in Krakow, proposed a four-year, Polish American joint venture (Eco-joule) comprising Hart Associates and two Polish firms: EKSA, the owner and operator of the Leg power station near Krakow; and MPEC, the owner and operator of Krakow's municipal district heating system. Eco-joule was to provide policy and project-level services in the areas of project management, financial advice, and public policy. These services were to be directed, through three pilot projects, toward the elimination of boiler houses through the extension of the district heating system.

BSC's technical group was negative about the merits of the Hart proposal because it did not contain any equipment and appeared to represent more of the "brygada marriotta" type of operation (see Section 2 above). The BSC, however, took an opposite view and supported it.

The financing was to be provided through a revolving fund which would be set up through interest by the World Bank in financing the modernization of the Leg power plant. Hart Associates, Inc was to be involved in proposing for the work to emerge from a World Bank loan, in which the revolving fund would become part of its proposal. It turned out that the contract for the moderniza-

tion was awarded by the EKSA management to Electricite de France and Hart Associates lost its ability to finance the revolving fund. Consequently, the firm had to withdraw and later was absorbed by an organization in Houston.

Hart turned over all of its studies made in connection with the project to EKSA, which then began implementation for its own account to expand the district heating system in its area and to provide the heat requirements from its power plant. EKSA management approached DOE for technical assistance through allowing Honeywell, under its cooperative agreement with DOE, to support EKSA's efforts, to which DOE agreed. EKSA has advertised its accomplishments in an elaborate booklet containing photographs and descriptions of 43 installations totalling 53 MWt, completed as of 1995.

EKSA reports in its booklet that

- it used its own funds to construct the connection from its existing main to the boiler house and the user relied on sources such as the Provincial Fund for Environmental Protection, Ecofund, and the DOE fund to construct heat exchangers with the automated controls;

- low emissions were reduced by 525 tonnes per year and gas pollution (presumably SO_x and NO_x and the total flue gases) by 31,500 tons per year.

- The cost to EKSA was about new Zl 11.4 million (U.S.$ 4 million).

- The plan is to eliminate all boiler houses by the year 2000 through the combined efforts of EKSA and MPEC.

27. Acurex Environmental Corporation

According to the summary in the DOE Selection Statement, Acurex proposed to manufacture and market coal-based briquettes according to a proprietary concept that produces approximately 70% less pollutant emissions. The target market is home stoves and small, hand-fed boilers. They were to form a joint U.S./Polish venture to collect technical performance data on Polish-manufactured briquettes and, prior to turning over the entire process to the joint venture, the briquettes were to undergo full production at a renovated plant outside of Krakow. The use of coal fines were to reduce costs for raw material and costs for grinding. In addition, the use of the briquettes was expected to reduce emissions of carcinogens. The DOE supported activity was to entail a two-year time frame.

Briquettes were to be made from several coals and numerous combustion and characterization tests were to be conducted to enable choice of the correct coal, coal/binder ratio, and briquette size to reduce technical risk and optimize performance.

The proposal presented environmental performance data based on experience with the use of Chinese coal. The data showed that the briquettes do not break up on combustion and using the clay binder reduces the molecular weight of the hydrocarbons emitted. The result is lower particular and hydrocarbon emissions. SO_2 emissions were to be reduced by coal washing to eliminate waste and salt.

The proposed briquetting plant had a capacity of one million tons per year with six parallel production lines. Modification of the combustion equipment in the market would not be required, and fuel distribution could be handled by existing delivery firms.

The business plan objectives were to obtain a 50% market share in Krakow within three years of the initial project launch and transfer the technology business strategy to other cities in Europe with similar fuel and heating markets. Acurex estimated profitability for the venture, however, with only 15% of the market.

Acurex proposed to share 58% of the costs. Acurex and its partners (PEC and AMM) were to provide in-kind contributions and Geraghty and Miller (Acurex parent firm) cash during Budget Period 1. The proposed Polish subsidiary/joint venutre was to be the source of financing for Budget Period 2.

28. Control Techtronics, Inc.

According to the summary in the DOE Selection Statement, Control Techtronics proposed to create a Polish joint venture comprising MPEC, Naftokrak-Naftobudowa, and itself to evaluate current district heating operations and recommend coal cleaning and grading solutions, boiler control and modification solutions, and personnel training to integrate the modifications into existing operations. The proposer along with Pennsylvania State University was to provide expertise and control systems and develop evaluation techniques for operational integration, as well as an operator training program.

The two year project was to retrofit a recommended boiler house in the first Budget Period, and to proceed to four retrofits during the second Budget Period.

The Proposer specified the combustion control technology as involving the installation of a state-of-the art microprocessor-

based controller, dampers to control the discharge of gases to the stack, variable inlet vanes on each forced-draft fan, and automatic speed variation for the stoker drive-motors. The firm projected emissions reductions for particulates as 75% and 20% for CO; and a 20% increase in efficiency. As an indirect benefit, burning less fuel would result in a 20-25% reduction in SO_2 emissions. The cost of the system would be repaid from fuel savings and reductions in environmental fees.

Control Techtronics was to provide the controllers, Pennsylvania State University the operator training, MPEC the facility (and would be the first commercial customer), and Naftokrak-Budowa the installation of equipment. The market in Poland was estimated at 1,000 units and efforts would be made to increase the content of Polish manufactured equipment in order to remain competitive. An intensive sales campaign would be launched.

Control Techtronics proposed to share 50% of the costs and identified cash and/or in kind contributions from MPEC, Naftokrak, Penn State, and the joint venture.

29. EFH Coal Company

According to the summary in the DOE Selection Statement, EFH proposed to produce a washed, graded coal for marketing throughout eastern Europe. Pennsylvania State University, and Viking Systems were identified as subcontractors to EFH. The process would employ heavy media coal washing and double screening to obtain graded and sized products. This process has had wide commercial application in the United States. Boiler house modifications would not be required, efficiency would be improved and fuel consumption (and hence emissions) would decrease.

The initial work would be the experimental work on Polish coals to determine the washability yields and hence the actual costs of production, employing the laboratories of Pennsylvania State University. The use of graded, washed coal in stokers combined with operator training was expected to result in emissions reduction at boiler houses.

The seven tasks in the first year of the project were aimed at the design of a 300 tons per hour plant, and the tasks in the second year of the project included equipment procurement, construction, and operation of the plant. Costs were to be recovered from the operating revenues of the cleaning plant.

The three team members were EFH, MPEC, and Naftokrak, the latter two supplying initial land, handling equipment, office space and delivery equipment. MPEC represented a built-in customer.

The proposer identified business risks to the success of the commercial venture, which specifically were securing contracts for the raw coal supply and securing stoker-coal supply contracts for the excess production from the plant.

EFH proposed to cost-share 53% of the total project cost and identified the joint venture (EFH, MPEC, Viking, and Naftokrak-Budowa) as the source of financing through cash and in-kind contributions.

30. Honeywell, Inc.

According to the summary in the DOE Selection Statement, Honeywell proposed a two-year, three-phase cooperative effort with MPEC to renovate the Krakow district heating system to improves its efficiency and to expand the system network controls.

Phase I Honeywell was to install a Supervisory Control and Data Acquisition System (SCADA) to monitor and supervise a pumping station and two group heat exchangers. In addition, was to install a control system in a group heat exchanger not currently connected to the main district heating network.

Phase II Honeywell was to expand the supervision and control of the district heating network to encompass 177 heat exchange stations.

Phase III Honeywell was to install equipment in buildings to provide additional savings in the buildings and to provide individual room comfort control.

The proposed equipment installations and renovations were to reduce energy consumption by 20-40%, reduce emissions particularly from local MPEC boiler houses, provide capacity to serve more customers, allow for retirement of coal-fired boilers, and reduce maintenance and extend equipment life. The products and systems proposed are commercially available and installed in several district heating systems in the U.S. and Western Europe. Such monitoring and control were at the time almost totally lacking in Poland. Financing of continuing efforts would be self-funding from energy savings.

The market in Poland was estimated as valued at about U.S.$ 1 billion based on cost to implement controls for the Balicka district.

Honeywell has the financial capability to support its cash contribution and stated that MPEC also proposed to participate in the cost sharing with cash and in-kind contributions.

31. LSR Technologies, Inc.

According to the summary in the DOE Selection Statement, LSR proposed a core separator system to address the problem of capturing particulate emissions from boilerhouses. The Core Separator avoids the limitation of reduced capture efficiency of conventional cyclone separators at less than rated capacity. Through an internal recirculation system for gases, the cyclones always operate at rated capacity regardless of reduce capacity for the system itself. The Core Separator can operate on a scale as low as 0.25 MWt with no practical limitation on larger capacities. LSR estimated its market penetration in Krakow at 25 units in 1997 (the termination of the DOE project), with annual sales increasing by 25 units through the year 2000.

The project team comprised LSR (the developer and patent owner for the Core Separator), Bradford Metal Works, Ltd. (an English supplier and licensee for European sales), Polinvest Ltd. (a Polish consulting firm), and Nathanson (consultant).

The proposal envisaged a four-year time frame to culminate in the establishment of a business office and a manufacturing facility in Krakow.

As division of work, LSR was to provide training for stack compliance sampling; Bradford, Ltd. training for Polish manufacture; and Polinvest the contribution of expertise and knowledge in the Polish economy and natural environment.

It appeared that the 50% cost sharing for Budget Period 1 was firm, and that LSR and a then to-be-determined source will provide the necessary financing for the second budget period.

32. Shooshanian Engineering Associates, Inc.

According to the summary in the DOE Selection Statement, Shooshanian in conjunction with two Polish firms (MPEC and Polinvest) proposed a two-year pilot project to design and construct new portions of the central station district heating system in the Koniewa district of Krakow. This district has reserve capacity. This new construction would eliminate local polluting boiler houses. The proposal anticipated that by the end of the pilot project, nine local boilers of total capacity of 18.1 MWt will have been connected and eliminated. The expectation was for emission reductions of 130,000 lb per year.

The DOE supported activities were identified for technical and economic studies and design and installation of a pilot state-of-the-art system extension. The indications were that, by the time the project was completed, construction techniques, energy-

efficient system features, and funding strategies will have been identified and optimized to insure financially viable future ventures. Elimination of the boiler house would reduce operating costs for MPEC. The initial cost was estimated at $32,000 per ton of emission reduction, falling later to $14,000 per ton as the Polish side became more experienced.

The market size was projected to be $100 million in Krakow and $1 billion in Poland. The project was planned to be financially self-supporting eventually through revenues from services rendered and recovery of investments through pricing policies, price subsidy, and participation by the Polish public sector. Promotion of the results to other cities in Poland would be based on the experiences gained in Krakow.

The cost share proposed was 50%. Financial commitments were made by MPEC for cash and in-kind contributions.

33. TCS, Inc.

According to the summary in the DOE Selection Statement, TCS proposed a 2.5-year program for the use of micronized coal along with limestone, involving the retrofit of a boiler located at a military base near the Krakow airport. The program proposes to reduce SO_x by the simultaneous combustion of micronized coal and limestone and to reduce NO_x by the combustion of micronized coal in a low NO_x burner.

Team members included TCS for coal micronization and combustion technologies, Amerex, Inc. for baghouse systems, and OPAM (a Polish firm) for design, installation, and construction of the overall system. Equipment would initially be provided from the U.S., but as experience is gained, manufacture and equipment supply would be transferred to OPAM facilities in Katowice. Balance of plant equipment would be provided from Polish sources initially to the greatest extent possible.

Micronized coal has the advantages of high reactivity, lower ignition temperature, earlier combustion completion, and reduction of slagging and erosion. Data indicate that 40-60% reduction in SO_2 is possible. They also indicate that 20% NO_x, 80% CO, and 70% particulate emissions reduction are possible. Since 1980, there have been over 90 TCS mills installed in utility and industrial boilers in the U.S., Canada, Europe, and Israel.

TCS estimated that there are 200 boiler houses in Krakow, 1,600 boiler houses in Silesia, and 3,000 boilers in Poland, which have the potential to use the TCS system. The proposal projected a 5-10% market share. A demonstration facility in Krakow would provide the basis for market penetration.

TCS provided a summary financial plan to fund 50% of the project. The funding sources are the project team members - TCS, Amerex, OPAM, and the Polish Military Unit 1616 - who proposed to contribute cash and in-kind services.

34. Tecogen, Inc.

According to the summary in the DOE Selection Statement, Tecogen (also known as Thermal Power Corporation) proposed as 12-month program to design and install integrated advanced coal technologies in the areas of coal fuel preparation and handling, combustion and emissions control, heat exchange, ash disposal, systems controls, and process integration so as to minimize the environmental impact resulting from the combustion of coal. The members of the project team were Control Techtronics, Pennsylvania State University, Catholic University of America, and four Polish firms - MPEC, Sefajo, Kowent, and Naftokrak.

Installations were planned for the Krzeslawice Boiler House as the means to demonstrate potential emissions reductions from small- and medium-sized boilers throughout Poland and to accomplish the transfer of technology and business operating procedures. The proposed system would have a 4:1 turndown, thermal efficiency greater than 95%, semi-automatic ash removal, once-a-year maintenance, and emissions of less than 0.16 lb SO_2, 0.22 lb NO_x, and 0.087 lb particulates all of the foregoing per million Btu. Emissions reductions were calculated to be 115.06 tons per year at a cost of $9,213 per ton; total emissions reductions at the end of three years as a result of the joint venture was projected to be 441.83 tons per year.

The payback period was projected as two years and two months at 10% interest. MPEC would share in the savings for five years after the debt is repaid; savings become income for the joint venture and will be used to finance partially the next job. The joint venture has a cumulative positive cash balance in year 5 after sales totalling 48 MWt, and projected sales of 388 MWt over 10 years.

Tecogen provided a financial plan for the 50% funding required of the participant. Although Tecogen did not propose to provide cash or in-kind contributions, they provided a letter of intent from JAIDO (Japanese International Development Organization) to provide the equity financing for the project.

35. Project Documents Reviewed

(1) Proceedings for ***Conference on Alternatives for Pollution Control from Coal-Fired Emission Sources***; held in Plzen, Czech Republic; April 26-28, 1994.

(2) Report ***Krakow Clean Fossil Fuels and Energy Efficiency Program - Phase I Report***: Brookhaven National Laboratory, June 1995.

(3) Proceedings for ***Krakow Conference on Low Emission Sources***; October 10-12, 1995; Prepared for Office of Fossil Energy, U.S. Department of Energy by Brookhaven National Laboratory.

(4) Krakow Low Emission Project - Phase III Report; May 23, 1996, Prepared by USAID/Warsaw.

(5) Contract and Amendments (Unnumbered) between Brookhaven National Laboratory (BNL) and Biuro Rozwoju Krakowa - Krakow Development Office (BRK), dated February 11, 1992.

(6) Interagency Agreement between U.S. Agency for International Development and U.S. Department of Energy, dated August 5th, 1991.

(7) Memorandum of Understanding between U.S. Department of Energy and the Polish Government Ministry of Environmental Protection, Natural Resources, and Forestry, dated October 16th, 1991.

(8) Clean Fuel Eko Energia Enterprise - Business Plan, Prepared by Acurex Environmental Corporation, March 14, 1996.

(9) Emissions Reductions in Coal Fired Home Heating Stoves through Use of Briquettes, prepared by Acurex Environmental Corporation, June 19, 1996.

(10) Brochure: ECOCOAL - Institute for the Chemical Processing of Coal, Zabrze, Poland; no date but before May 1992.

APPENDIX B. PERSONS INTERVIEWED

APPENDIX B – EVALUATION OF THE KRAKOW LOW EMISSIONS PROJECT
PERSONS INTERVIEWED AND AFFILIATIONS (Filename: PART09.wk1)

Name	Affiliation	Telephone	Fax
Bardel, Janusz	Krakow Development Office (BRK) Engineering Manager	48–12–11–20–22 Extension 201	48–12–12–55–04
Bazgier, Remigiusz	Production and Breeding of Horticul–tural Plants, Ltd. (PHRO), Krzeszowice Technical Specialist	48–12–82–26–50	48–12–82–26–50
Bieda, Jan	Krakow Development Office (BRK) Innovation Division Director	48–12–11–70–44	48–12–12–55–04
Blaschke, Dr. eng. Zofia	University of Mining and Metallurgy Mining Faculty	48–12–17–20–58	N/A
Boron, Jacek	ECOCOAL Engineering Manager	48–12–44–36–80	48–12–44–55–10
Breault, Dr. Ronald W.	Tecogen, Inc. Sr. Program Manager	617–622–1046	617–622–1075
Butcher, Dr. Thomas A.	Brookhaven National Laboratory Department of Applied Science	516–344–7916	516–344–2359
Cichy, Krzysztof	Production and Breeding of Horticul–tural Plants, Ltd. (PHRO), Krzeszowice Managing Director	48–12–82–26–50	48–12–82–26–50
Ciurlik, Leszek	Krakow Central District Heating Utility (MPEC, S.A.), President	48–12–44–55–33	48–12–44–55–10
Czepiel, Bogdan	Combined Heat and Power Plant, S.A. (EKSA), Development Specialist	48–12–44–21–77 Extension 412	48–12–44–71–74
Donimirski, Adam	Polinvest (Consultants) Vice President	48–12–33–37–92	48–12–34–26–80
Eggleston, Robert H.	ECOCOAL EFH Coal Company	48–12–44–56–33 717–823–7664	48–12–44–55–10 717–829–4515
Fox, Kevin J.	Brookhaven National Laboratory Contract Officer	N/A	N/A
Friedberg, Jan	City of Krakow, Poland Deputy Mayor	48–12–22–97–46	48–12–16–13–77

Name	Affiliation	Telephone	Fax
Gaweda, Miroslaw	Regional Ecological Education Institute Education Specialist	48-12-21-67-36	N/A
Ginter, Jacek	EcoInstal (Poznan) President	48-61-79-03-69	48-61-79-09-81
Glowacki, Kazimierz	Energy Affairs Plenipotentiary to the Mayor of Krakow	48-12-16-15-40	48-12-22-61-90
Goerlich, Krzysztof	City of Krakow, Poland Deputy Mayor	48-12-22-17-38 48-12-16-13-03	48-12-22-81-72
Gorska, Ewa Kinga	Krakow Development Office (BRK) Innovation Division Engineer	48-12-11-20-22 Extension 248	48-12-12-55-04
Gula, Professor Adam	Energy Efficiency Foundation (FEWE) Director	48-12-21-39-89 48-12-21-37-81	48-12-21-30-70
Guzik, Marek J.	U.S. Consulate/Krakow Political Affairs Specialist	48-12-23-00-79	N/A
Gyorke, Douglas	Pittsburgh Energy Technology Center DOE Project Manager	412-892-6173	412-892-4775
Jaglarz, Marek	Krakow Central District Heating Utility (MPEC S.A.), Vice President	48-12-44-57-14	48-12-44-55-10
Jozewicz, Wojciech	Acurex Environmental Corporation Project Manager	919-544-4535	919-544-5690
Kalinowski, Wieslaw	CTI Polska (Joint Venture) Vice President	48-12-66-61-00 Extension 215	48-12-66-61-00 Extension 215
Kaminski, Stanislaw	Ministry of Environmental Protection, Natural Resources and Forestry Deputy Director, Department of Air and Land Protection	48-22-25-20-03	48-22-25-41-41 48-22-
Kaplon, Jerzy	NaftoKrak-Naftobudowa Vice President	48-12-47-07-20	48-12-47-40-65

Name	Affiliation	Telephone	Fax
Kasprzyk, Tadeusz	Combined Heat and Power Plant, S.A. (EKSA), Development and Marketing Manager	48-12-44-79-62	48-12-44-41-74 48-12-44-79-62
Kinda, Ryszard	Krakow Development Office (BRK) President	48-12-11-11-04	48-12-12-55-04
Kossaki, Leszek	Krakow Regional Environmental Protection Department, Air Protection Division Head	48-12-16-05-72	48-12-22-64-90
Kurek, Janusz	Propal Sp.z.o.o. (Katowice) President	48-32-192-2851	48-32-192-2851
Lazecki, Andrzej	Krakow Development Office (BRK) Low-Emission Group Project Engineer	48-12-11-20-22 Extension 201	48-12-12-55-04
Lelek. Magdalena	Shooshanian Engineering Associates, Inc. Project Director	617-426-0110	617-426-7358
Litke, Miroslaw	EcoInstal (Poznan) Director	48-61-79-04-01	48-61-79-09-81
Marshall, Mary B.	U.S. Consul General Krakow, Poland	48-12-23-00-79	N/A
Mayer, Ing. Thomas	Honeywell Austria G.m.b.H Energy Conservation, Project Manager	43-1-727-80-437	43-1-727-80-345
Mazur, Janusz	Krakow Central District Heating Utility (MPEC S.A.), Strategy Office	48-12-44-55-33 Extension 534	48-12-44-55-10
Mundorf, William	Pittsburgh Energy Technology Center/DOE Contract Officer	N/A	N/A
Olds, Suzanne	USAID/Warsaw Mission Director	48-22-630-2840	48-22-628-7486
Olszewski, Grzegorz	Honeywell Sp.z.o.o. (Poland) Project Manager	48-22-642-2570 Extension 117	48-22-640-4599
Pajak, Ewa	Production and Breeding of Horticultural Plants, Ltd. (PHRO), Krzeszowice Production Director	48-12-82-05-25	48-12-82-26-50

Name	Affiliation	Telephone	Fax
Pecikiewicz, Andrjez	USAID/Warsaw Program Assistant	48–22–630–2840	48–22–628–7486
Plewka, Dr. eng. Hieronim	Brikpol Sp.z.o.o. (Lublin) President	48–81–232–27	48–81–232–27
Pointec (Sp?)	Kazimierz–Juliusz Mine (Sosnowicz) Director	N/A	N/A
Rozelle, Pete	EFH Coal Company Vice President	717–823–7664	717–829–4515
Salitra, Adam	NaftoKrak–Naftobudowa Director	48–12–47–07–20	48–12–47–40–65
Sheahan, Richard T.	TCS, Inc. Vice President	410–280–6055	410–280–5007
Strakey, Joseph	Pittsburgh Energy Technology Center/DOE N/A	N/A	N/A
Szewczyk, Thomas	CTI Polska Sp.z.o.o. Chairman of the Board	48–12–66–61–00 Extension 215	48–12–66–61–00 Extension 215
Szewczyk, Witold	Tawimex, Sp.z.o.o. Vice President	48–12–37–31–27 Extension 20	48–12–37–11–63
Telejko, Jaraslaw	Polinvest Ltd. (Consultants) N/A	48–12–33–37–92	48–12–34–26–80
Turzanski, Konrad Pawel	State Inspectorate for Environmental Protection, Vojevodship Inspector	48–12–22–48–95	48–12–22–36–12
Turzanski, Leszek	State Inspectorate for Environmental Protection, Data Manager	48–12–22–19–65	48–12–23–13–99
Uberman, Robert	Polinvest Ltd. (Consultants) Partner	48–12–33–37–92	48–12–34–26–80
Uletowski, Darius	State Inspectorate for Environmental Protection, Data Manager	N/A	N/A

Name	Affiliation	Telephone	Fax
Wertz, Jerzy	Krakow Environmental Protection Department, Director	48–12–22–04–41	48–12–22–64–90
West, John	Control Techtronics, Inc. President	717–257–5440	717–238–4694
Wysk, S. Ronald	LSR Technologies, Inc. Managing Director	508–635–0123	508–635–0058

The listing of personnel above incorporates all contacts made during the field work for the evaluation of the Krakow Clean Fossils Fuels and Energy Efficiency Project. One or more team members interviewed personnel on the Polish side in Poland oftentimes more than once. Team members visted Brookhaven National Laboratory and the Pittsburgh Energy Technology Center, now the Federal Energy Technology Center. Of the eight cooperating firms in Phase 3, team members visited Control Techtronics, Inc. in Harrisburg, PA, and Acurex Environmental Corporation in Durham, NC. In Poland, a team member visited EcoInstal at its booth in the 1996 Poznan Trade Fair and at the same time met with the Project Director for LSR Technologies. Other communications with U.S. firms were conducted by fax.