



Indústrias Nucleares do Brasil

**Technological Developments
in the Fuel Nuclear Production
Area of INB Brazil**

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INTRODUCTION

- The Nuclear Fuel Production Directory at INB Brazil (DPN-INB) is responsible for the industrial activities of the nuclear fuel cycle from the UF_6 conversion to the final assembly of the Nuclear Fuel Element, excluding the uranium enrichment process.
- Development of the Fuel Assembly technology by development of fuel components, design engineering activities, materials development and new design of Fuel Elements.
- By means of strategic partnerships with domestic and foreign companies, and aiming the insertion in the international market, developments have been performed that.
- Achieving autonomy in the technologies related to the nuclear fuel production, even if the demand is still low in Brazil. For this, an extensive training and development program of its human resources is also being performed.

TECHNOLOGICAL DEVELOPMENTS

• Advanced Fuel Assembly

- Constitution of a JV with the companies: Westinghouse Electric Company (WEC) and Korea Nuclear Fuel (KNF) for the design, assembly and test of an advanced 16x16 Fuel Assembly for WEC 2-loop plants.
- A new design was built up, incorporating improvements in terms of components and materials, resulting in a Fuel Assembly with much higher features in terms of thermal margin and burnup limits.



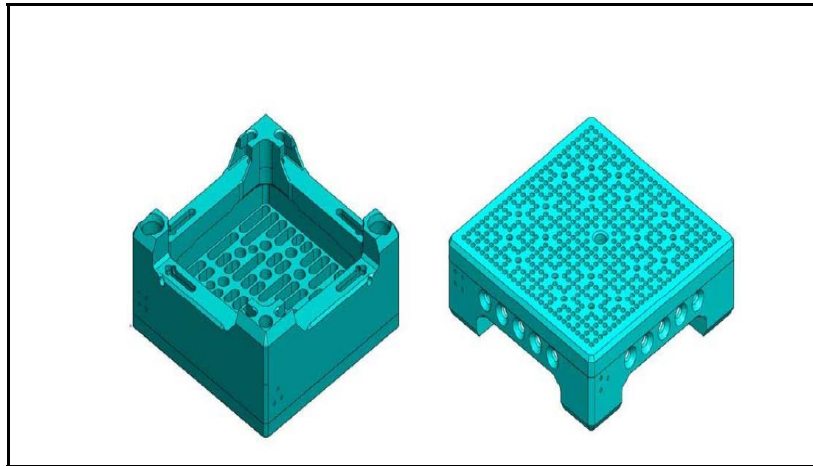
Advanced Fuel Assembly 16NGF

TECHNOLOGICAL DEVELOPMENTS

□ Fuel Assembly Components:

Cast steel nozzles

- Purpose of developing the cast steel process in order to nationalize the manufacturing of cast steel nozzles; for this, partnerships have been established with three different metallurgical plants to develop the CF3 stainless steel with low cobalt content by micro melting process and to nationalize the components manufacturing. This work is in progress.



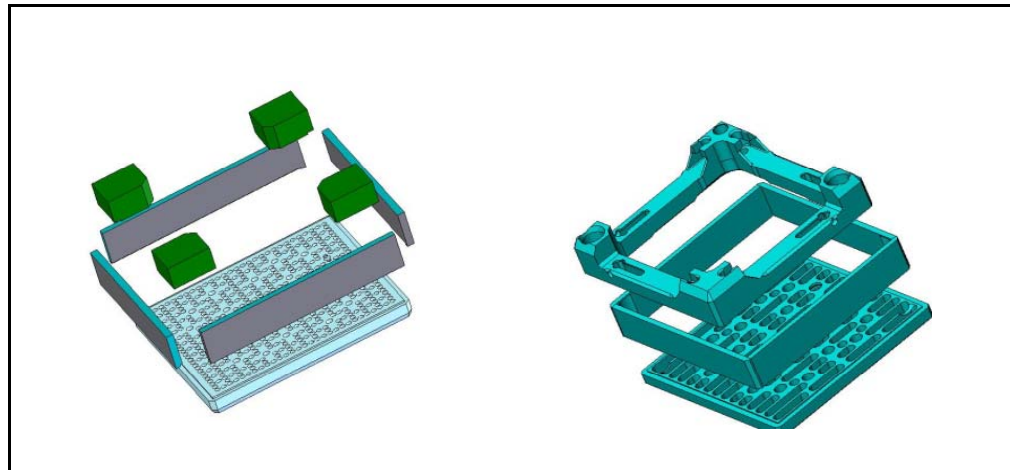
Cast Steel Nozzles

TECHNOLOGICAL DEVELOPMENTS

❑ Fuel Assembly Components:

Roller Plates steel nozzles

- Purpose of developing the manufacturing process of nozzles from roller plates steel in order to obtain a technological solution national optional to cast steel process. This work is already implemented.



Roller Plates steel Nozzles

TECHNOLOGICAL DEVELOPMENTS

□ Fuel Assembly Components:

Holddown Spring Device

- Process of manufacturing the leaf spring of the hold-down device is complex.
- Split in 25 sub-processes at the INB development plan.
- It involves acquisition of raw material (metal plates), laser cut, machining, bending, thermal treatment, shot peening and inspection. Some of these items have already been concluded in handmade way, other ones are still in development process. Next steps will be implementing an industrial process, requiring the purchase of some equipments.



Holddown Spring Device

TECHNOLOGICAL DEVELOPMENTS

□ Fuel Assembly Components:

Gadolinium oxide burnable absorber rods

- Purpose is to nationalize the manufacturing of U/Gd burnable absorber rods and to get technological autonomy in this product. For this, two fronts were opened: 1- manufacturing in industrial scale of U/Gd pellets; 2- Manufacturing line of U/Gd rods at INB Resende site.
- Set 1: a partnership was done with the Technological Center of the Navy (CTMSP), which developed first the U/Gd pellets in lab scale; this phase was concluded with the qualification of the pellets and now the process is evolving to the industrial scale.
- Set 2: INB plans to adapt an empty room and employ existing fuel rods filling and weld machines to assembly the U/Gd rods.

TECHNOLOGICAL DEVELOPMENTS

□ Conversion Project :

•INB is beginning the initial steps to build a Conversion plant at the INB site in Resende; this plant is foreseen to be commissioned in 2017 and is planned to produce 1500 ton/year of UF₆. The present status and challenges are:

- Defining the technological route to be used, for this purpose a Working Group was established at INB together with the Technological Center of the Navy (CTMSP). This institution is building a small conversion plant (40 ton/year) and its experience will be useful for INB to increase the build a 1500 ton/year plant.
- Beginning the process of preparing the licensing documentation in environment and nuclear areas.

TECHNOLOGICAL DEVELOPMENTS

□ Conversion Project :

- Establishing partnerships with companies mastering the conversion technology in order to train the INB team in UF_6 safety culture and to set up technological development of the conversion process.
- Summarizing, the strategy is to take advantage of the culture and experience of strategic partners to use it in the project implementation.



Demonstration Conversion plant USEXA/CTMSP

TECHNOLOGICAL DEVELOPMENTS

□ Development and Nationalization of Materials:

- Purpose is to develop and nationalize the manufacturing technology of nuclear materials, namely Zirconium alloys process production.

The steps to achieve these goals are in principle:

- To develop a Brazilian Zirconium alloy in lab scale using electrical furnace – together with the Federal University of Rio de Janeiro staff; this implies in a set of activities, including:
 - characterization of existing commercial alloys
 - development of experimental alloys with different compositions
 - prototype scale alloy melting
 - qualification of potential industrial suppliers of rolling equipment
 - characterization of metallographic structure of commercial alloys
 - melting of a prototype alloy for the manufacturing of parts.

TECHNOLOGICAL DEVELOPMENTS

□ Development and Nationalization of Materials:

- To develop the sponge-TREX production process, including :
 - the achievement and production of Zirconium oxide by chemical process
 - chlorination/reduction, pelletizing
 - production of sponge, production of Zirconium ingot, manufacturing of TREX
 - these activities are performed together with CDTN/Federal University of Minas Gerais staff



Zirconium sponge



Zirconium ingot

TECHNOLOGICAL DEVELOPMENTS

□ Technological Partnerships:

- To achieve technological development is important to build up a set of strategic partnerships with different institutions, of different natures and different nationalities, as:
 - Foreign technology suppliers in the nuclear fuel area as WESTINGHOUSE, AREVA, KNF, NECSA., by contracts and agreements that assure to INB technological transfer as well training of technical manpower.
 - National institutions as Universities, Technology Centers (Navy, Army) for the development of materials and processes.
 - National Industries as equipment and material suppliers (Stainless steel, zirconium oxide, welding machines).
 - Foreign industries as equipment, material and machine suppliers.
 - Funding institutions as FINEP.

TECHNOLOGICAL DEVELOPMENTS

□ Human Resources Training and Development:

- Ageing of its personal has pushed a renovation process at INB by hiring a relevant amount of new employees.
- To lift these people to the state-of-art in the nuclear technology, an extensive training program is being performed with foreign institutions (technology suppliers), academic institutions (Universities, Technological Centers), industries (equipment and machine suppliers), language courses, humanistic courses, leadership courses, among others.
- For 2011, around two hundred different trainings (one or more employees per training) are planned in the Nuclear Fuel Production Directory; around sixty employees of the mentioned Directory presently own MSc. or PhD. level, or are finishing these courses.

TECHNOLOGICAL DEVELOPMENTS

□ Human Resources Training and Development:

- INB has also an own Training Center, where internal trainings and seminars can be performed.



INB Training Center

CONCLUSIONS

- INB mission : *“To sustain the provision of nuclear fuel for the generation of electric power in Brazil, by means of technological and industrial autonomy in the nuclear fuel cycle activities”* and *“To participate in the World Market”*.
- To face the enormous challenges that this mission implies, INB is performing a technological development program that involves a set of steps and actions.
- These steps are distinguished by the development of advanced Fuel Assemblies, development and nationalization of fuel assembly components and materials, development and implementation of new processes in the nuclear fuel cycle and, above all, an extensive training and qualification program of its human resources.
- The establishment of strategic partnerships and agreements with qualified institutions and companies is an important way for INB to achieve its purposes. It should be emphasized that the short-term goal of INB is not to produce these items in an industrial scale, but to master the technological aspects involved in these processes.

Questions?

GRACIAS!
(THANK YOU)

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