

ROMANIAN-CANADIAN JOINT PROGRAM FOR QUALIFICATION OF FCN AS A CANDU FUEL SUPPLIER

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ABSTRACT

RENEL*, the co-ordinator of Romanian Nuclear Program, have decided to improve, starting 1990 the existing capability to produce CANDU nuclear fuel at FCN Pitesti. The objective of the program was defined with AAC** for the qualification of FCN fuel plant according to Canadian Z299.2 standard.

The Qualification Program was performed under AAC Work Order C-003.

The co-ordination was assumed by AECL, as overall Design Authority.

ZPI***, were designated to supply technical assistance, equipments and know how where necessary.

After a preliminary verification of the FCN fuel plant, including the processes and system investigation, performed under AECL and ZPI assistance, the Qualification Program was defined in all details.

The upgrading of documentation on all aspects required by Z299.2 was performed.

Few processes needed to be reconsidered and equipment was delivered by ZPI or other suppliers. This includes mainly welding equipments and special inspection equipments. Health Physics was practically fully reconsidered. New equipment and practice were adapted to provide adequate control on health conditions.

Every manufacturing and inspection process was checked to determine their performance during a Qualification Run based on acceptance criteria which have been established in the Qualification Plan.

Manufacturing Demonstration Run was an important step to prove that all plant functions have been accomplished during the fabrication of 200 fuel bundles. These bundles have been fully accepted and 66 of them have been loaded in the first charge of Unit 1 Cernavoda NPS. The surveillance and audit actions made by AECL and ZPI during this period confirmed the FCN capability to operate an adequate system meeting the to required quality assurance standard.

The very open attitude of AECL, Zircatec and FCN staff have stimulated the progress of the project and a successful achievement of the target.

The experience achieved during this project by all the parts involved ensures a good basis for the next joint programs.

* Romanian Power Authority

** AECL - ANSALDO Consortium

*** Zircatec Precision Industries Inc. (Canada)

INTRODUCTION

FCN fuel plant is a CANDU fuel manufacturing unit. FCN is placed in Pitesti - Romania, about 130 km far away from Bucharest. Until 1992, the fabrication line operated as a department of the Institute for Nuclear Research (ICN), i.e the former Institute for Nuclear Power Reactors (INPR). Since 1992 this unit became a distinct company being a subsidiary of RENEL. The Romanian Development Program for the nuclear fuel fabrication until 1992 was shown by paper (1).

In 1990, RENEL have mandated AECL to perform an evaluation of the system and of the fuel quality produced.

The conclusion of this evaluation performed by AECL and ZPI, was that the plant should be upgraded and qualified under Canadian assistance and a Quality Assurance Program according to CAN3-Z299.2 is necessary to be implemented. The main required actions to be performed are shown by paper (2).

Arrangements between RENEL and AAC ended up in november 1992 by the Work Order C-003 giving to AECL the coordinating role. ZPI, was selected to provide technical assistance and to supply equipments for several processes.

The program effectively started, after Export Permission issuing by the Canadian Government, in december 1993.

The Qualification was completed in July 1994 and a Demonstration Run was performed during October 1994 by fabricating about 200 CANDU-6 Fuel Bundles.

The plant capacity is of 23 fuel bundles per day, two shifts, this meaning about 100 U tones per year.

A number of 66 fuel bundles were charged in the first core in the channels L90 to L95. Fabrication of CANDU-6 fuel started essentially in January 1995.

The Final Audit for certification is planned for October 1995.

This paper describes how the Qualification Program was performed and its main achievements.

QUALIFICATION PROGRAM

Basic conditions for qualification have been established by AECL, which have the attribute of Design Authority for CANDU system.

The responsibility to operate Unit 1 of Cernavoda Nuclear Power Station, was undertaken by AAC by the Project Management Contract (PMC). The contract with RENEL included the assignment for AAC to provide assistance of qualification of Romanian nuclear fuel manufacturer. In these conditions, the Work Order for Pitesti Fuel Plant Qualification has been issued by AAC. The Organizations and Authorities involved in the Qualification Program are shown in Figure 1.

The first assessment made at Pitesti by Canadian teams in 1990 was focused on the existing technical capability and Quality Assurance Program and its findings conducted to which were performed after issuing the Work Order C-003:

Overall plant verification, including existing documents, equipment, processes, organization and QA system and Health Physics.

Training of FCN personnel by lessons made at FCN and by attachments at ZPI factory in Port Hope.

Documentation transfer from ZPI for manufacturing documents and AECL for updated Technical Specifications & Design Manual.

Transfer of specific equipment and necessary know how for a limited number of processes. Most important cases are the end cap welding and the assembly welding but there are a few other equipments procured under ZPI assistance with an important effect on technology upgrading and Health Physics.

Preparation by FCN of a new manufacturing and revised QA documents in both English and Romanian languages, which have been thoroughly reviewed and approved by ZPI and AECL. Even the group of acceptable documents has been revised and reviewed.

Improvement of existing equipments and processes, where necessary, based on ZPI/AECL recommendations.

Qualification of the material and services suppliers. Main material suppliers are Sandvik - Sweden for Zircaloy tubes, Cezus - France for Zircaloy bars and sheet, Acheson-USA for graphite and Feldioara Plant - Romania for uranium dioxide powder. Services are mainly supplied by ICN, including mechanical testing for Zircaloy materials, corrosion and autoclaving tests. An important part of measuring equipment calibrations is also performed by ICN.

Processes Qualifications. This phase was achieved by an intensive work ending up in processing representative quantities of material, permitting the verification of equipment operation and collection of data for the process capability evaluation.

Manufacturing Demonstration. A fabrication run by manufacturing 200 fuel bundles was required to demonstrate the FCN capability to operate all the systems and to produce quality CANDU fuel bundles. This phase was accomplished under ZPI and AECL surveillance in November 1994. All bundles produced during the Demonstration Run have been accepted.

Certification. AECL audited all systems as per CAN3-Z299.2 during Manufacturing Demonstration. Based on the audit report AECL have authorized the starting of fuel production. AECL monitoring program continues up to October 1995 when the final audit shall be performed. The recommendations resulted after audit and monitoring reports are already implemented.

CNCAN**** perform its own auditing actions and licensed FCN as supplier for Cernavoda NPS (QA License and Operating License). ON this basis and after Safety Report analysis, 66 fuel bundle have been introduced in Cernavoda NPS Unit 1 in 6 channel (L90 to L95), covering a wide range of operating conditions.

MAIN ACHIEVEMENTS AT FCN PLANT BY THE QUALIFICATION PROGRAM

Organization and Quality Assurance System

Based on Z299 Series and Canadian staff recommendation FCN became effectively a

****National Commission for Nuclear Activities Control

reactive system with strong features of a preventive one.

Organization was improved by increasing the role of inspection and engineering departments. Together with QA staff they became the strongest instruments to identify problems, find solutions and implement necessary corrective and preventive actions. The key role of production was maintained having in view that the principle of "to do things right the first time" must become effective in this area. The revised job description establishes more precisely the responsibilities and interfaces between key positions, the contact with managerial Canadian practice being of a real help to optimize the FCN organization.

General Requirements and Procedures. The main achievement is the enforcement of system functions. The better understanding of their correlations and the involvement of the whole system in reaching the quality target have conducted to a coherent system of procedures which fully covers the Z299.2 standard requirements. Based on their implementation together with second and third level procedures FCN system is able to perform efficiently the production target, to detect promptly any deviation from normal practice and to identify and implement the applicable corrective actions.

Personnel training

The main goal was to develop a QA attitude at all levels. Based on training programs and specific procedures the whole personnel (from top management to floor level) was indoctrinated in order to understand and apply the QA requirements. The continuous help offered by Canadian staff in this action was a strong support to reach this target.

It must be mentioned that indoctrination and training is a permanent task by which FCN maintain and improve their achievements.

Implementation of Improved Manufacturing Documentation

FCN have preserved an important part of the previous manufacturing practice. However FCN recognized Zircatec expertise in producing high quality CANDU fuel and consequently in many cases we adopted Zircatec practice in the limits of availability and compatibility with our technology.

Upgrading of the Equipments for Manufacturing and Quality Control

In the purpose of improving the product quality it has been decided that part of the equipment is necessary to be replaced by new equipment. This was supplied by Zircatec and other suppliers and arrangements were made through AAC line. The list of the new equipment includes:

- End cap welding machine
- Assembly welding machine (End plate welding machine)
- Rotary grit blasting for the appendages surface conditioning
- Tumbling machine for end plate deburring
- Coordinate machine for dimensional measurements on finished fuel bundle
- End plate punching die
- Microderm equipment for the measurement of thin layers by beta-back scattering

- (beryllium and graphite layers)
- Equipment for hydrogen element content determination, which was produced by ICN.
- Inspection tools and gauges for quality verification.

Improvement of the Processes, Process Qualifications and Process Control Practice

As established during the initial assessment, a number of processes or quality control methods needed to be upgraded to ensure high quality products.

Processes Qualification was finally concluded by means of a Process Capability Evaluation.

This was made using k_Q method, calculated for confidence level γ and $P \geq 1-\alpha$, where α equals the specific acceptable quality levels (AQL's). This represents an improved capability evaluation which ensured a better consistency for all processes.

Strengthening of the statistical process control through the use of the control charts to a higher number of processes combined with the first-off samples resulted in more consistent processes and adequate product quality. Permanent assessment of process trends by process engineering, production and QA staff have conducted to immediate corrective actions and continuous reduction of non-conforming products.

Improvement of Equipment and Practice for Health Physics

HP system was completely reconsidered and documented. Main achievements have been made in providing equipment for air sampling, monitoring and sample analysis. A suitable program for sampling and evaluation was implemented. The personnel was intensively indoctrinated to wear individual protective equipment and to apply all safety rules. The main progress is represented by the capability to ensure an adequate feedback for necessary corrective actions. On this basis FCN plant was licensed by the Romanian Regulatory Body represented by CNCAN.

Improvement of Problem Solving Ability

Working together with ZPI and AECL specialists during qualification period and daily meeting, permitted to be familiarized with Canadian practice to identify and solve problems.

Using the team work practice and lowering the level of decisions resulted a more operative way to solve the problems.

Introducing of New Preventive Maintenance Plans

CAN3-Z299.2 has not specific requirements for maintenance function. However during the project and mainly after production starting raised the necessity to improved the maintenance system in the following direction:

Organization was optimized by establishing specific maintenance responsibilities and interfaces for all departments.

Schedule servicing based on real reliability of equipments with the increase of revision

frequencies for old or key equipments. A continuous monitoring of interventions and revision actions is performed.

Specifications of the required inspection and rework actions at least for the basic equipments.

Maintaining a permanent liaison with equipment suppliers to be able to adopt the proper solutions in case of failure or when equipment improvements are required.

Procurement of spare parts in proper quantity to sustain scheduled revisions and accidental equipment shutdowns.

Establishment of a Direct Contact Liaison with AECL and Zircatec

One of the most important FCN benefit was the possibility to share with AECL & ZPI specialists their experience in design, production and irradiation of nuclear fuel

Retrieval of Confidence on Fuel Quality which can be produced by FCN Plant

This was one of the unwritten goals of this program. The AECL and ZPI confirmation of FCN capability to produce CANDU-6 fuel bundles at the same quality level as the experienced Canadian manufacturers represents a strong support for Customer and CNCAN to accept FCN fuel in the first load from Unit 1 Cernavoda NPS. FCN is also able now to start the evaluation and recovery of the fuel produced before 1991.

Production planning

Detailed monthly manufacturing plans are established and during the daily meetings the managerial team analyze the production results and establish the required corrective action if necessary .

Ensuring a rhythmic high quality production to support the reactor reloading schedule became the most important FCN target to be reached in the next future.

Physical protection

A new physical protection system of high performance was designed and implemented, FCN satisfying the last IAEA***** requirements.

DISCUSSION

The Project was influenced by a few factors which were decisive in the work progress. The Cernavoda Project Management Contract (PMC), stimulated the AECL, ZPI and RENEL co-operation on the Project but the international political circumstances brought

***** International Atomic Energy Agency

about a significant delay in obtaining the Export Permit and therefore a delay in Canadian equipments procurement and documentation transfer. Only our common efforts partially compensated this delay.

The main part of the Project was financed via AAC by PMC. On the other hand, RENEL sustained FCN to obtain necessary financial support from National Budget for a parallel Project, including building improvements, procurement of some conventional equipment and achievement of the plant physical protection. The long chain of financial approvals and procurement intermediaries, correlated with low flexibility in fund allocation during the progress of the work, also conducted to some delays.

Our co-operation with AECL and ZPI has been continuous. FCN perception is that AECL and ZPI staff have provided support to solve all the problems. They stimulated the work at FCN by positive evaluation when the case and by recommending adequate planning or corrective actions.

FCN have now a consolidated position. The ability to solve problems is considerable improved. The manufactured product is of high quality, this being proved by objective evidences.

Our relationship with Cernavoda Nuclear Power Station, was improved at managerial and technical levels, and a permanent Customer representative is maintained at FCN site.

The experience achieved by all parts in this project ensures a good basis for other joint Programs.

Possible future cooperation with AECL and other Canadian firms is for the assessment and recovery of the existing stock of about 30,000 fuel bundles fabricated before 1991. The negotiations are already initiated and are intermediated by AAC.

CONCLUSIONS

Further to the intensive efforts made by all parts involved in the project, FCN is now able to produce the necessary quantity of fuel bundles to ensure the Unit 1 Cernavoda NPS functioning.

The most important achievement is that FCN meet CAN3-Z299.2 quality assurance standard and a strong "quality attitude" was developed.

The successful co-operation of Romanian and Canadian organizations shall stimulate the next joint programs.

ACKNOWLEDGEMENTS

It is not enough space to mention the persons and organizations which contributed to achieve the project success. The whole FCN, ZPI and AECL staff and top management from RENEL and AAC have transformed with professionalism and dedication this technical project in much more : a sound bridge between our countries.

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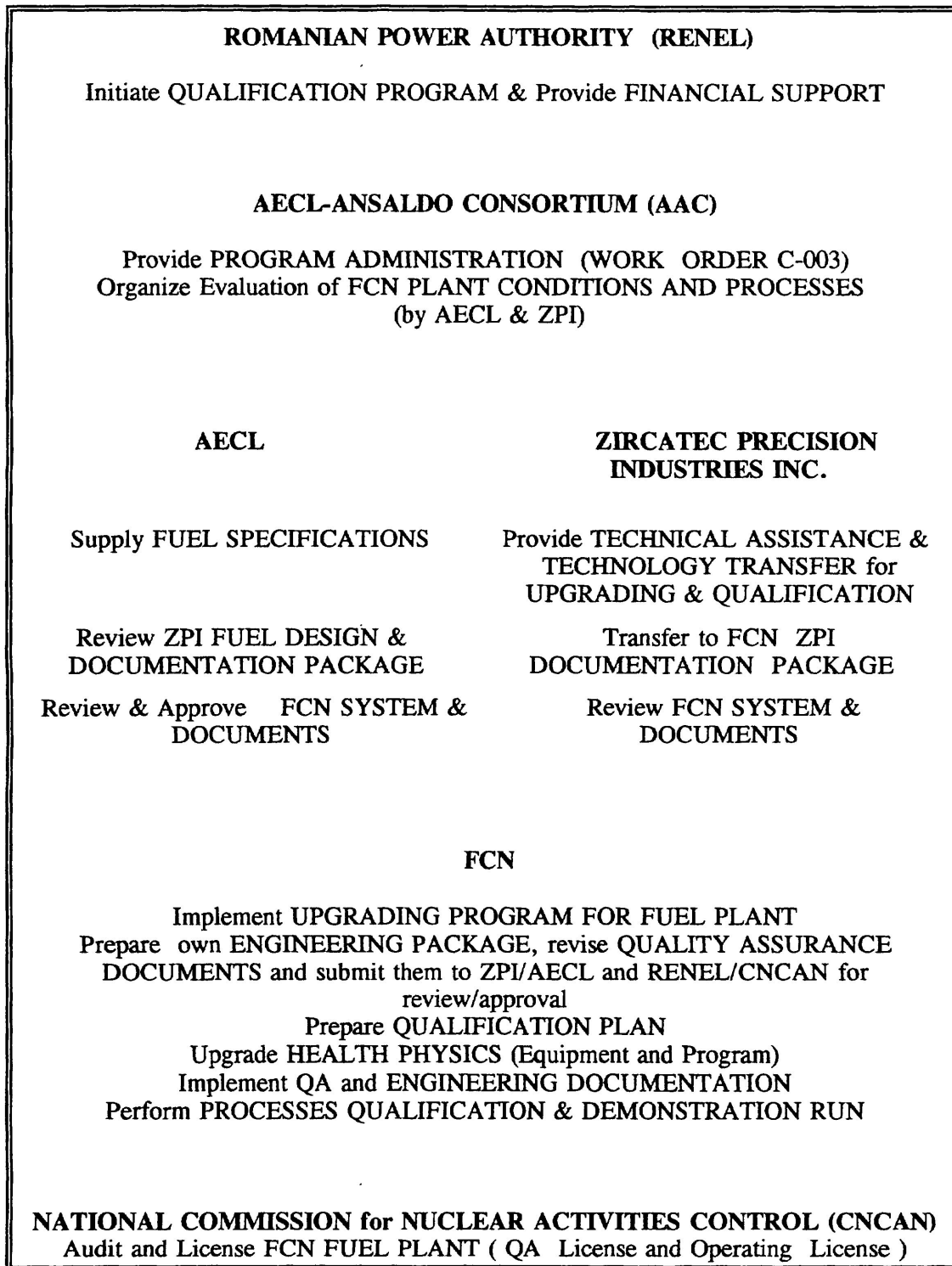


FIGURE 1 : Organizations and Authorities Involved in the Qualification Program of Pitesti Fuel Plant (FCN) as CANDU Fuel Supplier