"Demonstration of a PC 25 Fuel Cell in Russia"

Final Report

For Period: October 2001-September 2004

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Prepared by:
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Disclaimer

Abstract

This project involved the installation of a 200kW PC25C™ phosphoric-acid fuel cell power plant at Orgenergogaz, a Gazprom industrial site in Russia. In April 1997, a PC25C™ was sold by ONSI Corporation to Orgenergogaz, a subsidiary of the Russian company "Gazprom". Due to instabilities in the Russian financial markets, at that time, the unit was never installed and started by Orgenergogaz. In October of 2001 International Fuel Cells (IFC), now known as UTC Fuel Cells (UTCFC), received a financial assistance award from the United States Department of Energy (DOE) entitled "Demonstration of PC 25 Fuel Cell in Russia". Three major tasks were part of this award: the inspection of the proposed site and system, start-up assistance, and installation and operation of the powerplant.

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Introduction

The goal of this project is the installation and operation of a fuel cell in Russia for the Russian commercial power market using a PC25™ power plant at a Gazprom industrial site, as well as the demonstration for a wider audience of potential Russian customers. It is consistent with the Climate Change Fuel Cell Program to stimulate the commercialization of stationary fuel cell power plants in order to reduce green house gas emissions through the efficient use of fossil fuels.
In April 1997, a PC25C fuel cell power plant (fuel cell) was sold by ONSI Corporation to Orgenergogaz, a subsidiary of the Russian company "Gazprom". Due to instabilities in the Russian financial markets, at that time, the unit was never installed and started by Orgenergogaz. In October of 2001 International Fuel Cells (IFC), now known as UTC Fuel Cells (UTCFC), received a financial assistance award from the United States Department of Energy (DOE) entitled "Demonstration of PC 25 Fuel Cell in Russia". Three major tasks were part of this award:

1. Inspection of Proposed Site and System
2. Start-up Assistance
3. Installation and Operation of Powerplant

While the Statement of Objectives for the award references Gazprom as the host site, in actuality the site is an Orgenergogaz facility. Orgenergogaz, which is the owner of the fuel cell, is a subsidiary of Gazprom.

Executive Summary

The DOE Program to demonstrate the operation of a PC25 in Russia is considered a success. Highlights of this program were:

- The PC25 was stored properly in Russia for six years.
- The upgraded parts for the unit were successfully shipped to Russia, admitted through Russian Customs and properly installed by UTCFC, Hamburg Gas and Gazprom technicians.
- The PC25 was installed properly by Gazprom specialists at their facility outside of Moscow.
- American and German specialists successfully trained their counterparts from Gazprom in the operation of the PC25.
- The natural gas at the Gazprom site was of the proper quality for use in the PC25.
- The site water contained large quantities of minerals, which required utilizing distilled water for makeup water. An alternative not explored was the use of a reverse osmosis system to treat the water.
- The PC25 was successfully started by specialists from UTCFC, Hamburg Gas and Gazprom.
- The PC25 successfully "followed" the building's fluctuating electrical load.
- The PC25 operated continuously for approximately 5600 hours without interruption.

Experimental

Standard procedures were used for the installation of a PC25C fuel cell power plant. Refer to PC25C Installation Manual (FCR-13285), Service Manual (FCR-13616), and Installation Drawing Set.

Results and Discussion

Task 1.0 Inspection of Proposed Site and System

In preparation for the visit to the site UTCFC obtained an Export License from the U.S. Department of Commerce to transfer Technical Data on the PC25 fuel cell power plant to Gazprom. That License is included in Appendix A of this report.

In April of 2002, individuals from UTCFC and the DOE's National Energy Technology Laboratory (NETL) traveled to Moscow to visit the potential fuel cell site and inspect the condition of the fuel cell itself. The conclusions of the visit were:

1. The fuel cell was judged to be in good/excellent condition
2. The fuel cell is sited at one of Orgenergogaz's Engineering Centers outside of Moscow
3. Orgenergogaz was found to have completed a significant portion of the installation work for the fuel cell
4. UTCFC identified that some of the components contained in the fuel cell were of a previous design and should be replaced by "Upgraded Parts"
5. Some Spare Parts (defined as parts necessary to replace failed parts) at the site were also found to be in need of upgrading and should be replaced
6. Certain scheduled Maintenance Parts (defined as parts which are required for scheduled maintenance activities) which had been shipped with the fuel cell, such as ion exchange resins, appeared to have been damaged during storage and in need of replacement
7. The glycol coolant at the site was not that specified for fuel cell operation and therefore was also in need of replacement
8. UTCFC supplied detailed installation drawings with explanations to individuals from Orgenergogaz. It was judged that these individuals fully understood these drawings and the requirements for the successful installation of the fuel cell

Based on these conclusions it was decided to:

- Ship from UTCFC to Orgenergogaz "state of the art parts", replacement Spare Parts, Maintenance Parts and glycol coolant
- Proceed into the next Task of this Program

At the conclusion of the meeting Orgenergogaz, UTCFC and DOE jointly developed a detailed summary of the site visit and associated meetings at the site. The summary document is included in Appendix B

Task 2.0 Start-up Assistance

1. Appointment of a Program Manager

Mr. John Trocciola was appointed as the Program Manager.

2. Training of Orgenergogaz's Technicians in Operation and Maintenance of the Power Plant

During the original site visit in April 2002 as well as during the startup activities in February 2004, the Orgenergogaz Technicians were trained by UTCFC in the operation and maintenance of the power plant.

3. Supplying of Installation Documents to Orgenergogaz

Prior to the April 2002 site visit, during the visit as well as subsequent to the visit, installation documents were supplied to Orgenergogaz. A photograph of the actual fuel cell installation at Orgenergogaz is shown in Figure 1.

4. Review of Orgenergogaz's Installation Documents

A number of installation drawings were received from Orgenergogaz and reviewed by UTCFC. The fuel cell installation was designed to be operated independently of the electric grid, powering a building used by Orgenergogaz to produce composite vessels for the storage of natural gas on vehicles powered by that fuel. The connection between the building and the electric grid is through a hand operated electric switch, requiring operator intervention in order to connect the building to the fuel cell or to the electric grid.

Figure 1 - Installation of PC25 at Orgenergogaz Facility near Moscow

As part of UTCFC's review of installation drawings, Orgenergogaz also supplied analyses of the natural gas and water that would be supplied to the fuel cell at the site. In the case of natural gas, the presence of oxygen, nitrogen or sulfur compounds is of concern. More specifically, oxygen can cause excess temperature increases in the reformer from its reaction with hydrogen, nitrogen can react with hydrogen in forming ammonia which can further react with the electrolyte in the fuel cell impeding the electrochemical reaction, and sulfur compounds can deactivate the reformer catalyst.

In the case of site water, the concentration of silica compounds is important in that silica can deposit in the fuel cell's coolant system causing flow restrictions, reduced coolant flow and local overheating of the unit.

The gas analysis supplied by Orgenergogaz, which is shown in Appendix C, was found by UTCFC to be acceptable.

The site water analysis is shown in Appendix D. Two water analyses were supplied - namely the water from the facility boiler house and the site's distilled water. It was decided that the mineral content and the alkalinity of the boiler water was too high resulting in unacceptable risks for coolant system plugging. Therefore it was recommended that the site's distilled water be used for filling of the fuel cell coolant system.

5. Upgrading of the PC25

The PC25 sold to Orgenergogaz was constructed in 1996 and since that time UTCFC has accumulated extensive experience with PC25s installed and operated at various locations around the world. The data accumulated at these sites has resulted in various upgrades to the fuel cell. These include:

- Coated circuit boards to help prevent damage during moisture intrusion into the power plant
- Extended life coolant pump
- Improved power plant controller
- Cell stack air intake filter designed to remove finer particles to prevent ingestion of dust
- Heated filter to prevent ingestion of moist ventilation air into electronics compartment

A complete listing of the Upgraded Parts, as well as replacement Maintenance Parts and Spare Parts which were shipped to Russia are shown in Appendices E and F.

A summary of some of the Upgraded Parts and their benefits is given in Table 1.

Table 1 - Example Upgraded Parts

Component	Improvement	Result	Benefit	Comments
Circuit Boards	Conformal Coating	Resistance to Condensed Moisture	Reduced Failures During Rain	Reduced Maintenance
Cell Stack Coolant Pump	Ceramic Coated Windings	Higher Temperature Capability	Longer Life	Reduced Maintenance
Improved Air Intake Filter	Removes More Fine Particles from Air	Less Entrainment of Dust into Power Conditioner	Reduces Failures	Reduced Maintenance

6. Startup of the Unit

In January 2004, UTCFC sent two fuel cell specialists to Moscow to:

- Install the Upgraded Parts
- Assist Orgenergogaz in completing the installation of the power plant at the site
- Complete the training of the Orgenergogaz technicians
- Assist in the startup of the power plant

One of the fuel cell specialists was from UTCFC and the other was a specialist from a UTCFC customer in Germany - Hamburg Gas Consultants (HGC), which is a subsidiary of the large German Utility EON. HGC has installed several PC25s in Europe and continues to maintain those units, and it was judged beneficial to have a European specialist familiar with the PC25, physically close to the Orgenergogaz fuel cell.

Upon arrival at the fuel cell site, the specialists began the installation of the Upgraded Parts. A listing of some of the Upgraded Parts installed into the PC25 is shown in Table 2.

Table 2 - Upgraded Parts Installed Into PC25

- Burner igniter cable
- Natural gas vent limiter
- CSA coolant pump
- CSA flow restrictor
- Power supply fan upgrade kit
- Octagon controller
- Start burner insulation install kit
- WTS insulation install kit
- Valve brakes
- Air intake hood and demister
- Low voltage e-proms
- Parylene coated circuit cards

In addition to installing the Upgraded Parts, the two specialists conducted a variety of other tasks prior to starting the fuel cell. Some of these were:

- Because of the long term storage of the PC25, the UPS battery had lost charge and therefore all data had to be reinstalled manually.

- One of the heat exchangers HEX800, the external dry cooling tower, had developed several leaks in the coil. A radiator welder was hired for on site work and the leaks were repaired.
- The temperature switch for HEX800 was not functioning and it was overridden resulting in the tower fans operating continuously.
- The modem communications between UTCFC and the Orgenergogaz fuel cell were not possible because Orgenergogaz only has pulse dial phone lines and the control software uses tone dial. The software was rewritten and tested and found to be satisfactory.
- A pressure regulator was installed in the gas feed line and the natural gas supply was connected to the power plant.
- Additional intensive training was provided for the Orgenergogaz technicians.

Upon completion of the installation of the Upgrade Parts, the UTCFC and HGC specialists began the startup of the PC25. This startup activity was started and the unit produced power on February 3, 2004. The unit was installed to operate independent of the electric grid with a manually operated switch to connect the facility load back to that grid during PC25 outages. The buildings connected to the fuel cell included a building used by Orgenergogaz to produce composite gas cylinders for compressed natural gas vehicles (Figure 2). In all cases the building loads were below 200 kW.

Since these buildings are typically only occupied during the day, the building electrical requirements and consequently the output of the PC25 varied on a daily basis. This may be seen in Figure 3.

Figure 2 - Photo of Orgenergogaz Gas Cylinder manufacturing building

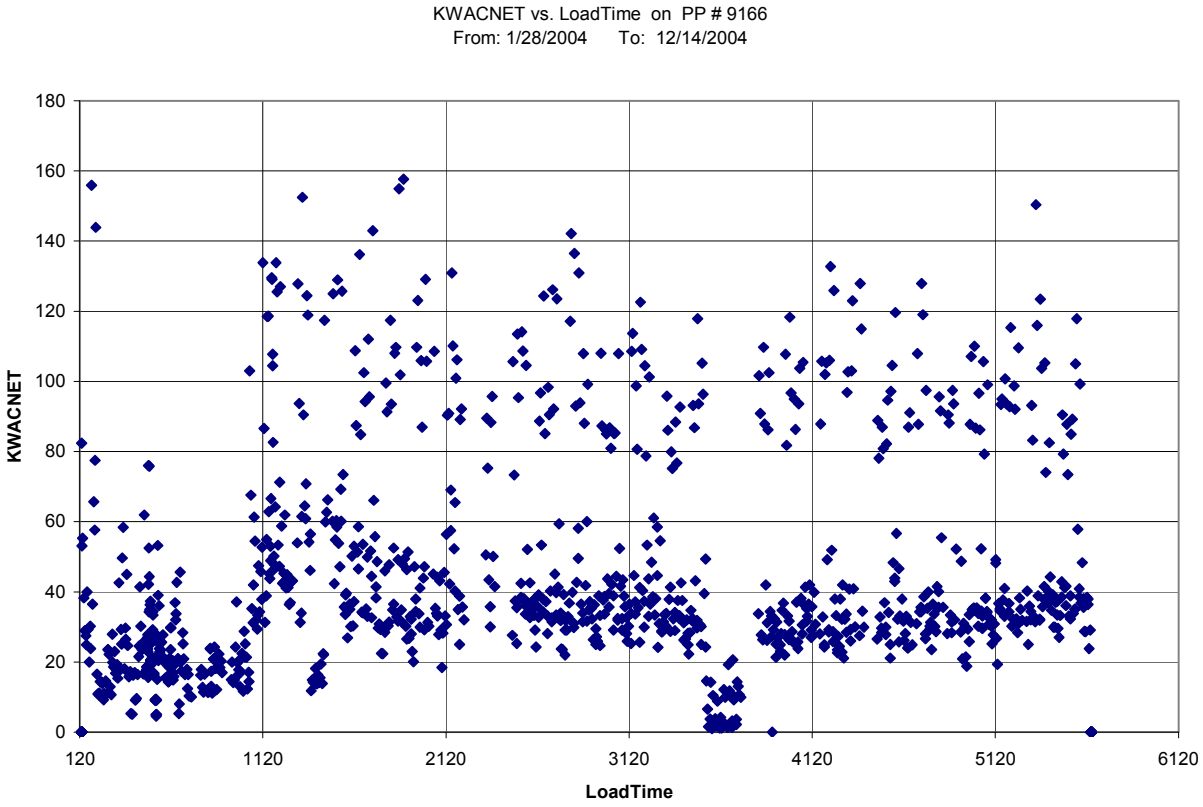

Figure 3 - PC25 Power Output vs. Time at Orgenergogaz Installation

During the time of varying electrical output of the PC25, it demonstrated its excellent efficiency at varying loads with efficiencies of 38% down to 125 KW. These efficiencies at varying loads are shown in Table 3.

Table 3 - PC25 Efficiency at Varying Electrical Outputs

Electrical Output(Kw)	Electrical Efficiency (%)
150	38
125	38
100	37
90	35
80	32
75	29

The PC25 operated without shutdown from February 3, 2004 to September 19, 2004 for a total load time of 5644 hours. At the end of 5644 hours the unit shutdown due to the failure of a steam valve which has been replaced by Orgenergogaz and the unit has been restarted.

Conclusion

The overall DOE Program to demonstrate the operation of a PC25 in Russia considered a success. Among the conclusions of this program are:

- The PC25 was stored properly in Russia for six years.
- The upgraded parts for the unit were successfully shipped to Russia, admitted through Russian Customs and properly install by UTCFC, Hamburg Gas and Gazprom technicians.
- The PC25 was installed properly by Gazprom specialists at their facility outside of Moscow.
- American and German specialists successfully trained their counterparts from Gazprom in the operation of the PC25.
- The natural gas at the Gazprom site was of the proper quality for use in the PC25.
- The site water contained large quantities of minerals, which required utilizing distilled water for makeup water. An alternative not explored was the use of a reverse osmosis system to treat the water.
- The PC25 was successfully started by specialists from UTCFC, Hamburg Gas and Gazprom.
- The PC25 successfully "followed" the building's fluctuating electrical load.
- The PC25 operated continuously for approximately 5600 hours without interruption.

References

PC25C Installation Manual (FCR-13258)
Service Manual (FCR-13616)
Installation Drawing Set

Bibliography

None.

List Of Acronyms and Abbreviations

None.

Appendix A - Export License

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C/O UNITED TECHNOLOGIES CORPORATION
1401 EYE STREET, NW, STE. 600
WASHINGTON, DC 20005

PURCHASER:
DAO OREGNERGOGAZ
MOSCOW REGION
LENINSKY DISTRICT

RAZVILKA, RUSSIA

ULTIMATE CONSIGNEE:

INTERMEDIATE CONSIGNEE:

ARZAMAS 16
SAROV CITY
NIZHNIV NOVGOROD COUNTY, RUSSIA

APPROVED END USER(S) :

COMMODITIES QTY	DESCRIPTION	ECCN	TOTAL PRICE
1	TECH DATA: FUEL CELL POWER PLANT INSTALLATION, REPAIR, MAINTENANCE & OPERATION…	EAR99	

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ULTIMATE CONSIGNEE:

ARZAMAS 16
SAROV CITY
NIZHNIV NOVGOROD COUNTY, RUSSIA

INTERMEDIATE CONSIGNEE:

APPROVED END USER(S):

COMMODITIES:

QTY	DESCRIPTION	ECCN	TOTAL PRICE
1	MODEL: MODEL C, EAR99 TECHNICAL DATA FOR INSTALLATION, REPAIR, MAINTENANCE AND OPERATION OF EAR99 FUEL CELL POWER PLANT	EAR99	
		TOTAL:	$0

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Appendix B - Schedule of Activity for PC25 Unit

ПЛАН МЕРОПРИЯТИЙ ПО ПОДГОТОВКЕ К ПУСКУ ЭНЕРГЕТИЧЕСКОЙ УСТАНОВКИ РС-25 (далее Установка)

SCHEDULE OF ACTIVITY FOR PC-25 UNIT (hereinafter referred to as the Unit)

No II/II	ДАО «Оргэнергогаз» Название мероприятия	Срок окон	No.	DAO Orgenergogaz Title of activity	Term of completion
1.	Создание группы пуска, опытной эксплуатации и технического обслуживания	Выполнено	1.	Set up a team for start-up, Experimental operation and Technical maintenance	Completed
2.	Предварительное ознакомление группы эксплуатационно - технического персонала Установкой	Выполнено частично	2.	Preliminary orientation of The operation and technical Team with Unit.	Partially Completed.
3.	Монтаж Установки на Площадке и подключение внешних систем	Выполнено частично	3.	Installation of the Unit on site And linking of external systems	Partially Completed
4.	Подготовка и предоставление фирме UTC установочных чертежей на азотную систему, систему охлаждения и электросистему.	13.05.02	4.	Preparation of Installation drawings For nitrogen, cooling And electrical systems And submitting to UTC Fuel Cells	May 13,2002
5.	Монтаж системы подачи газа	15.05.02.	5.	Erection and linking of Gas supply system	May 15, 2002
6.	Монтаж внешней электросистемы	Выполнено Частично	6.	Linking of external power system	Partially Completed
7.	Монтаж азотной системы	15.06.02	7.	Linking of nitrogen system	June 15,2002
8.	Монтаж системы охлаждения	15.06.02.	8.	Erection and linking of Cooling system	June 15 2002
9.	Монтаж телефонной линии к внешнему терминалу	Выполнено	9.	Linking of phone line Linked to the external terminal	Partially completed
10.	Приобретение компьютера (Pentium III, 400 MHz, или лучше, 128 Mb RAM)		10.	Purchase computer (Pentium III, 400 MHz, 128 Mb RAM, or better)	Install prior UTC Fuel Cells Personnel arrival
11.	Организация таможенной очистки, получения и складирования направленных UTC Fuel Cells запасных частей и расходных материалов		11.	Arrangement of customs Clearance, receiving and storage of up-grade parts spare parts, Consumables sent by UTC Fuel Cells	

12.	Предоставление анализа химического состава газа	30.05.02	**12.**	Provision of analysis of Chemical composition of Gas and water.	
13.	Заполнение и направление опросного листа по пуску Установки	За 1 месяц до прибытия специалистов UTC FUEL CELLS	**13.**	Complete check-list and Submit to UTC Fuel Cells.	1 month before UTC Fuel Cells Specialists arrival
14.	Сертификация Установки в России		**14.**	Certification of the Unit in Russia	
15.	Обеспечение перевода на русский язык информации от UTC, получаемой по факсу и e-mail.		**15.**	Provide translation of Information from and to UTC Fuel Cells obtained By fax or e-mail into Russian.	
16.	Обеспечение перевода на время проводимого американской стороной обучения группы персонала		**16.**	Provide translation for The period of training Of the personnel Performed by UTC Fuel Cells.	
17.	Назначить специалиста, владеющего английским языком, с которым Fuel Cells будет осуществлять связь по телефону в случае возникновения экстренных ситуаций		**17.**	Provide English-Speaking Contact for Emergency Communication.	
18.	Обеспечить присутствие специалиста по сварочным работам на время выполнения работ по модернизации Установки		**18.**	Provide a welding Specialist for the period Of the Unit upgrading Activity.	
19.	Направить заполненную анкету поставки	25.04.02	**19.**	Provide completed Shipping form.	25.04.02

MINUTES OF MEETING BETWEEN SPECIALISTS OF DAO ORGENERGOGAZ AND UTC FUEL CELLS

"

Participants:

DAO Orgenergogaz "

V. A.Usoshin

I.F.Egorov

R.K.Baishev

V.G.Sidorenko

A.A.Levin

S.I. Kozlov

N.N. Lushkin

I.T.Pismennyi

F.K. Iliasov

K.E.Dunchenko

L.S.Khodakova

A.E. Bazdyrev

DOE/N.ETL:
Diane T. Hooie
UTC Fuel Cells:
John Trocciola
Linda Boyd
Richard Wallace

1. The Parties examined actual condition of PC-25 power unit and concluded that the Unit is in satisfactory condition. All systems are preserved, no traces of corrosion found.
Electrical and electronic control systems were not tested.
2. The project of DAO Orgenergogaz on the Unit allocation and its utilization for power and beat supply of engineering administration office of DAO Orgenergogaz is approved by the manufacturer.
3. The site for the Unit meets the requirements of the project. The place of the Unit location and its positioning meets the requirements of the manufacturer.
4. The nitrogen system of station supply in case of shutdown (including emergency shutdown) meets the requirements of project and the manufacturer.
5. The system of fuel gas supply meets the requirements of project and the manufacturer.
6. The phone line communications installed constructed by DAD Orgenergogaz meet the requirements of the
manufacturer.

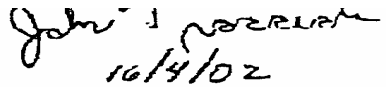
7. The set of up-grade parts, spare parts and consumables shipped with PC -25, are kept in safety.
8. The Parties agreed that the control system and software of the Unit must be upgraded.
9. Upgrade parts, spare parts and consumables will be sent by air to Moscow. The shipping expense will borne by UTC Fuel Cells. Customs duties and carriage in Russia will be the responsibility of DAD Orgenergogaz. Specification of supplied up-grade parts, spare parts and consumables will be presented by the UTC fuel Cells not later than May 10, 2002.
10. DAO Orgenergogaz shall present a scheme of utilization of the Unit heat-recovery in the heating system of the engineering-administrative office (including drawings) within a year from the date of initial start-up.

11. UTC Fuel Cells shall provide a trainer for DAO Orgenergogaz personnel free of charge at Orgenergogaz facility in Vidnoje. All travel expenses, local travel expenses, salary and accommodation for UTC Fuel Cells specialists to be born by UTC Fuel Cells.
12. The Parties have appointed specialists that will accumulate all necessary commercial and technical information.

a. On the part of DAD Orgenergogaz: technical information shall be accumulated by Mr. S. Kozlov, commercial information shall be accumulated by Mr. A. Levin
b. On the part of ,UTC Fuel Cells -technical information shall be accumulated by Mrs. Linda Boyd, commercial information shall be accumulated by Mr. John Trocciola.
13. The parties have developed a Schedule of Activity for PC-25 Unit, which is a part of the present Minutes.
14. A mutually agreeable date will be determined for the arrival of UTC specialists to begin the upgrade, training, and start-up and process. This will occur at least 1 month after UTC Fuel Cells receives the completed checklist and verification that all upgrade parts) spare parts and consumables are on site.
15. A mutually agreeable date will be determined for the date of commissioning. This will occur at least 1 month after all upgrade parts, spare parts and consumables arrival on site.
.

On be half of DAO Orgenergogaz

On behalf of UTC Fuel Cells



ПРОТОКОЛ ВСТРЕЧИ МЕЖДУ СПЕЦИАЛИСТАМИ ДАО «ОРГЭНЕРГОГАЗ» И ФИРМЫ UTC FUEL CELLS (США)

г. Видное

10 - 15 апреля 2002 г.

Участвовали:

От ДАО "Оргэнергогаз"

В.А. Усошин

И.Ф. Егоров

Р.К. Баишев

В.Г. Сидоренко

А.А. Левин

С.И. Козлов

Н.Н. Лушкин

И.Т. Письменный

Ф.К. Ильясов

К.Е. Дунченко

Л.С. Ходакова

А.Е. Баздырев

От DOE/NETL:

Diane T. Hoole

От фирмы UTC Fuel Cells

John Trocciola

Linda Boyd

Richard Wallace

1. Стороны определили фактическое состояние энергетической установки PC - 25 и пришли к выводу, что установка находится в удовлетворительном состоянии: все системы законсервированы, следов коррозии нет. Тестирование электрических и электронных систем управления не проводилось.
2. Выполненный ДАО «Оргэнергогаз» проект размещения установки и ее использования для электро- и теплоснабжения инженерно-административного корпуса ДАО «Оргэнергогаз» одобрен фирмой -изготовителем.
3. Площадка для размещения установки выполнена в соответствии с проектом. Место расположения установки и ее размещение на площадке удовлетворяют требованиям фирмы-изготовителя.
4. Азотная система продувки станции при останове установки (в т.ч. аварийном) выполнена в соответствии с проектом и

удовлетворяет требованиям фирмы- изготовителя.

5. Система подвода топливного газа удовлетворяет требованиям проекта и фирмы-изготовителя.

6. Телефонные коммуникации, выполненные ДАО «Оргэнергогаз», соответствуют требованиям фирмы-изготовителя.

7. Комплект частей для модернизации, запасных частей и расходных материалов, поставленных вместе с Установкой, находятся в полной сохранности.

8. Стороны пришли к соглашению о необходимости модернизации установки в части замены блоков системы управления и программного обеспечения.

9. Части для модернизации, запасные части и расходные материалы будут направлены фирмой UTC Fuel Cells в Москву самолетом. Расходы по транспортировке груза до Москвы относятся на счет UTC Fuel Cells. Расходы по таможенному оформлению груза и транспортные расходы по его доставке на площадку относятся на счет ДАО "Оргэнергогаз". Спецификация поставляемых модернизированных частей, а также расходных материалов будет представлена фирмой UTC Fuel Cells не позднее 10 мая.

10. ДАО «Оргэнергогаз» в течение года с даты первоначального пуска установки представит схему ее использования в системе теплоснабжения инженерно-административного корпуса (включая чертежи).

11. UTC Fuel Cells бесплатно предоставит услуги своих преподавателей для проведения обучения эксплуатационного персонала ДАО «Оргэнергогаз» в инженерно-административном корпусе в г. Видное. Расходы по приобретению авиабилетов, транспортные расходы внутри страны пребывания, суточные и расходы по проживанию преподавателей в гостинице относятся на счет UTC Fuel Cells.

12. Стороны назначили специалистов, в адрес которых должна направляться вся необходимая коммерческая и техническая информация:

a. От ДАО «Оргэнергогаз»: информация технического характера - в адрес С.И. Козлова, информация коммерческого характера - в адрес А.А. Левина.

№ п/п	UTC FUEL CELLS		№	UTC FUEL CELLS	
	Название	Срок окончания		Title	Term of completion
1.	Получение экспортной лицензии	Выполнено	1.	Obtain export license	Completed
2.	Визуальный осмотр Установки.	Выполнено	2.	Inspection of the Unit	Completed
3.	Предоставление установочных чертежей	Выполнено	3.	Submit installation drawings	Completed
4.	Утверждение установочных чертежей, полученных от ДАО "Оргэнергогаз"	1 июня 2002 г.	4.	Approval of the installation drawings received from DAO Orgenergogaz	June 15, 2002
5.	Предоставление ДАО «Оргэнергогаз» спецификации подлежащих поставке частей для модернизации, запасных частей и расходных материалов	10 мая 2002 г.	5.	Submit to DAO Orgenergogaz specifications for the upgrade parts, spare parts and consumables to be supplied	May 10, 2002
6.	Бесплатная поставка в Москву частей для модернизации, запасных частей и расходных материалов на 1 год технической эксплуатации станции	15 июня 2002	6.	Send upgrade parts, spare parts and consumables for 1 year of operation of the Unit free of charge, to Moscow customs.	June 15, 2002
7.	Бесплатное обучение эксплуатационно – технического персонала в Москве во время первоначального пуска Установки, в соответствии с п. 11 Протокола Встречи		7.	Conduct training of operation personnel in Moscow during the initial start-up of the Unit free of charge in accordance with p. 11 of the Minutes of Meeting	
8.	Оказание помощи ДАО «Оргэнергогаз» в модернизации Установки		8.	Assist DAO Orgenergogaz in upgrading of the Unit	
9.	Ревизия всех систем Установки и проверка правильности монтажа и подсоединения наружных систем. Осуществление первоначального пуска Установки (при участии специалистов ДАО «Оргэнергогаз»)		9.	Inspect all systems of the Unit and verify correctness of erection and linking of external systems. Performance of initial start-up of the Unit (with participation of DAO Orgenergogaz)	

10	Оказание в течение одного года с даты первоначального пуска технического содействия (по телефону, факсу, e-mail)	Начиная с даты пуска установки в эксплуатацию	10.	Provide one - year assistance (via phone, fax, e-mail).	Begins on the date of commissioning
11	Обеспечение ДАО "Оргэнергогаз" имеющимися в распоряжении UTC FUEL CELLS информацией и документами на английском языке, необходимыми для сертификации Установки в России		11.	Provide DAO Orgenergogaz with available information and documents in English, required for certification of the unit in Russia	

характера - в адрес г-жи Linda Boyd; информация коммерческого характера - в адрес г-на John Trocciola.

Стороны разработали План мероприятий по подготовке установки к пуску, являющийся приложением к настоящему Протоколу.

Стороны согласуют дату прибытия специалистов UTC Fuel Cells для проведения модернизации и пуска Установки, а также обучения персонала. Этот процесс займет по меньшей мере 1 месяц после получения фирмой UTC Fuel Cells заполненного проверочного листа и подтверждения того, что части для модернизации, запасные части и расходные материалы находятся на площадке.

Стороны в течение месяца с даты прибытия частей для модернизации, запасных частей и расходных материалов на площадку (г. Видное) согласуют предполагаемую дату пуска установки в эксплуатацию.

От ДАО " Оргэнергогаз»

От UTC Fuel Cells

John Trocciola

16/4/02

Appendix C - Gazprom PC25 Site Gas Analysis

No.	Technical data	Measurement unit	Rate as required by GOST 5542-87	Actual figures
1.	Calorific capacity, lowest at 20°C and at least 101.3 kPA	kcal/m³	7600	7968
2.	Vobbe number, highest at 20ºC and 101.3 kPA	kcal/m³	9850-13000	11789
3.	Mass concentration of hydrogen sulphide, not more than	g/m³	0,02	not available
4.	Mass concentrations of mercaptane sulphide, not more than	g/m³	0,036	0,0060
5.	Mass of foreign particles, not more than	g/m³	0,001	not available
6.	Oxygen contents, not more than	%	1	0,006
7.	Gas odor intensity at volume ratio of 1% in the air, at least	point	below	-13,3
8.	Moisture dew point at: Gas pressure Gas temperature	ºC kgf/cm² ºC	gas temperature	 26,9 2,0
9.	Gas composition: Methane Ethane Propane Iso-butane N-butane Cs+ highest carbohydrate Carbon dioxide Nitrogen + Oxygen	% of volume		98,524 0,442 0,118 0,019 0,020 0,012 0,032 0,833
10.	Gas density at 20ºC and 101,3 kPA: peak designed	Kg/m³		

Appendix D - Chemical Analysis

Russian Academy of Sciences

GEOLOGICAL INSTITUTE
CHEMICAL ANALYSIS LABORATORY

Protocol of Laboratory Tests of 2 water samples
No.01 dated 14 January 2003

CHEMICAL ANALYSIS

No. in order	Identified components	Sample No.1(PH-6.02) Distilled Water		Sample No.2 (pH-7.50) Boiler Water	
		Mg/l	mg-equiv/l	Mg/l	mg-equiv/l
1.	General minerals (dry)	16.0		352.0	
2.	General rigidity		0.12		0.21
3.	Calcium, Ca^{2+}	1.20	0.06	1.80	0.08
4.	Magnesium, Mg^{2+}	0.73	0.06	1.46	0.12
5.	Alkalinity, HCO_3	9.76	0.16	229.36	3.76
6.	Chlorides, CI	4.25	0.12	21.28	0.60
7.	Nitrate, No_3	0.25		2.80	
8.	Nitrites, No_2	<0.005		0.14	
9.	Silicates, SiO_2	0.06		6.00	
10.	Ferrous(Fe-generic)	0.02		0.22	
11.	Oxidizability (NMO)	0.05		3.20	
12.	Oxygen (O_2 soluble)	13.04		8.00	

Senior Scientific Worker **V. Stepanets**
16.01.03

Appendix E - Parts Shipped

Invoice No. Dated 2003

UTC Fuel Cells
A United Technologies Company

Consignee: DOAO "Orgenergogaz"
Luganskaya Street 11, building1,
Russian Federation, 115304, Moscow

Container/ box No. 1

Agreement on Technical and Demonstration Test 15 August, 2003

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		piece		kg	kg		
1	RESIN, NUCLEAR GRADE - ION EXCHANGE- FCCM4350-01	11 Cu. Ft.	8502.39.0000	18	-		
2	C-21 STACK COOLING WATER FLOW RESTRICTOR KIT CONTAINS 34 PIECES- FC15650-01	1	8502.39.0000	11	-		
3	GATE DRIVE CIRCUIT BOARDS FC14451-08	12	8502.39.0000	0.5	-		
4	CELEBRON CPU BOARD FC19066-01	1	8502.39.0000	0.5	-		
5	SWITCHMODE POWER SUPPLY FC14410-02	1	8502.39.0000	3	-		
6	LEM CURRENT TRANSDUCERS FC14426-02	18	8502.39.0000	0.5	-		
7	HEAD AND DISTRIBUTOR- FC10945-04	2	8502.39.0000	1	-		
8	VESSEL FC10945-03	2	8502.39.0000	7	-		
9	PUMP FEEDWATER,WTS PMP 451 FC19061-01	1	8502.39.0000	11	-		
10	CIRCULATING PUMP-450 FC19062-01	1	8502.39.0000	11	-		
11	SWITCH ASSY-FLOW FS-400- FC16789-01	1	8502.39.0000	0.9	-		
12	FIELD REPLACEMENT KIT-FLOW METER-FT140 FC13643-11	1	8502.39.0000	2	-		
13	HIGH VOLTAGE INTERFACE CIRCUIT BOARDS FC18186-02	6	8502.39.0000	0.2	-		
14	FLOPPY DISK-PROGRAMMED KEY FC18845-01	1	8502.39.0000	0.2	-		

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		piece		kg	kg		
15	CABLE-T/C EXTENSION FCCM0620-2001	50 ft	8502.39.0000	0.04	-		
16	RETROFIT KIT C68 INSTALL TE-820 W/O H/G-FC18180-01	1	8502.39.0000	0.9	-		
17	QUICK DISCONNECT FITTINGS, INLET-FCSP14865-01	6	8502.39.0000	0.1	-		
18	C-69 INSTALL NEW IGNITOR CABLE-FC18469-01	1	8502.39.0000	0.1	-		
19	HOSE CLAMPS-FCSP2678-01	12	8502.39.0000	0.1	-		
20	FILTER ELEMENT FC15250-02	6	8502.39.0000	0.2	-		
21	CIRCUIT BREAKER-40AMP FC14462-02	1	8502.39.0000	2	-		
22	SENSOR,UV MODIFIED BE-030 FC19293-02	1	8502.39.0000	0.5	-		
23	C-99 QUAD/DUEL POWER SUPPLY FAN KIT-FC19315-01	1	8502.39.0000	0.2	-		
24	RETROFIT KIT-C90 VALVE BRAKE REPLACEMENT-FC19221-01	8	8502.39.0000	0.5	-		
25	GASKET, ACC-400 INSPECTION COVER-FCSP10920-13	1	8502.39.0000	0.1	-		
26	C-72 P.C.S. LOW VOLTAGE EPROM REPLACEMENT KIT- FC18671-02	1	8502.39.0000	0.1	-		
27	AT BATTERY,TL-5242-FC16872-11	4	8502.39.0000	0.05	-		
28	REPAIR KIT-CV500 FC11934-55	1	8502.39.0000	1	-		
29	C-37 OVERLOAD MODULE FOR PUMP-400 KIT-FCSP12252-02	1	8502.39.0000	0.2	-		
30	QUICK DISCONNECT FITTINGS, EXET-FCSP14865-02	6	8502.39.0000	0.1	-		
31	THERMOCOUPLE INPUT MODULE (5B37)-FC13265-03	4	8502.39.0000	0.1	-		
32	CURRENT INPUT MODULE (5B32) FC13266-03	2	8502.39.0000	0.1	-		
33	CURRENT INPUT MODULE (SCM 5B42-01)-FC13266-06	1	8502.39.0000	0.1	-		
34	CURRENT OUTPUT MODULE (5B39) FC13266-05	2	8502.39.0000	0.1	-		
35	VOLTAGE INPUT MODULE (5B31) FC13266-04	1	8502.39.0000	0.07	-		
36	FILTER-AIR PASSIVATION, FC13438-01	1	8502.39.0000	0.1	-		

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		piece		kg	kg		
37	C-10 FUSE - REPLACE SMOKE DETECTOR-FCSP18658-01	1	8502.39.0000	0.1	-		
38	FUSE - 4 AMP FOR DIGITAL OUTPUT MODULES FC17938-01	12	8502.39.0000	0.0	-		
39	C-10 CONNECTOR - ELECTRICAL FCSP5373-01	2	8502.39.0000	0.0	-		
40	DIGITAL OUTPUT MODULE DRY CONTACT (RED)-FC13262-05	1	8502.39.0000	0.1	-		
41	DIGITAL INPUT MODULE 120VAC (YELLOW) - FC13264-04	3	8502.39.0000	0.1	-		
42	DRY CONTACT OUTPUT MODULE, FC16835-04	1	8502.39.0000	0.1	-		
43	CONNECTOR - T/C CHROMEL FCSP4158-01	4	8502.39.0000	0.0	-		
44	WATCHDOG TIMER MODULE (BLUE)-FC13264-05	1	8502.39.0000	0.1	-		
45	THERMOCOUPLE INPUT MODULE (5B37)-FC13265-03	3	8502.39.0000	0.1	-		
46	RETROFIT KIT C65-VENT LIMITER - PCV-020-FC17746-01	1	8502.39.0000	0.2	-		
47	C-10 FUSE HOLDER REPLACE SMOKE DETECTOR-FCSP8533-01	1	8502.39.0000	0.1	-		
48	DIGITAL OUTPUT MODULE (BLACK)-FC13261-04	3	8502.39.0000	0.1	-		
49	GASKET, FOR FLOW ORIFICE FO-420-FCSP10920-03	1	8502.39.0000	0.1	-		
50	IGNITER (SPARK PLUG) FC9563-01	1	8502.39.0000	0.1	-		
51	PUMP-400 INLET GASKET FCSP10920-05	1	8502.39.0000	0.1	-		
52	CONNECTOR - T/C CHROMEL FCSP4158-02	4	8502.39.0000	0.0	-		
53	ORIFICE PLATE FO-400-FC13569-04	1	8502.39.0000	0.2	-		
54	STACK COOLING WATER OUTLET GASKET-FCSP10920-06	1	8502.39.0000	0.2	-		
55	C-37 1/2 INCH UNION - MALE PUMP-400 KIT-FCSP5330-07	2	8502.39.0000	0.2	-		
56	C-37 1/4 TO 1/2 MALE CONNECTOR PUMP-400 KIT-FCSP4681-20	1	8502.39.0000	0.1	-		
57	POTENTIOMETER INPUT MODULE (SCM 5B36-03)-FC13266-07	1	8502.39.0000	0.1	-		
					379		

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz" shall take title to the Equipment and shall bear risks and any cost occurring after such delivery.

UTC Fuel Cells
A United Technologies Company

Invoice No. Dated 2003

Consignee: DOAO "Orgenergogaz"
Luganskaya Street 11, building1,
Russian Federation, 115304, Moscow

Agreement on Technical and Demonstration Test 15 August, 2003

Container/ box No. 2

No.	Description	Quantity	CC for IEA	Net weight	Gross weight		
		piece		kg	kg		
1	FILTER, 1 MICRON, REPLACEMENT FILTER-100 FC19345-01	2	8502.39.0000	2	-		
2	FILTER,DISPOSABLE, REPLACEMENT FILTER-150 - FC19145-01	4	8502.39.0000	1	-		
3	RETROFIT KIT C92 START BURNER INSULATION- FC19231-01	1	8502.39.0000	0.9	-		
4	RUBBER HOSE- FCRM7902-05	15 ft	8502.39.0000	5	-		
5	ACTUATOR-THERMAL CONTROL VALVE- FC19224-16	1	8502.39.0000	7	-		
6	FILTER HOUSING- FC15250-03	1	8502.39.0000	2	-		
7	CHARCOAL - ACTIVATED,90 LB.BAG- FCCM4351-01	2	8502.39.0000	20	-		
8	C-101 FILTER 100 KIT FC19358-01	1	8502.39.0000	9	-		
9	CONDENSOR CLEANING KIT W/O DRUM- FC19058-02	1	8502.39.0000	5	-		
10	ACTUATOR AND POT.ASSY FCV-110-V FC17582-22	1	8502.39.0000	7	-		
11	HOOK UP WIRE-ELECT.,125C, 600V- FCCM7913-06	20 ft.	8502.39.0000	0.2	-		
12	C-37 UNION-3/4 TO 3/4 MALE PUMP-400 KIT- FCSP4681-18	1	8502.39.0000	0.1	-		
13	*FC13676-02 SERVICE MANUAL*	1	8502.39.0000	2.3	-		
14	*FCCM7302-0401 WIRE*	20 Ft	8502.39.0000	0.2	-		
					178		0.00

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz' and shall bear risks and any cost occurring after such delivery.

This is to certify that the goods are manufactured in the U.S.A.

Appendix F - Parts Shipped

UTC Fuel Cells
A United Technologies Company

Invoice No. Dated 2003

Consignee: *DOAO "Orgenergogaz", Luganskaya Street 11, building1, Russian Federation, 115304, Moscow*

Container/ box No. 3

Agreement on Technical and Demonstration Test 15 August, 2003

No.	Description	Quantity	CC for IEA	Net weightPiece	Gross weight		
		piece		kg	kg		
1	C-97 DIVERSIFIED TO OCTOGON CONTROLLER-FC19292-01	1	8502.39.0000	30	-		
2	RESIN, NUCLEAR GRADE - ION EXCHANGE-FCCM4350-01	14 Cu. Ft.	8502.39.0000	18	-		
					359		

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz" shall take title to the Equipment and shall bear risks and any cost occurring after such delivery.

This is to certify that the goods are manufactured in the U.S.A.

UTC Fuel Cells
A United Technologies Company

Invoice No. Dated 2003

Consignee: *DOAO "Orgenergogaz", Luganskaya Street 11, building1, Russian Federation, 115304, Moscow*

Container/ box No. 4

Agreement on Technical and Demonstration Test 15 August, 2003

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		piece		kg	kg		
1	PUMP ASSEMBLY FC17775-05	1	8502.39.0000	49	-		
					88		

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz" shall take title to the Equipment and shall bear risks and any cost occurring after such delivery.

This is to certify that the goods are manufactured in Japan

UTC Fuel Cells
A United Technologies Company

Invoice No. Dated 2003

Consignee: *DOAO "Orgenergogaz", Luganskaya Street 11, building1, Russian Federation, 115304, Moscow*

Container/ box No. 5

Agreement on Technical and Demonstration Test 15 August, 2003

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		piece		kg	kg		
1	C-89 FILTER 150 HOOD AND DEMISTER -FC19142-01	1	8502.39.0000	18	-		
2	RETROFIT KIT C91 WTS ENCLOSURE INSULATION-FC19210-01	1	8502.39.0000	16	-		
					73		

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz" shall take title to the Equipment and shall bear risks and any cost occurring after such delivery.

This is to certify that the goods are manufactured in the U.S.A.

UTC Fuel Cells
A United Technologies Company

Invoice No. Dated 2003

Consignee: *DOAO "Orgenergogaz", Luganskaya Street 11, building1, Russian Federation, 115304, Moscow*

Container/ box No. 6

Agreement on Technical and Demonstration Test 15 August, 2003

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		piece		kg	kg		
1	C-37 PIPING FOR INSTALLING PUMP-400 FC17213-31	1	8502.39.0000	20	-		
					61		

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz" shall take title to the Equipment and shall bear risks and any cost occurring after such delivery.

This is to certify that the goods are manufactured in the U.S.A.

UTC Fuel Cells
A United Technologies Company

Invoice No. Dated 2003

Consignee: *DOAO "Orgenergogaz", Luganskaya Street 11, building1, Russian Federation, 115304, Moscow*

Container/ box No. 7

Agreement on Technical and Demonstration Test 15 August 2003

No.	Description	Quantity	CC for IEA	Net weight/Piece	Gross weight		
		gallons		kg	kg		
1	100 % PROPYLENE GLYCOL-DOW FROST-FCCM9261-01	55	8502.39.0000	4	-		
					270		

The value is indicated expressely for the customs purposes

UTC Fuel Cells shall deliver, at its sole costs and risk, the Equipment to the customs terminal entry point of the Russian Federation in Moscow only (CPT Moscow, Incoterms 2000), and DOAO "Orgenergogaz" shall take title to the Equipment and shall bear risks and any cost occurring after such delivery.

This is to certify that the goods are manufactured in the U.S.A.