enusa nuclear fuel

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Nº 10 - 2017

ENUSA signs contracts for the supply of Nuclear Fuel Doel 3 and Tihange 2 NPPs

ENUSA has been awarded contracts for the supply of nuclear fuel and associated services for Doel 3 and Tihange 2 Nuclear Power Plants in Belgium for the period 2018-2020, covering the delivery of 3 lots of nuclear fuel for Doel 3 and 2 lots for Tihange 2 and two optional lots for each unit. The contract signature took place in October 2016 and was the result of a tender process initiated back in April 2013 followed by the submittal of the ENUSA offer in July 2013 and which, after several months of interaction with Engie-Electrabel and Tractebel Engineering have successfully concluded with the final award. The volume of nuclear fuel to be provided to both units will be equivalent to 124 tons of Uranium.

These new contracts will be executed by ENUSA in the framework of the EFG (European Fuel Group), joint venture of ENUSA with Westinghouse, created in 1991 for the cooperation in the marketing, design, engineering, sales and servicing of PWR fuel in the European market.

ENUSA will supply 17x17 RFA-2 Opt fuel design which includes Intermediate Flow Mixing Grids (IFM) fabricated from ZIRLO®(*) alloy, Optimized ZIRLO™ (*) cladding material and the zirconium dioxide protective coating on fuel rods.

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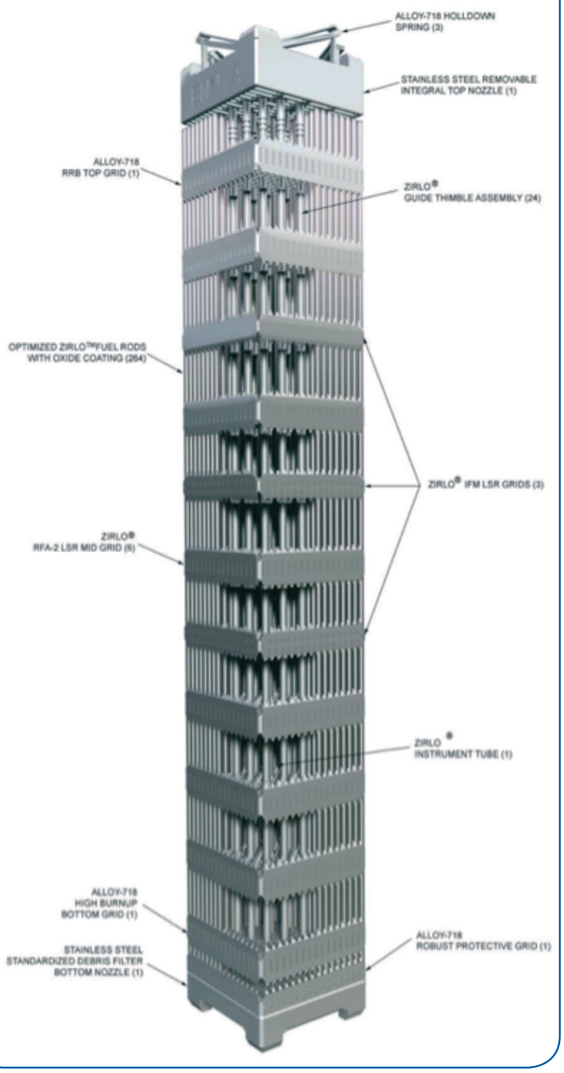
IFM enhances the heat transfer from the fuel rod to the coolant and promote a substantial benefit in departure from nucleate boiling (DNB) performance. They also contribute to minimize rod bow and assembly bow and to improve fretting wear performance.

Eight fuel assemblies with Optimized ZIRLO fuel rods have successfully operated in Tihange 3 NPP during three cycles and the characterization of the corrosion behavior has allowed to confirm the significant improvement in resistance of the Optimized ZIRLOTM cladding as compared to the Standard ZIRLO®.

RFA-2 OPT FUEL ASSEMBLY SKETCH



The oxide coating on the lower part of the fuel rod provides an additional protection against debris and grid-to-rod fretting by the increase of the surface hardness, and thus the wear resistance, of the ZrO2 layer.

The RFA-2 Opt fuel design is based upon the evolutionary development of earlier successful designs (RFA/RFA-2). The RFA-2 and its precursor, RFA, have extensive operating experience in European and USA reactors that have similar characteristics to those of Doel 3.

Westinghouse introduced the 17x17 Robust Fuel Assembly (RFA) fuel design in 1997. To further improve performance of the RFA fuel assembly, a slightly modified grid design called RFA-2 was introduced in 2002. Reload regions of RFA and RFA-2 fuel have operated in plants worldwide and burnup experience data is provided for 27 plants representing 15,446 assemblies.

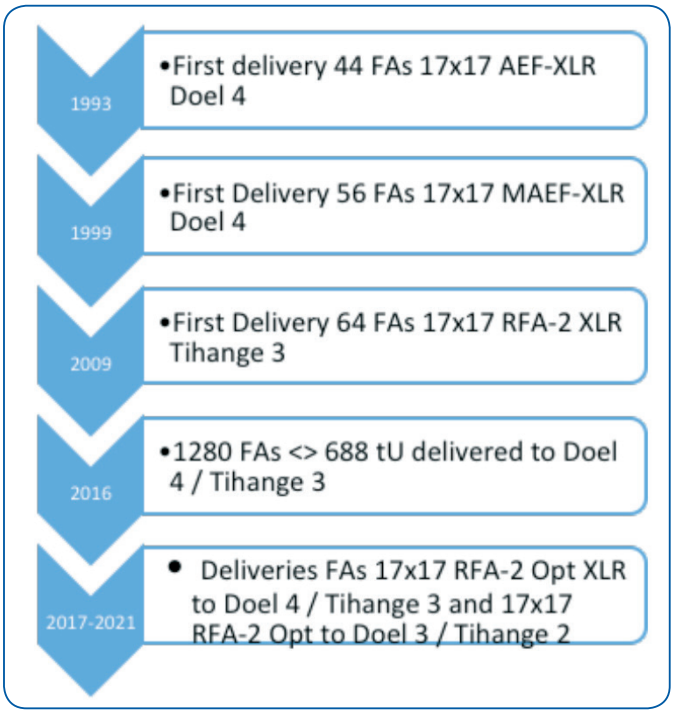
Optimized ZIRLOTM cladding is rapidly gaining burnup experience since the introduction of the first Optimized ZIRLO cladding Lead Test Assembly (LTA) in 2002. As of December 31, 2014 thirty six plants worldwide contain Optimized ZIRLO fuel rods. There are currently 3,700 assemblies representing over 893,000 rods currently in operation or discharged. The irradiation experience involves discharge fuel rod burnups beyond 72,000 MWd/tU.

This award is the proof of confidence that Engie-Electrabel and Tractebel Engineering have put on ENUSA/EFG again.

The relationship among these companies started back in 1993 with the signature of the first contract for the fuel supply to Doel 4 for the lots 12D4-14D4. Later on, in 1996, ENUSA signed with Electrabel/Tractebel the second contract for the supply of the lots 15D4-20D4. In 1998, under this new contract, ENUSA reached the first 100 tons of Uranium delivered to this unit. Subsequent extensions allowed ENUSA additional supplies of the lots 20D4-25D4.

In 2007 and following a similar tender process as the one already described, ENUSA was awarded contracts for fuel supply of the lots 26D4-30D4 as well as, for the first time, lots 21T3-25T3 of Tihange 3. In July 2014 ENUSA was awarded contracts for the supply of nuclear fuel and associated services for Doel 4 and Tihange 3 for the period 2016-2021. The first reloads under this contracts have recently been supplied in 2016.

During this prolonged time frame, a total of 1280 fuel assemblies have been supplied to both units, equivalent to 688 tons of Uranium.



For the new contracts awarded, Doel 3 and Tihange 2 units, ENUSA will produce the nuclear fuel in its manufacturing facility in Juzbado (Salamanca), with fuel assembly components and conversion services provided by Westinghouse in the US and Springfields Fuels Ltd. in UK respectively.

A significant scope of engineering related activities are also envisioned for the time frame of the new contracts to support the first introduction of RFA-2 Opt design in Doel 3 and Tihange 2 units, among others, reload safety evaluations and support the introduction of the new regulatory rules for LOCA.

In the on-site services area ENUSA, in collaboration with its partner Westinghouse, will continue to support Electrabel and Tractebel in the close follow up of the fuel behavior in order to ensure a reliable operation.

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Methodology for the assessment of Dry Cask Storage and transportation of Spalled Spent Fuel

Introduction

The classification of the spent fuel for dry cask storage and transportation requires demonstrating compliance with a number of safety conditions by the fuel-cask system: subcriticality, heat removal, shielding, confinement and retrievability. Therefore, an assessment of the fuel assembly containing defects should be conducted in order to determine the conditions for its dry storage and transportation.

One of the mechanisms that could prevent the fuel rod from performing these safety functions is the local embrittlement of the cladding due to a hydride blister that may be formed under a waterside oxide spalling. Indeed, above a certain oxide layer thickness, this layer may start to spall during in-reactor operation and cold spots could appear underneath the spalled area. Under certain irradiation conditions, these cold spots may attract hydrogen picked-up from the cladding corrosion, which is dissolved in the fuel rod cladding, and could precipitate in these cold spots as hydride lenses. Both the reduction of the Zirconium base material and the local embrittlement may degrade the cladding ability to maintain its integrity, under the mechanical and thermal loading expected during storage and transportation.

Background

Although the impact of a hydride blister on fuel performance has been studied under normal and accident in-reactor conditions, the analysis to support the cladding integrity of spalled PWR fuel under the dry cask storage and transportation loads, has not ever been reported. Zircaloy-4 clad fuel with spalled oxide layer has been only assessed under dry storage scenario involving mainly creep mechanism. The evaluation of the mechanical integrity of fuel rods showing spalling under transportation scenarios has never been addressed.

Methodology of assessment

Under the frame of a Joint Development Program signed in 2013, ENUSA and Westinghouse have developed a methodology to assess the mechanical integrity of PWR fuel rods with spalled waterside oxide layer under dry storage and transportation scenarios. The purpose of this joint project is to generate a methodology to determine the conditions that should be met by the fuel rods with spalled oxide to be classified as non-damaged.

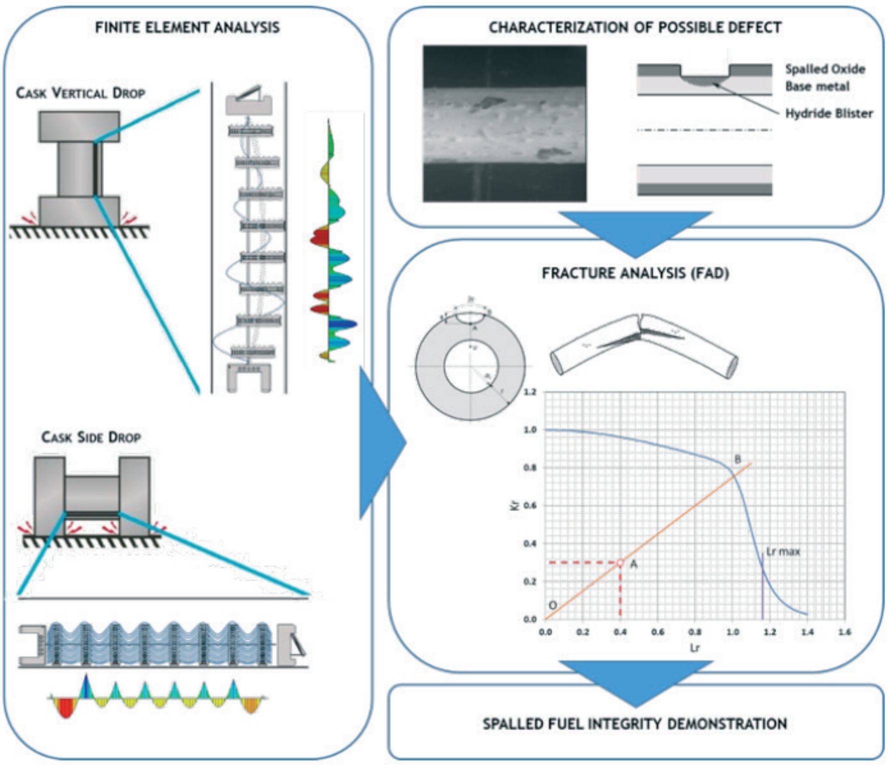
The evaluation is based on assuring the cladding integrity, in order to ensure the safety requirements, in particular, the need of fuel assembly retrievability after transportation to the Centralised Interim Storage Facility (ATC).

In the proposed methodology, hydride blisters that may appear underneath spalled areas are conservatively considered as cracks instead of notches. Regarding elastic-plastic materials properties and the fracture toughness, the used values take into account the temperature range from drying to long-term storage and the influence of a high-level of hydrogen surrounding the hypothetical hydride blister. International experts (ANT-International) have independently supported some of the assumptions considered in the methodology.

Static and dynamic Finite Element Analyses (FEA) of the fuel rod and assembly have been performed using ANSYS models in order to determine the loading conditions of the concerned fuel rod cladding section during the hypothesized transportation accidents in the regulation. Both horizontal and vertical drops of the cask system have been evaluated.

Once the loading conditions are calculated, the integrity is assessed by using advanced elastic-plastic fracture mechanics: the Failure Assessment Diagram (FAD). The FAD approach correlates brittle fracture and plastic collapse to evaluate failures in mechanical structures, under different loading conditions and for a certain defect size. As a result, FAD determines if a certain blister, considered as a crack, is acceptable or not under the defined loading conditions.

The comparison of the results of the application of the methodology to the experimental results from hot cell tests in Studsvik on a 17x17 PWR rod has shown the conservatism of the developed method.



Future work

Further efforts in the field of structural and hydride blister modelling, among others, are under way to further refine the methodology. Besides, an experimental research project on unirradiated material is providing deeper insights into the performance of the hydride blisters as cladding defects.

In this way, the developed methodology can be applied to demonstrate the spalled fuel integrity under dry cask storage and transportation.

For further information, please contact jmu@enusa.es

Spanish Nuclear Group for Cooperation sponsors the International Youth Nuclear Congress in Hangzhou, China

The Spanish Nuclear Group for Cooperation, SNGC, a consortium formed by ENSA, ENUSA, Ringo Valves and Tecnatom has sponsored the International Youth Nuclear Congress (IYNC) held in Hangzhou (China) from July 24th to 30th 2016. SNGC has been represented by four young professionals, Liu Tom (Tecnatom), Alejandro Palacio and Alberto González (ENSA) and José García Laruelo (ENUSA).

IYNC stands for "International Youth Nuclear Congress" which is a bi-annual congress on the nuclear energy field, which is dedicated to young but also senior nuclear professionals, with the purpose of sharing knowledge and experience in a culturally diverse audience representing all six continents. This congress has a strong technical content related to: Plant Operation and Maintenance; Advanced Reactors Design; Reactor Physics and neutronics; Thermal Hydraulics; Nuclear Fuel and Materials; Nuclear Safety, Security, Safeguards (including non-proliferation) and Radiation Protection; Nuclear Fuel Cycle, Waste Management and Decommissioning; Fusion; Education, Human Resources Development and Knowledge Management; Politics, Economics, and Societal issues, together with interactive workshops.

Opening Session moment with SNGC's representative

SNGC's representative, José García Laruelo, presenting the company during the exhibition opening.

IYNC has gathered more than 400 young professionals and students from 30 different countries, as well as several major companies in the nuclear sector in China.

The congress activities officially started on Sunday 25, with the IYNC games (a walk around the West Lake) and a welcome reception. The second day, the opening Session and keynotes Sessions took place. The President of State Nuclear Power Technology Corporation (SNPTC), the vice-presidents of China Nuclear Engineering & Construction Group (CNEC), CGN Power Company, Shanghai Electric Group and Dongfang Electric as well as the Chief Engineer of China National Nuclear Corporation (CNNC) attended to the opening session, among others.

China Atomic Energy Authority (CAEA), the government of Zhejiang Province, National Energy Administration and State Nuclear Safety Agency, also attended it.

During Keynotes Sessions, leadership speakers from well-known companies (Westinghouse, General Electric, CNNC, CGN or SNPTC), and National and International Institutions (IAEA and CAEA) appear on stage.

The congress, along four days hosted 12 technical tracks, 15 workshops, 3 plenary sessions, 7 panel sessions and countless opportunities to network, more than enough to learn the latest news and works on any topic.

SNGC, as a sponsor of IYNC, has had the opportunity to present the skills, services and products of its member companies to various representatives and authorities as well as to provide information to 400 international participants to the event.

Finally, on the last day of the conference, the announcements for the next IYNC were made. SNGC congratulate to Argentina as the next host (IYNC2018) and Denis Janis as new IYNC President.

For further information, please contact jgl@enusa.es

ENUSA's Commitment to Excellence: World Nuclear University Summer Institute

"Excellence is an art won by training and habituation. We do not act rightly because we have virtue or excellence, but we rather have those because we have acted rightly. We are what we repeatedly do. Excellence, then, is not an act but a habit", Aristotle.

ENUSA's commitment to excellence needs of a strong investment in the best training for their professionals. In this regards, every year since 2006, one ENUSA young professional has the chance, to join to the World Nuclear University Summer Institute Program.

The World Nuclear University (WNU) is a worldwide network of educational and research institutions engaged in peaceful uses of nuclear energy. It was inaugurated in 2003 under a Declaration of commitment by 32 initial participants and 4 founding supporters: the World Nuclear Association (WNA), the World Association of Nuclear Operators (WANO), the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA). Since its inception, the WNU network has expanded to include more than 40 intergovernmental, academic and industry institutions in some 30 countries. WNU offers a range of unique nuclear educational and training programs around the world. By drawing on the support of industry, governments and academia, these programs are designed to meet the training requirements of international nuclear professionals, particularly in the area nuclear leadership.

World Nuclear University Summer Institute. Fellows 2016

Specifically, the WNU Summer Institute (WNUSI) is an intensive six-week program designed for future nuclear leaders held annually in different locations. The WNUSI offers a comprehensive program of lectures, tutorials, field trips to nuclear and industrial facilities, and team projects led by some of the world's foremost authorities in the nuclear field. These cover the global environment and sustainable development, nuclear-related technology innovation, nuclear diplomacy and nuclear operations, among others.

I was selected by ENUSA to attend the 2016 WNUSI edition, held in Ottawa, Canada, from June 28th to August 5th. Seventy-one participants from 31 countries had the opportunity to meet each other and lecturers from 16 countries. A total effective time of 270 hours were structured as follows:

- One third of the time, the fellows attended oral presentations with technical content about the nuclear industry: nuclear fuel cycle, economics, law, safety-security-safeguards, communication, human factors, leadership, teamwork, etc. Part of the lecturers were leaders in their organizations as, for instance, IAEA Directors, Fukushima Daiichi Chief Decommissioning Officer, WANO Chief Executive Officer, NEI Sr. Vice-President for Communications and Public Affairs, Canadian Nuclear Laboratories Chief Executive Officer or Canadian Nuclear Safety Commission President. All fellows realized from the very first day that we would learn from the best professionals of the nuclear industry.
- For one whole week, 15% of the program, we traveled across Canada visiting key nuclear facilities which are the base of the Canadian nuclear fuel cycle and which make Canada a leading country in nuclear power generation. Cameco uranium mines and mill in North Saskatchewan (McArthur River, Key Lake and Cigar Lake) are the most productive mines in the world. We visited Cameco conversion facility in Port Hope, the producers of the natural uranium used in CANDU reactors. Darlington nuclear power plant owned by Ontario Power Generation (OPG) is one of the CANDU plants that will be completely refurbished during the next 10 years, assuring clean and sustainable energy for the Ontario citizens until 2065. Canadian Nuclear Laboratories (CNL) installations in Chalk River, pioneers in the nuclear research and developers of CANDU technology. During the technical visits week we had the privilege of knowing firsthand the main steps of the nuclear fuel cycle in world-class facilities.
- The remaining 55% of the time, the development of leadership and teamwork capabilities were enhanced. From the start, we organized in working groups. Each member of the team came from a different country, culture and professional career, with the mentoring of a highly skilled and experienced professional from the nuclear industry. The main goal of the working groups was to practice concepts described during the oral presentations: leadership, decision making in risky environments, team-working, effective communications and human performance through different exercises that challenged the team members moving us every time out of our comfort zones. And here is where the magic happens, all the WNUSI fellows squeezed the maximum of ourselves, feeling selected to take the most from this one of a kind opportunity.

In summary, I have had the opportunity to learn in an international framework, exchanging knowledge and experience with the best professionals in the nuclear industry. During the WNUSI 6 weeks, I understood the importance of the leaders within an organization and how a good leader can make the difference facing any challenge. This experience has been a turning point in my career and I strongly believe that ENUSA will be closer to excellence while training young professionals as WNU fellows.

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ESPIGA - Functional Tests and Design Review

ENUSA provided the description of ESPIGA device, as well as the process and tools to carry out its installation into the fuel assembly in Newsletter 8. In summary, the ESPIGA device is a structural component designed to carry the weight of the fuel assembly complying with the design criteria for 17x17 12-ft assemblies. The device consists of two rods (inner rod and outer one) and two nuts (see figure for a short prototype). The rods are introduced through the instrumentation tube, and fixed to the top and the bottom nozzles. ENUSA designed and manufactured an electro discharge machining (EDM) equipment and several tools for the installation of ESPIGA device. Tests had been performed at ENUSA fuel manufacturing facility in Juzbado (Salamanca) with shorter length tools on real skeleton simulating the installation and uninstallation processes.

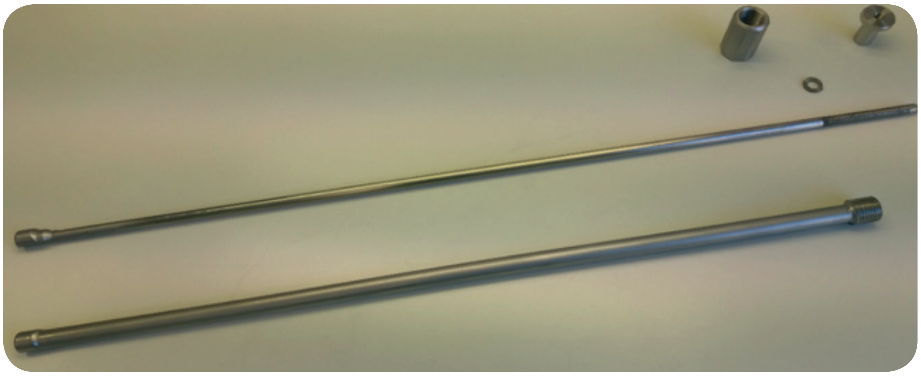
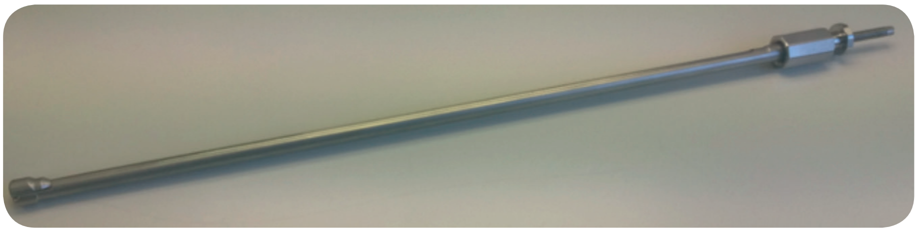


Figure 1. Parts of ESPIGA device, ESPIGA device assembly.



During the last month, ENUSA carried out the development and manufacturing of the real tooling at the proper length (10 metres long) and some of the final functional tests.

The first test was devoted to verify the installation process of ESPIGA device into the fuel assembly with the real tools were performed in air, testing on skeleton and ESPIGA dummies with several lengths.

The development team considered the results from these tests adequated and defined a consistent procedure. The final step was to perform a test under water. The test considered all the steps of the installation process, including the EDM process to perform the hole in the top nozzle on the instrument tube location, needed to introduce ESPIGA through the instrument tube.

This test was performed at the ENSA facilities in Maliaño, Santander. ENUSA required the exact simulation of the spent fuel pool conditions:

- The water condition was simulated using a pool of 6,5 metres depth.
- The installation process was performed from a scaffold located at 13 metres from the pool ground. In this way, we could simulate the distance between the platform where the operator is and the upper part of the spent fuel assemblies, equivalent to the real process in the Nuclear Power Plant spent fuel pool.
- Since the fuel assemblies, where the ESPIGA devices will be installed, are located into the racks of the spent fuel pool, a rack simulator was used to simulate this condition.
- Similar audio-video system than that to be used in the spent fuel pool.

In figure 2 picture taken during the installation/uninstallation process are given. The first one shows the rack simulator and two skeleton dummies in the rack cells. The second picture shows the ESPIGA device installation with the corresponding tools.

The tests were performed in the last week of September with satisfactory results. ESPIGA device was installed and uninstalled several times in a skeleton in similar conditions than in the nuclear power plant spent fuel. Some small improvements to the process and tools were identified which are being implemented.

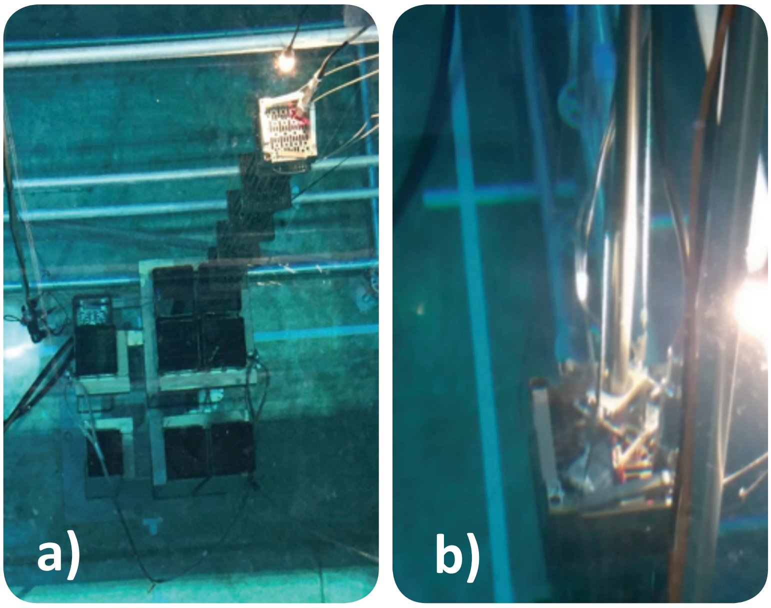


Figure 2. a) test set up, b) installation of ESPIGA device.

Additionally, other activities such as qualification of manufacturing process of ESPIGA device are going on. When all these actions were finished, a Final Design Review will be concluded. This Design Review will take into account functional requirements, design criteria and their verification, manufacturing, installation/uninstallation tools and process, verification tests, etc.

In summary, ENUSA has been able to demonstrate, with the functional test of the installation/ uninstallation of the ESPIGA under water and at similar conditions than in the Nuclear Power Plant spent fuel pool, that the ESPIGA device and the installation process is going to work under the real condition at the NPP. A real ESPIGA device, a real fuel skeleton, the special tools manufactured for this installation process and the EDM machine have been used. Therefore, ENUSA is very satisfied with this final test since the whole process worked perfectly with excellent results.

The final step, before the real installation in affected fuel assemblies, will be the Blanck Test that ENUSA has agreed to perform in two NPP in Spain in the coming weeks.

For further information, please contact rch@enusa.es and mll@enusa.es

New Automatic Visual Pellet Inspection Development

Fuel pellets must be 100% visually inspected for surface integrity to fulfill very tight requirements such as cracks, grinding marks, inclusions, chips, etc. in lateral surface (Fig. 1). Even though the end pellet surfaces are not inspected, according to ENUSA experience, if those type of defects are in the base surfaces, they usually manifest on the lateral face as well, therefore they can be detected by vision system too. The inspection is performed after the final grinding operation at the production line with an inspection rate of 200 pellets per minute approximately.

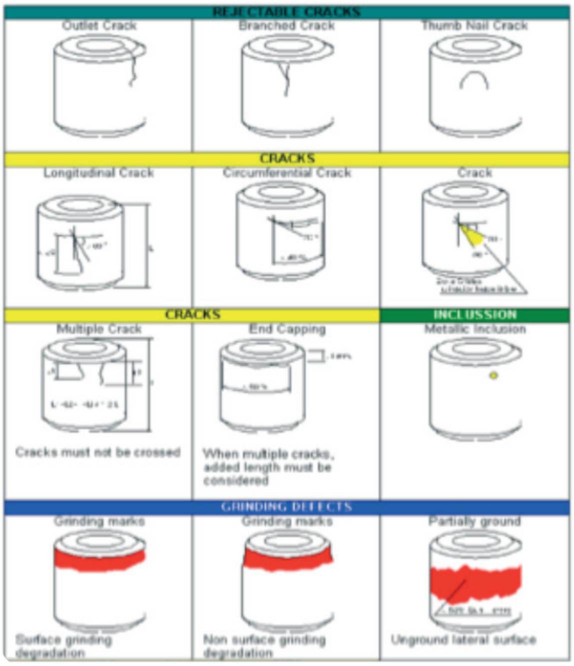


Figure 1.

In 2002 ENUSA developed the first Automatic Visual Pellet Inspection System (Fig. 2) in Juzbado plant for avoiding tiredness problems in manual visual inspection, reducing radiological exposure on the inspectors and reducing subjectivity in the inspection. This system was based in a table with two arms Cartesian robot. One of the arms has an optical set (camera and lighting) of vision to inspect the pellet surface and the other has a grip to remove the suspicious or rejected pellets. There is a loading area at the beginning of the table, and other uploading area at the end. The pellets are loaded in trays containing around 1400 pellets and they are pushed into the inspection area where fuel pellets are turned on rollers for the whole surface to be scanned. A digital linear CCD camera placed over one of the arms scans each pellet surface, and the computer with the analysis software processes the image to find defaults on the pellets in real time. Then, a grip laid on the other arm, removes rejected or suspicious inspected pellets from the reception area. Finally, pellets are placed again on another tray and become ready to continue the process. The vision system is controlled by a PC, and the whole system by a robot and a PLC integration.

In 2007 ENUSA developed the second generation of the Automatic Visual Pellet Inspection integrated with the grinder and laser diameter inspection (Fig. 3). In this system, the pellets are inspected in two parallel lines directly connected to the grinder and laser inspection. The vision system inspects 20 pellets at the same time with the same production rate of 200 pellets per minute, and the rejected or suspicious pellets are scraped by a pusher installed after the vision system. The vision system and software are identical for both generation systems.

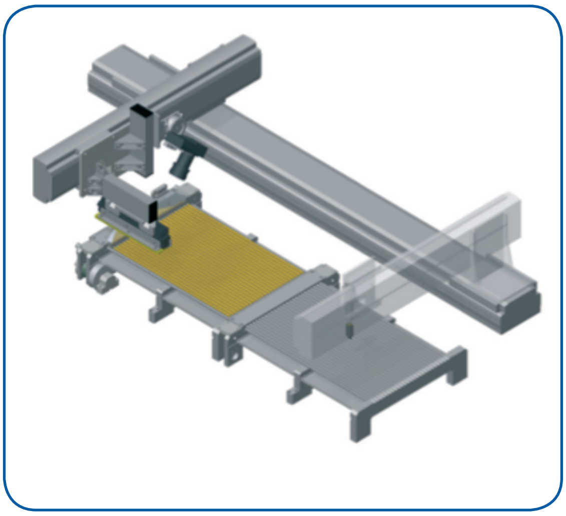


Figure 2.

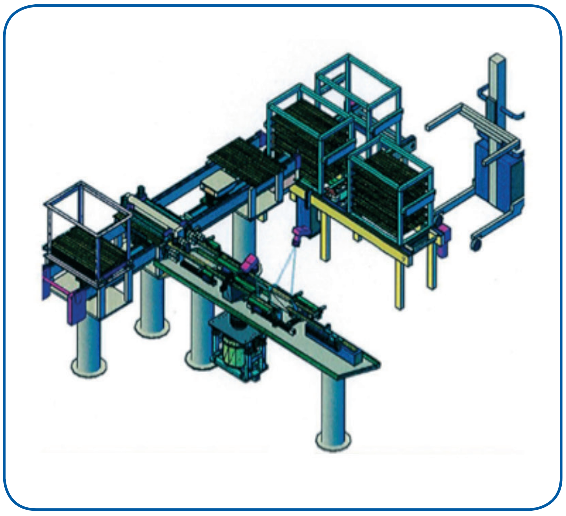


Figure 3.

New features and improvements in the IAP-16 system

In 2016 ENUSA has taken steps towards future commercialization of the Automatic Visual Pellet Inspection System (IAP-16).

In order to facilitate the system integration in the customer facilities, the system to be commercialized is based on the first equipment generation, inspection by trays. The new system has been improved in both, visual system and software application.

The improvements in the vision system regarding the previous system are:

- Top of the range camera with higher resolution (16 vs. 12 kPixel).
- New framegraber card for the camera-PC and from the same brand than the camera to ensure continuity and compatibility.
- LED lighting with low-energy, less lightingvariability and higher durability.
- Industrial type ethernet communication (Modbus TCP/IP).
- Last version of the image analysis tool, HALCON.

The improvements in the software application are:

- The analysis software is an integral part of the automatic pellet visual inspection equipment, delivering both full-system integration and a single point of control for all the equipment. The last version software has been upgraded to work with most modern vision components, drivers and frameworks, running on Windows 8 OS.
- The interface has been reprogrammed but preserving the inspection algorithms and solving inconsistencies in the current program.

• Completely upgraded interface, user friendly, and developed under the operative experience of ENUSA.

• Automatic report generation with multiple result information (by pellets, trays, batch, defects, statistics…).

• Parameters management in the software application instead by text file.

• New calibration tools integrated in the software: visual and lighting calibration interactive guided process, step by step. This feature improves result accuracy and minimize errors due to operator intervention.

• Two types of inspection: normal and quick. Normal inspection analyses all the defects in each pellet. Quick inspection just rejects the pellets starting with the most visible detected defect.

• Initial Self-Checking function: allows the software check if every part of the equipment, communications and application architecture is ready to use.

• Activity and Event log Monitoring: keeps track of different operation events, system status, errors… saving it in daily log files.

• Automatic scheduled backup of configuration, logs and reports files. Manuals backups can be also done by the operator.

Portable prototype system

In order to customize the system inspection for each customer, a vision prototype has been developed and manufactured (Fig. 4).

The purpose of the prototype is to test pellets with different characteristics in the customer facilities in order to develop new features for detection algorithm according to each customer requirements.

The prototype includes the same components than the visual part of the complete equipment (camera, frame grabber, led-lighting). The mechanical system includes an arm with the LED light, a support frame to fix the camera, and two independent rollers to allow turn on the pellets and to scan the whole surface of the pellets in the same way than the final equipment. In addition, the computer with the inspection software is connected to the system.

The prototype with the upgraded visual application has been validated in ENUSA plant with real product.

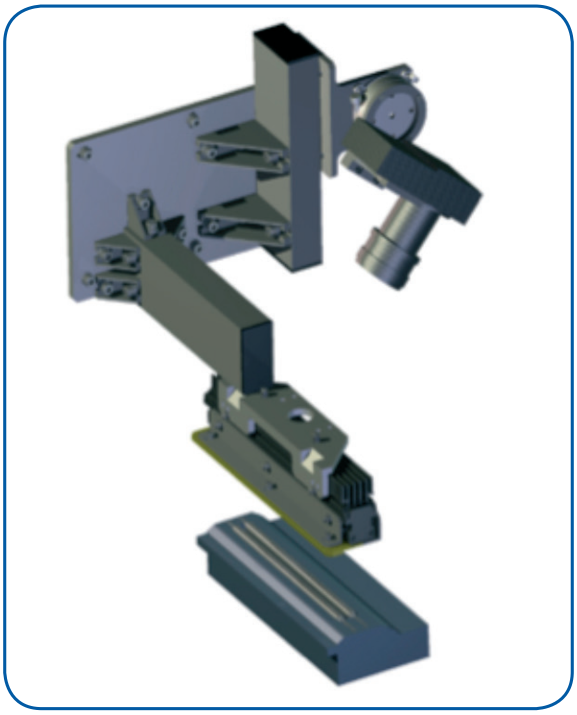


Figure 4.

Currently the prototype is ready to perform the acquisitions at the customer facilities.

Conclusions

The nuclear industry has been struggling in the last years for having a competitive and reliable automatic inspection for fuel pellets. Different systems have been proposed and some of them have been installed at fuel facilities in different countries. However, much of the pellets inspection processes worldwide are still being performed by human inspectors. ENUSA brings to the market a proven and reliable system with more than 20 years accumulated experience at Juzbado fuel plant. The system is accredited by the qualifications performed in Juzbado, which have been approved by ENUSA high demanding customers. The design of the IAP-16 also allows for an easy integration with virtually any fuel plant layout. With this new equipment ENUSA expands its portfolio of specialized inspection systems for the nuclear fuel industry.

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28th ENUSA Annual Customers Meeting

The 28th ENUSA Annual Customers Meeting took place on January 25th, 26th and 27th, 2017, in the city of Toledo, Spain. The goal of this meeting is to gather together the Spanish nuclear fuel industry stakeholders. Attendees included representatives from utilities ENDESA, IBERDROLA and GAS NATURAL FENOSA, from nuclear plants operators ANAV, CNAT and NUCLENOR, and from the Association of Spanish Utilities UNESA. In this edition ENUSA partners ENRESA, ENSA and TECNATOM also shared their views and experiences.

The meeting started with a speech by ENUSA's Business Development & Technology Director, Roberto González, who reviewed ENUSA's nuclear fuel business status, the nuclear fuel market and the main challenges in the short and medium terms.

The meeting had several technical sessions, in which ENUSA reported on various current topics, including the Evaluation of Safety Analysis margins for the Spanish PWRs in view of the expected RIA and LOCA future regulation, Security and Safety in Irradiated Fuel Transport, and Irradiated Fuel Mechanical Integrity during Storage, Transport and final Disposal.

Javier Montes, ENUSA's Operations Director, informed about the recent License Renewal Process for Manufacturing and Operations of the Juzbado factory.

ENUSA also presented the current situation of the uranium market, from the points of view of uranium oxide concentrates procurement, and enrichment procurement.

Plenary sessions were devoted to the challenges and needs of nuclear plants operation, and to the spent fuel management. In both sessions, the plant operators ANAV, CNAT and Nuclenor, provided an overview of their current activities and requirements for BWR and PWR Spanish reactors. Jordi

Estrampes, Ascó Reactor Engineering responsible, highlighted the limitations derived from the spent fuel pools situation, and how the management of the spent fuel in both units has become a critical aspect for the planning of the plant activities. Marta Boada, CNAT Fuel Engineer, described the status of Trillo interim storage facility (ATI), and the activities for licensing and construction of Almaraz ATI. Celia González (Nuclenor) and Luis López (Cofrentes) completed the overview for the BWR reactors. Regarding plant operations, the focus was placed on Safety, post-Fukushima improvements and life extension by Jordi Sabartes (Ascó), operations cost reduction and fuel cycle optimization by Julia Gómez (Almaraz), and fuel reliability and core design flexibility by José Pedro Feijoo (Cofrentes).

In this annual meeting, a special session was held with ENSA President Eduardo González Mesones and ENRESA President Juan Jose Zaballa. They shared information about the design activities for spent fuel transport and storage casks and canisters, and about the legal status and future perspectives of the ATC (Spain's centralized interim spent fuel disposal facility), respectively.

The closing act of the 28th Annual Customers Meeting was a round table discussion among Juan María Moreno, ENDESA Nuclear General Director for Iberia, Jose María Nubla, Gas Natural Generación Director of Nuclear Generation and Pedro Mata, Iberdrola Technical Services Director, moderated by ENUSA President, José Luis González. José Luis González pointed out the current industry challenges: plant operation beyond 40 years, personnel renewal and know-how transmission, spent fuel management and ATC, and nuclear generation public perception. Juan María Moreno added that nuclear industry will have to cope with economic challenges, including the taxes affecting nuclear assets, in a framework of electrification and decarbonisation of the economy. Pedro Mata focused on costs reduction and long term planning subject to the stability of the legal and regulatory frame. Jose María Nubla spoke about the need for economic and technological soundness of nuclear generation as an input to a political debate about the future electricity generation mix. The dialogue raised an interesting debate with the public attending the round table.

Along the three days, the participants highlighted the significance of this convention as a meeting point for the different nuclear fuel stakeholders.

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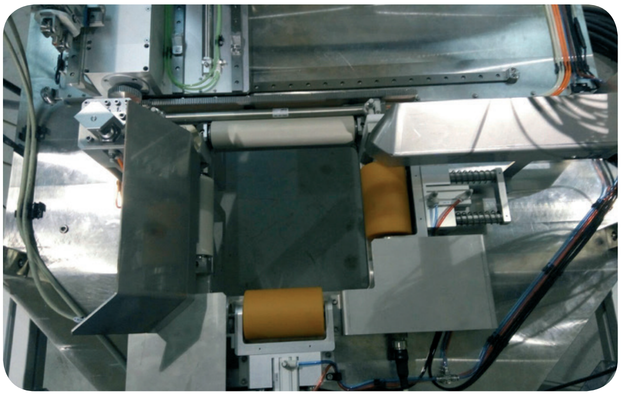
New contract in China for the supply of a SICOM-COR Inspection Equipment

Last October 27 saw the signature of a SICOM-COR equipment supply contract between ENUSA and the Suzhou Nuclear Power Research Institute (SNPI), a Chinese corporation belonging to the China General Nuclear Group (CGN.) This is the second supply contract between ENUSA and SNPI, after the SICOM-UT supply agreement signed in 2015.



SICOM-COR equipment delivered to SNPI

The new contract includes the supply of an advanced version of the SICOM-COR equipment which was jointly developed by ENUSA and TECNATOM. The main features of the system include the measurement of the fuel rods corrosion layer by eddy current as well as the measurement of fuel rods profilometry by visual techniques on the peripheral fuel rods. The equipment has been recently delivered to SNPI and finally accepted after the successful Site Acceptance Test (SAT) conducted at CGN facilities at Daya Bay site.

Last January SNPI and ENUSA-TECNATOM entered into a framework agreement in the field of nuclear fuel inspection. The new contract strengthens and consolidates this relationship, making ENUSA and TECNATOM two relevant partners of the CGN group in fuel assembly service inspection.

ENUSA-TECNATOM SAT crew with SNPI representatives at CGN Daya Bay facilities

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ENUSA belongs to Grupo SEPI, a corporate holding which includes a total of 16 state-owned companies in which it has direct, majority shareholding participations, with a workforce of more than 75,000 professionals; it also includes the Spanish state-owned television and radio corporation, Corporación Radiotelevisión Española, which is attached to SEPI, and one public foundation. Equally, SEPI has direct minority shareholdings in a further nine companies, and indirect shareholdings in more than one hundred companies.