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**Extension and Improvement of Central Station District
Heating Budget Period I and II
Kraków Clean Fossil Fuels and Energy Efficiency Program**

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**Final Report
July 1997**

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Federal Energy Technology Center
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Abstract: Project aim was to reduce pollution levels in the City of Kraków through the retirement of coal-fired (hand and mechanically-stoked) boiler houses. This was achieved by identifying attractive candidates and connecting them to the Kraków district heating system, thus permitting them to eliminate boiler operations.

Because coal is less costly than district hot water, the district heating company Miejskie Przedsiębiorstwo Energetyki Cieplnej S.A., henceforth identified as MPEC, needed to provide potential customers with incentives for purchasing district heat. These incentives consisted of "offerings" which MPEC made to the prospective client. The offerings presented the economic and environmental benefits to district heating tie-in and also could include conservation studies of the facilities, so that consumption of energy could be reduced and the cost impact on operations mitigated.

Because some of the targeted boiler houses were large, the capacity of the district heating network required enhancement at strategic locations. Consequently, project construction work included both enhancement to the district piping network as well as facility tie-ins.

The process of securing new customers necessitated the strengthening of MPEC's competitive position in Kraków's energy marketplace, which in turn required improvements in marketing, customer service, strategic planning, and project management. Learning how U.S. utilities address these challenges became an integral segment of the project's scope.

Project Scope:

The work was divided into the following major tasks:

- Task 1: Identify and Evaluate Potential District Heating Clients and Develop Client Offering Including Engineering and Economic Analyses; Negotiate Binding Client Commitments
- Task 2: Engineering Design
- Task 3: Construction: Distribution Enhancement and Connection of Clients
- Task 4: Train MPEC Personnel in Marketing, Customer Service, Strategic Planning and Project Management Practices

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I. EXECUTIVE SUMMARY

In 1994 Shooshanian Engineering Associates, Inc. of Boston, in partnership with Miejskie Przedsiębiorstwo Energetyki Cieplnej (MPEC) and Polinvest Ltd. of Kraków, Poland, entered into a cooperative agreement with the U.S. Department of Energy to participate in the *Kraków Clean Fossil Fuels and Energy Efficiency Program*. The program identified practical ways to reduce emissions from the low emission sources (hand and mechanically-stoked boilers) in Kraków, Poland.

The focus of Shooshanian's partnership was to extend and improve the central station district heating system. Extension of the central station district heating system resulted in the elimination of local coal-fired boiler houses in favor of heat supplied by more efficient, less polluting cogeneration plants.

At the closure of the project the following has been accomplished:

- Thirty three facilities located within the City of Kraków, utilizing coal-fired boilers for their thermal energy needs were identified, negotiated with, and connected to the Miejskie Przedsiębiorstwo Energetyki Cieplnej S.A. (MPEC) central high temperature hot water heating network. These facilities are:

Zesp. Szkół Łączności (Monte Cassino 31)
Dworzec PKP (Kraków Rail Station)
Metaloplast (Rydlówka 40)
"De Medici" (Rzemieślnicza 5)
Zesp. Szkół Mech.nr 2 (Skrzyneckiego 12)
Kryniczna 2
Friedleina 10
Friedleina 19
Odrowąża 22
Konfederacka 21
ESPEFA (Lea 208)
Hydrokop (Lea 210)
Słowackiego 26
Słowackiego 28
Łokietka 6b
Grottgera 1/3
Bujwida 4
Kołłątaja 16
Łobzowska 57
Teresy 7
Teresy 16
Słowackiego 11b
Słowackiego 13
Lubelska 27

Śląska 7

Wojskowy Szpital Klin. (Montelupich 3/5)

Areszt Śledczy (Montelupich 7/8)

Dom Pomocy Społecznej (Helclów 2)

Dom Pomocy Społecznej (Zielna 41)

Halicka Street area

Szeroka Street area

Powstańców 48/50

Akademia Rolnicza (29-Listopada 48)

- As a result of site connection to the central heating network, a total of approximately 40.8 MW of coal-fired boilers have been retired, abandoned or demolished. The peak heating capacity shifted to the central network is 28.4 MW. Reduction of subbituminous coal consumption within Kraków is estimated in excess of 13,193 metric tons per year (ton/year).
- Incremental emission reduction associated with the load shift totals 957.8 metric tons per year (ton/year) allocated as follows; Particulates - 265.6 ton/year, Sulfur Oxides (SOx) - 258.3 ton/year, Nitrogen Oxides (NOx) - 45.1 ton/year and Carbon Monoxide (CO) - 388.8 ton/year.
- Total expenditure in the project equates to \$3,924,607. The total cost includes that for client identification, client offering, negotiations, project design, equipment procurement, construction, marketing and customer service. Travel and travel related expenses associated with the project are inclusive in the total.
- The cost to abate a metric ton of boiler emissions for the all the project sites averages \$4,098 per ton of total emission (particulate, SOx, NOx and CO).
- To improve MPEC service to the Kraków energy market, hence encourage potential customers to use clean thermal district energy, selected MPEC employees were provided with comprehensive training in various areas related to efficient operation of the company and greater customer satisfaction. Topics covered in the training component of the project included: utility marketing, customer service, project management and financing, energy studies and strategic planning. MPEC was also equipped with a powerful project management software "Primavera" allowing improved scheduling and tracing of tasks and costs of variety of projects.
- Project team members developed a good working relationship and intend to continue working on potential future joint projects in the area of energy efficiency and environmental protection.

II. PROJECT OVERVIEW

Shooshanian Engineering Associates, Inc. of Boston, MA entered into a partnership with Miejskie Przedsiębiorstwo Energetyki Cieplnej (MPEC) and Polinvest, Ltd. of Kraków, Poland in order to participate in the U.S. Department of Energy's *Kraków Clean Fossil Fuels and Energy Efficiency Program*.

In the most general sense, the project was a construction job, aimed at reducing air pollution in Kraków through the elimination of selected coal-fired boiler plants. This was achieved by extending the district heating system hot water piping into areas of the city originally not served, thus allowing the retirement of local coal-fired boilers. Our work included marketing, technical and economic analysis, engineering design, and construction. This effort was geared towards optimizing the new network segments to be as cost-effective and efficient as possible. Infrastructure improvements included not only the distribution piping, but also all required pumps, heat exchangers, metering, controls, and other items needed to make the system functional, reliable and efficient.

In addition to the design and construction efforts, focus was placed on the development and implementation of marketing strategies which provided theoretical instruction and direct exposure to the robust, market-driven economics of American utility companies.

As the prime contractor, the responsibility of Shooshanian Engineering was to manage the work to ensure that funds were spent prudently and that project tasks are accomplished in a timely manner. In addition, Shooshanian was responsible for all progress reporting to DOE.

Following is a brief description of the project team members:

Shooshanian Engineering Associates, Inc.

Shooshanian Engineering, the U.S. member of the project team, is a mechanical and electrical engineering firm specializing in study, design and construction services for commercial, industrial and institutional clients. Shooshanian Engineering has extensive experience in underground piping, energy distribution, energy conservation and demand side management and has developed close working relationships with both end users and utility companies. Since the early 1970s, the firm has been active in the international arena, providing mechanical and electrical engineering consulting services to governments, corporations and architects worldwide.

Shooshanian Engineering was the Prime Contractor and the principal contact and liaison to the U.S. Department of Energy throughout the project. Shooshanian coordinated activities between the three team members (Shooshanian, MPEC and Polinvest).

MPEC S.A. (Miejskie Przedsiębiorstwo Energetyki Cieplnej S.A.) - Municipal District Heating Company, Joint Stock Company

MPEC is a municipal district heating company. MPEC's core business involves the distribution and supply of hot water for space heating and for domestic hot water in the city of Kraków. MPEC also delivers process steam to a small number of customers. The majority of heat distributed by MPEC is purchased from three combined heat and power (CHP) plants. MPEC also owns and/or operates a number of heat-only plants. Hot water is distributed to customers located throughout the city via a network of approximately 700 kilometers (approx. 438 miles) of mostly underground pipes. The peak demand output supplied by MPEC exceeds 1,800 MW.

MPEC played a very important role in the project as it was MPEC's network that was being expanded and improved. MPEC also shared in the overall cost of the project.

Polinvest Ltd.

Polinvest is a Polish economic and legal consulting firm providing a range of services for commercial, industrial, state and private sector clients. Polinvest has expertise in the following areas: privatization and restructuring of state owned enterprises, management consulting, marketing strategies and planning, economic analyses and feasibility studies, real estate ownership issues, tax regulations and legal advice, organization of finance, negotiations with Polish and foreign investors, etc.

Polinvest was responsible for providing the bulk of the legal and economic analysis and assistance in this area to other project partners. Polinvest performed work as a subcontractor to Shooshanian.

III. SCOPE AND SCHEDULE OF WORK

A. General

The objective of this project was twofold:

- To reduce atmospheric emissions in the city of Kraków by retiring local coal-fired boiler houses and connecting their loads to the district heating network. At the beginning of the project it was expected that over 18 MW worth of coal-fired boilers would be retired in the course of the project. This number however, was significantly exceeded and amounted to 28.4 MW.
- To create a new Polish-U.S. commercial enterprise designed to promote:
 - * district heating as a cost-effective, marketable alternative to fossil fuel-fired heating supplied by small local boilers
 - * energy conservation services

To attain the ultimate goals described above, a number of key strategies had to be implemented. These included:

- identifying energy conservation measures to reduce energy consumption by the end-user thus offsetting increased utility costs for customers that switch from coal to more expensive district heat.
- reducing energy losses in the heat distribution system by introducing modern equipment and controls thus ultimately reducing distribution cost.
- introducing new cross-connections between the main heat transmission lines to improve the system's redundancy and reliability (an important marketing component for potential customers), and overall hydraulics.
- providing MPEC with knowledge of marketing and customer service techniques, allowing MPEC to improve its service quality and ultimately the image of the company which has historically been very poor.
- exposing MPEC to modern project management methods which make possible improvements in the management of construction projects and prudent use of the available resources.
- introducing to MPEC new project financing methods aimed at helping MPEC identify available funds for further expansion of the district heating system.

- evaluating market and demand for similar services to be provided by new ventures elsewhere in Poland and in the entire region, and if feasible and desirable creating a new joint venture to render these services.

With these strategies implemented, an efficient and market-oriented district heating company was envisioned to be in place at the conclusion of the project. This company should have the capability to provide extensive energy-related services, including the following:

- * Comprehensive energy conservation and pollution abatement studies, which will encourage the retirement of coal-fired plants while simultaneously minimizing costs associated with district network connection.
- * Financial advice and potential financial incentives for network connection. Such efforts will serve to illuminate the long-term fiscal benefits of district heating to the building owner.
- * State-of-the-art engineering analysis and design. The originally envisioned joint venture was to provide unparalleled engineering services relating to heating technologies.

The project work was divided into two phases. Phase I included market assessment, analytic and experimental evaluation of customer sites, preliminary system installations and the development of an effective marketing strategy.

Phase II capitalized on the work of Phase I and focused on utilizing the developed techniques to secure additional clients for tie-in to the district heating system. Marketing strategies were further refined and incrementally developed during Phase II.

B. Scope of Work

In general the scope of work can be divided into the following major tasks:

Task 1.

Identification and evaluation of potential district heating clients, development of client offering (including engineering and economic analyses), and negotiation of binding agreements.

Task 2.

Engineering design of the new client connections.

Task 3.

Construction activities including hot water distribution enhancement and connection of clients.

Task 4.

Training of MPEC personnel in:

- marketing, customer services, and strategic planning practices, including assistance in establishing a Marketing Department and a Customer Service Office,
- energy conservation studies,
- project management and financing techniques.

Task 5.

Joint venture formulation including market research, investigation of potential clients and projects, joint services proposal development, financial planning and legal issues analyses.

As previously mentioned, the work was carried out in two phases. Because the notion of selling district heating in a competitive marketplace is new to Poland, a significant portion of the Phase I tasks was geared towards marketing through the development of promotional materials which can be used to educate potential customers to the advantages of district heating, by providing new and beneficial customer services that enhance the appeal of both district heating and the envisioned heating company, and by providing customers with economic expertise so that they may fairly assess the benefits and disadvantages of the district heating tie-in. In particular, Phase I included the following tasks:

- Identification of attractive, viable candidates to tie into the district heating system
- Development of a packaged offering which MPEC may present to the potential customers, outlining the benefits of district heating
- Physical tie-in of the targeted customers to the MPEC district heating system

- Development of a marketing strategy for MPEC which accentuates, from the customers' perspective, the economical and environmental benefits of district heating
- Provide training for MPEC personnel in utility marketing techniques, demand-side management planning, financing practices, etc.

During Phase II, the developed services were refined and applied to a new pool of potential customers. The major thrust of Phase II was customer tie-in, with continued training activities and only minor adjustments to the economic and energy conservation services developed in Phase I.

Phase II included the following tasks:

- Continued identification of promising candidates for tie-in to the district heating system
- Presentation of customer offerings and negotiation of the long term contracts
- Physical tie-in of new customers to the MPEC district heating network
- Refinement of marketing strategies with particular emphasis on customer service activities, and energy conservation practices
- Training for MPEC in the US strategic planning techniques, capital raising methods, and project management practices

The following is a more detailed discussion of the tasks in each budget period.

Budget Period I:

Identification of Clients: It was highly desirable to locate large, consistent users of thermal energy for network tie-in. These users provide the greatest potential for emissions reductions and supply MPEC with a reliable revenue source following tie-in.

Feasibility Studies: Once clients were tentatively identified, a preliminary examination of connection requirements and costs, conservation opportunities and appropriate technologies, economic ramifications, and emission reduction effects (environmental and economic) was performed. This helped to isolate the most attractive candidates for tie-in to the network.

Incentive Analysis: MPEC was encouraged to develop pricing strategies to promote acceptance of district heating.

Negotiations with Boiler Owners: Negotiations with the owners of the targeted boiler houses were required to determine their interest in and commitment to district heating system tie-in.

Engineering Studies: As a part of the negotiations, some clients who agreed to proceed with the tie-in process underwent energy conservation studies. The studies were used to help clients lower their district heating connection and operating costs, and aid them in their energy and cost allocation efforts.

Design: This included the preparation of drawings and specifications. These documents defined the work to be done and were used to competitively bid the construction work.

Phase I Construction: This work was managed primarily by MPEC, with some construction administration assistance by Shooshanian. The work involved all construction activities allowing physical interconnection between MPEC's heat distribution network and a customer's facility. This included installation of underground hot water piping, heat exchanger stations, electrical wiring, control and automation systems.

Marketing Development: District heating is to be marketed to customers as "clean", relatively reliable and inexpensive to install and maintain. It must compete with other heating sources in the marketplace, such as oil and natural gas. In an effort to secure market share, a marketing department was developed within MPEC, which effectively promotes district heating as the preferred alternative. The marketing department plans to utilize the following:

Education: Develop and distribute informational literature describing the environmental, economic and cost benefits of district heating to the customer.

Analytical Services: Render engineering and economic analysis services which provide the customer with maximized facility efficiency and minimized operating costs. Streamline and standardize the services to enable broad application, both in Poland and elsewhere.

Funding Options: Develop new and innovative financing options to stimulate network connection. Where appropriate, develop incentive programs which reward the selection of district heating.

A significant portion of the marketing development consisted of customer service and utility marketing training for MPEC personnel. A delegation of six management- level MPEC personnel traveled to the United States in January 1995 to confer with utility specialists in incentivization, demand-side management, financial planning, advertising and marketing practices. MPEC was also provided with marketing training at their headquarters in Kraków covering:

- Marketing Department Activities
- Market Research
- Local Legal and Economic Considerations
- Telephone and Software Systems
- Public Relations

- Negotiation
- Determination of Peak Load
- Collection of Accounts Receivable
- Comparative Cost Analyses

Budget Period II:

Client identification and evaluation: Client identification, assessment of the feasibility of the client connection, incentives analysis, and negotiations with clients were also components of Budget Period II scope of work. Methodology for these tasks, developed in Budget Period I, was used and further improved upon. As a result, several new customers signed binding agreements with MPEC for the supply of district heat.

Engineering Analysis and Economic Studies: As in Phase I, potential customers were provided with engineering and economic services which maximized the value of district heating tie-in.

Engineering Design: Similar to Phase I

Phase II Construction: Similar to Phase I. As in Phase I, several more customers were tied into the district heating network.

Refinement of marketing techniques: In order to effectively market district heating services, MPEC needed to improve the image of the company which historically was very poor. One of the reasons for the poor image was lack of adequate customer service and absence of any form of customer service office, where employees would be assigned exclusively to deal with customer inquiries and concerns. Resulting from Budget Period I marketing development activities was a recognition of the necessity to create a customer service group, staffed with trained personnel dedicated to providing quality customer service.

In Budget Period II, to help MPEC accomplish this goal, a training seminar took place in Boston for six MPEC employees to provide them with the knowledge of customer service techniques used by US utilities. Following the training, a customer service office was opened at MPEC headquarters building in Kraków.

Energy conservation promotion: To successfully promote prudent energy use and provide energy conservation-related services, MPEC employees were trained in the methodology and tools used in conducting technical audits for facilities.

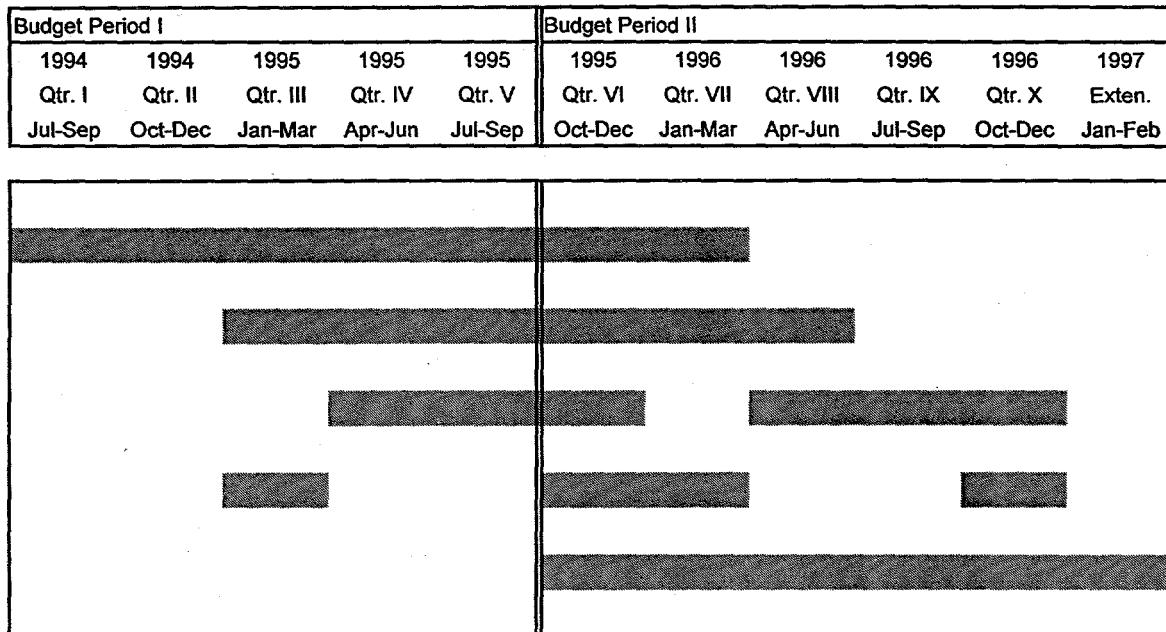
Building skills in strategic planning for utility companies: To further MPEC's efforts to successfully market and continuously increase supply of the clean district thermal energy, short and long term strategic planning issues were addressed in a week long seminar conducted in Boston, MA for six MPEC senior management representatives. Lectures, panel discussions and meetings with their US counterparts introduced MPEC trainees to modern strategic planning techniques used by US utility companies.

Raising capital and improving methods of managing construction projects: Every year MPEC completes numerous construction projects ranging in size from small equipment or distribution pipeline repairs, to large capital intensive construction of primary infrastructure improvements or expansion. To improve planning and implementation of future projects, four MPEC representatives from the Construction and Marketing and Development Departments attended a four day seminar dedicated to project management. Various aspects of raising funds for new projects were also addressed in the project financing portion of the seminar.

Future business development: It has been one of the project goals to investigate Polish energy market and evaluate existing and future demand for energy related services and products. Efforts related to this task focused on discussions with potential clients, charting the basis for future cooperation between Polish and American project team members and positioning the team in the marketplace.

C. Schedule of Work

The graph below represents the schedule of work that was followed in the project.



Task 1 Identify potential clients, develop offerings, negotiate binding agreements

Task 2 Engineering design

Task 3 Construction and clients connection

Task 4 Training

Task 5 Market research, funding framework, analysis of legal issues for future cooperation and joint projects

D. Areas of Responsibilities and Respective Contributions of Project Team Members

Specific areas of responsibility and contributions of project team members were as follows:

Shooshanian:

- Management and reporting functions of prime contractor.
- Preliminary energy utilization analysis and development of energy conservation strategies for selected potential customers.
- Preliminary comparative engineering and economic analyses of facility conservation options for selected potential customers.
- Calculation of emissions reduction due to the elimination of local coal-fired boilers.
- Preparation of preliminary implementation costs and energy savings attributable to conservation efforts.
- Participation in the development of coherent marketing approach utilizing engineering optimization, financing options, conservation studies, advertising and improvement of public relations to expand the district heating market share.
- Development and execution of training programs in which MPEC personnel were introduced to the utility marketing and demand-side management techniques applied in the US.
- Preparation and execution of training in customer service organizations to familiarize MPEC with customer service concepts and functions in utility companies.
- Assistance to MPEC in establishing Customer Service Office.
- Preparation and execution of an on-site energy audit training to equip MPEC with the ability to offer potential customers added value for converting to the district heating system.
- Formulation and delivery of a Strategic Planning Seminar for six MPEC senior executives and department managers.
- Design and execution of training in project management and financing.
- Technical advice to MPEC on available new technologies in the area of heat generation and distribution, HVAC systems and energy conservation.
- Assistance in identifying potential third-party investors.

MPEC:

- Technical expertise in existing distribution system configuration.
- Evaluation of existing customer tie-in practices and technologies.
- Operational requirements and controls.
- Negotiations with coal-fired boiler owners and other entities for possible financing of customer connections and boiler load shifting to the district heating system.
- Preparation of customer offerings for the connection to district heat and negotiated binding agreements.
- Customers facility/network interface design.
- Construction planning and oversight.
- Evaluation of new district heat technology implementation.

Polinvest:

- Legal and economic expertise to identify the Polish regulations relevant to the project tasks.
- Cost/benefit analysis of the connection of selected potential customers.
- Determination of boiler house ownership, if required, and delineation of ownership issues.
- Analysis of environmental costs.
- Comparative analyses of different heat sources for selected potential customers.
- Negotiations with potential customers.
- Preliminary evaluation of legal and economical issues for selected potential customers.
- Preparation and presentation of a one day training session (part of marketing training session prepared by Shooshanian as described above) on local legal and economic considerations.
- Assistance in the development of customer offerings.
- Help in identifying new project leads and potential business opportunities.

IV. PROJECT ACTIVITIES

A. General

Project work was originally scheduled to take place over a two year period. It was subsequently extended for an additional nine and one half months. Budget Period I included the first year of work plus a three month extension period. Budget Period II included the three remaining quarters of the second year and nine and one half months of extension periods.

Activities are summarized by quarter or extension period on the following pages. Where appropriate, reference is made to previously submitted quarterly reports.

Activities undertaken in Budget Period I are only briefly summarized here. The comprehensive discussion for that period was provided in the Final Report for Budget Period I submitted to DOE in October 1995.

B. Activities in Budget Period I - Summary (July, 1994 - September 30, 1995)

Quarter I (July 1 - September 30, 1994)

First quarter work concentrated on two areas:

- Definition and Refinement of Scope of Work between MPEC, Shooshanian and Polinvest

Due to changes in the MPEC customer base, revisions to long-term expansion plans and an enhanced awareness of customer tie-in potential since the original proposal, Shooshanian, MPEC and Polinvest Ltd. needed to revise their inter-team agreement to ensure that attractive customer sites would be brought onto the district heating network. Although the overall project objective and emission reduction targets remained unchanged, the implementation plan required significant revisions. These modifications took shape over several days of negotiations in April, August and September of 1994.

- The preliminary evaluation of energy conservation potential and viability of district heating tie-in for ten potential MPEC customers.

In conjunction with Polinvest, MPEC developed a list of potential customers for connection to the district heating system. In order to ascertain the most attractive candidates, a preliminary examination of the sites was carried out, focusing on:

- energy conservation potential at the ten sites
- economic status of the sites
- owner interest in tie-in

Shooshanian performed substantial preliminary field work over Quarter I. Ten customer sites were examined to determine their viability as district heating customers. "Viability" entailed logistical practicality, customer interest in district heating interconnection and customer financial stability. Shooshanian worked with Polinvest Ltd. to provide MPEC with a summary report of this work, a copy of which was included in the appendix of the Quarter I Technical Progress Report submitted to DOE in October 1994.

Quarter II (October 1 - December 31, 1994)

Quarter II efforts focused on MPEC offerings and negotiations with potential clients, and on development of a marketing and customer service training program for a training session which was conducted for a Polish delegation during a visit to Boston in January 1995.

Activities in the second quarter included the following (for support materials consult the appendix of the Quarter II Technical Progress Report submitted to DOE in January 1995):

- A binding agreement between MPEC and PKP (Polish rail) was signed. PKP, the Polish rail authority, has agreed to utilize MPEC district heating for the Kraków train station. The load shed under Budget Period I was 1.2 MW in coal-fired heating. PKP hopes to connect additional office facilities located nearby in the future, bringing the total load shed to 3.0 MW.

There are several significant benefits to the signing of PKP. First, the train station is centrally located just outside of the Old Town (Stare Miasto). Hence, it is a highly visible acquisition for MPEC and may have marketing value in the future.

PKP indicated an interest in connecting a nearby office building to the MPEC system. Thus, PKP is a customer with growth potential.

Third, by extending the district heating network to the PKP station, MPEC can begin to develop a long-term strategy for the neighborhoods of Wesoła, Warszawskie and Piasek. Future expansions, over three or four years, into these neighborhoods could permit the retirement of over 30 MW in coal-fired boiler houses.

Due to its public use, the rail station can be an excellent showplace for conservation activities, system reliability and system functionality (i.e. comfort).

Finally, connection of the rail station permitted commencement of major hydraulic improvements to the district heating network, which in turn simplifies the connection of future customers in the surrounding area.

- An engineering assessment of various mechanical design options was performed for WSK, an attractive potential customer for MPEC district heating. WSK is a large manufacturing plant operating approximately 13 MW of coal-fired boilers to meet their heating load. MPEC's offering to WSK consequently suffered, since it was unclear to WSK management whether or not the district heating system could meet facility loading adequately due to several technical difficulties. Shooshanian Engineering was brought to the site to assess the facility hot water system and to ascertain whether district heating could indeed work.

Shooshanian's analysis of the hot water system at WSK revealed that with modest changes in the site distribution piping and with utilization of modern heat exchanger technologies, WSK could not only be extremely well served by MPEC, it could also enjoy extensively improved overall plant operations.

Shooshanian prepared a set of schematic drawings for MPEC and WSK review which were very well received. It was hoped that with the technical issues now clearly described and addressed, WSK would proceed with an agreement. Consult the Quarter II Technical Progress Report for the assessment.

- A preliminary evaluation of energy conservation potential and district heating tie-in viability for possible MPEC customers located in the Bagatela district of Kraków was performed. Due to its location abutting the Old Town, there had been significant interest in eliminating boiler houses from the Bagatela district. Unfortunately, the boiler houses in this area are widely scattered, generally difficult to access, and small in size. In general, conditions were found to be unfavorable for district heating in these buildings. Consequently, MPEC could not economically rationalize development into Bagatela at that time. Most likely natural gas will emerge as the preferred fuel in this neighborhood. Consult the Quarter II Technical Progress Report for the assessment.
- Negotiations with potential clients continued.
- Shooshanian developed a *Marketing and Customer Service Training Manual* for MPEC to assist the company in defining the services which should be provided in a competitive marketplace. MPEC has recognized a new market situation, where due to political changes the company is forced to compete with alternative heating solutions such as gas and oil. MPEC has identified marketing and customer service as key ingredients to successful competition, while acknowledging its own lack of experience and knowledge in these areas.

The manual described at a fundamental level what these services are and what they are intended to accomplish. It also discussed techniques applied by three U.S. utilities in an effort to illustrate practical (or at least actual) implementation of marketing and customer service principles. The manual was prepared as a supplement to the marketing and customer service training session that was conducted in Boston in the subsequent quarter. Consult the Quarter II Technical Progress Report for a copy of the manual.

- A survey and review of US district heating (and cooling) practices and pricing was conducted to be used by MPEC in development of a marketing department. The review discussed various rates and typical district heating billing practices in the United States and described the rationale behind them. The advantages of long-term customer agreements and their impact on rates were stressed, as was the linkage between energy use and cost.

Quarter III (January 1 - March 31, 1995)

The Quarter III effort focused on engineering design, procurement of piping for construction, and Marketing and Customer Service training. Ongoing negotiations with the potential customers continued. Three additional customers signed binding agreements with MPEC indicating their commitment to the purchase of district heat.

Activities in the third quarter included the following:

- Binding agreements were signed with ESPEFA, Technikum Łączności (Technical School), and Metaloplast. The Metaloplast site includes the Metaloplast facility and two other adjacent facilities: "De'Medici" Krak. Zakł. Futrz. (fur and leather processing factory), and Zesp. Szkół Mech. nr 2.(mechanical school).
- Design of the network extension into PKP and connection of the facility with the district heating system proceeded. Shooshanian was shown detailed drawings of the work to be performed and provided with copies of the plans. The bid for the construction of the designed pipelines was awarded to Naftokrak-Naftobudowa (local construction company) in late March.
- A delegation from MPEC visited Boston to meet with U.S. utility representatives and their customers. The training visit introduced MPEC personnel to United States practices in utility marketing and to the working of utility customer service offices. The visited utilities included: Boston Edison (the local electric utility), Trigen (a Boston-based district steam supplier) and Commonwealth Energy Systems (a Cambridge-based supplier of district steam).
- A week-long training session was held in Kraków. It covered various marketing and customer service topics in detail. This included development of a companion manual, a copy of which was forwarded for DOE documentation with the Quarter III Technical Progress Report submitted in May 1995.

A team of four engineers from Shooshanian traveled to Kraków to provide the training. Feedback from MPEC personnel indicated that the training sessions were very well received by the MPEC staff. Topics covered included:

- Marketing and Customer Service Department Activities
- The Role of Marketing Research
- Software and Telephone Systems
- Local Legal and Economic Considerations
- Negotiation
- Public Relations
- Building Load Determination
- Collection of Accounts Receivable
- Comparative Cost Analysis

The section on local legal and economic considerations was provided by Polinvest Consultants, Ltd.

- Ongoing negotiations with potential clients continued.
- Shooshanian requested a Budget Period I extension to September 30th to accommodate brief delays in the construction schedule.

Quarter IV (April 1 - June 30, 1995)

The Quarter IV effort focused on engineering design, procurement of materials for construction and actual construction for ESPEFA, Technikum Łączności (Technical School), PKP (Polish Rail) and Metaloplast.

Activities in Quarter IV included the following:

- The design of the network extension connecting ESPEFA, Technikum Łączności, PKP and Metaloplast with the district heating system was prepared.
- Construction of extensions to the piping network and connections of Budget Period I customer sites was begun.
- Negotiations with potential clients continued. Signing of binding agreement between MPEC and Hydrokop indicating Hydrokop's intention to purchase district heat. Hydrokop is a large office building located in close proximity to ESPEFA.
- MPEC approached Shooshanian with a request for additional marketing and customer service training sessions.
- Construction documentation was processed.
- Future cooperation and joint commercial activities between MPEC, Shooshanian, and Polinvest after completion of the DOE sponsored project were discussed.

Budget Period I Extension (July 1 - September 30, 1995)

The Budget Period I Extension effort focused primarily on final engineering design and actual construction for the ESPEFA, Technikum Łączności (Technical School), PKP (Polish Rail) and Metaloplast sites, and seven MPEC owned and/or operated local, coal-fired boiler houses.

Activities in the Budget Period I Extension included the following:

- Connections to the district heating system for Technikum Łaczności, PKP, Metaloplast, De'Medici, Mechanical School and five MPEC operated local boiler houses were substantially completed. This work led to the retirement of 10.3 MW of hand-stoked, coal-fired boilers at the six sites. Total heating load shifted to the district heating system was equivalent to 7.2 MW.
- A pollution reduction assessment was performed based on empirical data compiled by the Polish government and the United States Environmental Protection Agency (EPA). Pollution reduction analyses are issued on a facility-by-facility basis and are included in Chapter VI of this report.

- A total of 34 new sites were identified for possible connection to the district heating system under Budget Period II. Total load planned to be connected was estimated at 20 MW for these sites.
- Construction documentation was processed.
- Ongoing discussions were held on future cooperation between Shooshanian and Polish partners.
- An MPEC delegation of four visited Boston in early July. The group included: MPEC Vice President and Director of Shooshanian Project, Mr. Ryszard Frankiewicz, Manager of Shooshanian Project and MPEC's Deputy Head of Strategic Planning Office, Mr. Janusz Mazur, Deputy Head of MPEC Construction Department, Mr. Jerzy Bielewicz, and Emission Reduction Specialist Mr. Wiesław Krowicki. The visit agenda included construction status, scope of work as well as budget, invoicing and training issues.
- Shooshanian, in conjunction with MPEC and Polinvest, submitted to DOE the Continuation Application for Budget Period II.

C. Activities in Budget Period II

1. Quarter VI (October 1 - December 31, 1995)

The Quarter VI effort has focused on completion of the 1995 construction season, customer service and energy audit training, negotiations and preparations of customer agreements, and discussions about Shooshanian and MPEC joint venture opportunities. A number of customers have signed binding agreements with MPEC indicating their commitment to purchasing district heat. The design activities involved in connecting these customers were scheduled to occur in Quarter VII.

Activities in Quarter VI included the following:

- Completion of the district heating connections continued at some of the Budget Period I sites until the end of the 1995 construction season.
- A team from Shooshanian visited Kraków, Poland in the month of October. The agenda for the visit included a presentation at the Kraków Conference on Low Emission Sources for the Kraków Clean Fossil Fuels and Energy Efficiency Program. The visit agenda also included review of construction activities, planning and project budgeting.
- Shooshanian performed an on-site energy audit training involving facilities located in Stare Miasto (the Old Town) in Kraków. The training introduced MPEC personnel to United States energy auditing practices and equipped MPEC with the ability to offer added value to potential new customers for converting to district heat.
- Members of the MPEC Marketing Department visited Boston in December. The subject of the visit was customer service and marketing techniques. MPEC also confirmed an earlier request for an executive strategic planning training seminar. It was scheduled to be conducted in Boston in January or February 1996.
- Ongoing negotiations with potential clients continued. A list of ten promising customers and seven MPEC owned and/or operated boiler houses considered for conversion to the district heating system in Budget Period II was established. The cumulative coal-fired boiler capacity at these sites was estimated to be in excess of 20 MW. One of the potential customers was WSK (large manufacturing company), with which discussions had been reinstated and were continuing.
- Preliminary (conceptual) design of Budget Period II client connections was created. The bidding process was also begun for the selection of the design firms that were to prepare complete technical designs of network connections for new customers.
- Construction documentation, Budget Period I Final Report and ongoing reports (Monthly Summary, Quarterly Foreign Travel Report) were processed.

- Formal discussions began about Shooshanian and MPEC joint venture opportunities for future projects incorporating U.S. products and services and utilizing complimentary expertise of both companies.

What follows is a brief discussion of the Quarter VI activities. For support materials consult the appendix of the Quarter VI Technical Progress Report submitted to DOE in February 1996.

Final construction stage at PKP: The heat exchanger connecting the PKP building with MPEC's network branch was installed allowing the supply of district heat to commence. Network (outdoor) work continued (also sparingly due to the weather conditions) in some Budget Period I sites (ESPEFA, Hydrokop) until late fall.

October visit to Kraków: Doug Yon and Maria Lelek traveled to Poland for the week of 8-13 October to represent Shooshanian Engineering Associates, Inc. at the Kraków Conference on Low Emission Sources, where they reported on Budget Period I activities. They toured some of Budget Period I sites with the representatives from DOE, the World Bank, Brookhaven Laboratory and MPEC. They also collected additional data for construction and cost documentation involving Budget Period I sites.

Kraków Energy Audit Training: During the period of 7-16 December 1995, Harry Shanley, P.E. of Shooshanian, traveled to Kraków to provide on-site energy audit training involving facilities located in Stare Miasto (the Old Town). The training equipped MPEC with the ability to offer potential new customers with added value for converting to the district heating system.

Shooshanian engaged local assistance from the Instytut Inżynierii Cieplnej I Ochrony Powietrza, Politechnika Krakowska (Kraków University of Technology, Institute of Heat Engineering and Air Protection) to provide general instructions on basic thermal properties of materials and heat transfer. Assistance was also provided on how to conduct basic facility surveys and to perform heat demand calculations in accordance with local codes and standards. The University prepared a report containing the results of tasks carried out by their personnel. The report was completed in January.

Shooshanian provided instructions on application and analysis of energy conservation measures. Other Shooshanian activities included:

- Audit and evaluation of energy conservation measures for the Old City Hall, a distinguished historical building located at the Main Square in Stare Miasto.
- Audit and building survey training for individuals selected by MPEC.
- Demonstration of the capabilities of the DOE-2 Building Modeling Program. As a result, MPEC is considering a purchase of the program.

- Delivery of surface temperature and heat-transfer coefficient ("K") measuring devices

The surface temperature measuring instrument (Omega Infrared Thermometer) subsequently had to be returned as it was not performing acceptably. It was replaced with a different model, a US made MIKRON infrared thermometer with laser sighting. The new instrument operated satisfactorily. MPEC is planning on using it not only for surface temperature measurements but also for maintenance procedures in detecting trouble spots in insulation etc.

Shooshanian continued to work on a comprehensive energy audit report including conservation measure calculations. The report was finished at the end of February, 1996.

Visit to Boston of the members of the MPEC Marketing Department: Shooshanian designed and conducted a training program on Customer Service Organizations, which took place during the week of December 4, 1995. The training session was attended by six MPEC employees: the Director of Marketing, the Manager of Customer Service, the Manager of Billing, and three customer service representatives. This training session differed from the one previously held in Boston on marketing and customer service by concentrating specifically on customer service issues and the operations of call-in centers.

Shooshanian prepared a 26 page supplemental report which included examples of organizational structures of customer service and sales departments, descriptions of jobs and responsibilities, and techniques for handling difficult customers. A copy of this report was included in the appendix to Quarter VI Technical Progress Report.

The week's activities included three site visits to local utility call-in centers, lectures, and an interesting panel discussion with invited guests. The panelists were a sales engineer, a manager of customer service, a market research consultant, and a large purchaser of utilities. The various viewpoints of our guests provided insight and breadth to the discussion of customer service.

During the week, additional ways of improving MPEC operations were identified and discussed. The trainees learned a lot by observing the physical layout and equipment of the call-in centers, and by hearing how the performance of the customer service representatives is measured. The training program was viewed as a tremendous success.

Selection of tentative construction tasks for Budget Period II: A list of tentative construction tasks was prepared including two new customers who had signed agreements for connection to the district heating network in June and July 1995, eight promising potential customers, and seven MPEC owned and/or operated boiler houses. The two committed customers were the temporary retention jail located in the center of Kraków at Montelupich 7 Street and the Nursing Home located in the south-west part of town at Zielna 41 Street.

In the course of Quarter VI, as a result of preceding negotiations, three more customers signed agreements indicating their commitment to purchase district heat. They included: the Academy of Agriculture located along 29-Listopada Avenue, the Military Hospital facilities located at

Montelupich 3 Street, and Studium Medyczne (medical school) located at Michałowskiego 12 Street.

MPEC solicitation of bids for design work for future Budget Period II construction: MPEC published in the local newspaper, the request for proposals for design services for 1996 construction work.

Formal discussions about a joint venture: A number of discussions about Shooshanian and MPEC joint venture opportunities for future projects took place in Quarter VI. A working document summarizing these discussions was prepared and presented to MPEC's executives before their visit to Boston in February 1996. The document was meant to serve as the basis for continued discussion of the issue, leading to the creation of a valuable business entity shared by both organizations. A copy of the document was included in the appendix of Quarter VI Technical Progress Report.

2. Quarter VII (January 1 - March 31, 1996)

The Quarter VII effort focused on making preparations for the 1996 construction season, delivery of an Energy Audit Report, training in strategic planning, negotiations and preparations of customer agreements, and discussions about Shooshanian and MPEC joint venture opportunities. MPEC continued pursuing new customers and negotiating new agreements for connections to the district heating system. Designs were under way to provide connections for newly committed customers.

In general, activities in Quarter VII included the following:

- Energy Audit: Shooshanian issued an energy audit using data collected at the on-site energy audit training involving facilities located in Stare Miasto (the Old Town) in Kraków. The training, conducted in Quarter VI, introduced MPEC personnel to United States practices in energy auditing and equipped MPEC with the ability to offer added value to potential new customers for converting to district heat.
- Strategic Planning: Shooshanian conducted a Strategic Planning Seminar for top level MPEC executives. The seminar introduced MPEC executives to U.S. management practices associated with the strategic planning processes of utility companies.
- Ongoing negotiations with potential clients: New potential customers were contacted and evaluated for conversion and connection to the district heating system. The previously reinstated discussions with WSK concluded without an agreement reached.
- Design: MPEC completed the bidding process for the selection of the design firms that later prepared complete technical designs of network connections for new customers. Preliminary (conceptual) design work was continued on the Budget Period II client connections. Actual designs of the distribution piping for committed customers were begun.
- Reports: As appropriate, Shooshanian worked on ongoing reports (Monthly Summary, Quarterly Foreign Travel Report, Quarterly Technical Progress Report and Federal Assistance Management Summary).
- Shooshanian and MPEC signed a "Memorandum of Understanding" and "Letter of Intent" describing joint venture opportunities for future projects incorporating U.S. products and services and utilizing the collective strength and experience of both companies. Formal discussions about additional Shooshanian and MPEC joint venture opportunities were continued.

What follows is a brief discussion of the Quarter VII activities. Documentation and support materials can be found in the appendix to the Quarter VII Technical Progress Report submitted to DOE in April 1996.

Technical Energy Audit Report: Based on data collected during the on-site energy audit training conducted in Quarter VI, Harry Shanley, P.E. of Shooshanian completed a Technical Energy Audit Report for the Old City Hall Tower which is located in the Main Square of Stare Miasto (the Old Town) in Kraków. The report was a comprehensive energy audit including conservation measure analysis and savings calculations. The report was submitted to MPEC in February 1996. A copy of the Technical Energy Audit Report was included with Quarter VII Technical Progress Report.

Having participated in the energy audit training, the Instytut Inżynierii Cieplnej I Ochrony Powietrza, Politechnika Krakowska (Kraków University of Technology, Institute of Heat Engineering and Air Protection), submitted a report to MPEC that contained the results of the cooperative tasks carried out by the University's personnel. The University report was not submitted to Shooshanian.

Strategic Planning Training Program: Shooshanian formulated and conducted a Strategic Planning Seminar which took place in Boston during the week of February 3, 1996. The seminar sessions were attended by six MPEC Senior Executives and Departmental managers: Mr. Leszek Ciurlik, President; Mr. Marek Jaglarz, Vice President; Mr. Adam Świerz, Manager of the Strategic Planning Department; Mr. Jacek Boroń, Manager of the Marketing Department; Mr. Marek Iwanek, Manager of the Network Department and Member of the MPEC Supervisory Board; and Mr. Tomasz Zimnicki, a Business Plan Specialist. The training included Shooshanian lectures on the latest strategic planning tools, a one day workshop by a management consulting firm, and a panel discussion on the strategic planning process with invited guests of various backgrounds.

Outside consultants were limited to Arthur D. Little, Inc. and Ms. Kathleen Therrien, who is a former Boston Edison Sales Management executive. Arthur D. Little, led by Mr. Steven Fink, presented a full day workshop covering strategic planning in the utility industry and conducted "visioning exercises." Ms. Kathleen Therrien provided a lecture on strategic planning tools. With the assistance of Ms. Lisa Kolarik of Shooshanian, Ms. Therrien led a workshop on "What If Scenarios."

Panel guests discussing the strategic planning process included Mr. James Hall, Manager of Steam Marketing for Trigen-Boston Energy Corporation; Mr. Paul Gromer, former Commissioner of Massachusetts Division of Energy Resources; Mr. Joe Posk, Quality Manager for Narragansett Electric Company; Ms. Kathleen Therrien, former Sales Manager for the Boston Edison Company; and Mr. Philip Giudice, Vice President of Mercer Management Consulting (a firm providing strategic management consultations for utility companies).

The seminar also included the premier screening of the MPEC Customer Service Training video tape. The tape was produced in January 1996 and submitted to DOE with the report for Quarter VI. The MPEC executives praised the video recognizing its training value for MPEC employees who would benefit from watching the original sessions.

Design: MPEC received bids responding to a solicitation reported in the previous quarter. These bids were for design work for Budget Period II construction. The bids were reviewed and an on-call list of design firms was created in January. The design bid documentation was included in the appendix to the Quarter VII Technical Progress Report.

Construction: Through the winter, network (outdoor) construction continued sparingly due to the weather conditions for some Budget Period I sites (ESPEFA, Hydrokop). Connections of many of the new Budget Period II clients were made technically possible by the extension of the MPEC distribution main. Construction of this extension started in Budget Period I and continued through the Budget Period II.

Formal discussions about a joint venture: A number of discussions about Shooshanian and MPEC joint venture opportunities for future projects took place in Quarter VII. Negotiating through a working document summarizing these discussions, Shooshanian and MPEC drafted and signed a "Memorandum of Understanding" and "Letter of Intent" describing joint venture opportunities for future projects incorporating U.S. products and services and utilizing the collective strength and experience of both companies. These documents were meant to serve as the basis for continued discussion of the issue, which in turn would lead to the creation and formalization of a valuable business entity shared by both business organizations. Copies of both documents were included in the appendix to the Quarter VII Technical Progress Report.

3. Quarter VIII (April 1 - June 30, 1996)

The Quarter VIII effort focused mainly on the technical designs and construction activities. Also continued identification of new potential customers and discussions about Shooshanian and MPEC joint venture opportunities. Shooshanian submitted to DOE an Application for Extension of the duration of the project. The original completion date of June 29, 1996 was requested to be changed to December 31, 1996. This time-only extension was requested to permit MPEC and Shooshanian to continue to participate in the Program through the end of the construction season. The application for extension was approved. The project duration was increased by six months.

In general, activities in Quarter VIII included the following:

- **Designs:** Work continued on the designs of distribution piping and heat exchanger stations for Budget Period II client connections.
- **Construction:** Intensive construction activities were taking place at the 29-Listopada and Powstańców 48/50 sites, as well as on the extension of MPEC's distribution main.
- **Ongoing negotiations with potential clients:** MPEC continued marketing efforts. Some very promising potential clients were identified in the historical district of *Kazimierz* and in the neighborhoods surrounding the extension of MPEC's distribution main which was being constructed at that time.
- **Site visits:** Shooshanian visited Kraków, Poland on two separate occasions, once in April and once in June. Visit agendas included documentation of construction activities, project planning and coordination, and discussion concerning future cooperation.
- **Reports:** As appropriate, Shooshanian worked on mandatory reports (Monthly Summary, Quarterly Foreign Travel Report, Quarterly Technical Progress Report and Federal Assistance Management Summary, Construction Documentation Report).

What follows briefly details the Quarter VIII activities. For documentation and support materials consult the appendix of the Quarter VIII Technical Progress Report submitted to DOE in July 1996.

Designs: The majority of the distribution piping and heat exchanger stations designs were already complete or at a very advanced stage. This permitted MPEC to solicit construction work and purchase heat exchanger units. MPEC provided Shooshanian with copies of some of the complete designs of the district heating distribution piping. Copies of these engineering designs were included with the Quarter VIII Technical Progress Report.

Construction at 29-Listopada Site: Construction of the connection of the Academy of Agriculture complex (Site 29-Listopada 48). Progress on the construction of the network

connection was reported in the Construction Documentation Report from April and June 1996. The Academy is a large, multi-building facility located in the center of town (north of the Krakow main train station) along 29-Listopada Avenue. It includes a number of educational buildings, dormitories, greenhouses and other supporting buildings. The facility heating needs were served by three large coal-fired boilers located on the Academy premisses.

The new district heating service line extends from the existing MPEC distribution pipeline running along 29-Listopada Avenue. By the end of Quarter VIII the new service line was completed. The remaining work including improvements to the existing local distribution network and installation of several heat exchanger stations was carried out during subsequent months.

Construction at Powstańców 48/50 Site: Construction work progress at this site (a light industrial park located in the northeastern part of the city) was reported in the Construction Documentation Report from April and June 1996. Majority of the network connection was constructed during the course of Quarter VIII. Final completion and commissioning of the new pipeline as well as heat exchanger installation occurred later in the project.

Construction at Zielna 41 Site: The site is a nursing home formerly supplied with thermal energy from a coal-fired boiler room located in the basement of the facility main building. Network connection construction was reported in the April 96 Construction Documentation Report. At the conclusion of Quarter VIII outdoor work on the service pipeline construction was completed. Preparations were taking place for the installation of the heat exchanger station.

Construction of the extension of MPEC's distribution main (Phase II & III): Phase II consisted of a 400 mm diameter supply and return main transmission pipeline extending approximately from Kraków's main train station to Kamienna Street. Phase III enclosed the continuance of a 400 mm (toward the end becoming a 350 mm) transmission pipeline from Kamienna Street to Świętokrzyska Street. At the end of Quarter VIII, Phase II was at its final stage and Phase III was roughly 45% complete.

Site visits: Shooshanian made two trips to Kraków, Poland in the last quarter, one in April and one in June. The April visit was dedicated to laying out a baseline for Budget Period II construction activities and to identifying and preliminarily evaluating MPEC's and Shooshanian's potential joint projects elsewhere in Poland. The main purpose of the June trip was to verify and document construction progress and to coordinate plans for the remainder of the project. Construction Documentation Reports submitted to DOE followed each visit.

Negotiations with potential clients: MPEC satisfactorily concluded negotiations with the owners of the light industrial park located at Powstańców 48/50. Terms of the contract between MPEC and the owners for the purchase of district heat were prepared and agreed upon by all parties at the beginning of 1996. Minor issues however, were still pending until Quarter VIII. Signed copies of the Agreement were included in the Quarter VIII Technical Progress Report.

MPEC was evaluating newly identified potential customers in the area of *Kazimierz*. In addition, as the construction of MPEC's distribution main was advancing, some potential customers along the pipeline expressed an interest in district heat.

Joint venture discussions: Discussions on Shooshanian's and MPEC's joint venture opportunities for future projects continued throughout Quarter VIII. Considered leads included modernization and operation of two district heating systems elsewhere in Poland, an energy conservation program for an apartment complex and a design of a new hospital facility south of Kraków. Although MPEC and Shooshanian actively searched for new opportunities for future collaboration and joint venture creation, no formal steps were taken in Quarter VIII.

4. Budget Period II Extension No. 1 (July 1 - December 31, 1996)

The efforts undertaken in the Budget Period II Extension No.1 focused mainly on construction related activities including bidding procedures and selection of contractors for individual projects, physical construction and construction supervision and documentation. Other activities involved the planning and execution of additional training seminars and ongoing reporting as well as discussion of potential cooperation between MPEC and Shooshanian beyond the project duration. Preparation also began for project closeout activities.

Activities in this period included the following:

- Continued project development of the connections of individual Budget Period II sites: For all the sites engineering designs were complete in the beginning of the extension period, however for some sites the construction permits were still pending and some designs were being fine tuned throughout the first half of the extension period.
- Construction: Construction activities dominated Budget Period II Extension No.1. This involved the selection of contractors, underground pipeline construction, installation of heat exchanger stations at customers facilities, etc. Shooshanian visited the ongoing construction sites and viewed designs and construction documentation during the site visit to Kraków in August. The Construction Documentation Report describing construction status was submitted to DOE after the trip.
- Training activities: Shooshanian prepared and conducted a training seminar in project management and project financing for four MPEC representatives from the Construction Department and the Department of Marketing and Development. The seminar allowed MPEC to get acquainted with methods of managing large construction projects in the US and with project capital rasing options.
- Ongoing discussion on future cooperation: In September 1996, MPEC's corporate structure was changed on request of the owner (the city of Kraków). For the period of at least three years the company became a part of a large holding of three municipal companies: The Municipal Water Company (MŚW), The Municipal Transportation Company (MPK) and The Municipal District Heating Company (MPEC). The new status does not allow MPEC to own equity or shares in other companies or to create joint ventures. Therefore the strategy for future cooperation between MPEC and Shooshanian had to be approached from a different perspective. Shooshanian and MPEC started developing new plans and strategies which would permit them to capitalized on the experience gained in the course of the joint project without creating a formal joint business entity.
- Beginning of the project close out: Shooshanian, MPEC and Polinvest prepared and executed a presentation of the results of the joint project. The presentation was intended to demonstrate the accomplishments of the project and to increase its general recognition in the region as well as to promote project participants and their services.

The presentation took place in Kraków in December 1996. Shooshanian also began preparation of the project final report.

- Shooshanian requested two more extensions to the duration of the project. The first one was seeking February 28, 1997 as a completion date. It was later changed to April 11, 1997. Both requests were for the time extension only, and were brought on by minor delays in the construction activities.

What follows briefly details the activities in the Budget Period II Extension No. 1.

Construction of MPEC's distribution main Phase II and III: The construction of MPEC's distribution main Phase II and III (continuation of Phase I constructed in Budget Period I) was completed, tested and commissioned in the course of the Budget Period II Extension No.1. The new pipeline connected two MPEC mains (northern and western mains) creating a loop. This not only allows connection of many current coal users located along the newly constructed pipeline, but also improves overall system redundancy and hydraulics. Among the new customer connections resulting directly from the construction of the new main pipeline were five of our Budget Period II customers and former coal users (Montelupich 3, Montelupich 7/8, Helclów 2, Śląska 7, Lubelska 27). In Budget Period I, as a result of Phase I extension, main train station facilities (PKP) were connected in the center of town.

Connection of Montelupich 3 Site: This large, multi-building complex at Montelupich 3 houses various facilities of Wojskowy Szpital Kliniczny (Military Clinical Hospital). A 100 mm diameter pipeline serving the site, branches perpendicularly in a northeast direction from the newly constructed main and terminates in the former boiler room located in the basement of the building at Montelupich 3. Due to the small length of the connection (approximately 8.5 meters), its construction was included in the scope of work for the main pipeline construction. Therefore, the branch was built along with the Phase II of the main pipeline. Later, the heat exchanger installation was completed. By the end of Budget Period II Extension No. 1 the site was fully connected to the district heating network.

Connection of Śląska 7 Site: The site consists of three several story high multi-dwelling residential buildings. As in case of the Montelupich 3 site, the 50 mm diameter pipeline serving the site branches directly from the new MPEC main. Due to its fairly short length (approximately 28 meters), it was built along with the Phase III of the main construction. Although the pipeline connection was completed, the heat exchanger will be installed next year. This is due to the necessity of upgrading the building side hydronic system before the heat exchanger can be connected and the interface with district heating system can be finished. The upgrading work can only be performed during the summer months, as the building system has to be shut down for the work. The heat exchanger will be placed in the basement of the building at Śląska 7. Coal-fired boilers, currently residing there, will be disassembled and removed.

Connection of Montelupich 7/8 Site: The site consists of several buildings housing a temporary retention jail. The pipeline connecting the site also branches directly from the constructed in

Phase II portion of the MPEC's distribution main. However, construction of this 100 mm diameter branch was handled as a separate project. Based on the competitive bid, on 12 July 1996 the project was awarded to Naftokrak Company. At the end of the Budget Period II Extension No. 1 period, the connecting pipeline branch and the installation of the heat exchanger were finished.

Construction at Helclów 2 Site: The site at Helclów 2 is a large nursing home complex with the peak heat demand exceeding 2 MW. It is located across Słowackiego Avenue from the prison complex. Up to July 1996 it has been considered a tentative customer as MPEC was still negotiating the agreement with the client. Later on, however, the negotiations were satisfactorily concluded, first with verbal and then with a signed written Agreement and the customer's long term commitment to purchase space heating and domestic hot water from MPEC. This allowed retirement of a number of very old and deteriorating coal/coke fired boilers. In anticipation of the positive outcome of negotiations, MPEC prepared the technical design for the site connection. This permitted immediate commencement of the construction work upon customers commitment.

Five construction companies responded to MPEC's solicitation of this construction work. On 12 July 1996 contract was awarded to Naftokrak. At the end of the year the pipelines connecting the site to MPEC's distribution network were completed. The heat exchanger installations were at the final stage.

Connection of Lubelska 27 Site: Lubelska 27 Site is an institutional building housing some of the offices of municipal and state administration. The bidding procedure for the construction of the connection of Lubelska 27 site was also completed early during the Extension No.1. Although the construction contract was awarded to KZT on 12 July 1996, the work could not commence until much later when long awaited construction permits were issued. Nevertheless, by the end of the year the district heating system pipeline connection and the heat exchanger installation were completed.

Connection of Łobzowska 57, Teresy 16 and Teresy 7 Sites: All three sites, each consisting of one multi-dwelling residential building, were connected to the district heating system through one common pipeline branch. Each building, however, has an individual heat exchanger. MPEC solicited network construction and heat exchanger installation for all three sites as one project. On 17 July the construction contract was awarded in competitive bid to Pormat Company. All three site were fully converted to the district heat by the end of the Extension period.

Connection of Słowackiego 11b and Słowackiego 13 Sites: Słowackiego 11b is an eleven story apartment building while Słowackiego 13 is a complex of four, seven story apartment buildings. Both sites are located in close proximity to each other. The district heating system network connection and installation of two individual heat exchangers were handled as one project. Three companies participated in the bid for the construction and installation work included in the project's scope. The contract was awarded to Firma Handlowo-Uslugowa Marek Bańdo on July 17, 1996. All construction and installation work was fully completed

by the end of 1996. Connection of the adjacent site at Słowackiego 11a, although considered and planned at the beginning of the construction season, was not carried out due to an ongoing dispute regarding ownership of the mechanical equipment of the coal-fired boiler house serving this site. MPEC will continue to negotiate with this client.

Connection of Zielna 41 Site: For this site (a nursing home complex) the network construction was completed at early stages of Budget Period II. Installation of the heat exchanger station however, took place during the Extension No.1 period.

Connection of Powstańców 48/50 Site: Construction of the district heating system network connection of this light industrial park was finished during the early stages of the Extension No.1 period. The new pipeline was tested, inspected and commissioned on 16 July 1996. The heat exchanger installation then started and was completed toward the end of the year.

Construction at 29-Listopada 48 Site (Academy of Agriculture): The district heating system network connection of this site was completed at the end of June 1996. Intensive work continued though on the installation of several heat exchanger stations located throughout the site, as well as on some improvements to the site's local distribution network, throughout the second half of the year.

Depending on the specifics of individual heat exchanger station equipment and site installation requirements, some installations were handled as individual projects. For six of the stations separate bids were solicited. Naftobudowa S.A. was awarded all of the work. For other installations, the contractor was selected from a pool of pre-qualified vendors.

Construction at Halicka area and Szeroka area Sites: Halicka area and Szeroka area sites consist of numerous residential and institutional buildings in two neighborhoods located along Halicka Street and Szeroka Street in the historical district of Kazimierz. MPEC solicited network construction for this area as two separate projects. Five companies responded to each request for proposal. On July 17, 1996 the contract for the Halicka site was awarded to Insbud Company while the contract for the Szeroka site was granted to Naftobudowa. Construction work continued at these sites throughout the entire period of the Budget Period II Extension No. 1.

Training activities: An MPEC delegation of four visited Boston in October to participate in a Project Management and Project Finance seminar prepared and conducted by Shooshanian. The MPEC representatives included Mr. Adam Świerz - Vice President of Construction, Mr. Krzysztof Marendziuk - Deputy Head of Marketing and Development Department, Mr. Miroslaw Wróblewski - Manager of Technical Development Division, and Ms. Elżbieta Żarów - Senior Superintendent in Construction Administration Department. The training involved Shooshanian lectures, presentations by guest speakers and site visits.

Shooshanian completed a summary of the hand-outs prepared by some of the speakers as supplements to their October training presentations. This collection will serve as a reference manual to MPEC employees in the future.

Purchase of "Primavera": MPEC acquired "Primavera", an American project management software package to improve planning and implementation of their construction projects and to enhance the overall efficiency of their operation. A number of sessions were conducted at MPEC by a local Primavera distributor to train MPEC's employees in the proficient use of the software.

Ongoing discussion of future cooperation: Shooshanian and MPEC continued discussions on potential future joint projects. To discuss some of the potential financing sources and methods, we met with World Bank representative in Washington D.C.

Project Results Presentation: Shooshanian representative traveled to Kraków in the month of December. The visit was dedicated mainly to the preparation and execution of the Project Results Presentation. The visit agenda also included review of construction activities.

The presentation was prepared jointly by Shooshanian, MPEC and Polinvest, and took place at the Academy of Agriculture in Kraków on 10 December 1996. The main purpose of the presentation was to demonstrate the accomplishments of our joint project. As the project neared its completion we wished to increase its general recognition in the region and further publicize the project's main concepts and methodology. The presentation also served to promote project participants and their services.

The Academy of Agriculture building complex was selected as the site of the presentation because it could accommodate a large public meeting, and it is one of the largest loads connected to the district heating system in the course of the Shooshanian project (29-Listopada Site). The presentation included speeches by all project participants and some of the invited guests, as well as a visit to one of several heat exchanger stations installed at the site to allow the faculty to be served by the district heat. The presentation was followed by a lunch reception. On the way to the reception, participants were shown several other project sites formerly served by coal-fired boilers and currently enjoying clean thermal energy from the district heating system.

Attending guests included the city and region authorities, members of the Steering Committee, Ms. Ruta Elvikas of the US Consulate in Kraków, representatives of MPEC's Supervisory Board and Board of Directors and of large regional manufacturers. As the presentation was intended to increase public recognition of the project, it also served as a media conference. Leading local press, radio and TV reporters and stations were present at the presentation and conducted interviews with project participants which were aired or printed the next day in local medias.

Speakers at the presentation included: Mr. Leszek Ciurlik, MPEC President, Mr. Janusz Mazur the manager and coordinator of the project for MPEC, Ms. Magdalena Lelek as the project coordinator for Shooshanian, Mr. Adam Donimirski representing Polinvest, Mr. Jerzy Wertz, Director of Department of Environmental Protection in the Kraków Voivodship Office, Mr. Jan Bieda, Director of BRK and local coordinator for the DOE program in Kraków, Mr. Paweł Pytko, Vice Chairman of the Kraków City Council. All guest speakers were pleased

with the project results, stressing its value to the City and its citizens and expressing hope that Shooshanian will remain a landmark on the region's energy market.

5. Budget Period II Extension No. 2 and No. 3 (January 1 - April 11, 1997)

Activities undertaken during the period of January 1 through April 11, 1997 concentrated mainly on the project close-out procedures, preparation of the Final Report summarizing all project activities and results, and ongoing discussions related to potential future cooperation between project team members.

MPEC completed construction of the distribution pipelines and connection of Budget Period II sites. During the last week of February, an engineer from Shooshanian traveled to Krakow to view completed construction at new customer sites and to collect final documentation. The engineer also discussed marketing strategies for possible future joint commercial activities with MPEC, Polinvest and other parties identified during the course of the project.

V. POLLUTION REDUCTION SITES

A. Budget Period I Pollution Reduction Sites

A total of six sites within the Kraków city limits were connected to the MPEC central heating network by the closure of Budget Period I. Three of the selected sites were the result of identification of over ten clients, and subsequent offerings and negotiations thereof. Three additional sites were MPEC owned or operated local boiler houses. Design and construction of site connections to the central heating network was undertaken by subcontractors of MPEC upon the signing of binding agreements.

The sites connected under Budget Period I included:

- Zesp. Szkół Łączności, a technical telecommunications school
- Dworzec PKP, Kraków's Polish Rail Authority
- Metaloplast, "De' Medici" Krak. Zakł. Futrz. and Zesp. Szkół Mech. nr 2, three adjacent facilities
- Kryniczna 2, residential/commercial complex
- Friedleina 10, Friedleina 19, Odrowąża 22, three residential/commercial buildings
- Konfederacka 21, utility building

For detailed description of each site and the design of associated district heating system network extension refer to Budget Period I Final Report submitted to DOE in October 1996.

In addition connection of five more sites to district heating system started during Budget Period I construction season. It was later completed in Budget Period II. These sites included:

- Chemiczno-Farmaceutyczna Spółdzielnia Pracy "ESPEFA" (pharmaceutical company) and Przedsiębiorstwo Specjalistyczne "HYDROKOP" S.A. (office complex) - two adjacent facilities sharing a common boiler house
- Bujwida 4, Kołłątaja 16 - two apartment buildings
- Słowackiego 26 and Słowackiego 28 - two residential/utility/commercial buildings
- Łokietka 6b - apartment building
- Grottgera 1/3 - utility/residential building

The following page presents the central section of the Kraków city plan with marked location of Budget Period I pollution reduction sites.



SITES LOCATION

Budget Period I

B. Budget Period II Pollution Reduction Sites

A total of fifteen sites, all within the Kraków city limits, were connected to the MPEC district heating system by the conclusion of Budget Period II. A section of the city plan on the following page shows the location of the sites.

The sites connected under Budget Period II included:

- High-rise apartment building at Łobzowska 57 Street
- Multi-apartment building at Teresy 7 Street
- Multi-apartment building at Teresy 16 Street
- Multi-apartment building at Słowackiego 11b Street
- Four high-rise apartment building complex at Słowackiego 13 Street
- Municipal and state office building at Lubelska 27 Street
- Residential complex at Śląska 7 Street
- Wojskowy Szpital Kliniczny (Military Clinical Hospital) complex at Montelupich 3/5 Street
- Areszt Śledczy (Temporary Retention Jail) at Montelupich 7/8 Street
- Dom Pomocy Społecznej (Nursing Home) at Helclów 2 Street
- Dom Pomocy Społecznej (Nursing Home) at Zielna 41 Street
- Several residential and institutional buildings along Halicka Street
- Several residential and institutional buildings along Szeroka Street
- Light industrial park at Powstańców 48/50 Street
- Akademia Rolnicza (Academy of Agriculture) complex at 29-Listopada 48 Street

What follows is a brief description of each site. To better illustrate the sites and work accomplished there, enclosed in the Appendix A through I are photographs showing site views, retired boilers and newly installed heat exchanger stations. Also included there are plot plans of district heating system network extensions and site connections.

Powstańców 48/50

29-listopada 48
Akademia Rolnicza

Lubelska 27
Śląska 7

Łobzowska 57
Teresy 7
Teresy 16

Słowackiego 11b
Słowackiego 13

Zielna 41

Ludwinów

Zakrzówek

Broka
Lagiewniki
Cegielianka
Kraków Bonarka

Montelupich

Halicka Street area
Szeroka Street area

Site Locations

Budget Period II

1. Łobzowska 57

Site Description

The building at Łobzowska 57 Street is located in a highly populated area in the center of town. The building is eleven stories high. Although predominantly residential, a portion of the ground floor is used for commercial space. The peak demand for space heating reaches approximately 530 kW.

The space heating for the building was supplied by two coal-fired boilers located in the boiler room in the basement of the building. The boiler room was operated by MPEC. The Eca-IV type hot water boilers had a maximum capacity of approximately 280 kW each. They were hand-stoked and not equipped with any emission control devices. Two circulation pumps were used to distribute the heat throughout the buildings.

Coke was predominantly used at the site. According to MPEC data, approximately 200 metric ton of coke was burned at the boiler plant every heating season (204.8 ton in 1994/95 heating season). The following is a summary of the site characteristics:

Total number of boilers:	2
Number of boilers retired:	2
Boiler type and capacity:	hot water boilers, type Eca-IV, capacity - 280 kW/each, hand-stoked mainly coke
Fuel type:	hydronic with mechanical pumping
Type of heating system:	none
Emission control/reduction devices:	approx. 530 kW
Load connected to district heating network:	200 metric ton/year
Annual reduction in coal consumption:	

Network Extension Design

One common pipeline extension provides connection to the district heating network of three adjacent sites. These sites include building at Łobzowska 57 Street and two buildings at Teresy Street (site Teresy 16 and Teresy 7 described on following pages). The 80 mm diameter pipeline extension originates at a manhole on an existing MPEC distribution pipeline. The manhole is located in close proximity to the Łobzowska 57 building on its north-west side (near Słowackiego Ave). The new pipeline extension runs underground from the manhole in the south-east direction for approximately 50 meters through the backyards of couple buildings at Łobzowska Street. It then enters the basement of the building at Łobzowska 57 where it branches to provide a connection to the heat exchanger station. The heat exchanger station is located in the former coal storage space, now fully adopted for a new application. The main pipeline (at the reduced size of 65 mm diameter) continues through the basement and exits the building on its north-east side. It then proceeds underground for approximately 78 meters in the south-east direction toward the building at Teresy 16. It crosses the building through the basement where it branches to provide connection for the heat exchanger station located there.

After the branch, the main pipeline is reduced further (to 50 mm diameter). It exits the building on the south-east side and continues under Teresy Street toward the building at Teresy 7 (approximately 56 meters). There the pipeline terminates in the basement of the building where the heat exchanger for this facility is located. All underground pipes are preinsulated pipes (ABB brand) with built-in fault detector. Refer to Appendix A for the site plan and several pictures of connected building and installed heat exchanger.

2. Teresy 16

Site Description

Teresy 16 is a multi-apartment, residential building located in the same city block as the Łobzowska 57 site, on the corner of Łobzowska and Teresy Streets. The building is four stories high. The peak heat demand of the building averages to 88 kW.

The space heating for the building was provided by one coal-fired boiler located in the basement of the building. The boiler room was operated by MPEC. The hot water boiler, type Eca-IV had maximum capacity of approximately 240 kW. It was hand-stoked, and had no emission control equipment. Mechanical pumping was used to circulate hot water in the building system.

Coke was predominantly used at the site. According to MPEC data about 46 metric tons of coke was burned at the boiler every heating season (46.1 ton in 1994/95 heating season). The following is a summary of the site characteristics:

Total number of boilers:	1
Number of boilers retired:	1
Boiler type and capacity:	hot water boilers, type Eca-IV, capacity - 240 kW/, hand-stoked mainly coke
Fuel type:	mainly coke
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating network:	approx. 88 kW
Annual reduction in coal consumption:	46 metric ton/year

Network Extension Design

The pipeline extension serving this site is part of a common pipeline for Łobzowska 57, Teresy 16 and Teresy 7 sites. See description provided for Łobzowska 57 site above for more details. Also refer to Appendix A for the site plan and several pictures of connected building and installed heat exchanger.

3. Teresy 7

Site Description

The building at Teresy 7 Street is located in close proximity to the two sites described above, approximately 50 meters from building number 16, on the other side of Teresy Street. It is a multi-family, four story building. The peak demand for space heating reaches approximately 76 kW.

The space heating needs of the building were served by one coal-fired boiler located in the boiler room in the basement of the building with installed capacity of 158 kW. The boiler was operated by MPEC. It was hand-stoked, and was not equipped with any emission reduction devices. The system operated without mechanical pumping as a gravity hot water installation, although a back up pump was installed.

Coke was mainly burned at the site. According to MPEC data about 40 metric ton of coke was used at the site every heating season (40.2 ton in 1994/95 heating season).

The site characteristics are as follows:

Total number of boilers:	1
Number of boilers retired:	1
Boiler type and capacity:	hot water boilers, type Eca-IV, capacity - 158 kW/, hand-stoked
Fuel type:	mainly coke
Type of heating system:	gravity hot water (with back up pump)
Emission control/reduction devices:	none
Load connected to district heating network:	approx. 76 kW
Annual reduction in coal consumption:	40 metric ton/year

Network Extension Design

The pipeline extension serving this site is part of a common pipeline for Łobzowska 57, Teresy 16 and Teresy 7 sites. See description provided for Łobzowska 57 site above for more details. Also refer to Appendix A for the site plan and several pictures of connected building and installed heat exchanger.

4. Słowackiego 11b

Site Description

Słowackiego 11b is a seven story, residential building located in the same neighborhood as the sites described above. The peak heating demand of the building averages to 263 kW.

Space heating for the building was provided by three coal-fired boilers located in the boiler room in the basement of the building. The boiler room was operated by MPEC. The hot water boilers, type Eca-IV had a maximum capacity of approximately 180 kW each. In addition, one smaller, coal-fired boiler (type KZ-5, capacity 116 kW) was used to supply heat to a single family house located in the back of the seven story building. All boilers were hand-stoked, without any emission reduction equipment. Mechanical pumping was used to circulate hot water in the system.

As with other MPEC operated boiler rooms, coke was mainly used at the site. About 119 metric ton of coke was burned in the boilers every heating season (119.6 ton in 1994/95 heating season).

The site characteristics are as follows:

Total number of boilers:	4
Number of boilers retired:	4
Boiler type and capacity:	hot water boilers, hand-stoked 3 type Eca-IV, capacity-180 kW/each, 1 type KZ-5, capacity-116 kW
Fuel type:	mainly coke
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating network:	approx. 263 kW
Annual reduction in coal consumption:	119 metric ton/year

Network Extension Design

The pipeline extension connecting building at Słowackiego 11b with the district heating network originates at the nearby existing MPEC's distribution pipeline running parallel to the building on the south-east side. The new extension branches perpendicularly from the existing pipe. After a short (approximately 10 meters) underground stretch the pipeline enters the basement of the building where it terminates in the heat exchanger station located near former boiler room. The underground pipe is a preinsulated pipe with built-in fault detector. The diameter of the connection is 50 mm. A short, separate pipeline connection was installed for the single family house located in the back of the main building. This pipe also branches from the existing MPEC distribution line. Refer to Appendix A for the site plan and several pictures of connected building and installed heat exchanger.

5. Slowackiego 13

Site Description

The site is a complex of four high-rise apartment buildings located along Slowackiego Avenue, numbered 13a through 13d. Two buildings (13a and 13b) are adjoined while the other two (13c and 13d) are free standing. The Slowackiego 13 complex is located in the immediate vicinity of Slowackiego 11b, in the same city block.

Space heating for all the buildings was provided by coal-fired boilers located in the basement of building number 13a. The heat was distributed throughout the complex through a local piping network. The boiler room was operated by MPEC. The following is a brief summary of site's characteristics:

Total number of boilers:	4
Number of boilers retired:	4
Boiler type and capacity:	hot water boilers, type Eca-IV 3 boilers - 296 kW/each 1 boiler - 353 kW
Fuel type:	predominantly coke
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating system:	approx. 790 kW
Annual reduction in coal consumption:	279 metric ton/year

Network Extension Design

The Slowackiego 13 site is connected with the district heating network through a short pipeline branching from an existing MPEC's distribution line running through the middle of the site (the same pipeline from which Slowackiego 11b is supplied). For a brief distance the existing pipe runs in the basement of Slowackiego 13a building. This is where a new branch serving the site was installed. This new branch supplies the site heat exchanger station located in the mechanical space, next to former boiler room. From the heat exchanger station thermal energy is distributed into the buildings through an existing local piping network. Refer to Appendix A for the site plan and several pictures of connected buildings and installed heat exchanger.

6. Lubelska 27

Site Description

The site consists of one, five story building housing a number of city and state offices. The building is situated in a densely populated, residential and commercial area located in the center of the city, at the intersection of Wrocławska Street and Słowackiego Avenue.

The space heating for the building was supplied by MPEC operated coal-fired boilers located in the basement. The site's characteristics are as follows:

Total number of boilers:	2
Number of boilers retired:	2
Boiler type and capacity:	hot water boilers, type KZ-5, 172 kW/each
Fuel type:	predominantly coke
Amount of fuel used:	approx. 56 metric ton/heating season (based on MPEC data)
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating system:	approx. 96 kW
Annual reduction in coal consumption:	approx. 56 metric ton/year

Network Extension Design

Lubelska 27 site is connected to the district heating system through an approximately 63 meters long pipeline branching from a newly constructed MPEC's transmission main. From its point of origin the pipe proceeds south for 15 meter. Subsequently, after a number of turns needed to bypass an existing building it reaches Lubelska Street. The pipeline continues under the street parallel to its center line. Eventually the pipeline makes another turn, crosses the street and enters the basement of Lubelska 27 building where the heat exchanger is located. The nominal diameter of the connection pipeline is 100 mm. The preinsulated ABB pipes were used for the construction. Refer to Appendix B for the site plan and several pictures of connected building and installed heat exchanger.

7. Śląska 7

Site Description

The site is a complex of three, multi-apartment buildings located at the corner of Śląska and Lubelska Streets, approximately a half block away from the site at Lubelska 27. The buildings are three to four stories high and include following addresses: Śląska 7, Śląska 9, and Lubelska 20.

All three buildings are supplied with space heat from a common coal-fired boiler room located in the basement of building at Śląska 7, and operated by MPEC. The following is a brief summary of site's characteristics.

Total number of boilers:	4
Number of boilers retired:	4
Boiler type and capacity:	hot water boilers 1 boiler - type Eca-I, 140 kW 1 boiler - type Eca-IV, 326 kW 1 boiler - type Eca-IV, 381 kW 1 boiler - type KZ-5, 150 kW
Fuel type:	predominantly coke
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating network:	approx. 411 kW
Annual reduction in coal consumption:	approx. 183 metric tons

Network Extension Design

A short (28 meters long) new pipeline extension connects Śląska 7 site with the district heating system. The branch originates at the newly constructed MPEC's transmission main and terminates in the basement of Śląska 7 building. The heat exchanger will be located there. From the heat exchanger station thermal energy will be distributed into all three buildings of the complex through the existing local network. The new connection is constructed of preinsulated 50 mm diameter pipes. Refer to Appendix B for the site plan and several pictures of connected buildings.

8. Montelupich 3/5

Site Description

The site consists of several buildings located along Montelupich Street in the center of Kraków. The buildings vary in size and age. They range from one story warehouse-type structures to several story high multi-purpose buildings. The complex, once serving as an army station, was recently purchased by a military hospital and is now being adopted to new functions including administration offices, doctor offices, outpatient units, etc.

Thermal energy for the entire facility was provided by a local boiler house located at the site. Four hot water boilers were used for space heating during winter seasons. One steam boiler was used year round to supply domestic hot water. All boilers were hand stoked and had no emission reduction devices of any kind. The following is a brief summary of the site's characteristics.

Total number of boilers:	5
Number of boilers retired:	5
Boiler type and capacity:	4 hot water boilers for space heating, type Eca-IV, capacity -465 kW/each 1 steam boiler for domestic hot water, type Eca-IVa, capacity - 407 kW, all boilers hand-stoked
Fuel type:	coal and coke mixture
Type of heating system:	hydronic with mechanical pumping
Emission control devices:	none
Load connected to district heating system:	approx. 1,800 kW
Annual reduction in coal consumption:	approx. 800.8 metric tons

Network Extension Design

A 100 mm diameter pipeline extension serving the site branches perpendicularly in the north-east direction from a newly constructed MPEC's transmission main and terminates in the mechanical room located in the building at Montelupich 3. The mechanical room houses the heat exchanger from which thermal energy is distributed throughout the entire complex. The overall length of the new pipeline extension amounts to approximately 8.5 meters. Refer to Appendix C for the site plan and a picture of the newly installed heat exchanger.

9. Montelupich 7/8

Site Description

The Montelupich 7/8 site is a temporary retention jail complex consisting of a total of 11 buildings. The two main buildings are four story high. The remaining buildings are of various size and function. The complex houses prisoners quarters, administration, kitchen, laundry room, workshops, and other spaces typical for this kind of institution. The site is located at the center of town, at the corner of Montelupich and Kamienna Streets.

The heating needs of the entire jail complex were provided by five coal-fired boilers located in the free standing boiler house, in the center of the jail premises. The boilers were used for space heating, domestic hot water and steam for kitchen and laundry equipment. As a result of the conversion of the site to the district heat three boilers were retired. Two other boilers will remain in operation (to provide steam for the kitchen and the laundry) until they are converted to gas, as MPEC has no ability to provide this site with process steam at this time. A summary of the site characteristics follows:

Total number of boilers:	5 (4 main + 1 back-up)
Number of boilers retired:	3
Boiler type and capacity:	5 steam boilers, type Eca-IV, capacity - 493 kW/each
Fuel type:	mainly coke
Type of heating system:	hydronic with mechanical pumping
Emission control devices:	none
Load connected to district heating network:	approx. 1,855 kW
Annual reduction in coal consumption:	approx. 600 metric ton/year

Network Extension Design

The 100 mm diameter pipeline extension connecting the Montelupich 7/8 site branches directly from the newly constructed MPEC's transmission main. From the point of its origin the new pipeline proceeds in the general south-west direction making a number of turns to avoid existing buildings and utilities while creating natural compensation for thermal expansion and compression of the pipes. The pipeline terminates in the boiler house where the heat exchanger station is located. The length of the extension amounts to approximately 154 meters. Refer to Appendix C for the site plan and pictures of the old boiler room and the newly installed heat exchanger.

10. Helclów 2

Site Description

Helclów 2 is a large nursing home complex, located in the center of town and occupying a block between Długa Street, Słowackiego Avenue, Helclów Street, and the Politechnika Krakowska (University of Technology) campus. The site consists of a three story main building and several smaller buildings housing support facilities. The main building is an impressive three wing structure situated around a courtyard and gardens. The central portion of the courtyard is occupied by a chapel connected with the main building by a hallway passage. Although it performs its original function, the complex is registered as a historical site due to its architectural and historic value.

The heating needs of the facility were provided by three boiler rooms located throughout the site. The boiler room in the main building was equipped with three boilers for space heating and one boiler dedicated to domestic hot water. These boilers were retired as a result of the conversion of the site to district heat. One of the former space heating boilers will remain in the building as a back up for domestic hot water. The other three will be disassembled and removed. A second boiler room is located in the basement of the "Old Laundry Building". It consists of two Eca-IV boilers dedicated to space heating and one steam boiler for domestic hot water and steam. The heat load for space heating and domestic hot water was already switched to the district heating system. The residual steam load is being phased out, as the function of the building changes (there will be no need for steam from these boilers in near future). The third boiler room is located in an old support building. It is equipped with two steam boilers. The boilers are currently not used however, and the building is being adopted as a special care tenants unit and will have no steam demand. Space heating and domestic hot water for this unit will also be provided by MPEC. A summary of site characteristics follows:

Total number of boilers:	11
Number of boilers retired:	11
Boiler type and capacity:	3 hot water boilers, type Eca-IV, capacity-493 kW/each 4 hot water boilers, type KZ-5, capacity-172 kW/each 2 hot water boilers, type Eca-IV, capacity-430 kW/each 2 steam boilers, type KZ-5, capacity-150 kW/each
Fuel type:	predominantly coke
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating network:	approx. 1,930 kW
Annual reduction in coal consumption:	approx. 660 metric ton

Network Extension Design

The district heating network extension serving Helclów site branches from MPEC's newly constructed transmission main near the Montelupich 3 building. It proceeds in general southward direction making a number of turns to avoid obstacles (existing utilities, buildings, etc.) and crosses Słowackiego Avenue below grade, in a steel, protective jacket. On the south side of Słowackiego Avenue a manhole was installed. This is the lowest point of Helclów branch and the draining valves and a sump were installed there. From the manhole, the pipeline continues south and then turns west into Helclów Street. It proceeds along the north side of the street where it branches toward a number of buildings on both sides of the street while the diameter of the pipe is reduced (from 250 mm to 100 mm).

There are four branches connecting the nursing home complex (the north side of Helclów Street). The first branch (80 mm diameter, 14.5 meter long) connects a new building located on the east side of the complex. The second branch (100 mm diameter, 4 meters long) terminates at the heat exchanger in the basement of the main building. The third branch (40 mm diameter, 4.5 meters long) supplies heat exchanger in the "Old Laundry Building". The last branch (40 mm diameter, 42 meters long) terminates in the heat exchanger station located in the old support building.

Other branches were installed to supply customers on the south side of Helclów Street. This includes a number of residential and commercial buildings. One new customer among them (and a former coal user) is a building located at Helclów 19 housing Bank Przemysłowo-Handlowy (Bank). This bank is already enjoying clean district heat. Other buildings on the south side of Helclów Street will have the connection to district heat completed during the 1997/98 construction season.

The overall length of the main Helclów extension (excluding short building branches) amounts to approximately 600 meters of 250 mm diameter pipe and 110 meters of 100 mm diameter pipes. All pipes were preinsulated ABB brand. They were installed underground. Refer to Appendix D for the site plan and several pictures of connected buildings and one of newly installed heat exchangers.

11. Zielna 41

Site Description

The site is also a nursing home complex consisting of one main building (three stories high) and a number of smaller structures housing storage and support facilities. It is located in the south-western part of town, in Dębniki district.

The boiler plant serving this site consisted of three coal-fired boilers. It was located in the basement of the main building. All boilers were at advanced stage of ware, hand stoked and without any emission reduction devices.

The following is a summary of site characteristics:

Total number of boilers:	3
Number of boilers retired:	3
Boiler type and capacity:	2 hot water boilers, type Eca-IV, capacity-380 kW/each 1 steam boiler, type KZ-5, capacity-128 kW
Fuel type:	coal and coke mix
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	none
Load connected to district heating system:	approx. 400 kW
Annual reduction in coal consumption:	approx. 178 metric tons

Network Extension Design

The district heat network extension serving the site originates from the constructed in Budget Period I service line for Telecommunication School located across Nowaczyńskiego Street from the Nursing Home. The new underground pipeline runs through the school premises, crosses Nowaczyńskiego Street, continues around the nursing home building and terminates in the basement where the boiler room was located. Now the room houses a heat exchanger station. Total length of the new pipeline amounts to approximately 212 meters. It was constructed of 50 mm diameter preinsulated pipes. Refer to Appendix E for the site plan and several pictures of the connected facility and the newly installed heat exchanger.

12. Halicka Street area

Site Description

This site is located south from Kraków Downtown (Stare Miasto), in the historic district of Kazimierz. It consists of a number of individual buildings located in four adjacent city blocks encircled by Halicka, Św. Wawrzyńca, Starowiślna and Berka Joselewicza Streets. The buildings are as follows:

- Spółdzielnia "Wspólnota" - commercial facility at Berka Joselewicza 21 Street
- High-rise residential building with commercial spaces on the ground floor at Starowiślna 56/58 Street
- Multi-dwelling residential building with commercial space on the ground floor at Starowiślna 60 Street
- "Piecbud" - commercial and office complex at Halicka 9/11 Street
- Student dormitory at Przemyska 3 Street

Heating needs of these buildings were supplied by coal-fired boilers located in each facility. Number of boilers and their capacity in each facility varied depending on the building heating load. All boilers were hand stoked without any emission reduction devices. Total load connected to the district heating network amounts to approximately 1.5 MW. Annual reduction in coal consumption is estimated at about 667 metric ton/year. Refer to Appendix F for site plan and several pictures of connected buildings.

Network Extension Design

The district heating network extension into Halicka Street area originates at the existing MPEC's distribution line near intersection of Św. Wawrzyńca and Starowiślna Streets. The new pipeline proceeds in the general north-west direction along Halicka Street as service lines to individual buildings branch from it. Subsequently the diameter of the main line is being reduced from 200 mm at the beginning of the extension to 150 mm toward the end.

13. Szeroka Street area

Site Description

Like the Halicka site described above, the Szeroka Street area is also located in Kazimierz and consists of mostly residential, commercial and institutional buildings including many distinguished historical sites from the old Jewish neighborhood. The site is enclosed between Św. Wawrzyńca, Dajwór, Miodowa and Jakuba Streets. The buildings connected to the recently extended district heating network include:

- Szkoła Podstawowa nr 14 - primary school at Wąska 5/7 Street
- Multi-dwelling residential building at Wąska 4/8 Street
- Multi-dwelling residential building at Józefa 44 Street. Boiler house located in the basement of this building served seven buildings in the neighborhood connected through a small local network. All these buildings are now connected through a common heat exchanger with the district heating system. Among them are residential and institutional buildings including museums.
- Police Station at Szeroka 35 Street
- Institutional building at Szeroka 16 Street (museum)

The heating needs of these buildings were met by coal-fired boilers located in each facility. The number of boilers and their capacity in each facility varied depending on the building heating load. All boilers were hand stoked and had no emission reduction equipment of any kind. Total load connected to the district heating network amounts to approximately 1.1 MW. Annual reduction in coal consumption is estimated at about 489 metric ton/year. Refer to Appendix G for the site plan and several pictures of connected buildings.

Network Extension Design

The district heating network extension into Szeroka Street area originates at the existing MPEC's distribution line near intersection of Św. Wawrzyńca and Bartosza Streets. The new pipeline proceeds in a general northerly direction along Wąska Street and through the backyards of buildings at Szeroka Street making a number of turns to avoid existing buildings and utilities. Service lines to individual buildings branch from the main pipeline and consequently the diameter of the line is reduced from 150 mm at the beginning of the extension to 80 mm toward the end.

14. Powstańców 48/50

Site Description

This site is a light industrial park consisting of ten buildings, mostly single story housing offices, warehouses, shops, etc. Two companies own individual buildings at the site. Four buildings at Powstańców 48 are the property of Spółdzielnia Pracy El-Mechanika Co. (work co-op). Six buildings at Powstańców 50 are owned by the housing cooperative-Spółdzielnia Mieszkaniowa Prądnik Czerwony. The site is located in the northeastern part of the city, a developing residential area.

The entire complex was supplied with heat from a common, free standing boiler house equipped with three, large coal-fired boilers, type WC-80. Site characteristics are as follows:

Total number of boilers:	3
Number of boilers retired:	3
Boiler type and capacity:	hot water boilers, type WC-80, mechanically-stoked with mechanical grate, capacity-1,105 kW/each
Fuel type:	coal and coke
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	basic cyclones
Load connected to district heating system:	1,500 kW
Annual reduction in coal consumption:	approx. 667 metric tons

Network Extension Design

The new pipeline connecting the site with the district heating network extends from an existing MPEC's distribution line running near a condominium complex located southeast from the industrial park. The total length of the connection amounts to approximately 170 meters of 100 mm diameter and 260 meters of 80 mm diameter preinsulated underground pipes. Pipes in the initial section of the pipeline were designed to accommodate future load anticipated in this area from the housing development. Refer to Appendix H for the site plan and pictures of the connected facility and the new heat exchanger.

15. **29-Listopada 48 - Academy of Agriculture (Akademia Rolnicza)**

Site Description

Akademia Rolnicza (the Academy of Agriculture) is a multi-building university campus located in the center of Kraków, along 29-Listopada Avenue. The complex includes a ten story building housing the Department of Forestry, a six story Department of Horticulture building, three eleven story high student dormitories, a greenhouse complex, a Student Culture Center building, a main student cafeteria and a number of other supporting facilities.

Space heating needs for all the buildings were secured by three large coal-fired boilers located in the free-standing boiler house at the Academy premises. The heat was distributed throughout the complex via a local piping network. A separate gas-fired boiler was used for domestic hot water. As a result of the conversion, heat for space heating and domestic hot water is now provided by district heating system. The gas-fired boiler was retained at the site as a back up for the greenhouse complex.

The following is a brief summary of the site characteristics:

Total number of boilers:	3
Number of retired boilers:	3
Boiler type and capacity:	hot water boilers, type WLM, mechanically-stoked, mechanical grate, capacity-2.9 MW/each
Fuel type:	low quality coal
Type of heating system:	hydronic with mechanical pumping
Emission control/reduction devices:	basic cyclones
Load connected to district heating system:	6,800 MW (coal load only, additional load from gas boiler - approximately 1 MW)
Annual reduction in coal consumption:	average 4,050 metric ton/year

Network Extension Design

The new service line for the facility extends northwest from a manhole located near Wileńska Street on the existing MPEC distribution pipeline running along 29-Listopada Avenue. It proceeds through the campus, along a greenhouse complex toward the rear of the premises where it terminates in the existing local network. This local network is utilized to distribute district heat to ten heat exchanger stations installed throughout the campus. Total length of the new service line amounts to approximately 200 meters. It was constructed of preinsulated pipes and installed underground. The diameter of the pipeline is 200 mm. Refer to Appendix I for the site plan and several pictures of connected buildings and one of newly installed heat exchangers.

VI. EMISSION REDUCTION ASSESSMENT

A. General

Coal is a solid organic material, rich in amorphous carbon, with differing properties and chemical compositions. Coal is classified by rank or grade according to degrees of metamorphism. Coal grades include anthracite, bituminous coal, subbituminous coal, and lignite in descending order.

Anthracite: Anthracite is considered the highest grade of coal. It possesses between 86 to 98 percent fixed carbon by mass and very low concentrations of volatile matter - 2 to 14 percent by mass. Physically, anthracite is shiny black, dense, hard and brittle, and is characterized as slow burning. Anthracite possesses a heating value, energy contained in the coal per unit mass liberated through combustion, of approximately 32 MJ/kg (13,700 Btu/lbm). Burning of anthracite is typically confined to stokers.

Bituminous Coal: Bituminous coal is by far the most abundant and largest group of all coals. Bituminous coal contains between 46 to 85 percent carbon by mass, and 20 to 40 percent volatile matter by mass. Bituminous coal is easily burned, especially when pulverized prior to combustion. Five groups of bituminous coal exist, ranked from high to low heat content as follows:

Table 1 - Bituminous Coal Groups

Bituminous Coal Group	Heat Content
Low Volatile Matter	35.0 to 37.0 MJ/kg (15,100 to 16,000 Btu/lbm)
Medium Volatile Matter	35.0 to 36.5 MJ/kg (15,000 to 15,700 Btu/lbm)
High Volatile Matter Type A	34.0 to 36.0 MJ/kg (14,600 to 15,400 Btu/lbm)
High Volatile Matter Type B	32.5 to 34.5 MJ/kg (14,000 to 14,800 Btu/lbm)
High Volatile Matter Type C	31.0 to 33.0 MJ/kg (13,400 to 14,200 Btu/lbm)

Subbituminous Coal: Coal with generally lower heating values than bituminous coal, low sulfur content, and a relatively high moisture content - between 15 and 30 percent by mass. Subbituminous coal physically is brownish black to black, and is burned in a pulverized form. Similar to bituminous coal, subbituminous coal is sub-divided into three groups:

Table 2 - Subbituminous Coal Groups

Subbituminous Coal Group	Heat Content
A	30.0 to 32.0 MJ/kg (12,900 to 13,800 Btu/lbm)
B	27.5 to 31.0 MJ/kg (11,900 to 13,300 Btu/lbm)
C	26.0 to 30.0 MJ/kg (11,200 to 12,900 Btu/lbm)

Lignite: The lowest classification of coal, lignite is brown in color and laminar in structure with visible wood fibers. Lignite is high in moisture content, up to 30 percent by mass, and contains large quantities of volatile matter. Heat content of lignite ranges from below 14.5 to 29.5 MJ/kg (6,300 to 12,700 Btu/lbm). Due to its appearance, lignite is commonly referred to as "brown coal".

Coke: When coal is heated in the absence of air or with great deficiency of air, the lighter constituents are volatized and the heavier hydrocarbons crack, liberating hydrogen and leaving a residue of carbon. The carbonaceous residue, containing ash and a part of the sulfur of the original coal, is called "coke". The amount of sulfur and amounts/nature of ash in the coke depend on the coal from which it is produced and the coking process used. Similarly, the heat content of coke may vary.

Analysis of coal relies heavily upon proximate or ultimate analysis to determine the coal constituents. Proximate analysis determines the mass percentage of fixed carbon, volatile organic matter (consisting mainly of hydrocarbons and other gases), moisture and ash (inorganic salts). Mass percentage of sulfur, which also contributes to the heat content of coal, is determined separately. Ultimate analysis determines the mass percentage of all chemical contained in the coal. At a minimum, proximate coal analysis is required to determine coal classification and heat content, and also emissions of combustion.

The heat content of coal on a mass basis is known as the heating value (HV) of coal. Such values are determined on as-received, dry or ash-free basis. Numerically, coal heating value is represented by the heat transferred when the products of combustion are cooled to the initial temperature of the air and coal. The heat content of coal may be expressed as a higher heating value (HHV) or lower heating value (LHV). HHV's assume that water vapor liberated in combustion condenses, as such contains the latent heat of vaporization of water vapor. LHV's are based on the assumption that water vapor does not condense. The LHV of coal may be determined by subtracting the product of the mass of water vapor in the products of combustion per unit mass of fuel by the latent heat of vaporization of water vapor at its partial pressure in the combustion products.

B. Discussion of Poland Fuel Mix

Poland possesses vast coal reserves, easily accessed and mined. Approximately 74,000 million tons of hard coal (deep mining) and 9,000 million tons of brown coal (open cast mining) are available for consumption. Hard coal is predominantly located in three geographic basins and obtained through deep mining techniques. Additional reserves of brown coal can be found in the Konin and Adamów districts and is obtained through open pit mining techniques. Approximately ninety-three percent of all economically recoverable hard coal in Poland is found in the upper Silesian Basin, one percent in the lower Silesian Basin and six percent in the Lubin Basin.

Table 3 on the following page lists the typical constituents on a percent by mass basis for highly volatile bituminous type B and subbituminous type A coals. Table values are approximate and are based on a worldwide database of coal types compiled by Combustion Engineering Inc., Windsor, CT, in 1981. In the event that actual coal analysis is not available for a site in Kraków, tabulated values form the basis for emission calculations.

Table 3 - Poland Coal
Typical Proximate Analysis

Component	Highly-Volatile B Bituminous	Subbituminous A
As Received:		
% Ash	11.5%	24.4%
% Moisture	8.8%	17.4%
Moisture and Ash Free:		
% Volatile Matter (VM)	37.1%	41.9%
% Carbon (C)	82.9%	74.2%
% Hydrogen (H)	5.2%	6.0%
% Oxygen (O)	9.9%	16.7%
% Nitrogen (N)	1.0%	0.9%
% Sulfur (S)	1.0%	2.2%
Higher Heating Value, Btu/lbm	14,550	13,020
Higher Heating Value, MJ/kg	33.8	30.3
Ash Composition:		
% SiO ₂	46.8%	55.0%
% Al ₂ O ₃	21.8%	24.1%
% Fe ₂ O ₃	9.6%	9.3%
% CaO	5.8%	3.4%
% MgO	3.5%	1.5%
% Na ₂ O	0.8%	1.1%
% K ₂ O	3.1%	1.7%
% TiO ₂	0.7%	1.1%
% P ₂ O ₅	0.3%	0%
% SO ₃	6.6%	2.8%

C. Coal Combustion

Of primary concern from an air quality standpoint are particulates, oxides of sulfur, oxides of nitrogen, and to a lesser extent carbon monoxide emissions from coal combustion.

Particulate

Particulate emissions from the coal combustion process is often given the greatest amount of public attention due to the highly visible nature of the pollutant which can be seen as fumes from a boiler stack and deposits of unburnt matter on surfaces. The effects of particulate matter in the atmosphere are many and varied. Besides the effects of decreasing visibility and increasing soiling and corrosion, there is an obvious health hazard associated with particulate emission.

Particulate matter, sometimes referred to as fly-ash, is a combination of inorganic or inert residue. The residue mix typically contains coal or coke particles carried over from incomplete combustion along with silicates, oxides, sulfates, phosphates, and trace compounds and elements. The amount of particulate matter emitted per unit of fuel burnt is strongly dependent upon the firing configuration, the operation of the boiler and the properties of the coal (most predominantly the percent ash content by mass). Particulate emission from a combustion process also increases in proportion to the load and in proportion to changes in load.

Methods of particulate emission reduction or control include multiple cyclone burners, electrostatic precipitators (ESP), fabric filters and wet- and dry-type scrubbers.

Sulfur Oxides (SO_x)

Oxides of sulfur are formed as the inherent sulfur in the coal is oxidized as the fuel is burnt in the combustion process. Approximately 90 percent of the sulfur contained in the coal is oxidized in this manner. Typically, sulfur oxides make-up 0.1 to 0.25 percent by volume in the products of combustion. Oxides of sulfur include to a large percent sulfur dioxide, SO₂, and to a smaller percent sulfur trioxide, SO₃. SO₃ is formed from SO₂ by the influence of molecular oxygen, the oxidation of SO₂ in the flue gas by atomic oxygen and the catalytic oxidation of SO₂.

From an air quality standpoint, sulfur oxide emissions pose a large health hazard to humans and vegetation. The oxides of sulfur emitted into the atmosphere react with materials in the air to form sulfuric acid, H₂SO₄, and ammonium and calcium sulfates, all of which are dangerous to plant and animal life.

The primary method of reducing the oxides of sulfur present in the flue gases after combustion is through flue-gas desulfurization techniques. Other methods of reducing sulfur oxide emissions include the use of low sulfur coal and chemical cleaning/solvent refining of the coal prior to combustion.

Nitrogen Oxides (NOx)

The oxides of nitrogen are collectively referred to as NOx. Oxides of nitrogen, NO and NO₂, are formed during combustion in the high temperature region around the flame zone where nitrogen in the atmosphere (referred to as thermal NOx) and nitrogen in the fuel (referred to as fuel NOx) oxidize. When firing coal in hand-stoked or mechanical grate boilers, approximately 20 to 60 percent of the nitrogen contained in the coal is converted into NOx (about 95 percent NO and 5 percent NO₂). The formation of NOx is strongly dependent upon temperature and the amount of oxygen present. Thermal NOx quantities are readily reduced by lowering the flame temperature and/or the amount of excess air. The amount of nitrogen present in the coal that is converted to fuel NOx is strongly influenced by the presence of oxygen in the combustion region.

In the atmosphere nitrogen oxide, NO, oxidizes to nitrogen dioxide, NO₂, under the influence of photochemical effects (sunlight) and organic matter suspended in the air. Environmentally, NOx reduces visibility through the creation of smog constituents. Furthermore, when inhaled through the lungs, NO₂ has a strong affinity for oxygen, stripping it from hemoglobin contained in the blood stream and depriving tissue matter of oxygen.

Methods of NOx reduction for coal combustion include use of low NOx burners, firing under low excess air, staging the combustion process (referred to as off-stoichiometric combustion) and injecting ammonia into the flue gas stream.

Carbon Monoxide

Carbon monoxide is formed in small amounts during combustion through the oxidation of carbon present in the coal. The health hazard posed by carbon monoxide is similar to that generated by the presence of nitrogen oxides in the atmosphere.

D. Site Emission Reduction Estimate

1. Assumptions and Methodology for Emission Reduction Calculations

Calculation of coal-fired emissions are based on empirical formulae derived from actual emission measurements of hand-stoked and mechanical grate fired boilers in Poland, predominantly in Warszawa. Compiled by the Centrum Informatyki Energetyki, ul. Mysia 2, skr. poczt. 143, Warszawa, Poland, the formulae are utilized to calculate site emissions for comparison to government mandated air quality levels for the purpose of establishing non-compliance.

Particulate, sulfur dioxide, nitrogen oxides and carbon monoxide emissions are calculated as follows:

$$\text{Particulate Emission}(E_p) = B \times \left(\frac{\mu \times p}{1 - c_p} \right) \times (1 - \eta)$$

where: E_p = Emission of particulates (kg/year)

B = Annual coal consumption (kg/year)

μ = Firing constant, 0.25 for mechanical grate firing, 0.15 for hand-stoked firing

p = Coal ash content (% ash), typically 0.16 for coal, 0.12 for coke

c_p = Volatility constant of coal constituents, use 0.25 without actual data

η = Particulate filter efficiency, typically 0, i.e. no filters

$$\text{Sulfur Dioxide Emission, } SO_2(E_{SO_2}) = 2 \times B \times a \times S$$

where: E_{SO_2} = Emission of sulfur dioxides (kg/year)

B = Annual coal consumption (kg/year)

a = Chemical binding potential constant, use 0.8 for pulverized coal, 0.7 for un-pulverized coal

S = Coal sulfur content (%S), typically 0.015 for coal, 0.01 for coke

$$\text{Nitrogen Oxide Emission}(E_{NO_x}) = B \times W_{NO_x}$$

where: E_{NO_x} = Emission of nitrogen oxides (kg/year)

B = Annual coal consumption (metric tons/year)

W_{NO_x} = Emission index constant. For boiler capacity less than 2.4 Gcal/h: 1.5 kg/ton for manual stoked combustion, 3.0 kg/ton for mechanical grate

combustion. For boiler capacity in excess of 2.4 Gcal/h: use 7.5 kg/ton.

$$\text{Carbon Monoxide Emission, } CO(E_{CO}) = B \times W_{CO}$$

where: E_{CO} = Emission of carbon monoxide (kg/year)

B = Annual coal consumption (metric tons/year)

W_{CO} = Emission index constant. For boiler capacity less than 2.5 Gcal/h: 45 kg/ton for manual stoked combustion, 5 kg/ton for mechanical grate combustion. For boiler capacity in excess of 2.4 Gcal/h: use 1 kg/ton.

Formulae and guidelines are attached in Appendix J.

The emission values calculated using the formulae developed by the Centrum Informatyki Energetyki are checked with values computed from empirical formulae compiled from the United States Environmental Protection Agency AP-42 Compilation of Air pollutant Emission Factors manual, Fourth Edition, published in September 1985, and updated September 1991.

Results correlate quite well between the two references. However, it should be noted that the EPA's reference data for hand-stoked coal-fired firing configuration is based only on a single datum or is extrapolated from a secondary reference. As such, confidence in the resultant approximations is low. All boiler plants decommissioned through connection to the central district heating system under Budget Period I and thirteen of Budget Period II are hand-stoked. However, as firing configurations become more efficient, test sampling encompasses multiple boilers, resulting in a higher level of confidence.

EPA empirical information is tabulated and attached in Appendix K.

2. Emission Reduction Estimate

Spreadsheet 1, 2 and 3 on the pages that follow summarize and total the estimated reduction in emissions in the Kraków area of Poland for the sites connected to the central district heating system in Budget Period I. Spreadsheets 4,5 and 6 provide analogical information for Budget Period II sites.

Spreadsheets 1 and 4 summarize the reduction in emissions based on calculation using the Centrum Informatyki Energetyki empirical information. Total emission reduction is estimated as follows:

under Budget Period I at 314,600 kg per year (314.6 metric tons)

under Budget Period II at 643,183 kg per year (643.2 metric tons).

Spreadsheets 2 and 5 summarize the reduction in emissions based on calculation using the EPA's empirical information. Total emission reduction is estimated as follows:

under Budget Period I at 233,839 kg per year (233.8 metric tons)

under Budget Period II at 548,799 kg per year (548.8 metric tons).

Spreadsheets 3 and 6 compare the results of the two computation methodologies for particulate, sulfur oxide, nitrogen oxide, carbon monoxide and total emissions reduction. The net difference is

for Budget Period I -25.67 percent

for Budget Period II -14.67 percent.

SPREADSHEET 1 - BUDGET PERIOD 1 EMISSION REDUCTION ESTIMATE

Basis for Calculation:
Centrum Informatyki Energetyki

Site No.	Site	Peak Heating Demand (Watt)	Estimated Annual Coal Consumption (kg/year)	Particulate (kg/year)	Emissions (Particulate, SOx, NOx, CO)				
					Sulfur Oxides (kg/year)	Nitrogen Oxides (kg/year)	Carbon Monoxide (kg/year)	Total Emission (kg/year)	Notes
1.	Zesp. Szkoł Lączności (Technical School)	900,000	400,000	11,200	4,200	600	18,000	34,000	(1.)
2.	Dworzec PKP (Krakow Rail)	1,200,000	533,881	17,084	11,211	801	24,025	53,121	(2.), (3.)
3.	Metaloplast DeMedici Krak. Zesp.Szkoł Mech.nr 2	1,200,000 1,800,000 485,000	533,881 800,821 215,777	17,084 25,626 6,905	11,211 16,817 4,531	801 1,201 324	24,025 36,037 9,710	53,121 79,682 21,470	(2.)
4.	Kryniczna 2	1,398,880	622,363	19,916	13,070	934	28,006	61,925	(2.)
5.	Friedleina 10b Friedleina 19 Odrowaza 22	65,505 68,705 77,885	29,143 30,567 34,651	933 978 1,109	612 642 728	44 46 52	1,311 1,376 1,559	2,900 3,041 3,448	(2.)
6.	Konfederacka 21	42,740	19,015	608	399	29	856	1,892	(2.)
	Totals	7,238,715	3,220,098	101,443	63,422	4,830	144,904	314,600	

Table Notes:

- (1.) Site coal data: 0.75% avg. sulfur content, 14.0% avg. ash content, 28.9 kJ/g (12,425 Btu/lbm) caloric value, 400,000 kg/yr coal consump.
- (2.) Annual site coal consumption estimated.
- (3.) PKP's peak heating demand is 3,000,000 Watts. Only 1,200,000 Watts will be connected to the MPEC district heating system in Budget Period 1.

NOTE: For most of the sites, precise or the most recent fuel consumption data was not available. The rate of fuel consumption varied depending on the ambient temperature during the heating season. For consistency of the calculations, estimated fuel consumption, based on the peak heat demand, was used at indicated sites.

SPREADSHEET 2 - BUDGET PERIOD 1 EMISSION REDUCTION ESTIMATE

Basis for Calculation:
 EPA Compilation of Air Pollutant Emission Factors
 Volume 1, Stationary Point and Area Sources, Supplement A, 1986

Site No.	Site	Peak Heating Demand (Watt)	Estimated Annual Coal Consumption (kg/year)	Emissions (Particulate, SOx, NOx, CO)				Total Emission (kg/year)	Notes
				Particulate (kg/year)	Sulfur Oxides (kg/year)	Nitrogen Oxides (kg/year)	Carbon Monoxide (kg/year)		
1.	Zesp. Szkoł Lecznicz (Technical School)	900,000	400,000	3,000	4,650	600	18,000	26,250	(1.), (3.)
2.	Dworzec PKP (Krakow Rail)	1,200,000	533,881	4,004	12,413	801	24,025	41,242	(2.), (3.), (4.)
3.	Metaloplast De'Medici Krak. Zesp.Szkoł Mech.nr 2	1,200,000 1,800,000 485,000	533,881 800,821 215,777	4,004 6,006 1,618	12,413 18,619 5,017	801 1,201 324	24,025 36,037 9,710	41,242 61,853 16,659	(2.), (3.) (2.), (3.) (2.), (3.)
4.	Kryniczna 2	1,398,880	622,363	4,668	5,788	934	28,006	39,396	(2.), (3.)
5.	Friedlahta 10b Friedlahta 19 Odrowaza 22	65,505 68,705 77,885	29,143 30,567 34,651	219 229 260	271 284 322	44 46 52	1,311 1,376 1,559	1,845 1,935 2,193	(2.), (3.) (2.), (3.) (2.), (3.)
6.	Konfederacka 21	42,740	19,015	143	177	29	856	1,204	(2.), (3.)
Totals		7,238,715	3,220,098	24,151	59,954	4,830	144,904	233,839	

Table Notes:

- (1.) Site coal data: 0.75% avg. sulfur content, 14.0% avg. ash content, 28.9 kJ/g (12,425 Btu/lbm) calorific value, 400,000 kg/yr coal consumed.
- (2.) Annual site coal consumption estimated.
- (3.) Emission factor rating based on only a single datum or extrapolated from a secondary reference.
- (4.) PKP's peak heating demand is 3,000,000 Watts. Only 1,200,000 Watts will be connected to the MPEC district heating system in Budget Period 1

NOTE: For most of the sites, precise or the most recent fuel consumption data was not available. The rate of fuel consumption varied depending on the ambient temperature during the heating season. For consistency of the calculations, estimated fuel consumption, based on the peak heat demand, was used at indicated sites.

SPREADSHEET 3 - PERCENT DIFFERENCE

Emission Type	Budget Period 1 Annual Emission Reduction Calculated per Following Guidelines		Percent Difference (%)
	Centrum Informatyki Energetyki (CIE) (kg/year)	Environmental Protection Agency (EPA) (kg/year)	
1. Particulate	101,443	24,151	-76.19%
2. Sulfur Oxides (SOx)	63,422	59,954	-5.47%
3. Nitrogen Oxides (NOx)	4,830	4,830	0.00%
4. Carbon Monoxide (CO)	144,904	144,904	0.00%
Totals	314,600	233,839	-25.67%

SPREADSHEET 4 - BUDGET PERIOD 2 EMISSION REDUCTION ESTIMATE

Basis for Calculation:

Centrum Informatyki Energetyki

Site No.	Site	Peak Heating Demand (Watt)	Estimated Annual Coal Consumption (Kg/year)	Emissions (Particulate, SOx, NOx, CO)				Total Emission (kg/year)	Notes
				Particulate (Kg/year)	Sulfur Oxides (Kg/year)	Nitrogen Oxides (Kg/year)	Carbon Monoxide (Kg/year)		
1.	Lobzowska 57	530,000	204,800	4,915	2,867	307	9,216	17,306	(1.)
2.	Teresy 7	76,000	40,200	965	563	60	1,809	3,397	(1.)
3.	Teresy 16	88,000	46,100	1,106	645	69	2,075	3,895	(1.)
4.	Slowackiego 11/b	263,000	119,600	2,870	1,674	179	5,382	10,106	(1.)
5.	Slowackiego 13	790,000	279,400	6,706	3,912	419	12,573	23,609	(1.)
6.	Lubelska 27	96,000	56,800	1,363	795	85	2,556	4,800	(1.)
7.	Slaska 7	411,000	182,854	4,388	2,560	274	8,228	15,451	(1.), (5.)
8.	Montelupich 3	1,800,000	800,821	19,220	11,211	1,201	36,037	67,669	(1.), (5.)
9.	Montelupich 7/8	1,855,000	600,000	14,400	8,400	900	27,000	50,700	(1.)
10.	Helclow	1,930,000	660,000	15,840	9,240	990	29,700	55,770	(1.)
11.	Zielna 41	400,000	177,960	4,271	2,491	267	8,008	15,038	(1.), (5.)
12.	Halicka area	1,500,000	667,351	21,355	14,014	1,001	30,031	66,401	(2.), (5.)
13.	Szeroka area	1,100,000	489,391	15,661	10,277	734	22,023	48,694	(2.), (5.)
14.	Powstancow 48/50	1,500,000	667,351	7,118	16,016	2,002	3,337	28,474	(3.), (5.)
15.	29-Listopada 48	6,800,000	4,050,000	21,600	97,200	30,375	4,050	153,225	(4.)
16.	ESPEFA/Hydrokop	1,100,000	489,391	11,745	6,851	734	22,023	41,354	(1.), (5.)*
17.	Slowackiego 26/28	167,000	74,298	1,783	1,040	111	3,343	6,278	(1.), (5.)*
18.	Lokietka 6/b	80,000	35,592	854	498	53	1,602	3,008	(1.), (5.)*
19.	Grotgiera 1/3	378,000	168,172	4,036	2,354	252	7,568	14,211	(1.), (5.)*
20.	Bujwida 4/kollataja 16	367,000	163,279	3,919	2,286	245	7,348	13,797	(1.), (5.)*
	Totals	21,231,000	9,973,360	164,117	194,898	40,261	243,907	643,183	

Table Notes:

(1.) Manual stoker, fuel-coke
(2.) Manual stoker, fuel-coal

(3.) Mechanical stoker, fuel-coal, boiler capacity-less than 2.4 Gcal/h
(4.) Mechanical stoker, fuel-coal, boiler capacity-more than 2.4 Gcal/h

(5.) Annual site coal /coke consumption estimated

* Connection of this site began in Budget Period I but was completed in Budget Period II
NOTE: For many of the sites, precise or the most recent fuel consumption data was not available. The rate of fuel consumption varied depending on the ambient temperature during the heating season. For consistency of the calculations, estimated fuel consumption, based on the peak heat demand, was used at indicated sites.

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SPREADSHEET 5 - BUDGET PERIOD 2 EMISSION REDUCTION ESTIMATE

Basis for Calculation:

EPA Compilation of Air Pollutant Emission Factors

Volume 1, Stationary Point and Area Sources, Supplement A, 1986

Site No.	Site	Emissions (Particulate, SO _x , NO _x , CO)						Total Emission (kg/year)	Notes
		Peak Heating Demand (Watt)	Estimated Annual Coal Consumption (kg/year)	Particulate (kg/year)	Sulfur Oxides (kg/year)	Nitrogen Oxides (kg/year)	Carbon Monoxide (kg/year)		
1.	Lobzowska 57	530,000	204,800	1,536	3,174	307	9,216	14,234	(1.), (5.)
2.	Teresy 7	76,000	40,200	302	623	60	1,809	2,794	(1.), (5.)
3.	Teresy 16	88,000	46,100	346	715	69	2,075	3,204	(1.), (5.)
4.	Slowackiego 11b	263,000	119,600	897	1,854	179	5,382	8,312	(1.), (5.)
5.	Slowackiego 13	790,000	279,400	2,096	4,331	419	12,573	19,418	(1.), (5.)
6.	Lubelska 27	96,000	56,800	426	880	85	2,556	3,948	(1.), (5.)
7.	Slaska 7	411,000	182,854	1,371	2,834	274	8,228	12,708	(1.), (4.), (5.)
8.	Montelupich 3	1,800,000	800,821	6,006	12,413	1,201	36,037	55,657	(1.), (4.), (5.)
9.	Montelupich 7/8	1,855,000	600,000	4,500	9,300	900	27,000	41,700	(1.), (5.)
10.	Heclow	1,930,000	660,000	4,950	10,230	990	29,700	45,870	(1.), (5.)
11.	Zielna 41	400,000	177,960	1,335	2,758	267	8,008	12,368	(1.), (4.), (5.)
12.	Halicka area	1,500,000	667,351	5,005	15,516	1,001	30,031	51,553	(2.), (4.), (5.)
13.	Szeroka area	1,100,000	489,391	3,670	11,378	734	22,023	37,805	(2.), (4.), (5.)
14.	Powstancow 48/50	1,500,000	667,351	3,003	17,518	2,169	2,002	24,692	(3.), (4.)
15.	29-Listopada 48	6,800,000	4,050,000	18,225	106,313	13,163	12,150	149,850	(3.)
16.	ESPEFA/Hydrokop	1,100,000	489,391	3,670	7,586	734	22,023	34,013	(1.), (4.), (5.)*
17.	Slowackiego 26/28	167,000	74,298	557	1,152	111	3,343	5,164	(1.), (4.), (5.)*
18.	Lokietka 6b	80,000	35,592	267	552	53	1,602	2,474	(1.), (4.), (5.)*
19.	Grotgera 1/3	378,000	168,172	1,261	2,607	252	7,568	11,688	(1.), (4.), (5.)*
20.	Bujwida 4/Kollataja 16	367,000	163,279	1,225	2,531	245	7,348	11,348	(1.), (4.), (5.)*
	Totals	21,231,000	9,973,360	60,648	214,263	23,215	250,672	548,799	

Table Notes:

(1.) Manual stoker, fuel-coke

(2.) Manual stoker, fuel-coal

(3.) Mechanical stoker, fuel-coal

(4.) Annual site coal/coke consumption estimated

(5.) Emission factor rating based on only a single datum or extrapolated from a secondary reference.

* Connection of this site began in Budget Period I but was completed in Budget Period II

NOTE: For most of the sites, precise or the most recent fuel consumption data was not available. The rate of fuel consumption varied depending on the ambient temperature during the heating season. For consistency of the calculations, estimated fuel consumption, based on the peak heat demand, was used at indicated sites.

SPREADSHEET 6 - PERCENT DIFFERENCE

Emission Type	Budget Period 2 Annual Emission Reduction Calculated per Following Guidelines		Percent Difference (%)
	Centrum Informatyki Energetyki (CIE) (kg/year)	Environmental Protection Agency (EPA) (kg/year)	
1. Particulate	164,117	60,648	-63.05%
2. Sulfur Oxides (SOx)	194,898	214,263	9.94%
3. Nitrogen Oxides (NOx)	40,261	23,215	-42.34%
4. Carbon Monoxide (CO)	243,907	250,672	2.77%
 Totals	 643,183	 548,799	 -14.67%

VII. MARKETING DEVELOPMENT AND TRAINING

A. General

The main purpose to this project was to decommission coal-fired boilers by extending the district heating network. The other purpose was to stimulate demand for U.S. goods and services. Initially envisioned as primarily a technical project that addressed distribution piping and hydraulics, and system and end-user energy efficiency, it soon became apparent that there was much more to connecting new clients than straight engineering. The issues of marketing, public relations, negotiation, research, and customer service all play important roles in expanding the network. Indeed, in the final analysis the engineering was probably the easiest part of the entire process.

MPEC has only recently been forced to compete for customers in a marketplace that is market driven rather than centrally planned. The development of a marketing strategy has been critical to the success of this project. In the past MPEC did not need to actively market its services to customers because central planning ensured a customer base. Now, coal-burning customers must be actively persuaded that district heat offers the best alternative to cost-effectively reduce pollution emission levels.

MPEC has two important marketing goals: to keep its existing customers and to sign new customers. In order to be successful in its endeavors, MPEC must put together a marketing plan that considers the entire Kraków energy market, competing utilities, and its own strengths and weaknesses. It must then be able to convey the advantages it offers through promotional literature, superior customer service, and sales people trained in negotiation. MPEC can add value to its service by augmenting it with long term economic analyses and energy conservation services.

Current coal users represent a relatively new market for MPEC as concerns about air pollution increase among local, federal, and world governmental organizations. Although MPEC has many advantages to offer its customers, price is not one of them. The per unit cost of MPEC energy is higher than the cost of natural gas or coal. In order to counteract this disadvantage, MPEC must clearly understand the other considerations (such as space, initial investment, environmental regulations, equipment maintenance costs, etc.) that customers are weighing, and market their services appropriately. In order to sign on coal users, MPEC needs to more aggressively market its services than it has had to in the past.

MPEC has learned that it cannot afford to be insulated from its customers. Within the MPEC organization there was no clear means by which even existing customers could communicate questions or concerns. Realizing that the MPEC marketing strategy must include improved communications. The Shooshanian Training Sessions encouraged MPEC to establish a Customer Service office. This effort should go a long way towards improving the district heating company's reputation within the community.

Other potential marketing strategies that were discussed during training sessions in Boston and Krakow are as follows:

- Segmentation of customer base according to revenue or industry in order to best allocate MPEC resources
- Development of promotional literature highlighting the advantages of district heat for both the customer and the environment
- Development of value added services such as energy conservation programs that help customers reduce energy consumption and bills

The following sections of this chapter provide brief discussion of project activities dedicated to the development of MPEC marketing strategies and practices.

B. Marketing Development Activities in Budget Period I

First Training Session in Boston

An MPEC delegation of six managers visited Boston during the week of January 23, 1995 for training in Marketing and Customer Service. The three major activities of the training week were as follows:

- Lectures at Shooshanian's offices
- Visits to the marketing and customer service offices of three local utility companies
- Discussions with major commercial and industrial utility customers for their perspective on utility related negotiations

A supplemental report to the training seminars (a copy of which was included with Quarter II Technical Progress Report submitted to DOE in January 1995) was prepared and sent to the trainees in advance of their arrival in Boston. The topics covered were as follows:

- An overview of customer service and its importance in the economic well being of a company
- Background on the hosting US utility companies including general statistics on size and area served, organization structure, role of marketing personnel, skills required of customer service personnel
- Rates and incentives offered by district heating companies in the United States

The three utilities visited were: Boston Edison, the local electric utility, Trigen, a Boston-based district steam supplier, and Commonwealth Energy Systems, a Cambridge-based supplier of district steam. The steam companies have operated in a competitive environment with natural gas, fuel oil, and electric heat suppliers for many years. Boston Edison has only recently experienced competition and so their situation was markedly similar to that of MPEC. Boston Edison has recently reorganized their marketing efforts to adjust to the new competitive environment.

In advance of the delegation's arrival, Shooshanian met with the utility companies to describe the situation at MPEC, point out specific areas of interest, and suggest presentation formats. Shooshanian's staff engineer and Polish interpreter attended all preliminary meetings, and requested presentation materials be provided in advance when possible.

Each of the utility companies were exceedingly generous with their time and put much thought and preparation into the materials they presented. Examples of the topics presented are as follows:

Boston Edison's "Reorganizing to a Proactive Sales Organization"

- Multi-year offensive and defensive strategies
- Selection criteria for "major" customers
- Options for major customer segmentation
- Customer/account personnel assignment
- Account executive time allocation
- Resource requirements
- 1995 sales department goals
- Role of communications in marketing the corporate image

Trigen-Boston Energy Group

- Analysis of customers needs: unquestioned reliability, stable pricing, cost-effective operations, responsive service
- Rate development
- Communications and advertising
- Customer metering
- Sales strategy

Commonwealth Energy

- Business strategies
- Customer benefits from steam
- Tracking a steam sale
- Measuring success

The Polish delegation also heard the perspectives of a few large customers, who recently had interesting interactions with local utility companies. The customers visited were Compass Management and BTE, Genzyme, and Massachusetts General Hospital. The MPEC managers learned first hand, how these customers made decisions regarding utility service and how utility marketing and customer service influenced these decisions.

Compass Management, the owners of a high-rise office building in downtown Boston, and their maintenance company, BTE, have participated in energy conservation programs offered by Boston Edison that have reduced the building energy bills by about 20%.

Genzyme built a new drug manufacturing facility in Boston in 1991 and decided to buy purchased steam from a ComEnergy plant across the Charles River rather than install their own boilers. As part of this decision, they also decided to buy steam-driven air conditioning and cooling equipment rather than electrically-driven equipment, to the dismay of the electric company.

In light of recent negotiations, Massachusetts General Hospital installed a private steam line to purchase steam from a different utility company.

At the end of the week, Shooshanian held a debriefing session to ask the trainees which aspects of the training they found most interesting. They were also asked about what they would like to learn during subsequent training. They responded with interest in market research, negotiation, public relations, telephone systems, and the collection of bills. Their feedback was very helpful to us in programming the training session that followed in Kraków.

In conclusion, the Boston visit went very well; local utilities and their customers were very generous in sharing their time and ideas with the delegation members, and the Polish contingent was pleased with the amount and quality of the information that was provided.

Second Training Session in Kraków

The second training session took place in Kraków, Poland during the week of March 20, 1995. The purpose of the training was to build on the experiences gained in Boston and to reach more members of MPEC's evolving marketing department.

A comprehensive, 250 page, training manual was prepared to help the trainees follow the lecture, but more importantly, as a document to which they could refer in the future. Copies of both the English and Polish versions of the manual were submitted to DOE with Quarter III Technical Progress Report in May 1995. The chapters covered the following subjects.

1. Introduction
2. Marketing and Customer Service Department Activities
4. Local Legal and Economic Considerations
3. Marketing Research
5. Software and Telephone Systems
6. Public Relations
7. Negotiation
8. Building Load Determination
9. Collection of Accounts Receivable
10. Comparative Cost Analysis

Of the ten lectures presented, nine were prepared by Shooshanian, and one, "Local Legal and Economic Considerations", was prepared by Polinvest. The lectures were attended by between 15 and 40 MPEC employees.

A brief summary of the training manual chapter contents is provided below.

Activities of Marketing and Customer Service Departments

This chapter provided MPEC with an overview of marketing department structures and responsibilities, including the activities of the planning, sales, and customer service offices.

Local Legal and Economic Considerations

Prepared by POLINVEST, this section addressed specific, local legal and economic considerations in the marketing of MPEC's services.

Role of Marketing Research

This section was prepared by Opinion Dynamics, Inc. as a subcontractor to Shooshanian. It covered the role of marketing research, traditional types of research performed by U.S. utility companies, sources of marketing research data, studies of competition, and research strategies for MPEC.

Software and Telephone Systems for Customer Service Department

Shooshanian covered various configurations of customer service computer and telephone systems, applications already formatted for customer service offices but still requiring some customization, major suppliers, and approximate costs of software and hardware.

Public Relations

This chapter described how public relations departments define issues, choose message strategies, design advertisements, and write press releases. Examples of U.S. utility brochures were provided.

Negotiation

This chapter covered negotiation strategy and preparation, initial meetings, subsequent meetings, and negotiation of long term contracts.

Determination of Building Peak Demand and Standard Connection Requirements

This section presented methods used in the U.S. to ascertain a customer heating load. It discussed ways of obtaining important information from the customer's records, and explained how to refine assumptions regarding usage and demand as well as presented requirements for a standard pipeline connection.

Collection of Accounts Receivable

This chapter discussed procedures and policies used by utilities in the U.S. to collect accounts receivable, from simple, friendly reminders on monthly bills to complex legal action. The establishment of payment plans was also covered.

Financial Spreadsheets and Cost/Benefit Modeling

This chapter covered financial modeling including factors such as the time value of money, internal rates of return, depreciation, operating expenses, and labor costs. An example of an actual comparative cost analysis between district heating and local boilers was given.

The training in Kraków provided MPEC with an introduction to a diverse range of topics related to the sale of district heat. Specifically the training program presented the business tools of market research, promotional literature, negotiation, and cost comparisons, and value added services, which may all be used to persuade current coal users to join the MPEC system.

MPEC responded very positively to the week of training. MPEC was particularly pleased with the Negotiation seminar, in which Shooshanian applied many of the discussed concepts by role playing, in which an MPEC employee negotiates an agreement with a skeptical, and sometimes hostile, customer.

The training manual became an important resource for MPEC employees and managers into the future as they continue to develop the new MPEC marketing department and strategies. Shooshanian was very pleased to be able to assist in meeting MPEC's need for marketing and customer service training.

C. Marketing Development Activities in Budget Period II

Valuable knowledge of marketing and customer service concepts was gained by MPEC from the Budget Period I training sessions. MPEC also developed an increased awareness of the role that marketing and customer service strategies would play in their long term success as an energy services company. This led to a continuation of marketing development activities in Budget Period II, with emphasis placed on customer service. Activities included changes within MPEC's organizational structure and creation of a customer service group.

The group is a division of the Marketing and Development Department. Several employees were assigned to various posts within the new office. In preparation for the reorganization, a one week training session was held for future customer service representatives and managers. This training program was designed to address issues associated with the organizational structure and functions of customer service and sales departments in the utility industry. Marketing issues were also a component of the strategic planning seminar which took place in February 1996. This training is described in Chapter VIII.

Customer Service Training in Boston

The training session took place during the week of December 4, 1994. It was attended by six MPEC employees including the Director of Marketing, the newly appointed Manager of Customer Service, Manager of Billing, and three customer service representatives. The week's events involved lectures prepared and presented by Shooshanian, visits to three local utility companies and panel discussion with invited guests.

As with the previous training, Shooshanian prepared a supplemental report (a copy of which was sent to DOE with the Quarter VI Technical Progress Report) which discusses the following:

- Examples of Customer Service and Sales Department organizational structures
- Job descriptions and associated responsibilities in each department
- Techniques for handling difficult customers

The three utilities visited were Commonwealth Electric (a local electric utility), Trigen (a district steam supplier), and Boston Gas (the local gas utility). In a manner similar to the first training session in Boston, each of the utilities generously shared their experience with the trainees. These visits however, differed from those held previously by focusing on customer service and the operation of Call-In Centers.

At Commonwealth Electric, Mr. Chuck Kiely, Manager of Customer Service, briefed the Polish delegation on the general structure of the department, its functions and operational methods. His presentation was followed with a speech delivered by one of ComElectric's marketing managers who stressed the necessity of effective integration of all organizational activities with customer needs. He also explained the concept behind their marketing strategy of "Delivering Business Solutions".

Also very interesting and educational was the presentation given by two customer service supervisors. They not only described the day-to-day operation of the company call-in center (where customer inquiries and concerns are handled), but also explained the employee training programs and performance evaluation process. The techniques used in dealing with customers (including angry and difficult clients) were described, as well as the extent of any employee's authority to make decisions (solve the problem immediately or forward the call to a supervisor). This presentation was of tremendous interest to the Polish delegation.

At the end of the visit, the group toured ComElectric's call-in center where the trainees had a chance to see the physical layout and organization of the customer service office. They were also given a brief presentation of the software used by ComElectric in their customer service operation.

At Trigen, the delegation met with the Manager of Marketing and the Customer Service Supervisor who delivered very informative presentations on the customer service and marketing activities in their company. Significant time was dedicated to the explanation of methods applied by the customer service representatives in dealing with difficult customers. The visiting group also toured a customer service office and was introduced to the main concepts of the software used in maintaining the customer service database.

During the visit to **Boston Gas**, the Polish delegation met Customer Service Managers who described main functions of the customer service office at their company. They also presented a general description of the software used in various applications by customer service representatives. A very interesting section of the presentation was dedicated to the procedures used by the company in collecting outstanding customer payments.

During the week of training, multiple ways of improving the MPEC operations were discussed. The trainees learned a lot by seeing the physical layout and equipment of the call-in-centers, and by hearing about the activities and routines involved in customer service and how the performance of the customer service representatives is measured.

The panel discussion held at Shooshanian offices allowed interesting discussion with invited guests among whom were a sales engineer, a manager of customer service, a market research consultant, and a large purchaser of utility. The various viewpoints of the panelists provided insight and breadth to the discussion of customer service. The training program was a tremendous success.

VIII. OTHER TRAINING ACTIVITIES

A. General

Originally, training activities undertaken in the course of our project were focused on marketing and customer service issues. Over time however, their scope was broadened to address issues which are not an immanent component of marketing department operation, but have a direct or indirect impact on MPEC's ability to retain existing clients and attract new customers.

New market situations create a need for new, creative long and short term planning of company operations. The company must be able to recognize its strengths and weaknesses as well as identify external and internal threats and market opportunities. This requires a new vision and a plan to successfully position the utility in the new marketplace. To address many of these issues, a seminar in strategic planning was prepared for a group of MPEC senior executives.

Successful, aggressive marketing leads to new customers who want to be connected to the district heating network. In addition, to be able to provide reliable service to existing customers (thus preventing them from leaving) and to attract potential customers (for whom dependability is an important decision-making factor when selecting the energy service), MPEC must constantly improve and expand its piping network and entire infrastructure. More efficient operation also leads to reduced energy and water losses in the transmission system resulting in reduced overall cost. This in turn allows better rates and greater flexibility with potential financial incentives for customers.

This all translates to the creation of many capital-intensive rehabilitation and new construction projects. As a result, MPEC has to learn how to prudently spend available resources by improving project management proficiency and reducing wasteful schedule and budget overruns. MPEC must also learn how to take advantage of both conventional and non-conventional funding sources. Project management and financing were the subject of the fourth training session in Boston. The session was attended by representatives of the MPEC Construction Department and the Department of Marketing and Development.

Competing successfully in the energy market means a utility company has to provide its customers with value added services such as analysis of energy conservation opportunities. To help MPEC develop such expertise, Shooshanian prepared and presented an on-site training course in how to conduct an energy conservation study.

What follows is a brief description of each of the training.

B. Seminar on Strategic Planning in Utilities

Shooshanian Engineering Associates hosted a group of six senior level MPEC executives and departmental managers for training in strategic planning during the week of February 5, 1996. The seminar sessions, held in the office of Shooshanian Engineering Associates in Boston, were attended by the President of MPEC, Mr. Leszek Ciurlik; the Vice President, Mr. Marek Jaglarz; the Manager of the Strategic Planning Department, Mr. Adam Świerz; the Manager of the Marketing Department, Mr. Jacek Boron, the Manager of the Network Department and a Member of the MPEC Supervisory Board, Mr. Marek Iwanek; and a Business Plan Specialist, Mr. Tomasz Zimnicki.

The training included lectures given by Shooshanian on the latest strategic planning tools, a one day workshop by a management consulting firm and a panel discussion on the strategic planning process with invited guests of various backgrounds. This training session was the third hosted by Shooshanian in Boston as part of the DOE program and was designed to meet the needs of the highest-level officers in the MPEC organization.

The agenda for the week included a variety of activities designed to enhance the learning experience through different forums. It also included a one day workshop presented by Arthur D. Little, an international management consulting firm.

Following is a brief discussion of each of the training agenda components:

The first day of the training program began with an introduction followed by an open discussion of MPEC's most important planning issues. In the afternoon a former Boston Edison Executive, Ms. Kathleen Therrien, presented a description of that company's strategic planning process. A copy of the handout material she prepared, titled "Strategic Planning: An Evolutionary Process", was sent to DOE with Quarter VII Technical Progress Report. Ms. Therrien and Shooshanian Engineering then led a workshop on "What If Scenarios" that required trainee participation to develop reaction plans to specific external changes in the economy, politics, and environmental regulation.

On the second day, Shooshanian Engineering presented a lecture on the use of several strategic planning tools, including the Boston Consulting Group matrix and the General Electric matrix. Shooshanian then applied the matrices to the MPEC organization by considering the following factors:

Industry Factors

Market share
Market growth rate
Historic profit margins
Competitive intensity

Internal Factors

Staff Professionalism
Engineering Skill
Marketing Skill

On the third day of the training, a full day workshop was presented by Arthur D. Little. The morning session, led by Mr. Steven Fink, consisted of an overview of the strategic planning process and presentation of several different planning techniques used to add structure to the planning process. Mr. Fink also prepared written material titled "Strategic Planning in the Utility Industry". Mr. Fink then led a workshop with a "visioning" exercise.

In the afternoon, Ms. Helen Vela of Arthur D. Little (ADL), presented material on "Strategic Planning for Utility Marketing" in which she covered the basics of designing a marketing plan, from defining goals to generating leads. She also presented a segment on "Utility and Its Economic Development Role" in which she described how a utility can further its own cause by providing local businesses with assistance in training and work force development, financing, technical analysis, and trade expansion. Copies of the ADL materials were submitted to DOE with Quarter VII Technical Progress Report.

An additional item on the group's training agenda was a visit to New England Power, a large electric utility headquartered just outside the Boston area, in Westborough, Massachusetts. The delegation met with several New England Power representatives, including two members of the utility's strategic planning department. One individual was involved in preparing the company for changes brought about by deregulation of the industry, and the other was from the load forecasting department. The trainees were particularly interested to hear how transmission and distribution of electricity will be managed, engineered, and regulated after more power generators begin to supply the main electricity grid with power. This situation is analogous to their own situation. As heat distributors, they must manage the flow of energy from different generating stations into a central distribution system.

On the last day of training the group participated in a panel discussion on strategic planning with invited guests. The invitees were selected so as to offer a variety of perspectives. Panel guests included Mr. James Hall, Manager of Steam Marketing for Trigen-Boston Energy Corporation (District Heating Company), Mr. Paul Gromer, a former Commissioner of Massachusetts Department of Energy Resources, Mr. Joe Posk, the Quality Manager for Narragansett Electric Company, Ms. Kathleen Therrien, a former Sales Manager for the Boston Edison Company and Mr. Philip Giudice, Vice President of Mercer Management Consulting (a firm providing strategic management consultations for utility companies).

To help the panelists understand MPEC's current strategic planning issues and general business concerns, discussions began with MPEC speaking about the company history and background, including central planning under the Communist system, the recent creation of new company departments, and current trends toward more formal studies of customers, suppliers, and competitors. MPEC concluded by presenting its current marketing strategy for revenue growth. Each of our guests then spoke for about ten minutes on the topics most relevant to his or her own experience. Interesting discussions followed each guest's comments.

The group of MPEC executives were exposed to many new strategic planning concepts and ideas during their one week stay. They left with a good understanding of the tools and processes used by U.S. utilities in strategic planning. The group adapted well to the informal

nature of the workshop exercises, participating with a steady flow of ideas. The exercises helped them to appreciate new responsibilities and control in defining the future of MPEC. This expectation is extremely different from the situation just five years ago, when all strategic decisions were made by officials in local or federal governments.

C. Seminar on Project Management and Financing

In October 1996, Shooshanian conducted a training seminar on project management and project financing for four MPEC representatives. The MPEC delegation included the Vice President of Construction, the Deputy Head of the Department of Marketing and Development, the Manager of the Technical Development Division, and the Senior Superintendent in the Construction Administration Department. The training featured lectures by Shooshanian Engineering, presentations by invited guests, and site visits.

Following is a more detailed description of the components of the training agenda:

- Presentation on financing schemes for large infrastructure projects in Europe which also covered basics of BOT (Build-Operate-Transfer) projects and their variations. The presentation was prepared and delivered by Ms. Lisa Kolarik, P.E., Shooshanian Project Manager.

Ms. Kolarik explained the definition of "Project Financing" and what differentiates it from other financing arrangements. She also presented and described the definition of a BOT project, its origin as a financing method, the development process associated with such a project and examples of parties typically involved in BOT projects. In addition she covered lenders approaches to assessing project risks, major types of risks, the role of government agencies in mitigating private sector risk, and an outlook for Eastern European project finance.

- Lecture on Unconventional Methods of Financing of International and Domestic Projects. The lecture was given by Mr. Guy Warner, the Managing Partner at Corporate Economic Strategies. It was focused on the development of power projects in the limited resources environment using a project financing approach. Topics covered included:
 - preparation of project documentation for presentation to potential financing groups.
 - conventional and unconventional financing resources and institutions.
 - overview of proposal evaluation criteria for power projects in developing countries (host-country business environment, financial and commercial issues, risk assessment and risk mitigation methods, security packages, project procurement and selection).
- Site visit to MITC building (Massachusetts Information Technology Center). Shooshanian prepared the design of mechanical and electrical systems in this building and supervised the construction phase of the project. MPEC representatives toured the site with the MITC Facility Engineer and Shooshanian Construction Administrator, and learned about the design and its implementation.

- Visit to construction sites on the Central Artery Project in Boston (a large infrastructure construction project). The visit included project overview, demonstration of project management software "Primavera" and its application to the Artery project, and a tour of several current construction sites.
- Presentation of Shooshanian's Construction Department, its organizational structure, functions, and responsibilities of individuals. The presentation was given by Mr. Jim Crook, Shooshanian Construction Administrator and by Ms. Karma Jones, a support member of Shooshanian Construction Administration Department. The topics covered included:
 - purpose and main responsibilities of the Construction Administration Department.
 - Shooshanian's position in the general structure of projects in which the company is typically involved.
 - typical steps in construction administration process (transfer from design to construction, preconstruction meetings, construction administration on the site, completion and commissioning of the project) and tools used to control project progress (schedules of values, schedules of work, requests of information, change orders, shop drawings, site visit reports).
 - personnel of Construction Administration Department.
- Lecture on basic definitions and principles in project financing prepared and presented by Mr. Stephen J. Ritchie, CFO of Shooshanian. Mr. Ritchie briefed the trainees on the general aspects of the following capital raising methods:

Debt Capital

Commercial Banks

Secured Lenders

U.S. Government Loans and Guarantees

U.S. Government International Trade Financing

Leasing

Transaction Financing

State and Local Development Bonds

Equity Capital

Partnership

Limited Partnership

Venture Capital

Employee Stock Ownership

Strategic Alliances/Joint Ventures

Public Stock

Special Purposes Capital

International Aid Programs and Foreign Banks

At each step during his presentation, Mr. Ritchie explained potential applicability of each method to MPEC. The lecture was an excellent summary of basic definitions and terms in the vast field of financing.

- Lecture on project management and financing presented by Mr. Steven R. Murray, P.E. and Mr. Robert Hubert of SPEC, Inc.

Shooshanian Process Engineering & Construction, Inc. (SPEC) is a new sister company of Shooshanian Engineering, created from the former company, Integrated Project Services of New England (IPS). Mr. Hubert and Mr. Murray both have many years of experience in organizing, financing and managing engineering design and construction projects from the conception to final completion.

Mr. Murray, Project Manager at SPEC concentrated on various aspects of successful project management. Mr. Hubert, President of SPEC, addressed financial issues associated with the project process such as methods of project delivery, project financial structure, etc. Topics included:

Project process overview

Key project milestones

People and functions in project delivery

Project manager skill set

Knowledge of design and construction

Human relations skills

Detail orientation

Functions of the project manager

Overall planning

Communication with management

Team selection and organization

Schedule control

Budget Control

Elements of budget control

Preliminary budgeting methods

Budget documentation throughout the project

Handling and documenting changes

Planning for unforeseen costs

Using incentives in cost control

Elements of schedule controls

Computerized scheduling systems
Traditional vs "Fast Track" scheduling
Adjusting to schedule delays
Using incentives in schedule control

Methods of project delivery

Design then build
Design Build
Turn-key

Project financing structures

Straight capital project
Sale/lease back
Developer financed and owned
Split approach

Preparing a project for funding

Initial project report
Presenting to private investors
Using institutional funds

- Site visit to U.S. Capitol Power Plant in Washington D.C.

Assisted by two Shooshanian Engineers, the group met with the Architect of Capitol Hill, who described the history, evolution and future plans of the Washington D.C.- based utility supplying central heating and cooling to most of the Capitol Hill buildings. Guided by the Plant Director and the Plant Engineer, the Polish delegation toured the central heating and cooling plant and talked about its history and day-to-day operation.

While in Washington D.C., Shooshanian and the MPEC delegation met with the World Bank Representative to discuss MPEC's ongoing World Bank loan issues and potential financing methods of envisioned future joint projects.

As a supplement to the Boston session, Shooshanian completed a summary of the hand-outs prepared by some of the speakers. The compiled collection will serve as a reference manual to MPEC employees in the future.

In order to further improve planning and implementation of its construction projects and to enhance the overall efficiency of its operation, MPEC acquired "Primavera", an American project management software. This excellent project management tool allows efficient planning, managing and control of projects of any size and complexity. A number of sessions were conducted at MPEC by a local Primavera distributor to train MPEC employees in the proficient use of the software.

D. Energy Conservation Study and Training

The study was a combination of an energy audit for the Old City Hall (a distinguished historic building located at the Main Square in Kraków) and hands-on training in performing energy audit for individuals selected by MPEC.

During the period of December 7-16, 1995, Harry Shanley, P.E. of Shooshanian traveled to Kraków to provide an on-site energy audit training and to identify energy conservation measures in the subject building as well as to collect all the data needed to complete a comprehensive evaluation of the measures.

Shooshanian training activities involved the following:

- Lectures presenting typical components of energy studies performed by Shooshanian.
- Demonstration of the capabilities of DOE-2 Building modeling program. As a result, MPEC is considering purchasing the software.
- Delivery and application demonstration of surface temperature and heat-transfer coefficient ("K") measuring devices. The infrared thermometer originally delivered by Mr. Shanley was later replaced with a superior-performing model. The new instrument (U.S. made MICRON brand with laser sighting) is not only planned to be used in building energy surveys, in conjunction with the heat flow meter, but also in MPEC's maintenance practices, for detection of insulation problems and other similar applications.
- As a measure of economy, Shooshanian engaged local assistance from the Instytut Inżynierii Cieplnej I Ochrony Powietrza, Politechnika Krakowska (Kraków University of Technology, Institute of Heat Engineering and Air Protection) to provide general instructions on basic thermal properties of materials and heat transfer and to conduct basic facilities surveys and heat demand calculations in accordance with local codes and standards. The University also prepared a report that contained the results of tasks carried out by the University's personnel.

For the trainees, Mr. Shanley prepared and delivered a supplementary manual entitled "Training in Energy Auditing Methods Using Heat Flow Measurements and Computerized Building Models." The main topics covered in the manual included:

- Energy audit types performed by Shooshanian Engineering
- General approach to energy audit process
- Variables effecting annual heat energy demand
- Determination of wall/roof K-value in a wall of unknown construction
- Theory behind heatprobe (heat flow meter) and infrared thermometer
- Instructions and product information for the Heatprobe-HB-100 (heat flow meter)
- DOE-2 program features
- Introduction to DOE-2

Upon return to Boston, MA Shooshanian continued to work on a comprehensive energy audit report including conservation measure calculations for the Old City Hall. The report was completed and submitted to MPEC in February 1996. A copy of the training manual and the energy audit report were submitted to DOE respectively with Quarter VI and Quarter VII Technical Progress Report.

IX. PROJECT ECONOMICS

A. Budget Period I

Table 4 on the following page compares budgeted costs for Budget Period I with actual costs for the period. As shown, total costs for the period came about \$139 over of what was budgeted.

Table 5 provides a breakdown of cost per major project components (tasks). As shown in the table, construction costs constitute the biggest portion of the Budget Period I costs (approx. 69%). This is consistent with the original budget forecast. The construction costs include design work, materials (piping, heat exchangers, etc.), freight, MPEC's subcontractors labor for excavations, pipeline installation, mechanical, electrical and controls installation at heat exchanger stations, and support services (X-ray checking of welded pipes, permitting, landscaping, etc.).

The cost associated with training activities in the Budget Period I represents 7.5% of the entire budget for the period and includes Shooshanian and MPEC labor, Polinvest and other subconsultants fees and related expenses (books, visual aids, reprographics, Shooshanian domestic travel, translation/interpretation services, etc). This cost does not include costs for international travel associated with the training sessions. These travel costs were incorporated in the separate category together with other foreign travel expenses.

The expenditures listed in the "Management, Negotiations, Studies" column cover labor and expenses associated with all other Budget Period I tasks. These included identification and evaluation of potential district heating customers, engineering and economic analyses and development of client offerings, negotiations of binding agreements between MPEC and potential customers, overall project management (including DOE reporting and construction documentation but not foreign travel) and all activities geared toward future commercial ventures in the region (market research, investigation of potential clients and projects, financial planning and legal issues analyses). This category constitutes approximately 19.5% of the total period spendings.

Foreign travel cost is summarized as a separate category. It includes the air fare, hotel and ground cost of all trips between U.S. and Poland undertaken during Budget Period I. These costs amount to approximately 4% of the Budget Period I total expenditures.

TABLE 4
BUDGET PERIOD I PROJECT COSTS

	Budgeted Costs (as of 6/94)	Actual BPI Costs (12/93 through 9/95)
Labor	\$639,688	\$410,129
Expenses	129,626	74,419
Construction Materials	588,300	780,572
Construction Services (design & construction)	210,050	303,283
TOTAL PROJECT COSTS	\$1,568,264	\$1,568,403

TABLE 5
BUDGET PERIOD I PROJECT COSTS PER MAJOR TASK

Training Activities	Construction (including design)	Management, Negotiation, Studies	Foreign Travel	Total
\$117,725	\$1,083,854	\$306,110	\$60,714	\$1,568,403

B. Budget Period II

Table 6 on the following page compares budgeted costs for Budget Period II with actual costs for the period. The total costs for the period came within about \$1,230 of what was budgeted.

Table 7 provides a breakdown of cost per major project task. Once again construction costs constituted the biggest portion of Budget Period II expenditures (approx. 86%). This is fully consistent with the original budget forecast. As in Budget Period I, the construction costs included design work, materials (piping, heat exchangers, etc.), freight, MPEC's subcontractors labor (general, mechanical, electrical contractors, etc) and relevant support services (welds X-rays checking, landscaping, etc).

The cost associated with training activities in the Budget Period II represents 5% of the entire budget for the period and includes Shooshanian labor, subconsultants fees and related expenses (books, visual aids, reprographics, Shooshanian domestic travel, translation/interpretation services, etc). This cost does not include international travel associated with the training sessions which, like in Budget Period I, were incorporated in the category with all other foreign travel expenses. In addition, the amount presented in this category covers the cost of equipment and services purchased by MPEC as a result of the training provided in the project. The purchased items included American project management software "Primavera" and the user training (provided by local distributor), an American infrared thermometer with laser sighting, and a heat flow meter. Total cost of the software and metering instruments was \$20,875.82.

The expenditures listed in the "Management, Negotiations, Studies" column represent labor and expenses associated with all other Budget Period II tasks. These included continued identification and evaluation of new promising candidates for tie-in to the district heating system, negotiations of long term contracts, overall project management (including DOE reporting and construction documentation) and all efforts associated with the investigation of potential market and business partners for future commercial activities in the region. This category constitutes approximately 7% of the total period spendings.

As with Budget Period I, foreign travel cost includes the air fare, hotel and ground cost of all trips between U.S. and Poland undertaken during Budget Period II. The foreign travel costs amount to approximately 2% of the Budget Period II total expenditures.

TABLE 6
BUDGET PERIOD II PROJECT COSTS

	Budgeted Costs (as of 6/94)	Actual BPII Costs (10/95 through 4/11/97)
Labor	\$432,407	\$254,686
Expenses	\$105,710	\$83,165
Construction Materials	\$1,094,817	\$463,179
Construction Services (design & construction)	\$724,500	\$1,555,174
TOTAL PROJECT COSTS	\$2,357,434	\$2,356,204

TABLE 7
BUDGET PERIOD II PROJECT COSTS PER MAJOR TASK

Training	Construction (including design)	Management, Negotiation, Studies	Foreign Travel	Total
\$121,987	\$2,018,353	\$175,432	\$40,432	\$2,356,204

C. Summary of Project Economics

The total costs for the entire project amounted to \$3,924,607 which is within \$1,091 of the budgeted \$3,925,698. Construction expenditures, as defined in the preceding sections of this chapter amounted to \$3,102,207 (79% of the total project budget). The costs associated with the training efforts equated to \$239,712 (6% of the total project budget). Expenditures related to all other project activities including identification and evaluation of potential district heat users, engineering and economic studies, negotiations of long term contracts, project management and marketing for future business in Kraków and elsewhere in the region amounted to \$481,542 (12% of the total project budget). Total foreign travel costs of \$101,146 constitute approximately 3% of the entire project costs.

We are pleased with the financial outcome of the project. The ability to channel more funds into construction achieved not only a lower cost per MW connected and per ton of pollution reduced, but it also allowed the groundwork to be laid for further expansion of the district heating system and future connection of many current coal users. This is especially true in the area where a looped connection in the MPEC piping network was created (between PKP rail station and Świętokrzyska Street). This connection reduces pressure drops and increases flow and system heating capacity.

X. FUTURE COMMERCIAL ACTIVITIES

A. Introduction

Shooshanian Engineering Associates, Inc. (Shooshanian) and Miejskie Przedsiębiorstwo Energetyki Cieplnej S.A. (MPEC) along with Polinvest Ltd (Polinvest) worked together under the U.S. DOE *Kraków Clean Fossil Fuels and Energy Efficiency Program*. Our joint project improved local air quality in Kraków by retiring old, polluting, coal-fired boilers and connecting their loads to the district heating network. This task involved substantially more than just technical analysis, design, and construction. The process of securing new customers necessitated the strengthening of MPEC's competitive position in Kraków's energy marketplace, which in turn required improvements in marketing, customer service, and strategic planning. Learning how U.S. utilities address these challenges became an integral segment of the project's success.

As the project moved into its final phase, it became clear that MPEC, Shooshanian and Polinvest's continued cooperation could be highly compatible with the strategic goals of each firm. Shooshanian offers MPEC potential access to U.S. investment funds, a conduit to the latest utility management practices, and a source of information about U.S. high technology. MPEC offers Shooshanian business contacts throughout Poland and the region, and a pool of highly trained and experienced personnel with strong expertise in the energy field. Polinvest could offer extensive assistance in the area of local economic and legal consulting. It was quite apparent that all parties could have a great deal to gain through a continued business relationship.

Discussions of the future cooperation between the companies have been ongoing since the early stages of the joint project. It was envisioned that our cooperative efforts would provide services primarily to utilities, municipalities, and private sector establishments who are attempting to streamline operations, increase efficiency, reduce emissions, restructure, diversify, and/or stimulate economic development. To the maximum extent possible, we could utilize materials, knowledge, and experience gained and developed as part of the *Kraków Clean Fossil Fuels and Energy Efficiency Program*, such as manuals, presentation slides, training videos, spreadsheets, cost data, and pollution abatement formulae. Of course we would also utilize the strong capabilities offered by each firm that are not related to the program.

Because of the nature of our cooperation in the DOE project, it was anticipated that the majority of our first clients would be Polish utilities and municipalities. Utilities may be district heating, electric, gas, or water utilities - we have relevant and strong experience working with all of the above, with MPEC's biggest strength being in district heat, and Shooshanian's in electric. Our services would be designed to make the utilities cleaner, financially stronger, more efficient, and more responsive to their customers.

Polish municipalities are undergoing great transformations as political decision-making is becoming more localized, and at the same time the need for infrastructure improvements and reversal of environmental degradation is much more emphatically recognized. Local funding for these needs is scarce, but substantial Polish national funds are available, as are funds from the European Bank for Reconstruction and Development (EBRD), World Bank, the European Community, and a

myriad of Western and Asian governments, including the United States', seeking to stimulate demand for their countries' goods and services. Projects that improve the quality of the environment are universally popular.

With a few successful projects in Poland to show to prospective clients, we could expand the client base to include institutional and industrial customers, and we can expand our geographical territory to include Belorus, Russia, Ukraine, Romania, and Bulgaria. There is increasing activity in these countries aimed at improving energy systems and infrastructure. With good positioning and contacts we have a good likelihood of getting involved with this work.

The approach to the issue of future cooperation between the project team members has been evolving as the external and internal factors affecting the decision making process were changing. Several scenarios for future cooperation involving creation of a formal joint venture were identified and evaluated earlier in the project. None of them is perceived to be feasible at this time by the management of Shooshanian and MPEC. However, there is a strong willingness on both sides to continue the business relationship and discussions continue toward that end.

What follows is a general outline of possible future activities discussed by Shooshanian and MPEC relating to continued cooperation in Poland.

B. General Description

Type and location of business

The companies are evaluating cooperative efforts in the areas of consulting services as well as retail and distribution business. It is expected that they will be operating from their offices in Boston, Massachusetts and Kraków, Poland and will focus on the Polish market with the plans to expand in the future to other Eastern European markets.

Customers

Due to the combined experience of both firms involved in the venture and the possible range of goods and services offered, the targeted customer base would consist of utilities, municipalities, developers/architects, private sector establishments, and the general public.

Services provided and product lines offered

The types of services and goods that companies contemplate to provide jointly include:

Services: General consulting, design, construction and installation, infrastructure master planning, utility market research, training

Products: HVAC equipment and controls, building management systems, electronics, high-tech and telecommunication items

Legal form of the venture

At this time it is envisioned that the cooperation would continue to be in the form of a collaboration of two independent business entities. This collaboration may need to be based on a cooperative agreement which would have to be drafted. The option to create a more formal form of the venture should be provisional, dependent on the desirability and feasibility of such a formalization and on the success of the preceding cooperation.

Business objectives

The short term objective of the considered cooperation is to maintain and strengthen existing links created in the course of the DOE project between Shooshanian and Kraków business community (especially MPEC). The long term objective is to establish a prosperous service/retail/distribution business in the Kraków area with the potential to expand the operation to other parts of Poland and later, into other Central and Eastern European countries.

C. Products and Services

The following services and products would potentially be jointly offered by cooperating companies:

Services

- *Design* - engineering design of utility systems, HVAC systems, building energy systems, telecommunication systems, radiant cooling and heating systems, chiller plants, security systems, etc.
- *Construction and installation* - construction management and installation services for HVAC systems (commercial, institutional and residential), controls, district heating systems, etc.
- *General consulting* - technical consulting and maintenance services for the products offered. This would include personnel training in operation and troubleshooting of same.
- *Master planning and feasibility studies for energy market* - for large, energy intensive facilities such as institutional, commercial and industrial clients. Utility companies (mainly district heating systems and plants) and municipalities would also be targeted.
- *Market research* - for utilities.
- *Business consulting* - marketing, customer service and strategic planning for utilities. Activities could include the identification and assistance in obtaining available funding for energy/environment-related projects.

Products

- Modern, energy efficient HVAC equipment with emphasis on air-conditioning, cooling and refrigeration equipment. These may include the following:
 - variety of DX air-conditioning units including window units
 - variety of chillers including gas engine chillers
 - radiant cooling equipment
 - refrigerators, freezers
 - automobile a/c units
- Electronics and telecommunication hardware including sophisticated diagnostic instruments for the energy market (eg infrared thermometers, heat flow meters etc), telephones, fax machines, etc.
- Environmental equipment - small home water filters, residential and small commercial water treatment and sewer treatment equipment, air filters, etc.
- Others - to be determined

D. Marketing Plan

Market Definition and Opportunity

It is our belief that the changes in the Polish economy are opening markets for the goods and services the venture may provide. The market components include new construction in residential and commercial sectors, many planned infrastructure improvements, along with privatization and restructuring of energy market.

The following is a list of the opportunities that we believe currently exist in these markets:

- Higher living standards expectation
- International companies planning to locate their office and manufacturing/warehouse facilities in Poland
- Local companies expanding and upgrading their facility to comply with expected standards (for instance air-conditioned offices) and new regulations (for instance emission control equipment for manufacturing plants)
- Many utilities, municipalities and larger manufacturers are in dire need for comprehensive master plans to chart out their future
- New large infrastructure and energy projects are being planned which require feasibility studies

- Limited supply of high efficiency cooling and refrigeration equipment resulting in high prices quoted
- Limited local experience in the design of state-of-the art cooling and refrigeration systems
- Limited local knowledge and experience in the area of utility customer service, marketing and strategic planning
- Large need for energy conservation and environmental protection combined with strong pro-environment national policy while funds are being made available from domestic and international sources.

Competition and other influences

We recognize a number of conditions and factors as our most significant obstacles to achieving our stated goals. These include:

- Growing local competition which has an advantage of lower labor costs. We hope to be able to alleviate this by creating a Polish/American team whereby the majority of the straightforward work would be performed by the Polish team members. The only assistance provided by American partners would be in unique areas not explored by Polish professionals. This should allow us to offer innovative solutions which are uncommon on the Polish market at a competitive price.
- Tariffs, import taxes, customs and import regulations and certifications. This can be the biggest issue in the retail/distribution branch of our considered joint business. To deal with this obstacle (which can be significant especially at the beginning of the venture) we would start with goods that do not require elaborate certification to be sold on the Polish market or with products for which such certification has already been obtained.
- Lower shipping and transportation costs for goods and services from Western European countries and significant pre-existing presence of Western European products and services. This could probably be alleviated through conducting economic analyses which would factor in these considerations and help select the most attractive goods.

Marketing strategy

The marketing strategy is constantly being redefined as the discussion on future cooperation progresses. The following are some activities that are contemplated as part of the overall future strategy:

In the area of consulting services:

The companies would closely monitor bulletins, newsletters and press releases from the relevant international and domestic organizations for procurement advertisement. They would respond to developers/investors' requests for proposals. Shooshanian should concentrate mainly on American

and international organizations and investors while MPEC and/or other Shooshanian partners in Poland would focus on the local market.

Promotional literature describing the capabilities of the team could be distributed. MPEC, Polinvest and other Polish business partners should be instrumental in this activity. When desirable and appropriate they could introduce individual Shooshanian qualifications, as well as the joint experience of the team to their peers, counterparts and potential clients.

In the area of retail and distribution:

An existing retail store owned by MPEC could be used as a retail space. Currently the store sells a variety of customer goods mainly to general public. The venture is considering adding to the store's current offering, small quantities of US goods that are believed to be in demand. This preliminary "experiment" could serve as a market tester. As mentioned before, initially the venture would most likely offer products that do not require elaborate certification on Polish market or are already certified. This step should allow to select a range of goods that are the "best sellers". Later the venture could concentrate on increasing the supply of such goods. In this manner, it could generate enough revenue to start "testing" (marketing) other goods which are more expensive and/or less known to Polish market.

At the same time, additional services could be developed including maintenance, installation and after-sale services for commodities that proved to be in demand (or were showing potential). Also the store environment (decoration, display, etc) and sales techniques could be improved. This may include training of the sales personnel, introducing proven sales methods, etc. Also full time, part time or on-call technical experts could be added to answer any customer's more involved technical questions.

Different forms of promotion could be used including advertising in medias, press releases and articles in trade magazines, educational programs, etc. As it is expect that the venture be able to offer a wide variety of products and services, the method of promotion should cater to a particular line of products being marketed to targeted customers.

As the plan is to utilize existing space in MPEC's retail store as well as all or some of the existing sales personnel, the considered venture should be able to lower the start-up cost significantly.

Market research

Our assumptions of the potential demand for goods and services are based on the experience gained in the course of the DOE project, our Polish partners' vast knowledge of the energy market in the region, and on the available statistics and publications.

As there was no specific market research conducted for our venture purpose, we are planning to reduce the risk of misjudging the market by structuring the sales approach in such a way that it allows a form of market "testing".

E. Management, Organization and Operational Plan

Management and organizational structure as well as the operational plan are still under discussion and a number of options are being considered and evaluated. Initially the venture would most likely be structured as a joint effort of two independent business entities. The basis for cooperation could be a ratified bilateral cooperative agreement and a business plan. There could be one coordinator from each participating organization. Detailed descriptions of responsibilities of involved individuals as well as personnel assignments would most likely be provided prior to the signature of the cooperative agreement.

Also prior to the ratification of any binding agreement, the parties involved would prepare a preliminary time frame for the cooperation. It could serve as a general schedule and include a set of goals against which progress can be measured. The anticipated major milestones may include:

- Signing of the Cooperative Agreement
- Performance review meeting (or conference call). We anticipate that every three months the performance of our venture would be evaluated. Correction to the strategic plan could be introduced if necessary. Once the long term viability of the venture is determined, less frequent meetings would probably be sufficient.

These milestones pertain mainly to the previously discussed retail business. For large projects handled on a project by project basis, individual, project-specific rules would be developed and applied.

F. Structure and Capitalization

It is considered that Shooshanian be on a form of retainer from MPEC or possibly share profits from the retail business. The retail goods would most likely be imported by MPEC without financial participation (at least initially) by Shooshanian. For large projects we would bid as a team and work out the specific structural and financial aspects on project by project basis.

XI. CONCLUSIONS

As of the conclusion of the DOE-sponsored project of Extension and Improvement of the District Heating System (11 April 1997), a total of thirty three facilities in twenty six sites have been connected to the MPEC district heating network. These sites are listed below.

BUDGET PERIOD I SITES	
No.	Site
1.	Zesp. Szkół Łączności (Monte Cassino 31)
2.	Dworzec PKP (Kraków Rail Station)
3.	Metaloplast (Rydlówka 40) "De Medici" (Rzemieślnicza 5) Zesp. Szkół Mech.nr 2 (Skrzyneckiego 12)
4.	Kryniczna 2
5.	Friedleina 10 Friedleina 19 Odrowąża 22
6.	Konfederacka 21
7.*	ESPEFA (Lea 208) HYDROKOP (Lea 210)
8.*	Słowackiego 26 Słowackiego 28
9.*	Łokietka 6b
10.*	Grottgera 1/3
11.*	Bujwida 4, Kołataja 16

* Construction work involved in the connection of this site began in Budget Period I but was completed in Budget Period II.

BUDGET PERIOD II SITES	
No.	Site
1.	Łobzowska 57
2.	Teresy 7
3.	Teresy 16
4.	Słowackiego 11b
5.	Słowackiego 13
6.	Lubelska 27
7.	Śląska 7
8.	Wojskowy Szpital Klin. (Montelupich 3/5)
9.	Areszt Śledczy (Montelupich 7/8)
10.	Dom Pomocy Społecznej (Helclów 2)
11.	Dom Pomocy Społecznej (Zielna 41)
12.	Halicka Street area
13.	Szeroka Street area
14.	Powstańców 48/50
15.	Akademia Rolnicza (29-Listopada 48)

Total boiler capacity retired at the twenty six sites exceeds 40 MW. The peak heating demand shifted to the central district heating network equates to 28.4 MW. Total coal consumption within the Kraków city limits is estimated to be reduced by an amount in excess of 13,193,458 kilograms per year (13,193 metric tons per year).

Total project emission reduction is empirically calculated to be 957,783 kilograms per year (957.8 metric tons per year) of combined pollutants. Emission reduction is allocated by pollutant as follows:

Table 8 - Emission Reduction Summary

Emission Type	Emission Quantity (kg/year)
Particulates	265,560
Sulfur Oxides (SO _x)	258,320
Nitrogen Oxides (NO _x)	45,091
Carbon Monoxide (CO)	388,811
Total	957,782

Total project expenditures, culminating in the connection of twenty six sites to the central district heating system during Budget Period I and Budget Period II, were \$3,924,607. The average cost per MW to connect the twenty six sites is \$138 per kW of connected load. Similarly, the average cost per metric ton of abated emissions for the connected sites is \$4,098 per metric ton per year. Please note that these costs include management, training and other costs not directly related to the construction.

As anticipated, relatively large variations existed from one site to the next in costs per MW shifted. The range of costs per MW of shifted heating load and metric ton of total pollutants per year is due to the following:

- The relative location of boiler houses to the central district heating system. Typically lengthy runs of buried piping installed in city streets required a greater relative expenditure of monies than short connection runs. Also, location of the site in more infrastructure-intensive areas (existing underground utilities, heavy building and transportation infrastructure) of the city results in greater construction costs due to more labor intensive excavation, traffic detouring, or use of different piping installation techniques (excavation-free, push through technology).
- In some cases, larger diameter pipes over that needed for particular sites were installed in anticipation of connecting future clients. This is particularly true of the pipeline between PKP rail station and Świętokrzyska Street, where large (500 mm, 400 mm, and 350 mm diameter) pipeline was laid. This resulted in the connection of six sites but also allowed creation of a loop between two existing MPEC transmission mains. This improved hydraulics and heating capacity of the MPEC hot water distribution network and provided groundwork for future connection to the district heat of many current coal users in the area.
- Some sites chose to retain ownership, and subsequent installation and maintenance costs, of all building-side modifications required to connect to the central district heating system. Such building-side components included the system heat exchanger, supply and return piping, valves and fittings, and pumping stations. These costs are generally not carried by the project.

- For some sites, only a small portion of the construction costs were carried by the project. This is particularly true for the following sites: HYDROKOP, ESPEFA, Słowackiego 26, Słowackiego 28, Łokietka 6b, Grottgera 1/3, Bujwida 4 and Kołłątaja 16. For these sites, materials were purchased and some construction started in Budget Period I. However, the connection was not finished until 1996. Therefore, costs associated with the completion of these sites incurred after September 1995 (conclusion of Budget Period I), were not carried by the project.
- Emission reductions are calculated from empirical formulae which are dependent upon ultimate coal analysis. When such coal constituent data is unavailable, mean values must be used.

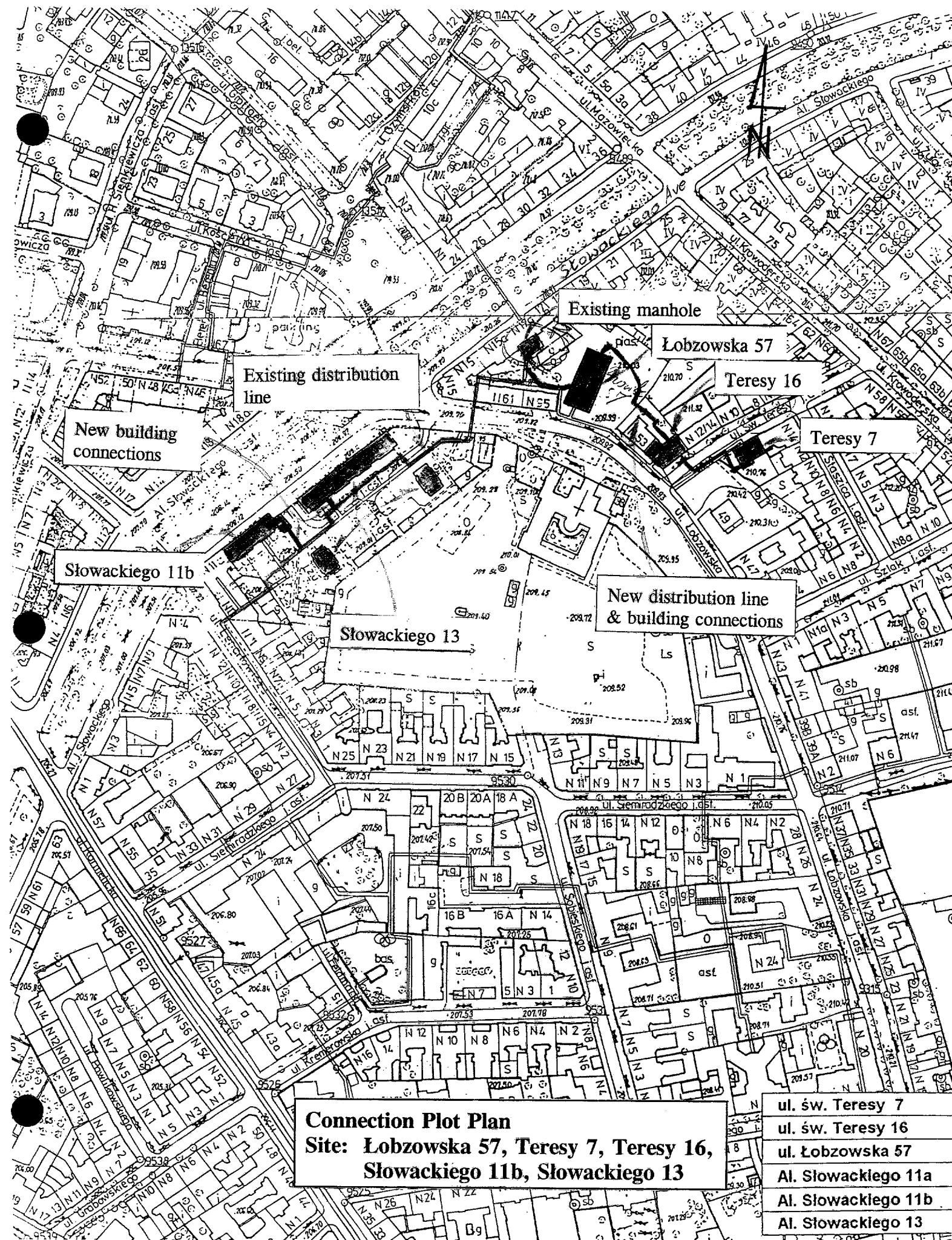
Based on the cost and pollutant reduction quantities achieved in the project, reduction of air pollution in Kraków through the elimination of selected coal-fired boiler plants by connection to the city's district heating system is economically justifiable. We remain firmly convinced that this approach to pollution reduction in Kraków (retiring coal-fired boilers and connecting to the district heating network) is by far the most cost-effective of those addressed in the Kraków Clean Fossil Fuels Program.

During the course of the DOE-sponsored project we managed to identify and develop a good relationship with a number of potential future business partners in Kraków. This includes, but is not limited to MPEC S.A. and Polinvest Ltd. Together with them we intend to continue promoting district heat and related value added services as well as energy conservation and energy efficient HVAC equipment. We also managed to familiarized ourselves with specific aspects of the Polish energy market and the potential demand for energy and environment-related services. Although we did not create a formal joint venture with any of our Polish partners, we developed strategies that are designed to maintain and extend links that currently exist. This should eventually lead to mutually profitable commercial cooperation in Poland and if deemed desirable, formalization of activities through the creation of an independent business entity in the region.

Appendix A

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Łobzowska 57
Teresy 7
Teresy 16
Słowackiego 11b
Słowackiego 13

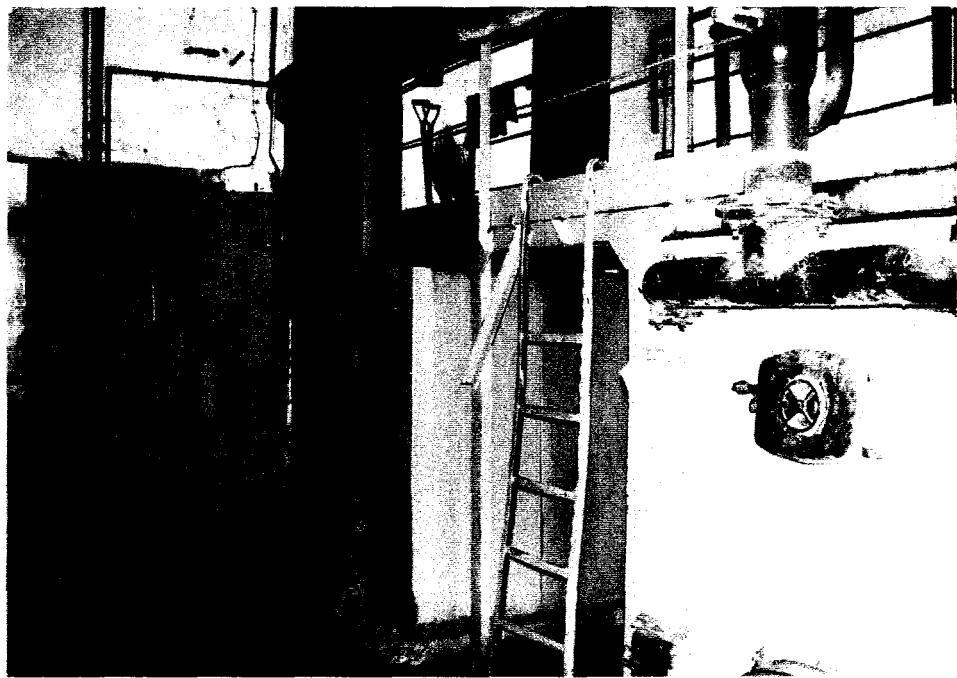


Lobzowska 57

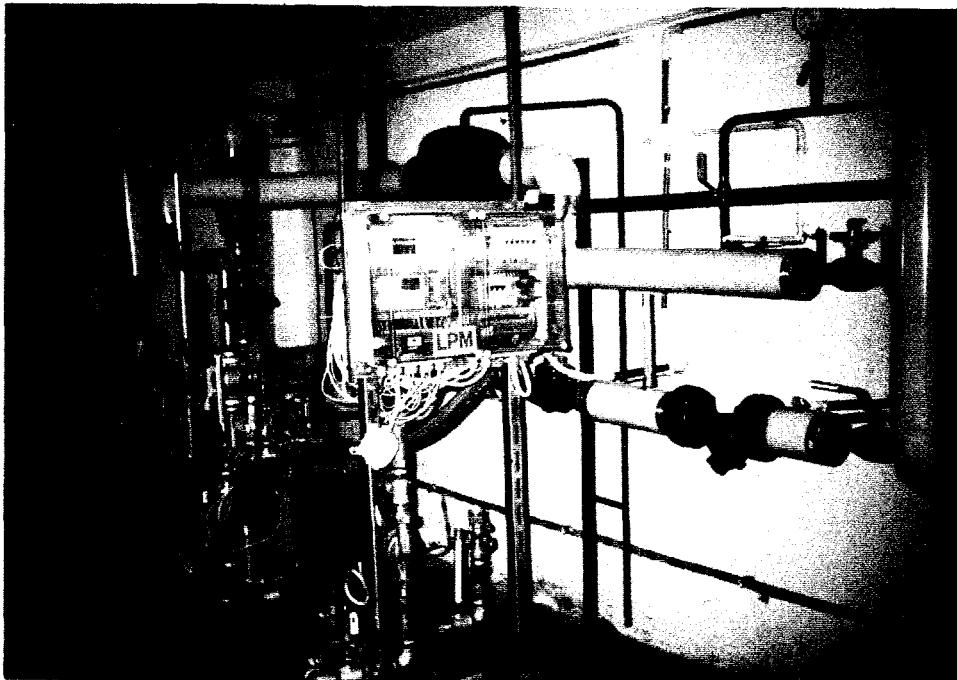


Site view

Łobzowska 57



▲ Coal-fired boilers formerly serving the site, now retired and disassembled



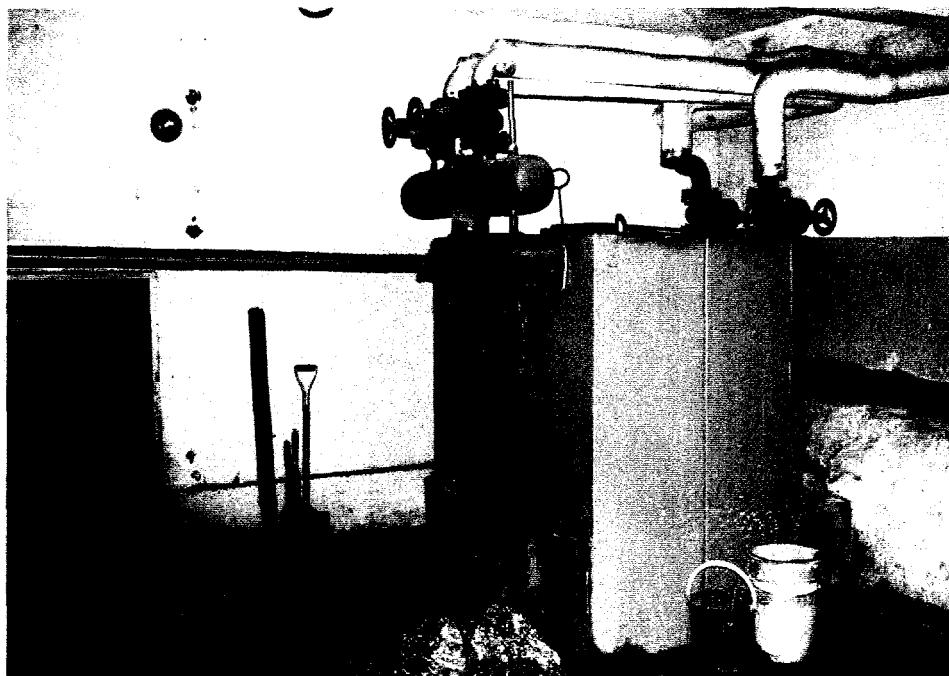
▲ Newly installed heat exchanger

Teresy 16

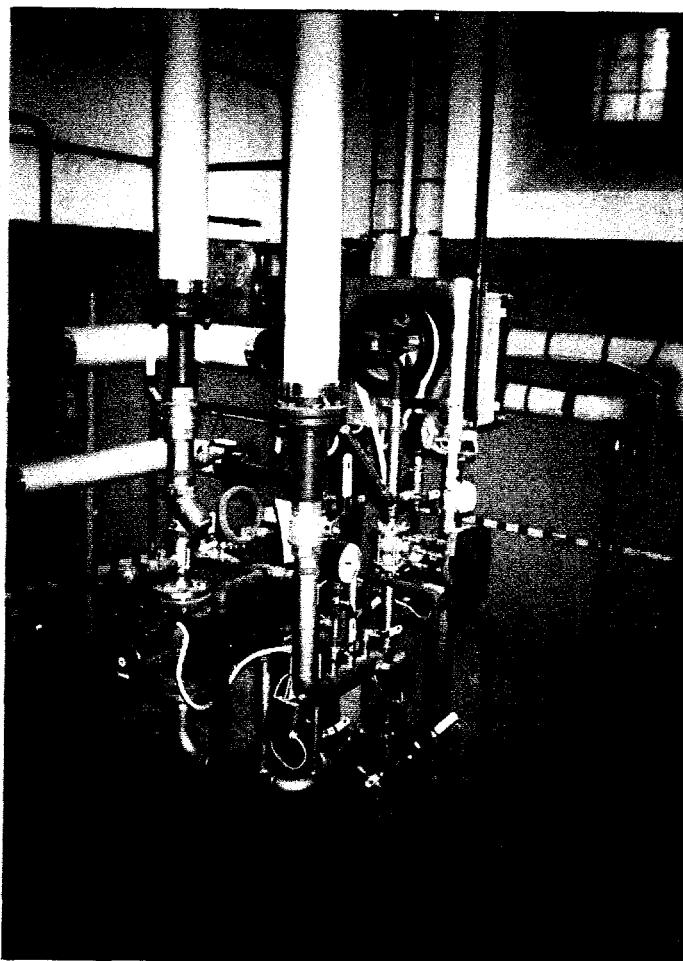


Site view

Teresy 16

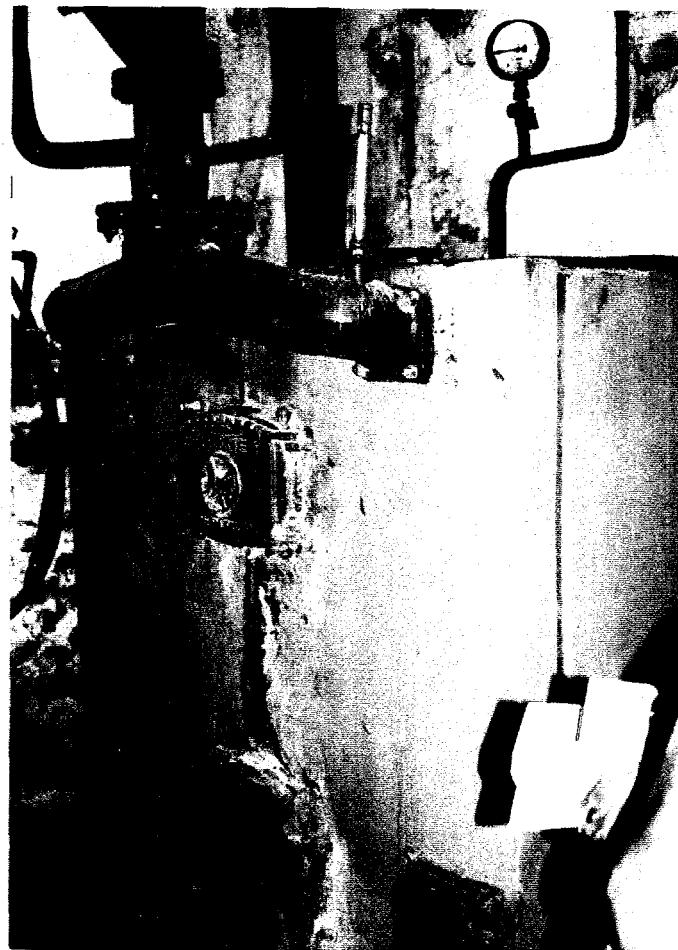


▲ Old site boiler (now disassembled)



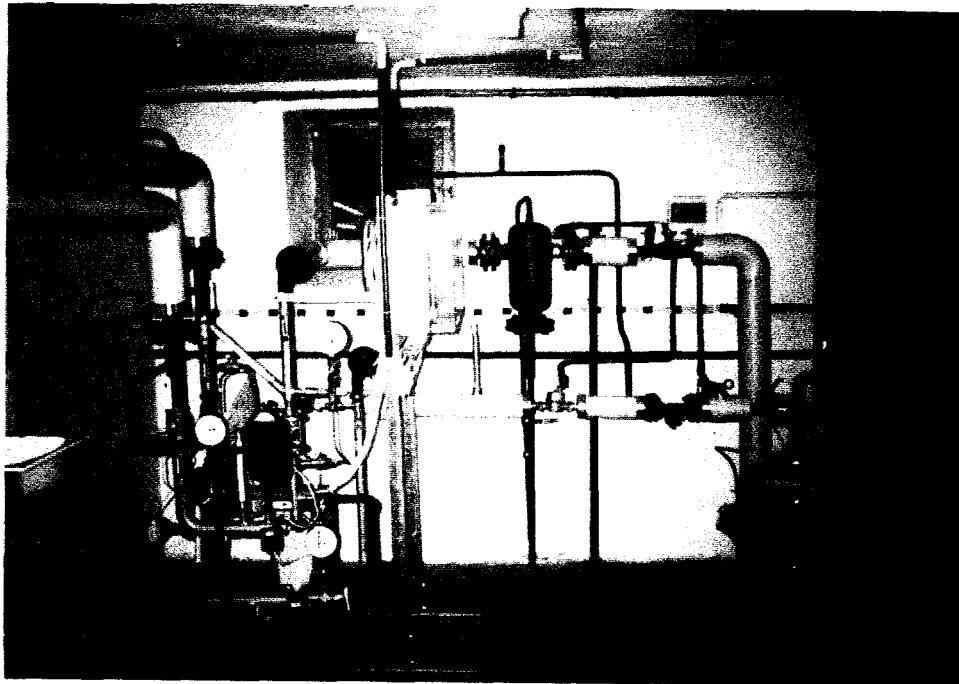
◀ Newly installed
heat exchanger

Teresy 7



Old site boiler
(now disassembled)

▼ Newly installed heat exchanger

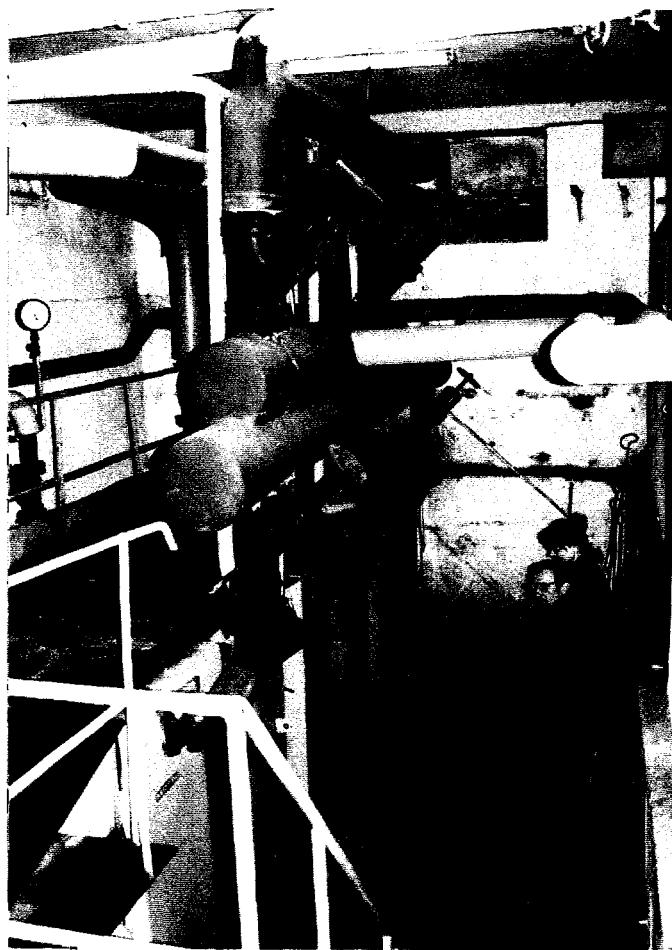


Slowackiego 11b

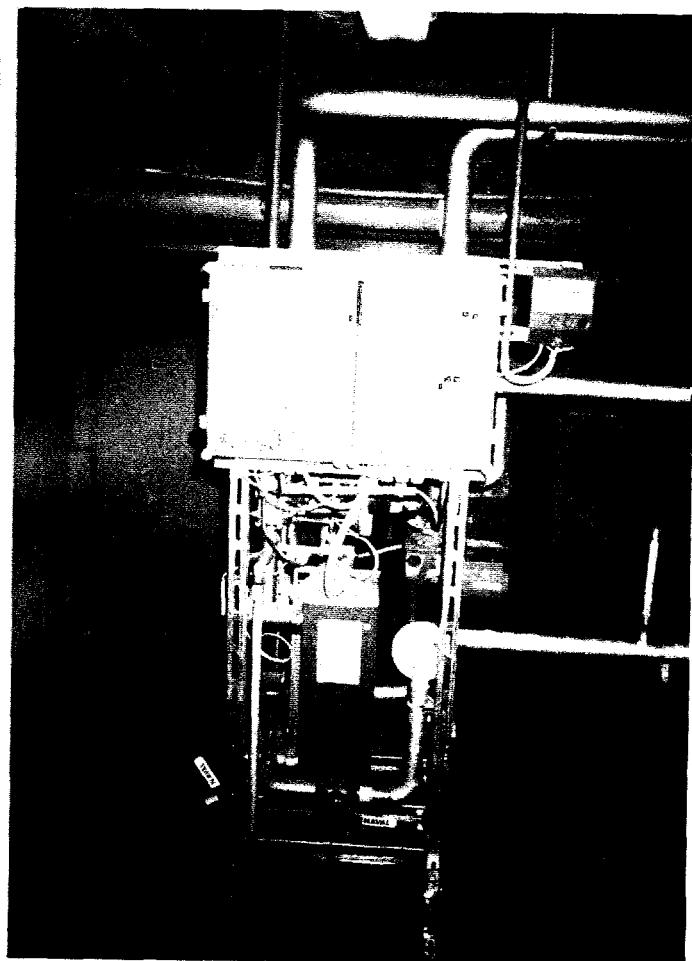


Site view

Słowackiego 11b



◀ Retired site boilers



Newly installed heat exchanger ▶



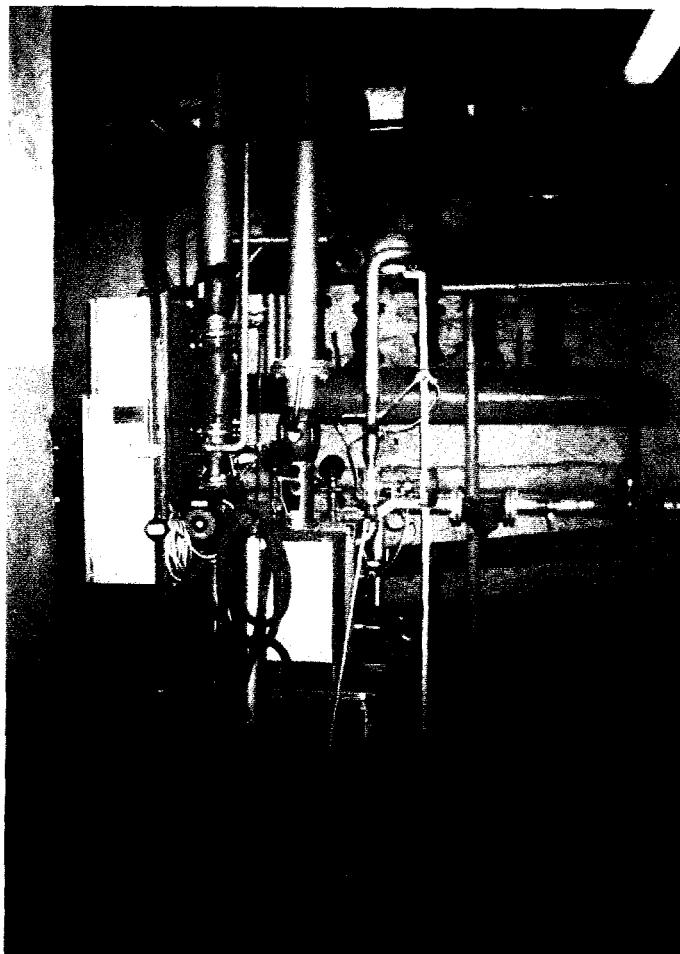
**Housing Complex
at Słowackiego 13**
Three site views



Słowackiego 13



▲ Site boilers (now disassembled)



▲ Newly installed heat exchanger

Appendix B

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Lubelska 27

Śląska 7

Teren

Newly constructed
MPEC's transmission main

New building connections

Śląska 9
(supplied from Śląska 7)

Lubelska 20
(supplied from Śląska 7)

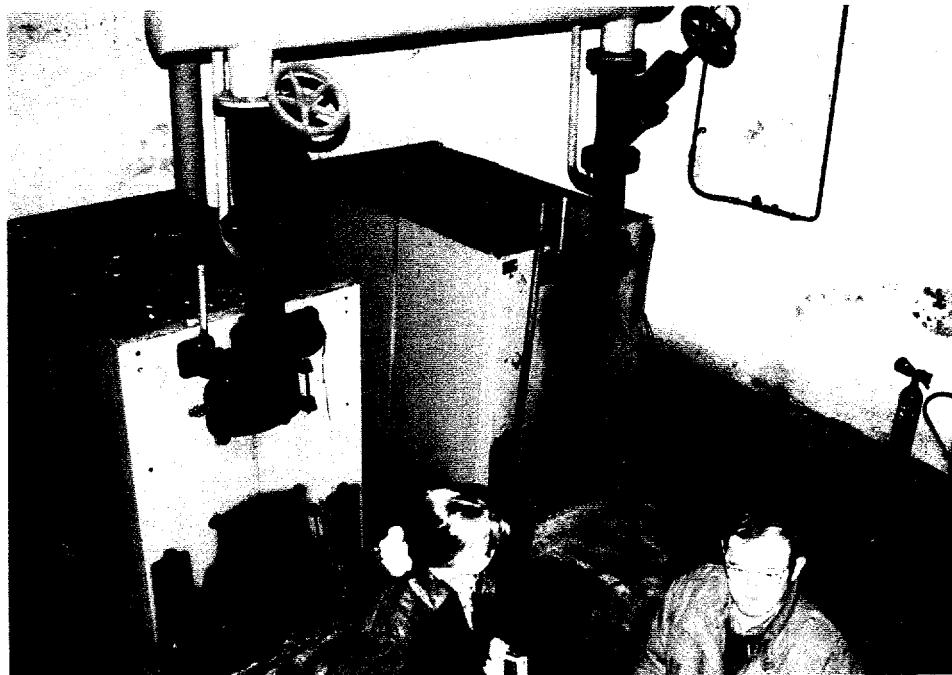
Connection Plot Plan

Lubelska 27

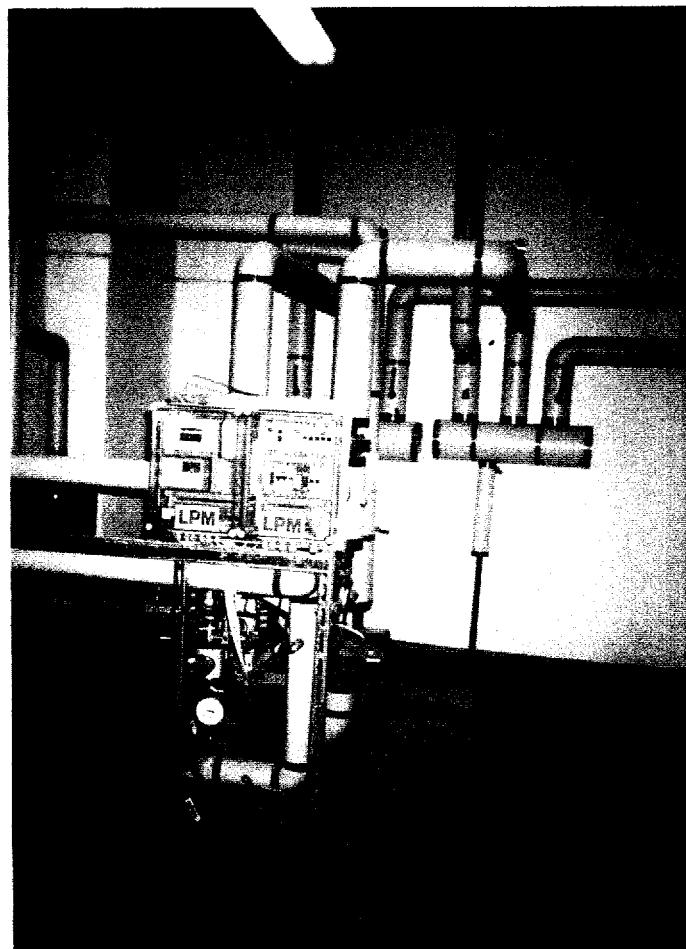


Site view

Lubelska 27



▲ Site boilers (now disassembled)

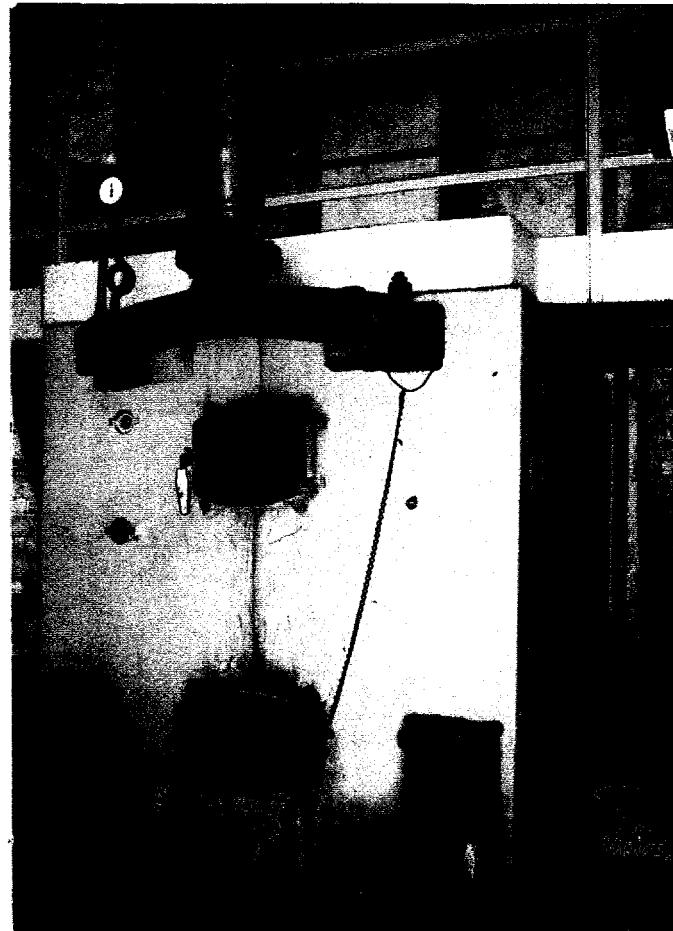


◀ Heat exchanger
installed in boiler
room (note abandoned
boiler pad)

Śląska 7



▲ One of three residential buildings at the site



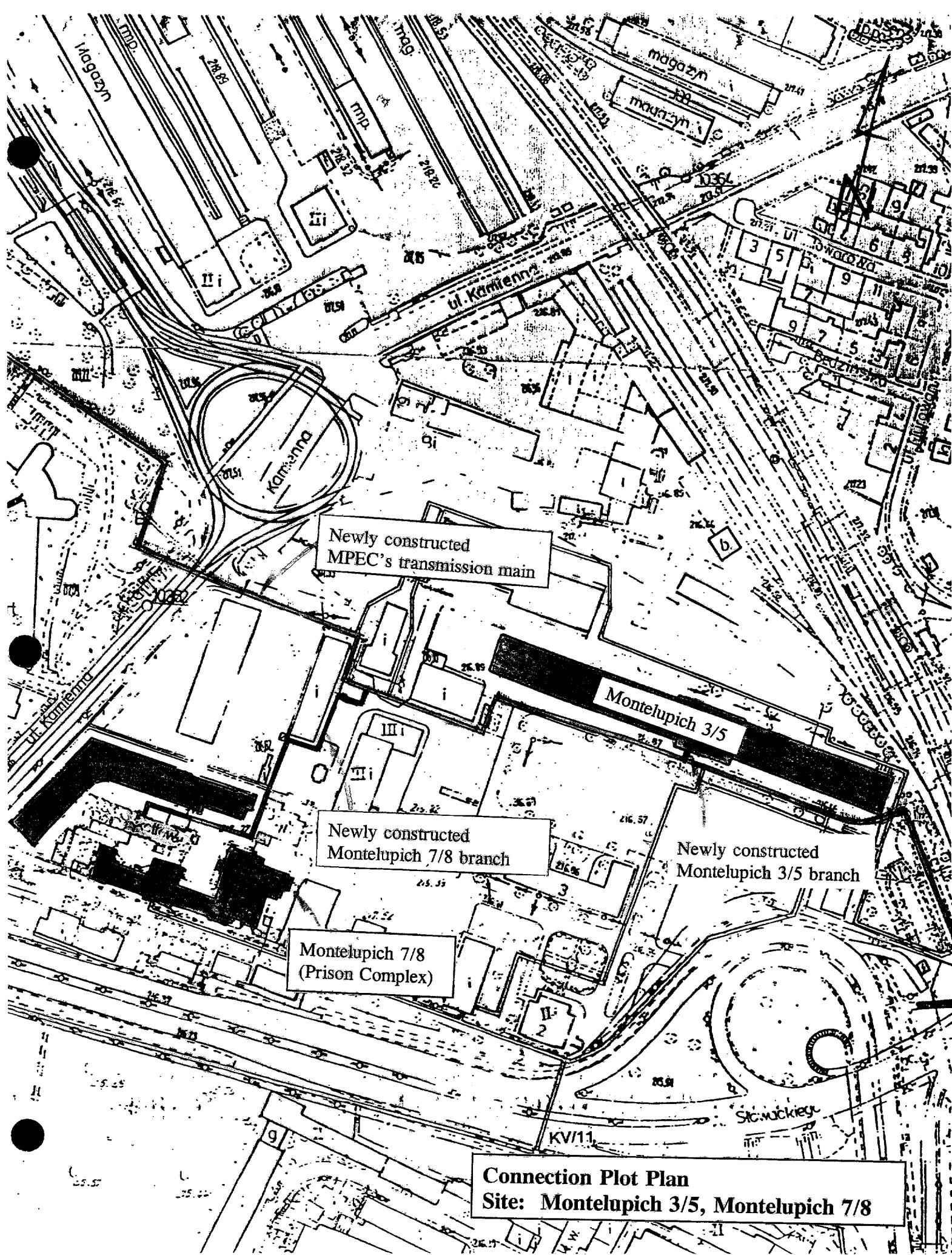
◀ One of four site boilers

Appendix C

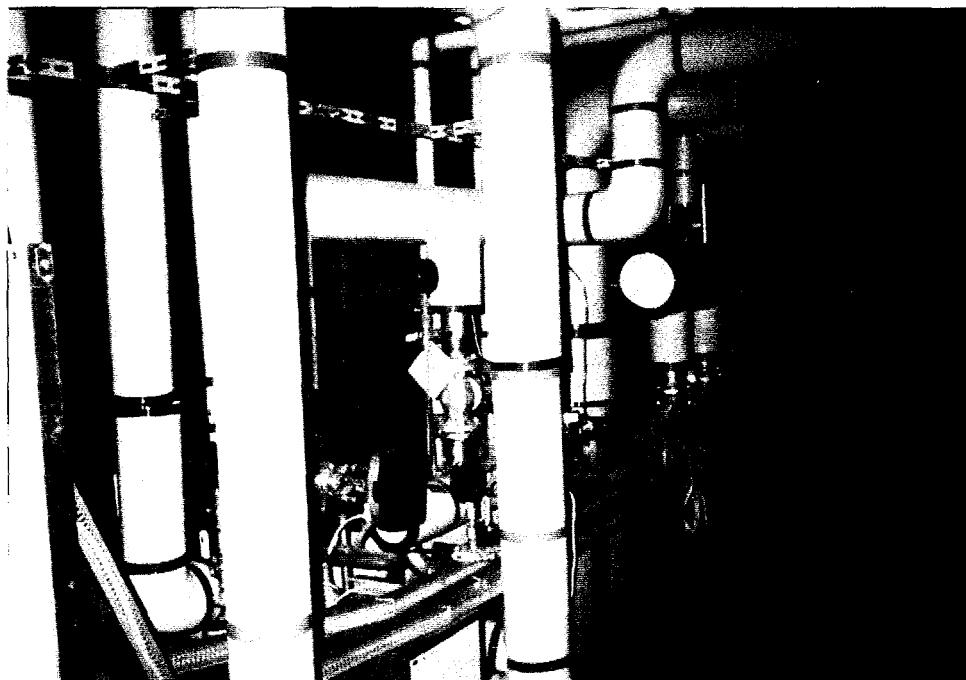
Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Montelupich 3/5

Montelupich 7/8

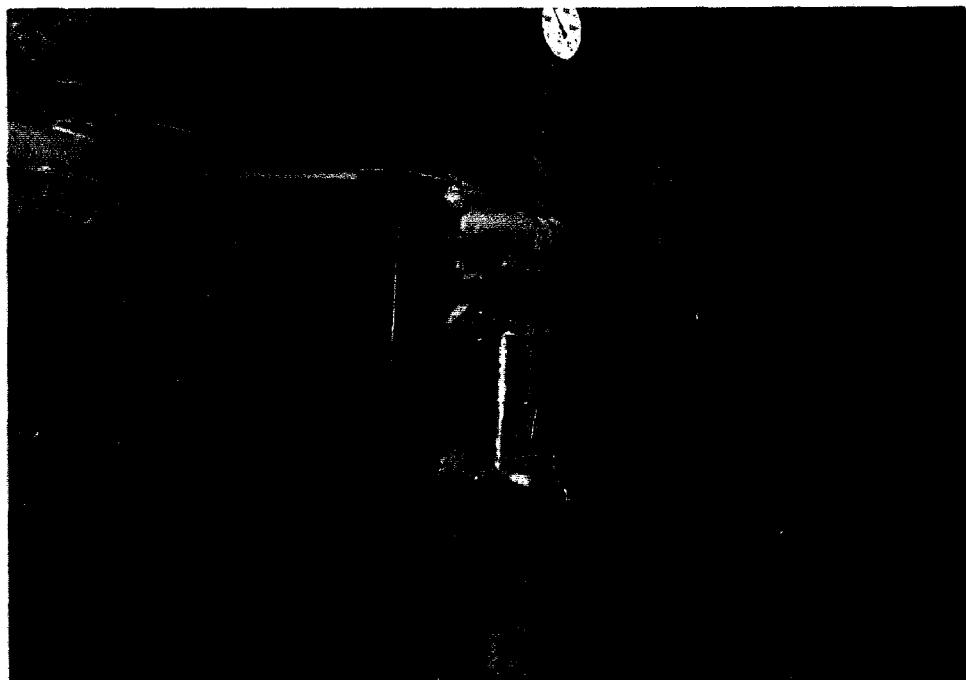


Montelupich 3/5

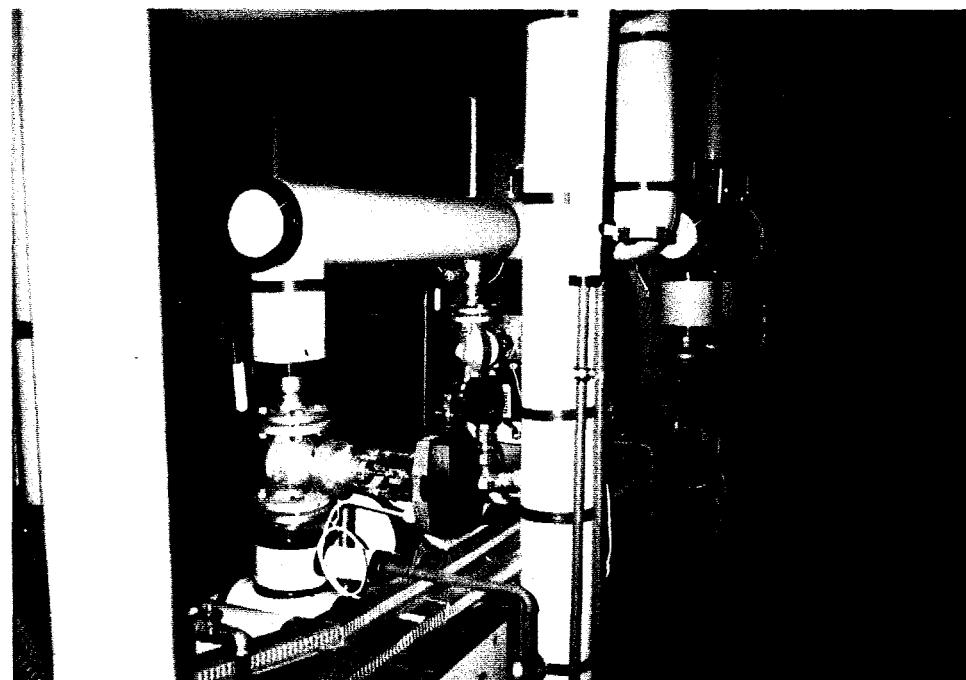


Newly installed heat exchanger

Montelupich 7/8



▲ Site boilers (partially retired)

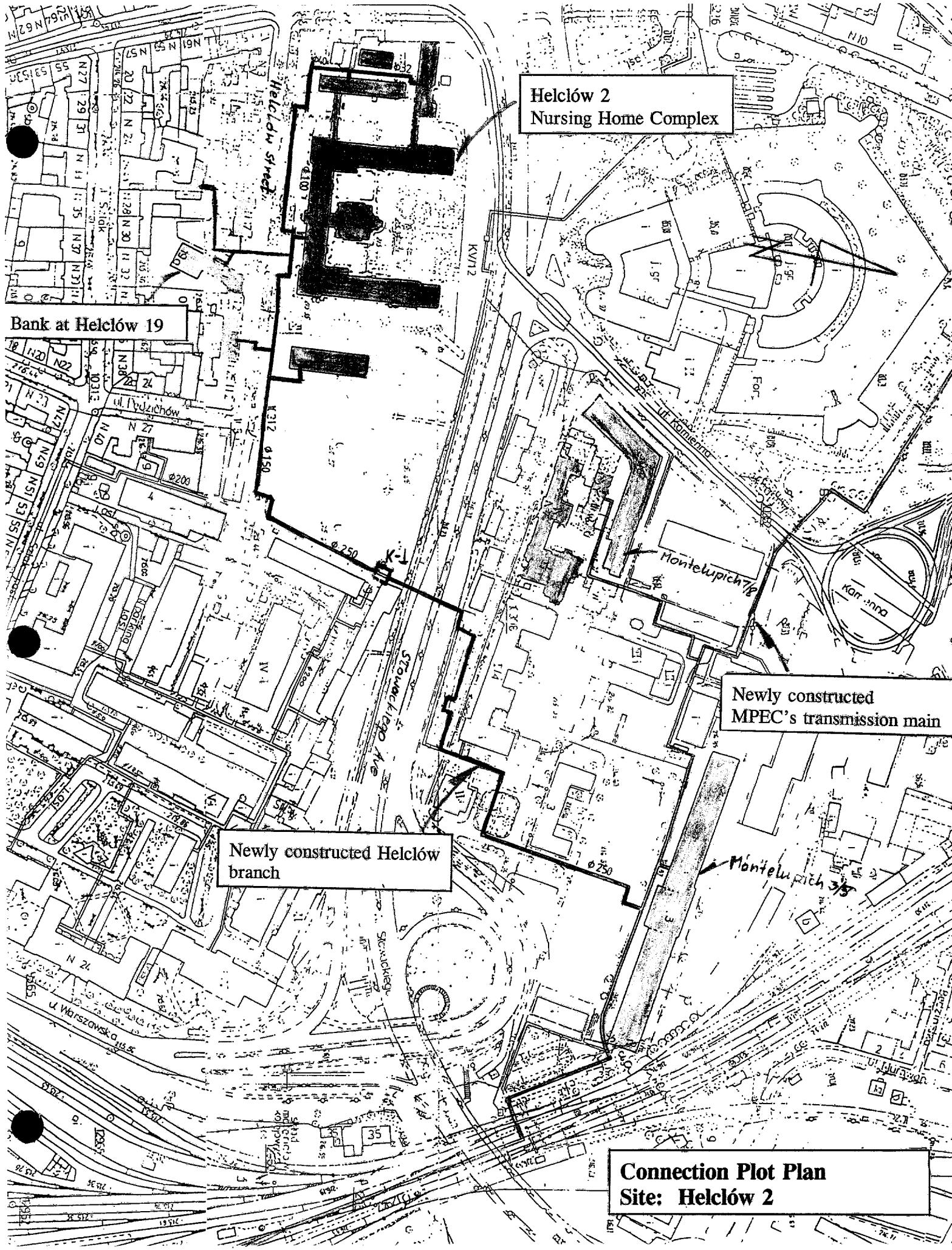


▲ Newly installed heat exchanger

Appendix D

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Helclów 2



Helclów 2
Nursing Home Complex

Newly constructed
MPEC's transmission main

Newly constructed Helclów
branch

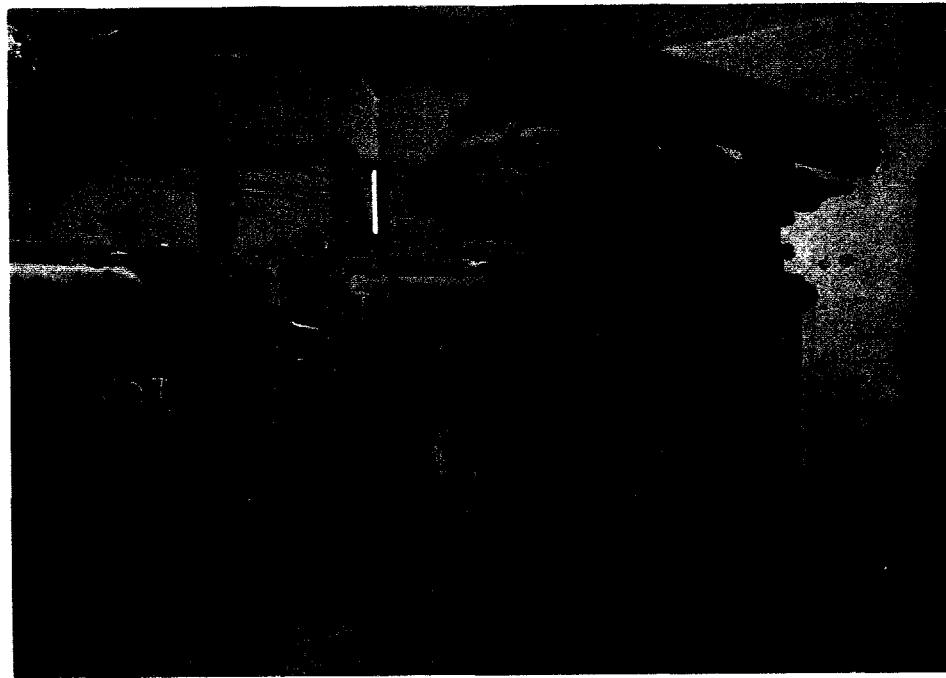
Connection Plot Plan
Site: Helclów 2

Nursing Home Complex at Helclów 2

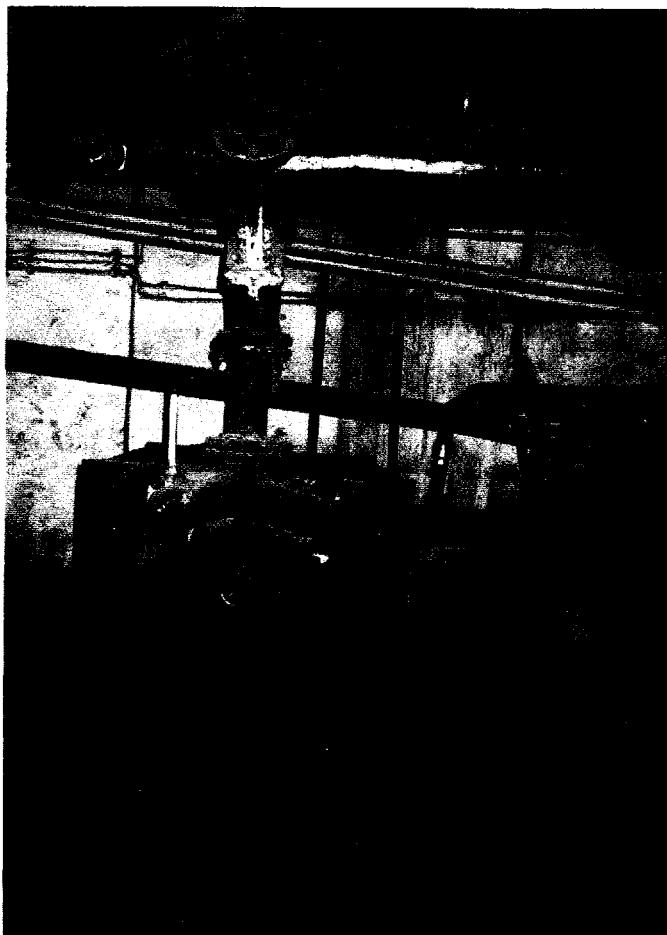


Main building

Helclów 2



▲ Boiler room in the main building. Boilers for space heating (now retired).



◀ Boiler room in the main building. Boiler for domestic hot water (now retired).

Helclów 2



New heat exchanger in the main building
(one of four installed throughout the complex)

Appendix E

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Zielna 41

Existing distribution line (service line for Telecommunication School)

New connection line

Nursing Home

Connection Plan

Nursing Home at Zielna 41



▲ Site view

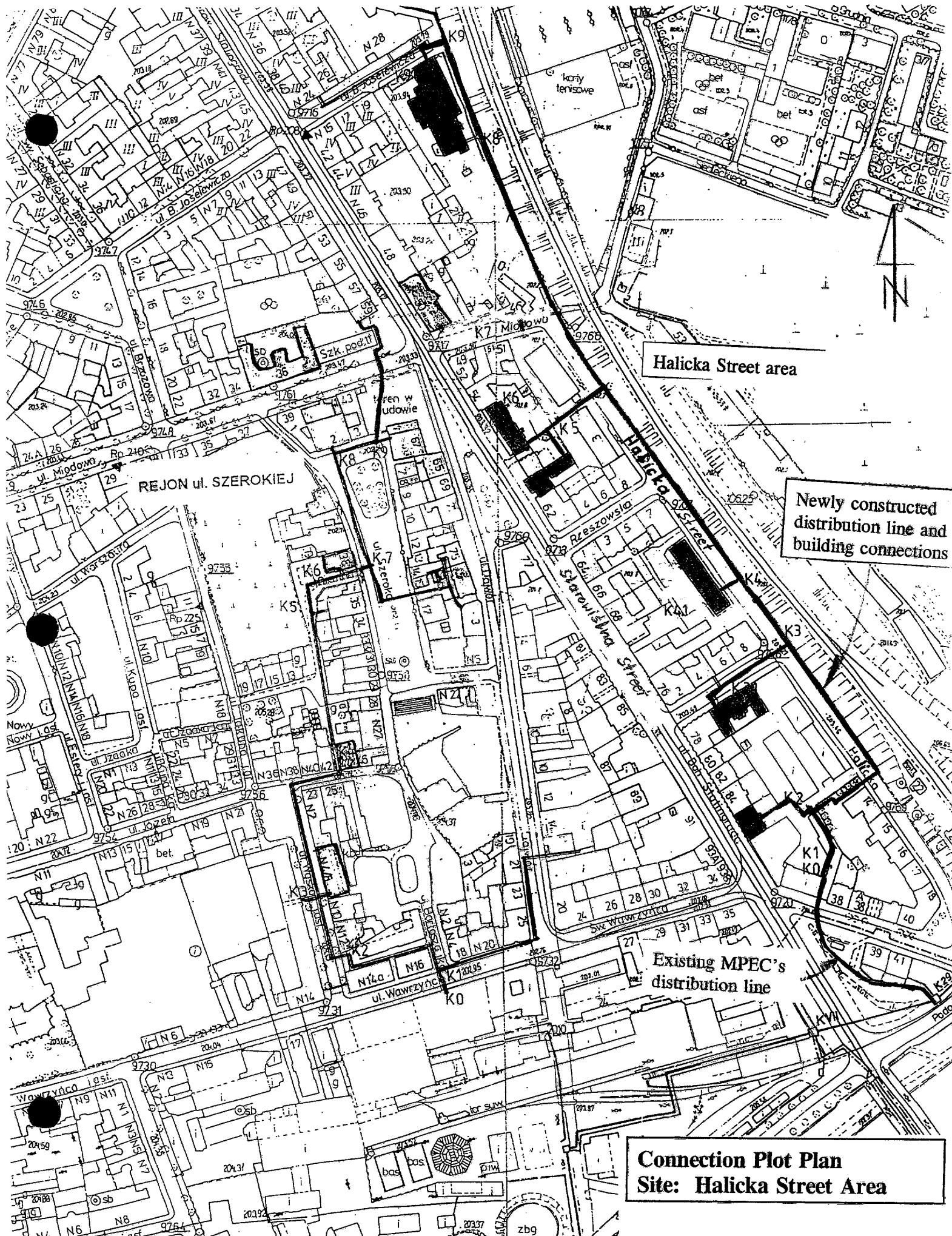


◀ One of three retired site boilers

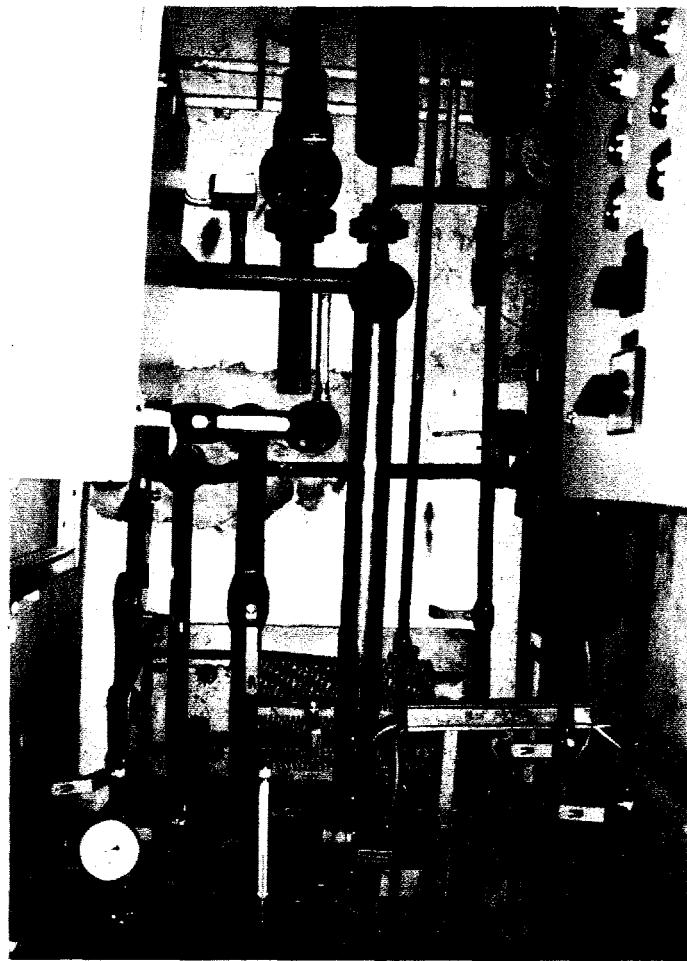
Appendix F

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Halicka Street area

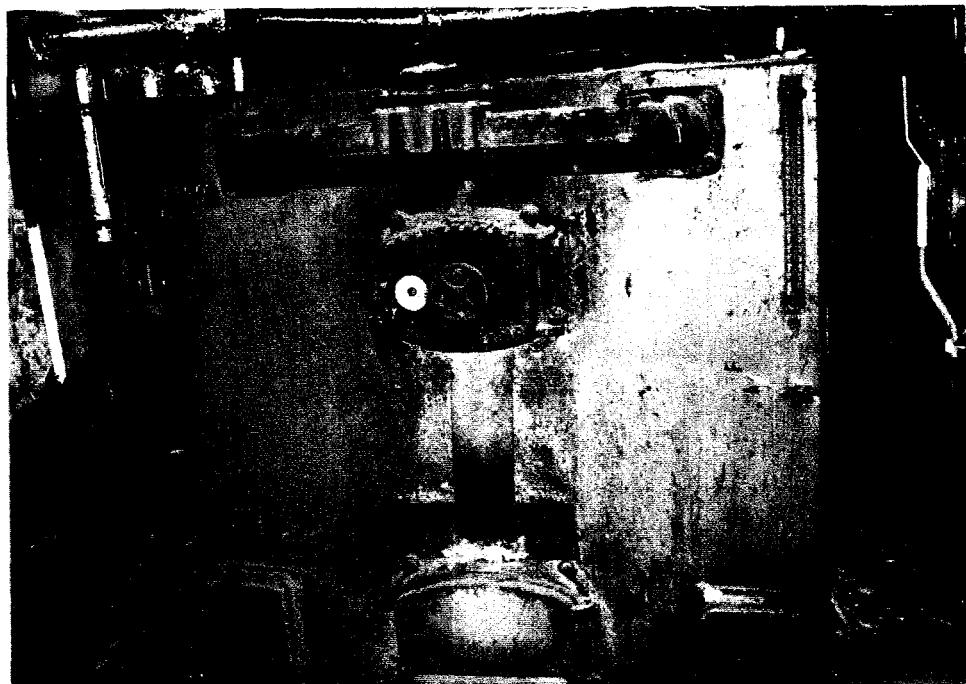


Halicka Street Area

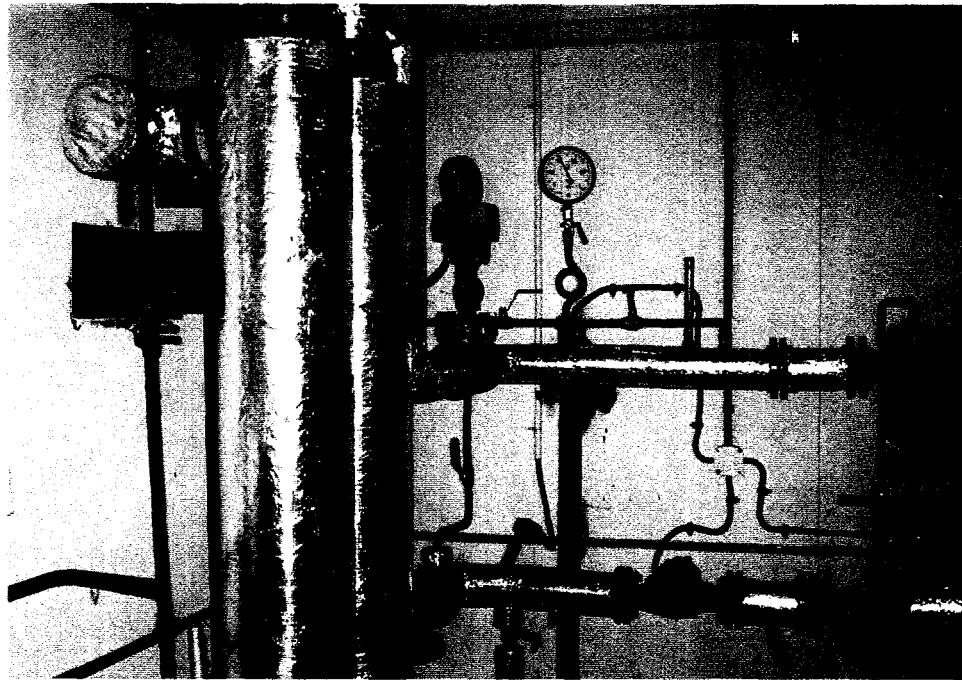


New heat exchanger station serving facility at Starowiślna 60

Halicka Street Area



▲ Recently retired boiler served facility at B. Joselewicza 21

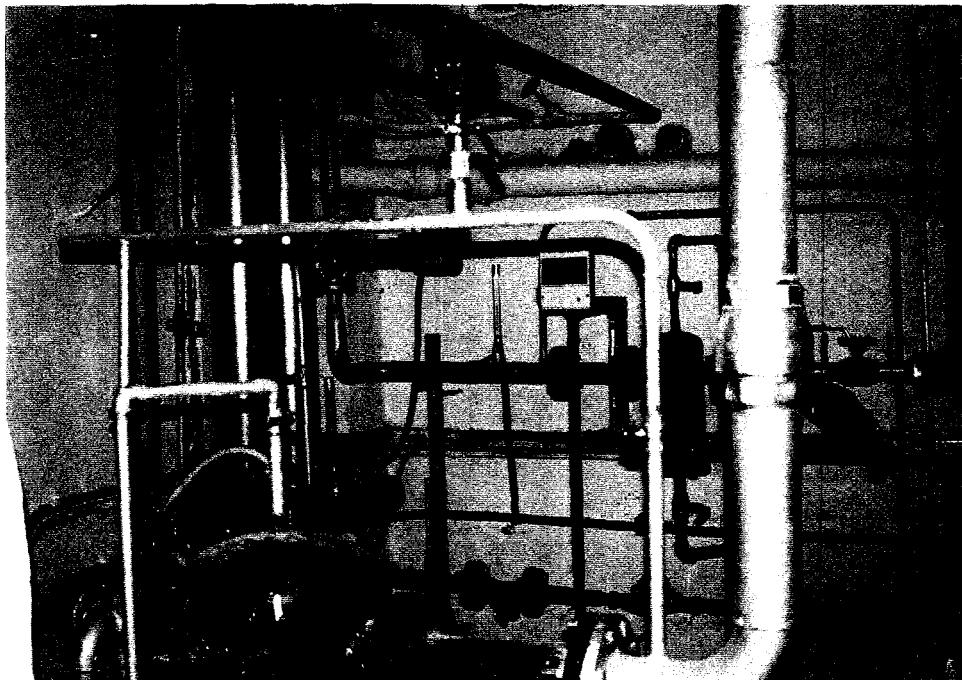


▲ Newly installed heat exchanger at B. Joselewicza 21

Halicka Street Area



- ▲ Residential/commercial complex at Starowiślna 56/58 - recently connected to the district heating system



- ▲ New heat exchanger at Starowiślna 56/58 facility

Appendix G

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Szeroka Street area

Szeroka Street area

Newly constructed distribution line and building connections

REJON ul. HALICKIEJ

Connection Plot Plan

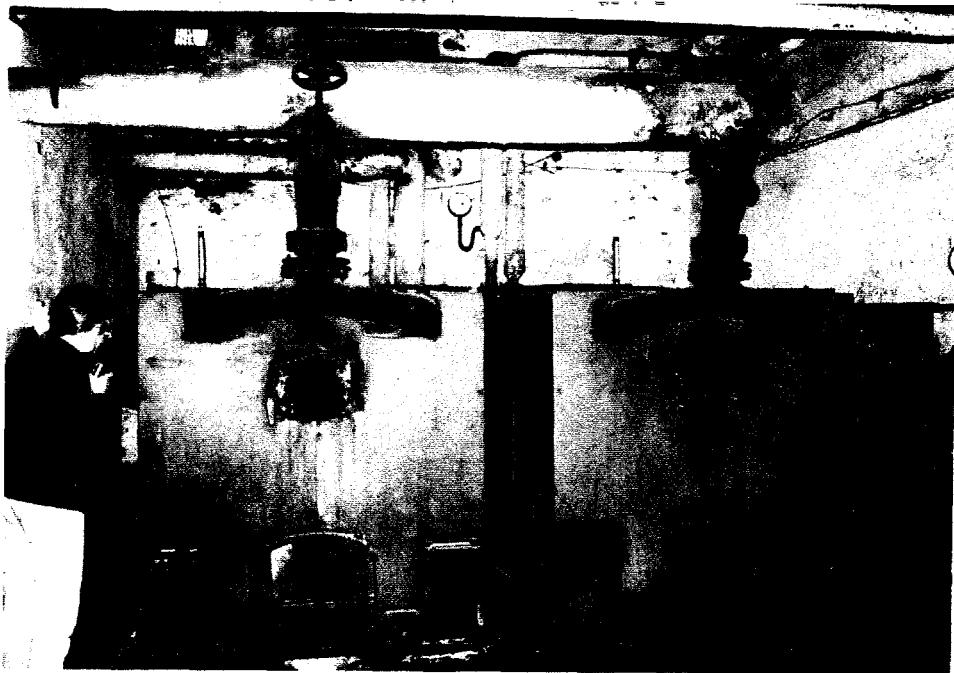
Szeroka Street Area



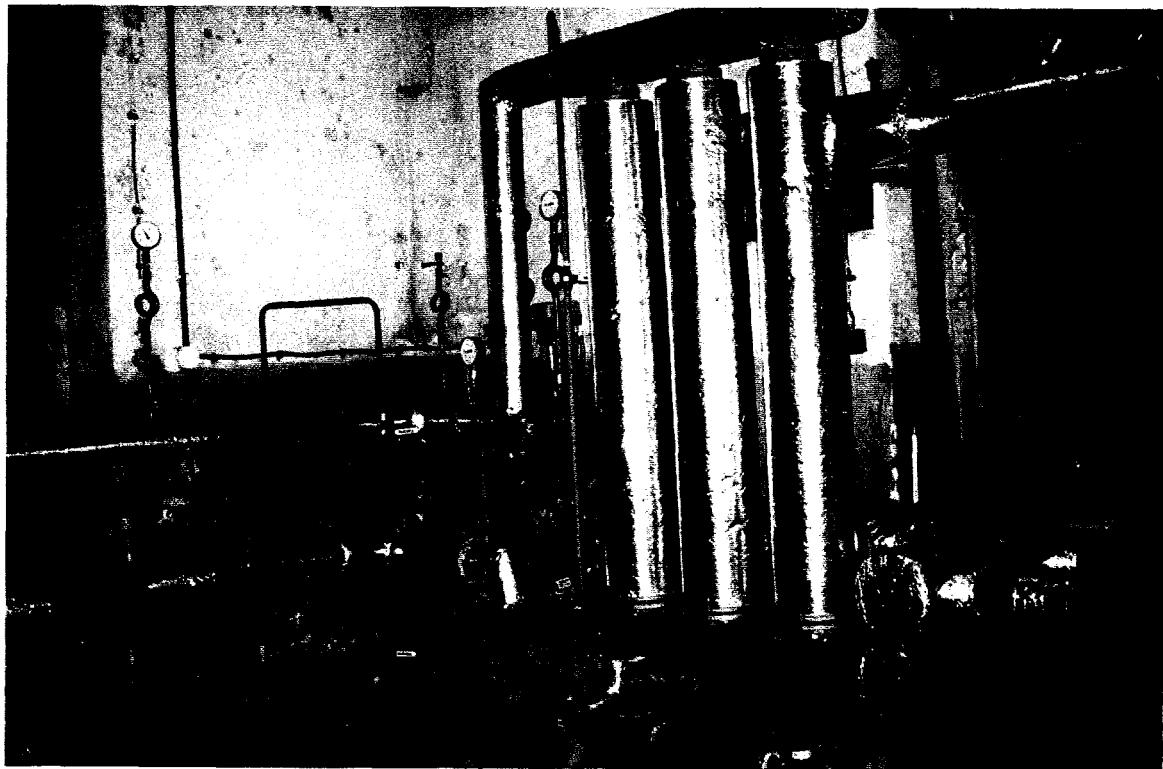
Two views of neighborhood supplied from a common heat exchanger recently installed in the basement of the building at Józefa 44 (above, second building from the right). Coal fired boilers located there, previously serving the site, were retired.



Szeroka Street Area



▲ Retired boilers at Józefa 44



▲ Newly installed heat exchanger at Józefa 44

Szeroka Street Area



▲ Police Department building at Szeroka 35 recently connected to district heat



▲ Recently retired boiler and new heat exchanger at Szeroka 35

Appendix H

Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

Powstańców 48/50

Heat exchanger station
located in decommissioned
boiler house

Newly constructed site connection line

Existing distribution line

Connection Plot Plan

Light Industrial Park at Powstańców 48/50

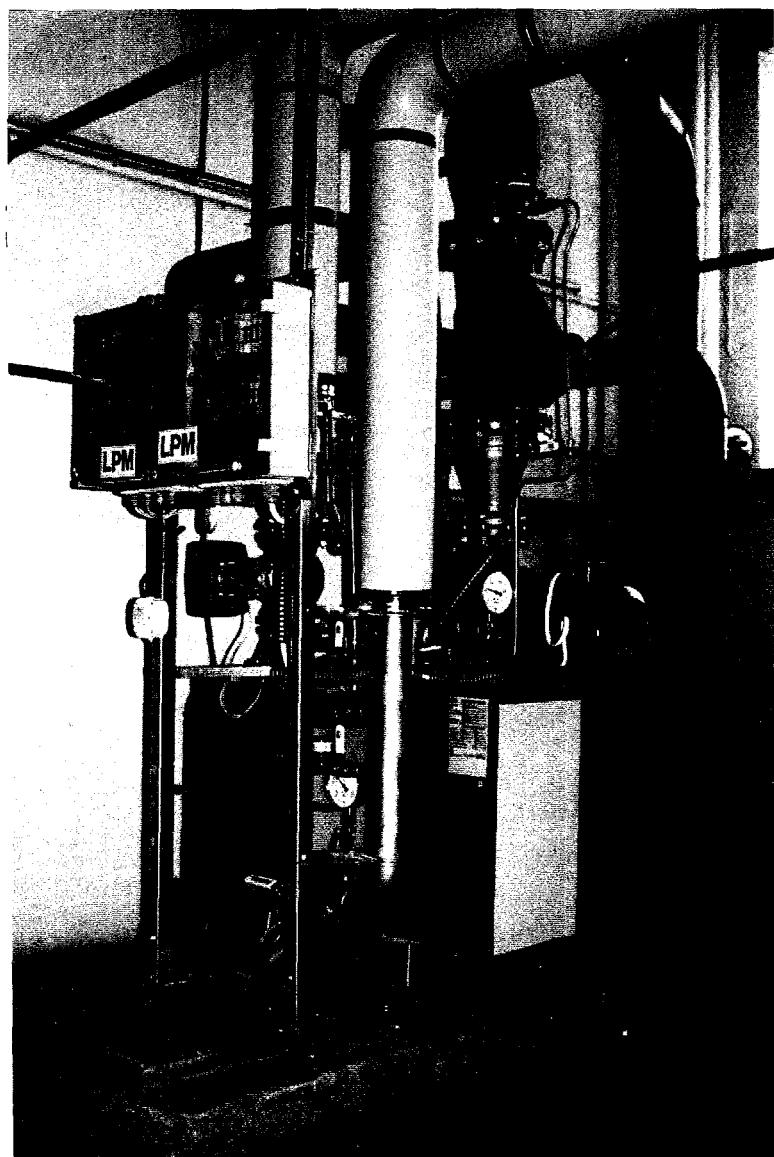


▲ Partial site view



▲ Retired site boilers

Powstańców 48/50

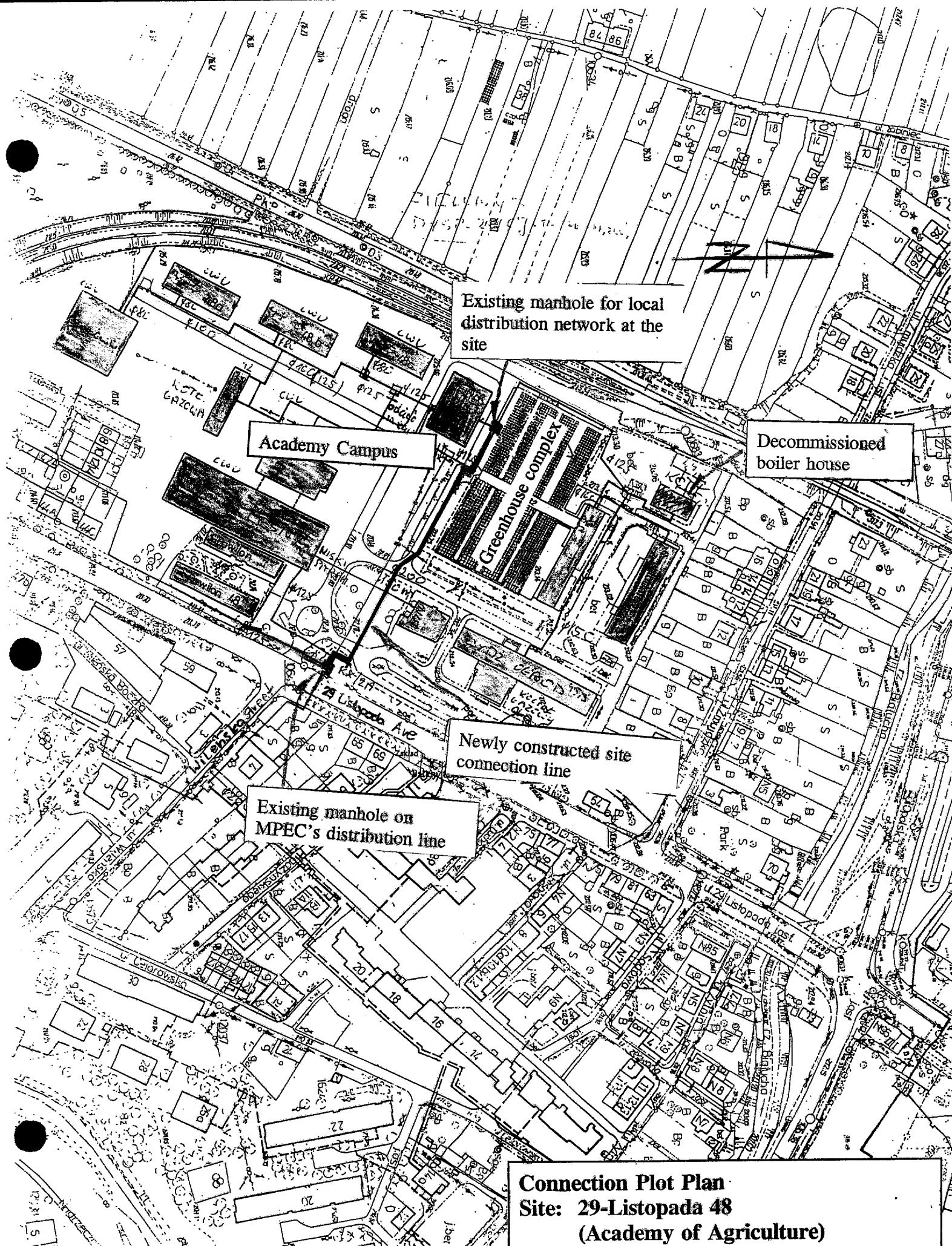


New site heat exchanger

Appendix I

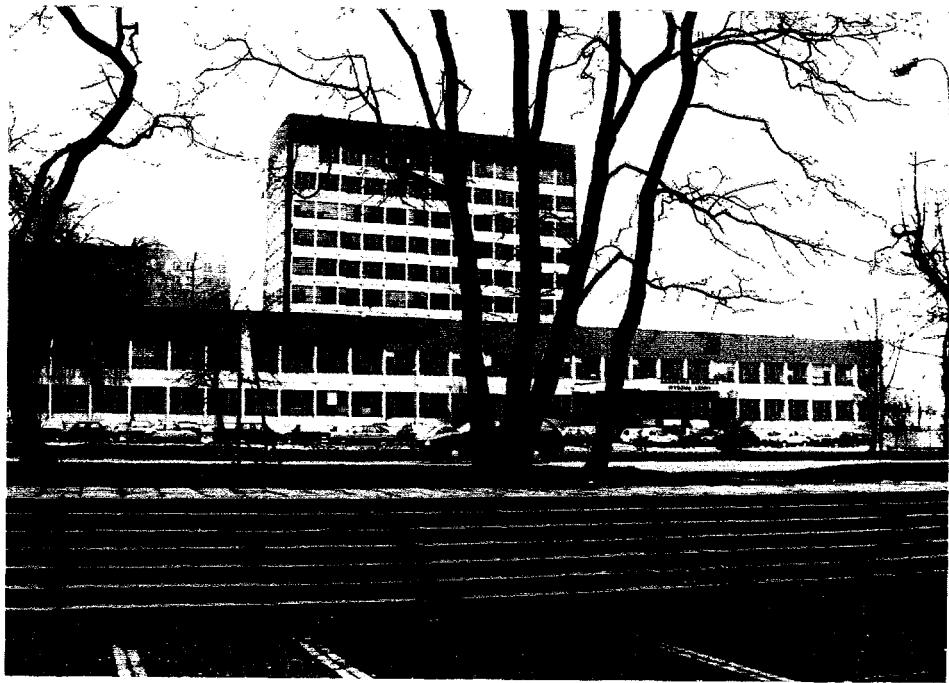
Plot plan for district heating system connection and photographs showing site views, retired boilers and newly installed heat exchanger stations for:

29-Listopada 48



Connection Plot Plan Site: 29-Listopada 48 (Academy of Agriculture)

**Academy of Agriculture Campus
(29-Listopada 48 Site)**



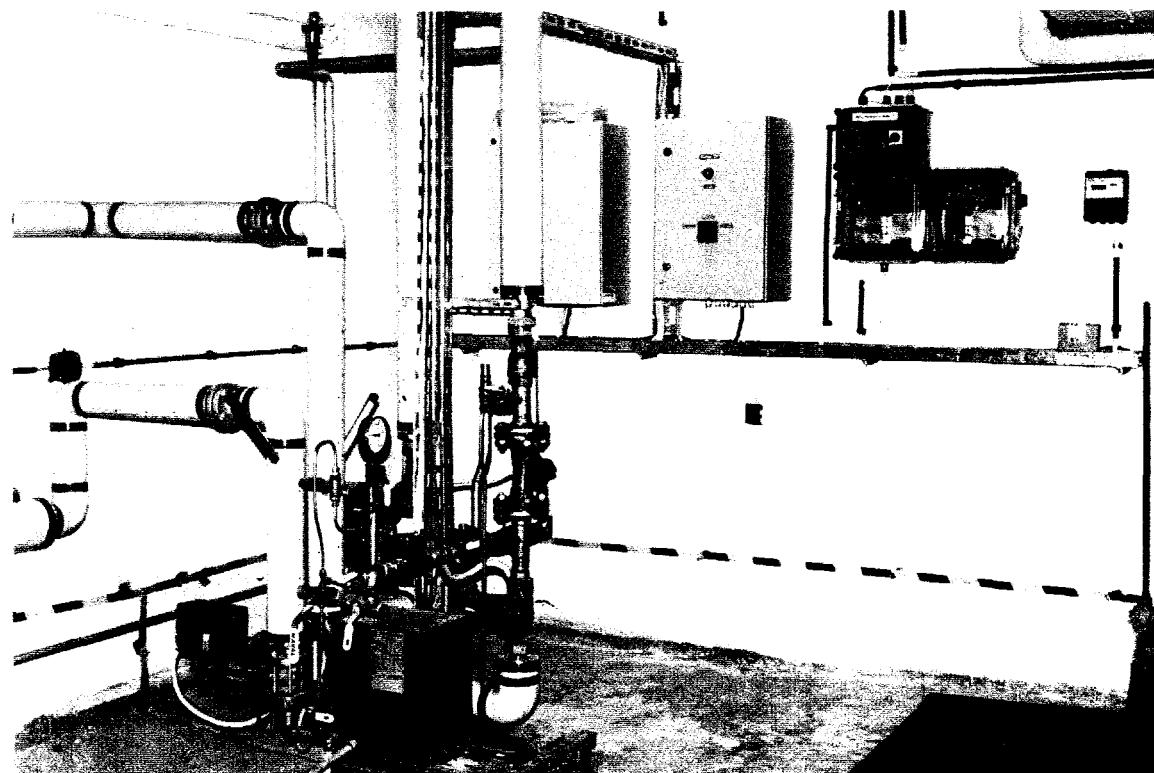
▲ Two views of the campus



Academy of Agriculture Campus
(29-Listopada 48 Site)



▲ Decommissioned central boiler house



▲ Heat exchanger station located in the Students Cultural Center is one of several similar stations recently installed throughout the campus.

Appendix J

Centrum Informatyki Energetyki Emission Formulae

MINISTERSTWO OCHRONY ŚRODOWISKA
ZASOBÓW NATURALNYCH I LEŚNICTWA
Departament Ochrony Powietrza
i Powierzchni Ziemi
PZoA/0631/1700/91

Janusz
Warszawa 1991-07-08

Tekuś.

AD WOJEWÓDZKI
W KRAKOWIE
Dział Ochrony Środowiska
1991 LIP. 10.

Data wpływu	
L.dz.	5931/91

wg rozdzielnika

✓ Departament Ochrony Powietrza i Powierzchni Ziemi przekazuje w załączniu wyjaśnienia dotyczące zapisów rozporządzenia Ministra Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa z dnia 12 lutego 1990r. w sprawie ochrony powietrza przed zanieczyszczeniem /Dz.U. nr 15, poz. 92/. Jednocześnie anuluje się podobne wyjaśnienia podane przy piśmie znak: Azoa/0631/3067/90 z dnia 14.03.1990r.

Prosimy o szerokie rozpowszechnienie w/w wyjaśnień na swoim terenie.

Jednocześnie informujemy, że przy naliczniu opłat w trybie rozporządzenia Rady Ministrów z dnia 11 grudnia 1990 /Dz.U. nr 88/90, poz. 511/ cienki azotu należy przeliczać na dwutlenek azotu NO₂. W pozycji 50 załącznika nr 1w/w rozporządzenia jest pomyłka drukarska.

W związku z końcową fazą prac redakcyjnych nad projektem ustawy o ochronie środowiska przyrodniczego, przekaznej przez resort do legislacji zewnętrznej Departament Ochrony Powietrza i Powierzchni Ziemi zwraca się z prośbą o zgłoszenie uwag i propozycji konkretnych zapisów w aktach wykonawczych do w/w ustawy dotyczących:

- ochrony powietrza
- hałasu
- promieniowania
- odpadów i gospodarki odpadami
- ochrony powierzchni ziemi

Wskazniki unosu i emisji zanieczyszczeń ze spalania paliw stałych

Węgiel kamienny, pochodne węgla kamiennego, węgiel brunatny

P A L E N I S K A

nr.	Substancja	pylowe			ruszt mechaniczny			ruszt stałym			koks		
		odzulanie		cykto-	12	3-12	MW	3	prod. wodne	prod. szaryj.	prod. parowate	prod. węgiel	szty.
		suche	pylne	nowe	MW	MW	MW	nat.	szty.	szty.	szty.	szty.	szty.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	SO ₂ /kg/Ng ³ /	19	19	19	17	16	16	16	16	16	16	16	16
2	NO ₂ /kg/Mg/												
3	CO /kg/Mg/	0.5	0.5	0.5	1	2.5	5	45	45	45	45	45	25
4	alup /kg/Mg/ z KO bez. KO	0.00001	0.00001	0.00001	0.00004	0.00016	0.00032	0.014	0.014	0.014	0.014	0.014	-
5	ryi /kg/Ng ³ /	7	8	2	3	2.5	2	1.5	1.5	2	1.5	2	1.5
6	Części paliwowe w pyle /%	3	5	2	1.5	20	25	25	25	25	25	25	5
7	Sadza /kg/Ng ³ / z KO	-	-	-	0.002	0.004	0.02	0.035	0.035	0.035	0.035	0.035	-
	bez. KO	-	-	-	0.001	0.001	0.02	0.05	0.05	0.05	0.05	0.05	-

wskaźniki zgodnie z rozporządzeniem z dnia 12.02.90 r. Dz.U. 15/90 poz. 92

- 2 -
teryeny nalezy zaliczac do "obszarów". Do "obszarów" nalezy zaliczyc również tereny takich jednostek, w których charakter prowadzonej dzialalnosci gospodarczej nie jest zwiiazany z produkcja powodujaca zanieczyszczenia powietrza, np. obiekty turystyczno-hypocochylne.

§3 Rodzaje i ilosci zanieczyszczen ujete w decyzjach o emisji dopuszczalnej nalezy podawać w jednostkach do ich egzaltowania, a dla zanieczyszczen powstajacych w procesie energetycznego spalania paliw rownowaz w wielosciach i jednostkach określonych w zał. nr 2. W przypadku prowadzenia pomiarow ciągtych emisji istnieje možliwość podawania emisji w g/Nm³. Wymaga to jednak odniesienia do zawartosci maksymalnej tlenu w spalinach i zatwierdzenia przez Wydział Ochrony Środowiska Urzędu Wojewódzkiego tak określonych wskaźników granicznych.

Dla substancji nie wymienionych w zał.nr 2, a powstajacych w procesie spalania paliw dopuszczalne wielosci emisji tych substancji ustala sie wedlug zasad dotyczących tzn. na podstawie granicznych wielosci emisji z uwzględnieniem t.a. Dopuszczalne wielosci emisji dla zakt adów nowoprojektowanych ustala sie na podstawie wartosci nominalnej mocy kotłów - emisja maksymalna, a emisja średnia na podstawie średniego wykorzystania mocy kotła w roku. Dla istniejących zakt adów emisje maksymalna ustala sie na podstawie wartosci nominalnej mocy kotłów, a emisja średnia na podstawie rzeczywistego zapotrzebowania mocy cieplnej /rzeczywiste zutycie paliwa w ciągu roku/.

Podstawa do obliczen emisji zo spalania paliw statycznych sa dane podane przez investora - dla wartosci maksymalnych najbardziej niekorzystne parametry węglia, dla średnich - wartosc średnia /tam gdzie to możliwe średnia nationa/. W decyzjach o emisji dopuszczalnej nalezy ustalać dopuszczalna emisje roczna. Nie nalezy liczyć skreślenia sumarycznego emisora ^{Smth} dla procesu spalania paliw.

Jeżeli w składzie chemicznym węgla stwierdzony zawartosc koflu okowiu nalezy liczyć opad tych metali wg. metodyki zawartej "Wytycznych obliczania stanu zanieczyszczenia atmosferycznego" MASTOS 1981/1983. W actnym do określania tła jest Państwowy Inspektor Sanitarny, w przypadku zakładów istniejących nalezy oznaczyć jego udcini w na podstawie posiadanej wiedzy.

§2 ust.3 - pod pojęciem "obowiązki wynikajace z potrzeb ochrony powietrza przed zanieczyszczeniem" nalezy rozumieć wszystko jest niezbedne dla zapewnienia właściwego stanu czystosci atmosfery w tym rownież pomiary imisji i emisji zanieczyszczeń /obowiązki te wynikaja bezpośrednio z ustawy o ochronie kozta towania środowiska - art.28/. Obowiązki określone w §3 ust.4/.

§6 Jednostki organizacyjne nie wymienione w §6 ust.1 i 2 mogą zadowalać do prowadzenia pomiarów w drodze odrębnych decyzji ust.4/.

Wielosci pomysel 100kg SO₂ lub 100kg pytu /§6 ust.2/ nale odnosić dla emisji tacznej z jednostki organizacyjnej. Warunki pomiarów emisji i imisji /§6 ust.4/ nalezy ustalać podstawie znajomosci metodyk, Polskich Norm, technologii zakt i ogólnej merytorycznej wiedzy o zakt edzie.

§7 Zapis §9 wyraźnie rozstrzyga, że sprawy wskazane i nie zakonczone ostateczna przed dniem wejścia w życie rozporządzenia rozpatruje się wg przepisów omawianego rozporządzenia. Decyzje wydane w trybie poprzedniego rozporządzenia nie tracą mocy prawnnej, ale mogą być zmienione w trybie art.30 ust.3 ustanowionego 10 maja 1990r. o zmianie ustawy o ochronie i kształtowaniu środowiska i ustawy - Prawo Wodne /Dz.U.nr 39, poz.222/. Natom decyzje dla inwestycji nowobudowanych nalezy zinterpretować w/w przepisów.

Załącznik nr 1
brak podanej wielkości w zał. nr 1 oznacza, że wielkości te nie są normowane dla całego pomiarowego. Natomiast do celów projektowych i obliczeniowych należy podawać niniejsze dane:

Lp	substancja W $\mu\text{g}/\text{m}^3$	obszar L2a	obszar specjalnie chroniony D2a	obszar D2b
1	chlorylontyl	7	7	
5	arsan	0.2	0.2	
7	acbest [kt/m^2]	1000	1000	1000
10	benzen	35	35	
11	benzoapirene [ng/m^3]	20	20	
13	chlorokwinylu	16	16	
14	chrom	8	2.5	
24	kadm	0.22	0.2	
28	mangan	13	7	
30	nikiel [ng/m^3]	340	340	
32	octan winylu	35	10	17.5
33	cebow	3.5	2	
35	pyt zawieszony	250	85	
36	rtęć	2	0.4	
39	styren	7	2	3.5
40	wanad	3.5	0.1	

Wartość rozporządzania pominiono w części jednostki dla niklu - wielkości te są podane w ng/m^3 .

Zapis dotyczący częstotliwości przekroczeń pod zał. nr 1 należy rozwinąć w następujący sposób:

- wartość stężenia 30 minutowego może przekraczać co najwyżej dwukrotnie wartość podana w rubrykach 3 i 6 zał. nr 11

- wartość stężenia 30 minutowego może przekraczać wartość rubrykach 3 i 6 zał. nr 1 przez co najwyżej 0.2% czasu
- wartość stężenia 30 minutowego może przekraczać wartość rubrykach 4 i 7 zał. nr 1 przez co najwyżej 2.0% czasu

Pojęcie "węgiel elementarny" oznacza węgiel węglowy powietrzu w różnych postaciach, głównie jako sadza.

Załącznik nr 2

Za instalacją uważa się zródło emisji zanieczyszczeń np nominalna moc źródła wyraziona jest Mk /megawaty termicznej jednostka cieplna mocy/. Dla źródła ponizej 0.2 Mk należy emisje dopuszczalne wg dotychczas obowiązujących zasad.

W przypadku używania mieszanego paliwa należy wyznaczyć wartość wskaźnika w zależności od udziału poszczególnego paliwa w mieszance.

Dla palenisk rusztycznych stałych nie określono wskazówki przypadku spalania węgla brunatnego, ponieważ umieścił się w prowadzenie spalania za niższąASCWE.

Dla kotłów fluidalnych należy stosować wartości jak dla nowych, grupa C i tak: dla SO_2 - 200 g/GJ , dla NO_2 - 170 g/GJ .

Pojęcie "pył" w zał. nr 2 oznacza pył całkowity.

Dla kotłów o mocy 50 Mk należy stosować wskaźniki takie kotłów o mocy mniejszej niż 50 Mk .

Emisje CO należy wyznaczać wspólną metodą dotychczasową.

Uwaga pod tabelą "x" oznacza sumę NO_x i NO w przeliczeniu na należy realizować w następujący sposób: $\text{NO}_x = 1.533 \cdot \text{NO} + \text{NO}$. Stosowanie obliczeń NO_x jest konieczne w przypadku, gdy technologiczne obliczenia NO_x uzyskano wielkość emisji NO.

staje NO₂ dla procesu energetycznego spalania paliw należy mierzyć stosując następujące zalecenia:

1) dla koksów kamiennego

$$= B * W_{Kz} * E_{Bz} \pm \frac{W_{Kz}}{100}$$

l.e:

emisja NO₂

- bazowy wskaźnik emisji NO₂ podany w załączniku nr 2 w grupie A do rozporządzenia Ministra Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa z dnia 12 lutego 1990r. w sprawie ochrony powietrza przed zanieczyszczeniem,
- wartość opałowa spalanego węgla kamiennego,
- bazowa wartość opałowa węgla kamiennego / należy przyjmować 19 000 kJ/kg /,

rzeczywiste zużycie węgla kamiennego.

IIa pozostały paliw stałych oraz cieczy i gazowych

$$E = B * W_{Kz} * E_{Bz}$$

l.e:

rzeczywiste zużycie paliwa,

- rzeczywista wartość opałowa paliwa,
- bazowy wskaźnik emisji NO₂ podany w załączniku nr 2 w grupie A do rozporządzenia Ministra Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa z dnia 12 lutego 1990r. w sprawie ochrony powietrza przed zanieczyszczeniem,

any wzór należy równiez stować do wyznaczenia wielkości siły tlenków azotu przy wykorzystaniu aptat za gospodarcze zyztanie ze Środowiska.

zelu spalenienia bazowego wskaźnika emisji NO₂ /E₀/ dla węgla kamiennego dla procesu energetycznego spalania paliw należy emisję wyliczyć do poziomu emisji granicznej spetniającej ten załącznik.

Dla źródła o mocy ponad 0,2 MWi należy dla emisji NO₂ równiez stosować wymienione wyżej wzory, bez konieczności porównywania wyliczonego wskaźnika emisji ze wskaźnikiem bazowym E₀.

Do obliczania wskaźników emisji należy stosować wartości emisji maksymalnej + licznej dla najkorzystnych parametrów spalania i uwzględniającej średniz wartość sprawności kotłów.

wskaźniki podane w zał. nr 2 sa wartościami, z kiedyymi należy porównywać wskaźnik rzeczywisty liczony w sposób opisany powyżej.

w przypadku, gdy z analizy uciążliwości wynika, że wskaźnik zanieczyszczeń jest niższy od wskaźników dopuszczalnych wg zał. nr 2, dopuszczalna wielkość emisji należy ustalić na poziomie rzeczywistym.

Zapis "Instalacje nie kwalifikujące się..." oznacza instalacje, których budowa rozpoczęta się przed dniem wejścia w życie rozporządzenia, które będą uruchomione przed 31.12.1994r.

Za rozpoczęcie budowy należy uwzgladnić datę wydania tawry fundamentowej zgodnie z Dzialeńnikiem Budowy.

Instalacje modernizowane i rozbudowywane podlegają przepisom o lokalizacji inwestycji należy je rozpatrywać jak w grupie C.

Zróżnicowanie wskaźników emisji w grupach A, B i C wynika z potrzeby ograniczania emisji.

Nie przewiduje się żadnych odstępstw od wymagań określonych w zał. nr 1 lub zał. nr 2 /f5/.

Rozporządzenie nie przewiduje żadnych odstępstw od wymagań określonych w przepisach prawnych w zakresie ochrony powietrza.

Przy określaniu uciążliwości stacji benzynowych należy wielkość skołka zanieczyszczeń w powietrzu powodowanych przez te obiekty porównywać z zalecanym dopuszczalnym stężeniem mieszaniny węglowodorków podanym w załączniku do "wytycznych obliczania stanu zanieczyszczenia powietrza atmosferycznego" oraz w miarę możliwości opierać się na wynikach pomiarów 1m i 10m od zanieczyszczeń dla istniejących stacji.

DYREKTOR D. i. AGENCJI
dr inż. Jerzy I. Włodzimierz
dr inż. Stefan J. Włodzimierz
dr inż. Stefan J. Włodzimierz

jasnienia dotyczące rozporządzenia Ministra Ochrony Środowiska, gospodarki Naturalnych i Leśniczwa z dnia 12 lutego 1990 r. w sprawie ochrony powietrza przed zanieczyszczeniem (Dz.U. nr 15, poz. 92).

jasnia się że nadal obowiązuje "wytyczne obliczania stanu zanieczyszczenia atmosferycznego" z 20 kwietniem 1983 r. ministra Administracji, Gospodarki Terenowej i Ochrony Środowiska - 1981/1983. W stosunku do substancji nie weryfikacyjnych nr 1 do rozporządzenia Ministra OS, ZNL należy postugiwac się wykazem zalecanych dopuszczalnych stężeń zanieczyszczeń w powietrzu atmosferycznym" - załącznik nr. 1 do "wytycznych obliczania stanu zanieczyszczenia atmosferycznego" GTOS 1981/1983. Jednocześnie informujemy, że wykaz ten obejmuje steryfikowany. W stosunku do zanieczyszczeń, które były ujęte w rozporządzeniu Rady Ministrów z 30 września 1980r. w sprawie ochrony powietrza atmosferycznego przed zanieczyszczeniem /Dz. U. 24, poz. 89/ a nie znalazły się w załączniku nr 1 do rozporządzenia Ministra Ochrony Środowiska, Zasobów Naturalnych i Środowiska z dnia 12 lutego 1990r. W sprawie ochrony powietrza zanieczyszczeniem /Dz.U. nr 13, poz. 92/ należy do analiz i pracować stosowac dotychczasowa wielkość dopuszczań.

kaźniki emisji stosuje się dla typowych urządzeń energetycznych. W odniesieniu do 54 ust. 2 wskazniki te w uzupełnionych przyfakach mogą być niższe.

jednoznacznie określa dla jakich obszarów zostają określone dopuszczalne stężenia substancji zanieczyszczających powietrze w określonej strefie, substancji określone w zał. nr 1, a także dotyczą terenów zajmowanych przez jednostki organizacyjne jednostek gospodarcza prowadzącej zanieczyszczenia atmosferyczne. Stężenia dla tych terenów określają się w st. 3 i oryginalnie. Stosowanie jednostki jest państwy Inspektor Pracy, właściwym do ich egzekwowania jest państwy Inspektor Pracy, jednostki inspektoratu takie jak szpitale, szkoły, hotele, gospodarstwa domowe, jednostki gospodarcze i ich kołekcyjne nie prowadzą działalności gospodarczej i ich jednostki inspektoratu.

jednoznacznie określa dla jakich obszarów zostaną określone puszczalne stężenia substancji zanieczyszczających powietrze, w wielkości dopuszczalnych stężeń substancji określone w załączniku I, a dotycza terenów zajmowanych przez jednostki organizacyjne powodujące działalność gospodarczą prowadzącą zanieczyszczenia chemiczne dla tych terenów określa się w ustawie i organem ministra.

Uwagi i propozycje dotyczące aktów prawnych i wskazników prosimy nadsyłać do 31 lipca br. Brak uwag do ww wskazników pozwala traktować jako ich akceptację.

Wytyczne

obliczania ilości poszczególnych rodzajów zanieczyszczeń dla kotłowni - do opłat za zanieczyszczenie powietrza atmosferycznego.

~~0257 0217~~
~~27,7~~ 27,7 %

1. Emisja pyłu :

$$E_p = B \cdot \frac{u \cdot p}{1 - c_p} \cdot 100 \text{ kg/rok.}$$

gdzie : E_p - roczna emisja pyłu w kg/rok,

B - roczne zużycie paliwa /węgla lub koksu/ w kg/rok,

u - współczynnik unosu pyłu / dla kotłowni posiadających paleniska z rusztem mechanicznym należy przyjmować $u = 0,25$, dla kotłowni posiadających paleniska z rusztem stałym $u = 0,15$ /,

p - udział popiołu w paliwie / przy braku danych od dostawcy należy przyjmować dla węgla $p = 0,16$, dla koksu $p = 0,12$,

c_p - udział części lotnych w paliwie / należy przyjmować $c_p = 0,25$ /,

- sprawność urządzeń odpylających / przy braku urządzenia $\eta = 0$, przy posiadaniu sprawnego odpylacza należy przyjmować rzeczywistą wartość sprawności odpylania, natomiast przy braku możliwości takiego ustalenia należy przyjmować wartość znamionową pomniejszoną o 10 %,

Gdy za kotłami są czopuchy o dużym przekroju obliczoną wielkość emisji pyłu można zmniejszyć o ilości pyłu pochodzącej z oczyszczania czopuchów. Ilości te winny być udokumentowane.

Jeśli w kotłowni spalany jest koks i węgiel obliczenia emisji pyłu należy wykonać osobno dla obu rodzajów paliwa, a otrzymane wielkości zsumować.

2. Emisja dwutlenku siarki / SO_2 / :

$$E_{SO_2} = 2 \cdot B \cdot a \cdot S \text{ kg/rok}$$

gdzie : E_{SO_2} - roczna emisja SO_2 w kg/rok

B - roczne zużycie paliwa w kg/rok,

a - stopień wiązania siarki w SO_2 / należy przyjmować dla mąka a = 0,8 ; dla pozostałych grubszych asortymentów a = 0,7.

S - zawartość siarki w paliwie / przy braku danych od dostawcy paliwa należy przyjmować dla koksu S = 0,01, dla węgla S = 0,015.

Jeżeli w kotłowni spalany jest koks i węgiel obliczenia emisji SO_2 należy dokonać osobno dla obu rodzajów paliwa a otrzymane wielkości zsumować.

3. Emisja tlenków azotu NO_x :

$$E_{\text{NO}_x} = w_{\text{NO}_x} \cdot B \text{ kg/rok}$$

gdzie : E_{NO_x} - roczna emisja NO_x w kg/rok,

w_{NO_x} - wskaźnik emisji NO_x w kg/tonę paliwa, należy przyjmować wg tabl. 1

B - roczne zużycie paliwa w tonach/rok,

4. Emisja tlenku węgla CO :

$$E_{\text{CO}} = w_{\text{CO}} \cdot B \text{ kg/rok}$$

gdzie : E_{CO} - roczna emisja CO w kg/rok,

w_{CO} - wskaźnik emisji CO w kg/tonę paliwa, należy przyjmować wg tabl. 1

B - roczne zużycie paliwa w tonach/rok

Tabl. 1

	w_{NO_x} kg/tonę paliwa	w_{CO} kg/tonę paliwa
Kotły o wydajności poniżej 2,5 Gcal/h z rusztem ręcznym z rusztem mechanicznym	<u>1,5</u> <u>3,0</u>	45 5
Kotły o wydajności powyżej 2,5 Gcal/h	7,5	1

Wskaźnikowe obliczenia emisji CO należy przyjmować tylko w przypadku braku wyników pomiarów emisji.

Appendix K

EPA Compilation of Air Pollutant Emission Factors

TABLE I-1-1. EMISSION FACTORS FOR EXTERNAL BITUMINOUS AND SUBBITUMINOUS COAL COMBUSTION^a

Factors represent uncontaminated emulsions unless otherwise specified and should be applied to coal consumption as stated. Based on EPA Method 5 (front half batch) as described in Reference 12. Where particulate is expressed in terms of coal ash content, A_1 factor is determined by multiplying weight % ash content of coal (as fired) by the measured value ash content. For example, if coal having 8% ash is fired in a dry bottom unit, the particulate ash factor would be $5 \times 8 = 40$ (lb/100 lb coal). The "condensable" matter collected in back half batch of EPA Method 5 averages 15% of front half batch for cokered coal and cokylene furnaces; 10% for spreader stoker; 15% for oil-fired furnaces.

other a stoker, and 50% for hand-fired units (Reference 6, 19, 49). Factors in parentheses should be used to estimate gaseous emissions for SO_2 , SO_3 , and H_2S as well as particulate sulfates expressed as SO_3 , including SO_2 , SO_3 , and H_2S emissions for subbituminous coal. In all cases, S is weight % sulfur content of coal as fired. See footnote b of example calculation. On average for bituminous coal, 97% of fuel sulfur is emitted as SO_2 and 3% as SO_3 . An equally small percent of fuel sulfur is emitted as SO_3 and H_2S . Small quantities of sulfur are also retained in bottom ash. With subbituminous coal (References 9, 13), 10% more fuel sulfur is retained in the bottom ash and particulate because of the more alkaline nature of the coal ash.

Conversion to gaseous sulfates about the same as for bituminous coal.

When combustion is not complete, homologous volatile organic compounds (VOC), expressed as C₂ to C₁₆ alkanes equivalents (reference 5b), because of limited data on HRGC available to distinguish the effects of firing configuration, all data were averaged

collectively to develop a single system for pul wetted coal units, cyclone, spreaders and overfeed stokers.

collected fly ash is re-injected to boiler, particulate from boiler reaching control equipment can increase by up to a factor of two.

Particulates directly at boiler outlet typically will be twice this level.) Factor should be applied even when ash is reheated to boiler from boiler, air heater or economizer dust hoppers.

Kinetics travelling at the surface and through base. Particulate loadings directly at bore outlets typically account for fly ash settling in breeching and plume base. Particulate loadings directly at bore outlets typically can be 50% higher than those at the surface. See Fig. 1 for discussion of apparently low sulfate cyclone control efficiencies, regardless of uncontrolled emissions.

TABLE 1.1-2. EMISSION FACTOR RATINGS* AND REFERENCES FOR BITUMINOUS AND SUBBITUMINOUS COAL COMBUSTION

Piiring Configuration	Particulate Rating	Sulfur Oxides Rating	Nitrogen Oxides Ref.	Carbon Monoxide Ref.	Nonmethane VOC Rating	Ref.	Methane Rating	Ref.
Pulverized coal fired								
Dry bottom	A	14,25	A	9,16-19,21, 31-37,39, 41-46,51-55	A 11,16,16-17, 21,46,56	A 16,18-19,21 47,57	A 55,58	A 58
Wet bottom	D	14,16,26	A	"	C 14,16	A "	A 58	A "
Cyclone furnace	D	14,19,22, 27-29	A	"	B 11	A "	A "	A "
Spreader stoker								
Uncontrolled	B	17,30-35	A	"	A 11,17,21-27 39-40,46	A 17,19,31-34, 36,47,51	A "	A "
After multiple cyclone								
With flyash reinjection	B	14,32,36-38	A	"	A "	A "	A "	A "
From cyclone								
No flyash reinjection								
from cyclone	A	17,31-35, 39,40,59	A	"	A "	A "	A "	A "
Overfeed stoker								
Uncontrolled	B	6,17,41-43, 43-47	A	"	A 11,17,19, 41-45	B 17,41-42,45, 47,51	A "	A "
After multiple cyclone	B	6,41,44-45	A	"	A "	B "	A "	A "
Underfeed stoker								
Uncontrolled	B	6,19,47-48	B	19,48	B 19,47-48	B 19,47-48	A 47,58	A 47,58
After multiple cyclone	C	6	B	"	B "	B "	A "	A "
Handfired units	D	49-50	D	"	D 50	D 50	D 50,58	D 50,58

*These ratings, in the context of this Section, refer to the number of test data on which each emission factor is based. An "A" rating means the factor is based on tests at ten or more boilers, a "B" rating on six to nine test data, and a "C" rating on test data for two to five boilers. A "D" rating indicates the factor is based on only a single datum or extrapolated from a secondary reference. These ratings are not a measure of the scatter in the underlying test data. However, a higher rating will generally increase confidence that a given factor will better approximate the average emissions for a particular boiler category.

Appendix L

Letter of Intent and Memorandum of Understanding
between Shooshanian Engineering Associates, Inc. and MPEC S.A. w Krakowie

MEMORANDUM OF UNDERSTANDING

between MIEJSKIE PRZEDSIĘBIORSTWO ENERGETYKI CIEPLNEJ (MPEC) S.A. W KRAKOWIE and Shooshanian Engineering Associates, Inc. (Shooshanian).

WHEREAS, over the past two years, MPEC and Shooshanian have cooperated successfully in the execution of work under the DOE Kraków *Clean Fossil Fuels and Energy Efficiency Program*.

WHEREAS, our joint DOE project is likely to be completed in calendar year 1996.

WHEREAS, our two firms possess complementary experience, qualifications, expertise, and contacts that strengthen our ability to access some types of project work.

WHEREAS, both firms are interested in expanding their marketplace and increasing revenues, both directly and through subsidiaries,

It is hereby understood and agreed upon between the parties,

THAT Shooshanian will include resumés of personnel from MPEC and/or its subsidiaries (POLTERM, KZT) in proposals for appropriate U.S.-funded work (e.g. Stare Miasto tunnel project, district heating system rehabilitation in Russia), and, upon award of contracts, Shooshanian will share the work with the named organizations and persons as proposed.

THAT MPEC will, where appropriate and beneficial, present the qualifications and capabilities of Shooshanian to potential clients with the intent of generating project work for both firms (e.g. new hospitals in Poland).

THAT both MPEC and Shooshanian will continuously attempt to identify opportunities that benefit both firms (e.g. purchase of small district heating utilities in Poland and Ukraine), and strongly consider the creation of one or more joint ventures to most effectively address these opportunities.

We agree, with the impending conclusion of our existing DOE project, that time is of the essence, and that adherence to the above Memorandum of Understanding shall be immediate and proactive.

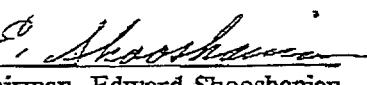
Signed on this ninth day of February, 1996

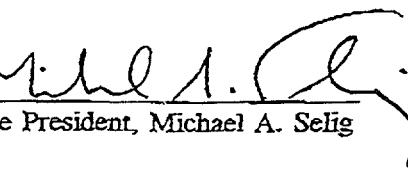
Miejskie Przedsiębiorstwo
Energetyki Cieplnej (MPEC)

by: 
the President, Leszek Ciurlik

by: 
the Vice President, Marek Jaglarz

Shooshanian Engineering
Associates, Inc.

by: 
the Chairman, Edward Shooshanian

by: 
the Vice President, Michael A. Selig

LETTER OF INTENT

This Letter of Intent is dated February 9, 1996 and made by the following:

MIEJSKIE PRZEDSIEBIORSTWO ENERGETYKI CIEPLNEJ (MPEC), located at Al. Jana Pawla II 188, 30-969 Kraków, Poland represented by its President, Mr. Leszek Ciurlik.

SHOOSHANIAN ENGINEERING ASSOCIATES, INC., located at 330 Congress Street, Boston, MA 02210-1216, USA, represented by its Chairman, Mr. Edward Shooshanian.

PREAMBLE

Shooshanian Engineering Associates, Inc. (Shooshanian) and Miejskie Przedsiębiorstwo Energetyki Cieplnej S.A. (MPEC) have been working together since July 1994 under the U.S. DOE Kraków *Clean Fossil Fuels and Energy Efficiency Program*. Our project, entitled *Extension and Improvement of Central Station District Heating*, has improved local air quality in Kraków by retiring old, polluting, coal-fired boilers and connecting their loads to the district heating network. This task has involved substantially more than just technical analysis, design, and construction. The process of securing new customers necessitated the strengthening of MPEC's competitive position in Kraków's energy marketplace, which in turn required improvements in marketing, customer service, and strategic planning. Learning how U.S. utilities address these challenges has become an integral segment of the project's successes.

As the project moves into its final phase, it is clear that MPEC and Shooshanian's continued cooperation is highly compatible with the strategic goals of each firm. Shooshanian offers MPEC and its subsidiaries potential access to U.S. investment funds, a conduit to the latest utility management practices, and a source of information about U.S. high technology. MPEC offers Shooshanian business contacts throughout Poland and the region, and a pool of highly trained and experienced personnel with strong expertise in the energy field, to work on future projects. It is undeniable that both parties have a great deal to gain through a continued business relationship. Moreover, the creation of a joint venture is an important target of the DOE program.

This Letter of Intent is the result of discussions held to date about future cooperation. It is meant to serve as the basis for the creation and formalization of a viable business entity shared by our two business organizations.

Therefore, the parties hereto make the following statements regarding their intent:

MPEC intends to provide:

- Introduction of Shooshanian's qualifications and capabilities to potential clients with the objective of generating project work for both firms.
- Technical expertise in district heating systems and their operational requirements.
- Contacts and potential leads in Poland and elsewhere in Europe that could lead to joint business opportunities.

Shooshanian intends to provide:

- Inclusion of resumés of personnel from MPEC and/or its subsidiaries (POLTERM, KZT) in proposals for appropriate U.S.-funded work.
- A share of the resultant work for the named organizations and persons as proposed.
- Trade contact for U.S. manufactured products, including:
 - Solid-state controls
 - Variable frequency drives
 - Metering equipment
 - Telecommunications components

Both MPEC and Shooshanian intend to continuously attempt to identify opportunities that benefit both firms and to undertake formal steps in 1996 meant to lead to the creation of one or more joint ventures to most effectively address these opportunities.

SHOOSHANIAN ENGINEERING ASSOCIATES, INC.

by E. Shooshanian
the Chairman, Edward Shooshanian

by M. A. S.
the Vice President, Michael A. Selig

MIEJSKIE PRZEDSIEBIORSTWO ENERGETYKI CIEPLNEJ

by L. Churlik
the President, Leszek Churlik

by M. Jaglarz
the Vice President, Marek Jaglarz

Appendix M
Statement of Polinvest's Activities

**REPORT CONCERNING
POLINVEST PARTICIPATION IN
IMPLEMENTATION OF KRAKÓW CLEAN FOSSIL
FUELS AND ENERGY EFFICIENCY PROGRAM -
EXTENTION AND IMPROVMENT OF MPEC
HEATING SYSTEM**

Kraków, March 1997

**REPORT OF ACTIVITIES PERFORMED BY POLINVEST IN KRAKÓW
CLEAN FOSSIL FUELS AND ENERGY EFFICIENCY PROGRAM FROM
JULY, 30 1994 TO JUNE, 1 1996**

During implementation of the contract signed on August 23, 1994 between MIEJSKIE PRZEDSIĘBIORSTWO ENERGETYKI CIEPLNEJ S.A. (MPEC S.A. Kraków) and SHOOSHANIAN ENGINEERING ASSOCIATES INC., and the contract signed on August 24, 1994 between SHOOSHANIAN ENGINEERING ASSOCIATES INC. and POLINVEST Sp. z o.o., POLINVEST undertook the following activities:

1. Preparing a letter from the Chairman of MPEC S.A. Board of Management informing about suggested cooperation and submitting a proposal for MPEC S.A. services to the following Clients:
 - a) Wytwórnia Sprzętu Komunikacyjnego KRAKÓW S.A.,
 - b) Zespół Szkół Łączności,
 - c) Teatr BAGATELA,
 - d) Krakowskie Zakłady Armatur,
 - e) Krakowska Fabryka Aparatów Pomiarowych S.A.,
 - f) Akademia Rolnicza,
 - g) Przedsiębiorstwo Handlowo-Produkcyjne HYDROWEX Sp. z o.o.,
 - i) Przedsiębiorstwo Remontowo-Montażowe REMUR S.A. w Radomiu Oddział w Krakowie,
 - j) Chemiczno-Farmaceutyczna Spółdzielnia Pracy ESPEFA,
 - k) Przedsiębiorstwo Specjalistyczne HYDROKOP S.A.

The letters were handed over to potential Clients on August, 1994.

2. Preparing the report "Primary evaluation of 10 potential Clients of MPEC S.A."

The report was prepared on September, 1994.

3. Bringing the WSK Management to write a letter signed by Marek Stich Msc. Eng. - Director of the Technical and Production Dept., addressed to the Chairman of MPEC S.A. Board of Management, informing about the interest of WSK S.A. in being submitted a proposal for MPEC S.A. services and expressing the will to cooperate with MPEC S.A. staff and MPEC S.A. contractors for the Project. The letter also proposed to include in the MPEC S.A. proposal an information about costs of heating based on an oil-gas boiler house.

4. Bringing the Chairman of ESPEFA Board of Management Mr. Ryszard Księżyk to write a letter addressed to the Chairman of MPEC S.A. Board of Management, informing about the interest of ESPEFA in being submitted a proposal for MPEC S.A. services and expressing the will to cooperate with MPEC S.A. staff and MPEC S.A. contractors for the Project.

5. Bringing the Director of Teatr BAGATELA Mr. Władysław Winnicki to write a letter addressed to the Chairman of MPEC S.A. Board of Management, informing about the interest of WSK S.A. in being submitted a proposal for MPEC S.A. services and

expressing the will to cooperate with MPEC S.A. staff and MPEC S.A. contractors for the Project.

The letters were handed over to MPEC S.A. on September 15, 1994.

6. Verification of technical specifications for the oil-gas boiler house planned by WSK S.A. as heat source. The verification was accomplished based on the "Technical-Economical Assumptions" developed by POLINVEST for the construction of an oil-gas boiler house by WSK S.A. and also on discussions with WSK S.A. staff responsible for the heating management.
7. Evaluation of the influence of potential reduction in emissions from the existing coal-fire boiler house on the financial flows in WSK S.A., related to heating and the impact on the natural environment.
8. Evaluation of the operation costs for WSK S.A. own oil-gas boiler house.
9. Developing gas and oil prices forecasts for the boiler house in 1995-2015.
10. Verification of WSK S.A. investments necessary to build an own oil-gas boiler house.
11. PV calculation of WSK S.A. cash flows related to an own oil-gas heating boiler house operation.

12. PV calculation of WSK S.A. cash flows related to heat supply from the municipal district heating network.
13. NPV calculation of MPEC S.A. cash flows and testing the sensitivity of the Project's NPV to changes in the most important elements of cash flows related to the Project implementation.
14. Development of assumptions allowing MPEC S.A. to submit a proposal of services being more advantageous than the construction and operation of an WSK S.A. own oil-gas boiler house.
15. Definition of the ownership issues referring to the siting of a future exchanger substation.
16. Development of "Initial offer of services provided by MPEC S.A. for WSK S.A.".

17. Developing a draft of the Letter of Intent concerning the terms of future cooperation between WSK S.A. and MPEC S.A. within the WSK Project and assuring reimbursement of MPEC S.A. costs covering further activities related to the Project.

Both the "Initial offer of services provided by MPEC S.A. for WSK S.A." and draft of the Letter of Intent including the leading letter signed on behalf of MPEC S.A. by the Project Manager Janusz Mazur were handed over to WSK S.A. on October 21, 1994.

18. Meeting with the WSK S.A. Board of Management to explain the content of the Letter of Intent and to present the benefits of signing this Letter by WSK S.A. The meeting was held on October 21, 1994.

19. Meeting with the WSK S.A. Board of Management to answer questions resulting from the WSK S.A. Management analysis of the Letter of Intent and proposal.

The meeting was held on October 26, 1994 in WSK S.A.

20. Introduction of amendments to the cash-flow calculations related to the WSK S.A. Project on the MPEC S.A. side and also resulting from detailed analysis of possible energy conservation in WSK S.A. buildings, performed by SHOOSHANIAN ENG. ASS. INC. as well as resulting from the implementation of a new exchanger type and an additional 3 MW capacity boiler house for technological heat and domestic hot water supply for WSK S.A. proposed by SHOOSHANIAN ENG. ASS. INC. (Appendix 9).

21. Preparation of a presentation concerning the forecasted cash-flows related to the operation of an WSK S.A. oil-gas boiler house.

22. Preparation of an amended version of the Letter of Intent in which MPEC S.A. expresses the readiness to sign a heat supply contract allowing WSK S.A. to bear lower costs for connecting to MPEC S.A. network than to implement an own oil-gas boiler house (calculated based on the formula of total future expenses).

23. Presentation for WSK S.A. Management members concerning the forecasted cash flows related with the operation of an own WSK. S.A. oil-gas boiler house to allow the

WSK S.A. Management to define the total amount of the future expenses for WSK S.A. heating.

The presentation took place in WSK S.A. on November 18, 1994.

24. Meeting with the WSK S.A. Management for handing over and clarification of the content of the amended draft of the Letter of Intent.

The amended draft of the Letter of Intent was presented during the meeting in WSK S.A. on November 18, 1994.

25. Meeting with the staff designated by the WSK S.A. Management to evaluate the assumptions concerning cash flows and PV values proposed during the presentation, to clarify particular elements of the cash flows.

The meeting was held in WSK S.A. on November 28, 1994.

26. Meeting with the WSK S.A. Management to get an answer for the submitted proposal and draft of the Letter of Intent.

The meeting took place in WSK S.A. on December 12 and 16, 1994.

27. Preparation of a description of WSK S.A. investments necessary to implement the oil-gas boiler house.

The description of investment was handed over on December 18, 1994.

28. Preparation of a draft of the Letter of Intent, taking under consideration the amendments suggested by the WSK S.A. Management in the total amount of future expenses related to WSK S.A. heating.

The amended version of the draft Letter of Intent was handed over to WSK S.A. on December 21, 1994.

29. Meeting with the WSK S.A. Management to define the position of WSK S.A. towards the draft Letter of Intent submitted on December 21, 1994.

The meeting took place in WSK S.A. on December 28, 1994.

30. Meeting with the WSK S.A. Management for a final answer on the proposal and draft Letter of Intent submitted by MPEC S.A.

The meeting took place on February 7, 1995.

31. Preparing report about the state of negotiations with WSK S.A. and conclusions resulting from the state.

32. Meeting with KFAP S.A. member of Board of Management Mr. Lesław Łoziński for collecting materials and information necessary for preparing "Initial offer of services provided by MPEC S.A. for KFAP S.A.".

33. Development of "Initial offer of services provided by MPEC S.A. for KFAP S.A.".

34. PV calculation of KFAP S.A. cash flows related to an own oil-gas heating boiler house operation.

35. PV calculation of KFAP S.A. cash flows related to heat supply from the municipal district heating network.

36. NPV calculation of MPEC S.A. cash flows and testing the sensitivity of the KFAP S.A. Project's NPV to changes in the most important elements of cash flows related to the Project implementation.

Activities listed in p. 32 - 36 were performed on January, 1995.

Activities listed in p. 1 - 36 led to identification the main problems which MPEC S.A. will come up to in its contacts with the Clients during implementation low emission reduction projects and to working out the method of presentation by MPEC S.A. its services.

37. Preparing proposal of assumptions for MPEC S.A. project of low emission reduction involved with implementation of connections in Central Railway Station area.

38. Preparing the maps for graphic illustration of disposition of boiler houses which were taken into the account in MPEC S.A. project of low emission reduction and for presentation of proposed phases of the project.

Activities listed in p. 37 and 38 were performed in February, 1995.

39. Meeting with Director of Zespół Szkół Łączności Mr. Andrzej Doskocz for collecting materials and information necessary for preparing draft Letter of Intent between MPEC S.A. and ZSL.

40. NPV calculation of MPEC S.A. cash flows and testing the sensitivity of the ZSL Project's NPV to changes in the most important elements of cash flows related to the Project implementation.

41. Development of the draft Letter of Intent between MPEC S.A. and ZSL.

42. Meeting with Director of ZSL Mr. Andrzej Doskocz for clarification of the content of the draft of the Letter of Intent.

43. Development of the draft of agreement between MPEC S.A. and ZSL.

Activities mentioned in p. 39 - 43 were performed on February and March, 1995.

44. Preparing manual and carrying out training about legal-economic consideration of MPEC activity in the projects resulting winning new Clients by MPEC S.A. and low emission reduction.

The training took place on March 22, 1995.

45 Preparing evaluations and report concerning analysis of MPEC S.A. project of low emission reduction evaluating the efficiency of implementation by MPEC S.A. the project of connecting local boiler houses located in the Center to central heating system.

46 Preparing review of analysis of MPEC S.A. project of low emission reduction for DOE.

Activities mentioned in p. 45 and 46 were performed from April to November, 1995

POLINVEST personnel performed the activities listed in p. 1 - 46 in 814 hours together where acvities performed:

- a) from July 1, 1994 to June 30 1995 by Team Leaders took 188 hours and activities performed by Team Members took 240 hours,
- b) from from July 1, 1995 to June 30 1996 by Team Leaders took 173 hours and activities performed by Team Members took 223 hours.

With respect



Wiesław Samitowski

Chairman of the Board of Management

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