

COMMUNICATION
INNOVATION
& ONE VOICE

 WE ARE
GLOBAL KNF

*KNF creates a clean and economic seed that grows into happiness,
and opens the doorway to an affluent society where human and nature live together.*



We are contributing

to a clean and economically viable

source of energy

We Make
the Great!

that is helping man and nature coexist

in harmony and affluence.

Beneficial
Economical
Sustainable
Technology



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KNF's VISION

Brief History

KNF [KEPCO Nuclear Fuel] is a group company of KEPCO [Korea Electric Power Corporation] founded in 1982. As a representative public atomic energy company, KNF provides nuclear fuel, equipment and related services to all nuclear power plants in Korea and customers in the global nuclear energy industry. KNF is the one and only fuel company in the world to fabricate PWR fuel [PLUS7™ and ACE7™] along with PHWR fuel [CANDU].



November
Founded KNF

1982

January
Established R&D Center

1992

August
Attained ISO 9001:2000
Certification

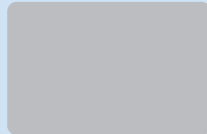
1997

May
Accredited as Calibration
Laboratory by KOLAS

2001

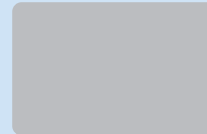
1998

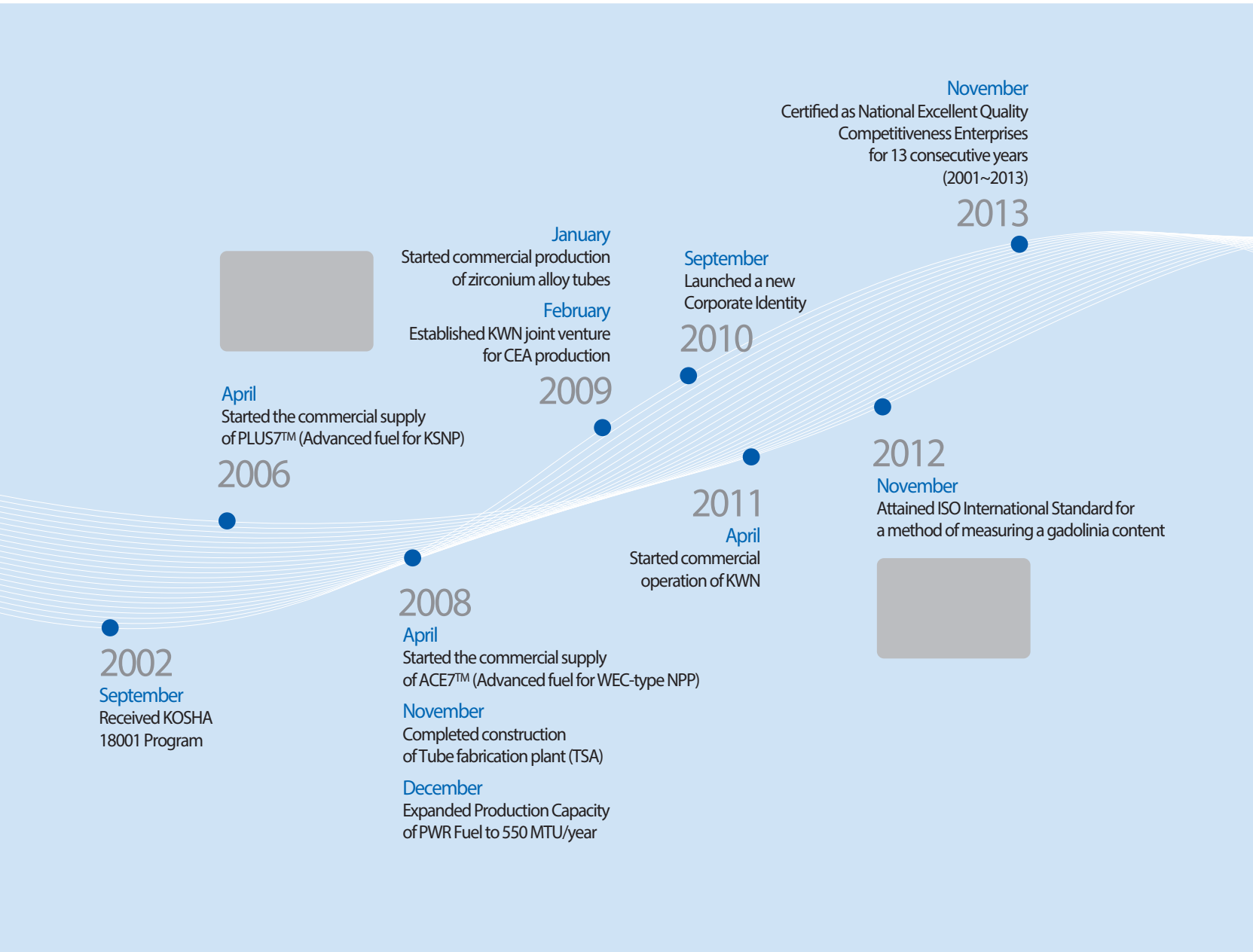
December
Completed construction
of PWR fuel fabrication plant (200MTU/year)



1998

January
Completed construction of the 2nd plant
and Launched commercial operation
of PWR fuel (200MTU->400MTU/year)
& CANDU fuel (400MTU/year)







Communication

Innovation & One Voice

We are Global KNF.

CEO Message

Hello. I am Lee Jae-hee, the president and CEO of KEPCO Nuclear Fuel Company. KNF is the one and only professional nuclear fuel design and fabrication company in Korea. As a government reinvested company, we have been responsible for providing high-end safe nuclear fuels to all local nuclear power plants in operation, both PWR & PHWR (CANDU) type, for more than 30 years as we succeeded in design and manufacturing localization. In many ways, KNF has been pursuing opportunities for upgrading and expansion to global markets developing patented nuclear fuel and design code. I am proud to say that we have achieved additional recognition by exporting other products in a wide range of areas such as primary parts, fuel cladding tubes and fuel service equipment. Finally we have also grown to supply our advanced nuclear fuel to the United Arab Emirates starting from 2016. To be global KNF, we will focus on building the basis of creativity management and driving a growth engine of the future with core values—Customer Priority, Global Competence, Business Development, Social Responsibility.

Building the basis of Creativity Management

We will build the basis of creativity management through innovation and communication. Our strategy is to perform a constructive transformation in organization and human resources to maximize efficiency and effectiveness accompanied by enterprise risk management.

Carrying out Social Responsibility


To be a company contributing to the state and society with being loved by the people, we will commit ourselves to carrying out social responsibility as a state-owned company and establishing ethical management including diverse interests.

Driving a Growth Engine of the Future

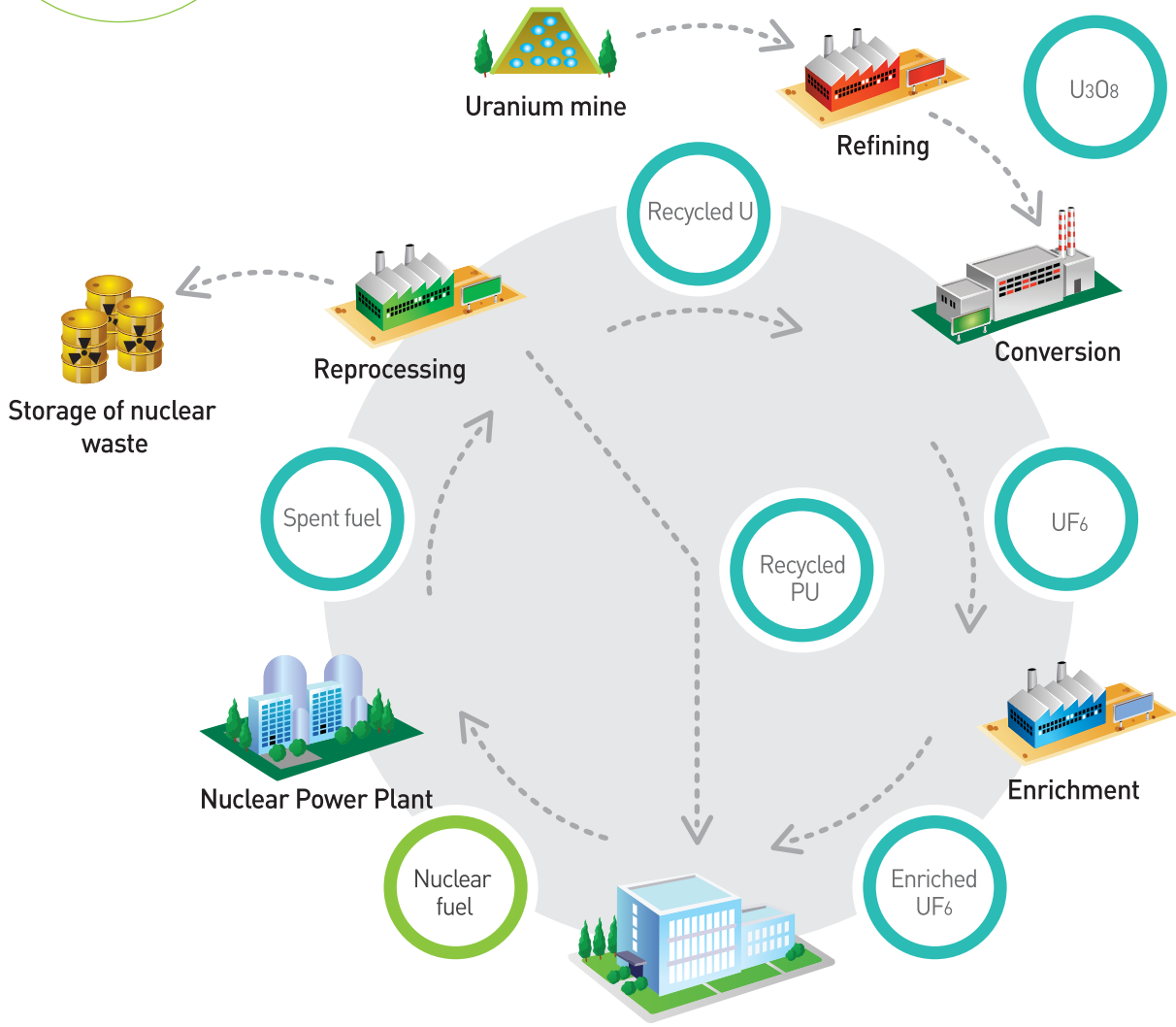
KNF will take the lead in driving a growth engine of the future through improving patented technologies that has been made so far, staying ahead of technological innovations for the nuclear power plant, and developing new projects both locally and internationally.

I am very excited about our prospects to be a global fuel cycle company striving more to enhance the economic growth in Korea and leading the international nuclear fuel market. We deeply appreciate your support and interest in our company.

Sincerely,

Lee Jae-hee 이 재 희 
President & Chief Executive Officer
KEPCO Nuclear Fuel Company

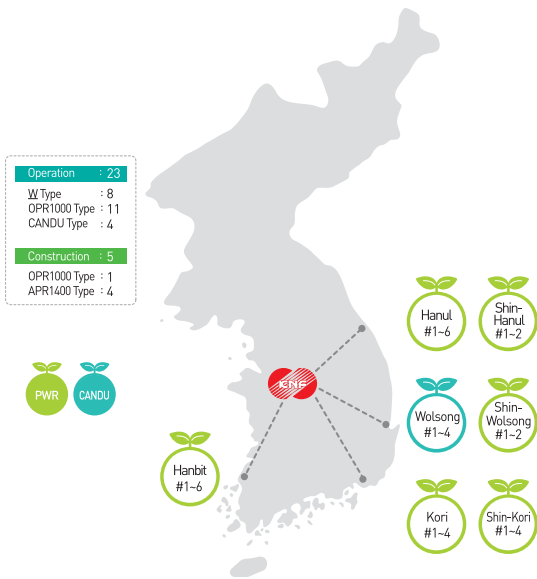
Fuel Cycle and Business Area



Business Areas

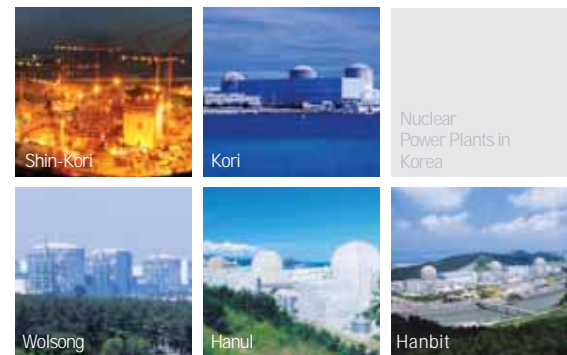
- Design of the nuclear reactor core
- Safety analysis for nuclear power plants
- Nuclear fuel design and fabrication
- Nuclear fuel services and engineering
- Nuclear fuel research and development
- Development of nuclear fuel resources

Nuclear Power Plants in Korea

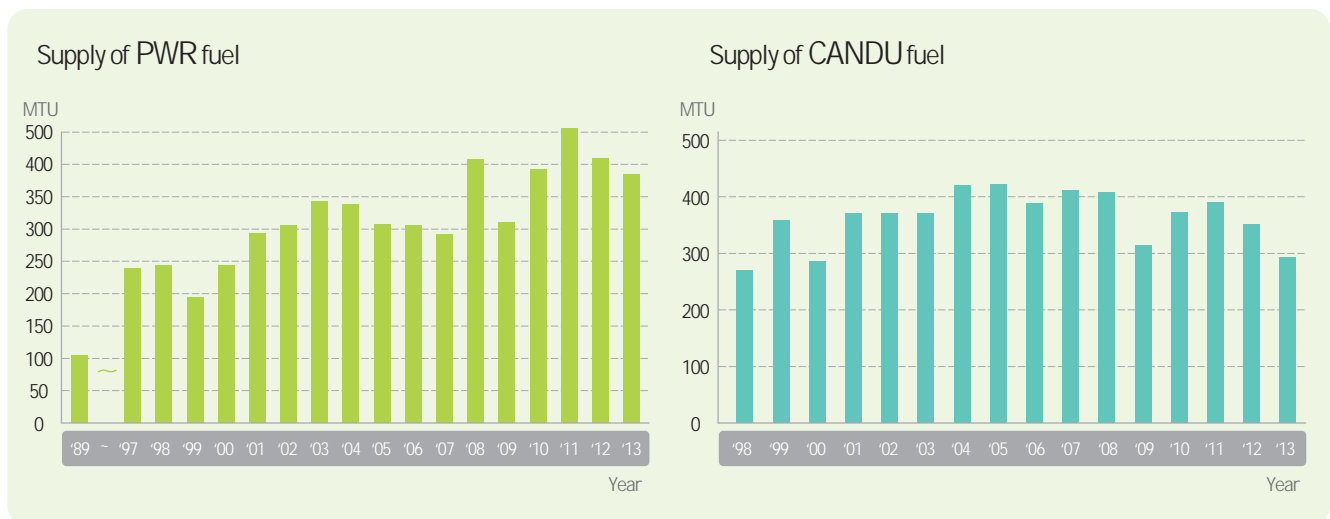


Status of NPP in Korea

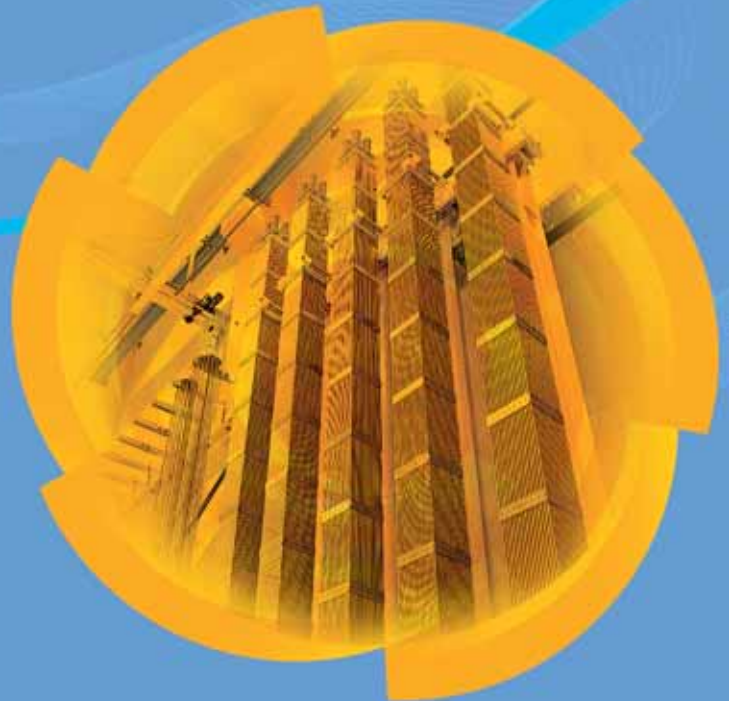
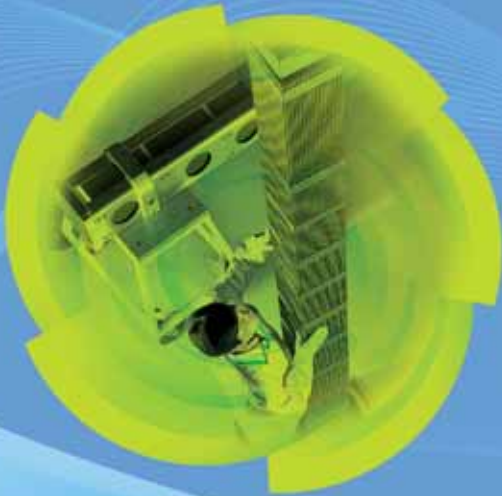
Type	In Operation	Under Construction
OPR1000	11	1
APR1400	0	4
W14x 14	1	0
W16x 16	1	0
W17x 17	6	0
CANDU	4	0
Total	23	5



Fuel Supply Growth



FUEL DESIGN AND FABRICATION



- Initial/Reload Core Design & Safety Analysis
- PWR Fuel Assembly Fabrication Process
- CANDU Fuel Assembly Fabrication Process

Initial/Reload Core Design & Safety Analysis

KNF performs high-level core design and safety analysis for safe and economic nuclear reactor fuel. We solely offer core design and safety analysis for all domestic pressurized light-water reactors in operation and also contribute to enhance operational performance and economic feasibility of the nuclear reactor based on our design technologies accumulated over the years.

KNF provides the initial core design and safety analysis for 5 local nuclear power plants under construction. We also offer the reload core design and safety analysis for other 19 nuclear power plants in operation: 8 WEC-type and 11 OPR1000.

To ensure that the fuel loaded in the reactor safely performs and produces enough energy necessary for power generation, we carry out transient and accident analysis and as well as offer designs for core, thermal-hydraulics, fuel rod, and fuel assembly. We believe that our excellent performance of reactor core design and safety analysis is a key procedure for safe plant operation and this enables us to support the need for reliable and economic power supply.

Core design selects the core loading pattern and analyzes core characteristics; thermal-hydraulic design fixes critical heat flux limit value; fuel rod design evaluates rod integrity such as rod internal pressure and corrosion resistance; fuel assembly design evaluates fuel assembly integrity such as component stress and strain; transient and accident analysis conduct safety evaluation to show that there is no problem in safety even under assumption of the power plant accident. That is, core design and safety analysis are important processes to produce electricity stably by securing economic efficiency as well as ensuring the safety of nuclear power plant. Along with this, KNF offers high added value engineering services with the most advanced technology to increase safety, convenience and economic efficiency of nuclear power plant.





PWR Fuel Assembly Fabrication Process

Reconversion

The chemical conversion process to manufacture the uranium dioxide (UO_2) powder from low-enriched uranium hexafluoride (UF_6) and the blending stage to further mix the powder with additives for pellet manufacturing.

Pelletizing

The ceramic processes to compress the UO_2 powder in a die first into the shape of a cylindrical pellet, called "a green pellet", and then sinter it in a furnace at a temperature higher than $1700^\circ C$ to produce high-density ceramic UO_2 pellets. The sintered pellets are then ground to precise dimensions.

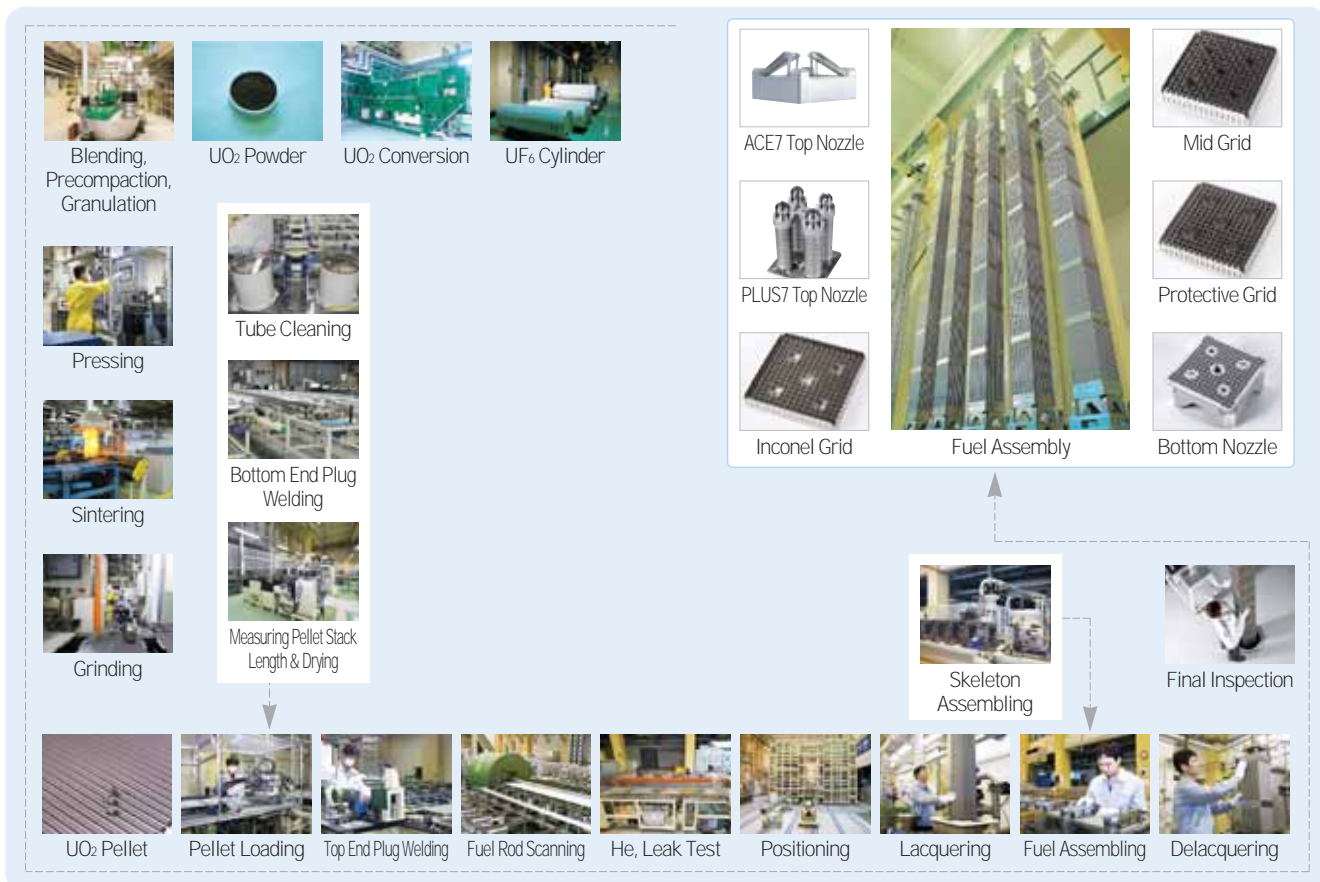
Fuel Rod Manufacturing

The manufacturing processes to load the pellets into a zirconium alloy (Zircaloy)-cladding tube and seal-weld the each end by resistance welding. A compression spring is inserted at one end to hold the pellet stack, and helium gas is also filled inside the tube at this stage.

Fuel Assembly Manufacturing

The final assembly process to form a fuel bundle by inserting the completed fuel rods into a skeleton. Grid assemblies and control rod guide thimble tubes are mechanically joined, and then top and bottom nozzles are attached after rod insertion to finalize the fuel assembly.

| PWR Fuel Assembly Fabrication Process |



CANDU Fuel Assembly Fabrication Process



Pelletizing

The ceramic process to complete the UO₂ pellets from imported natural uranium dioxide powder (UO₂) through the same process as that of PWR's.

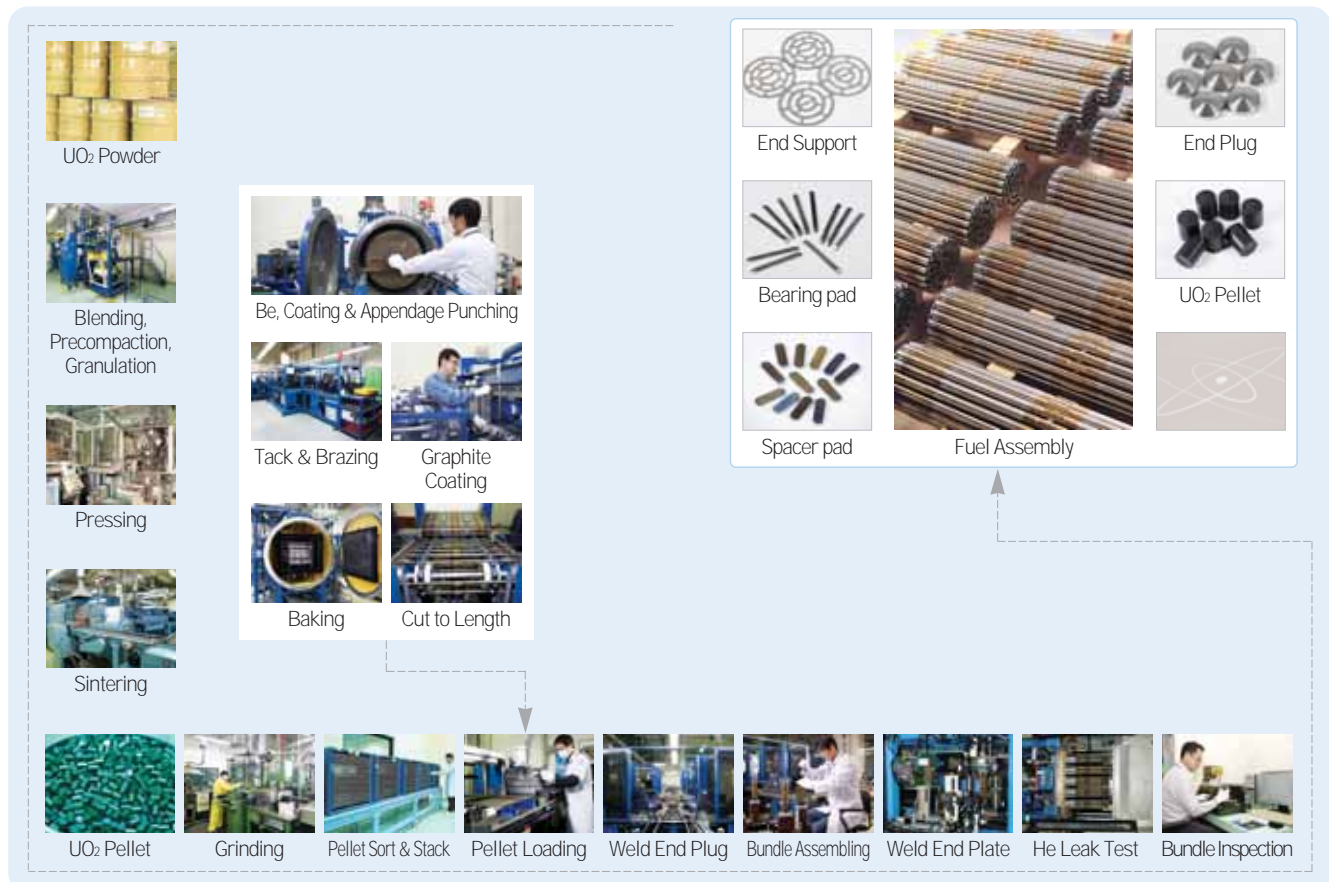
Fuel Assembly Manufacturing

The final assembly process to form a fuel bundle by collecting manufactured fuel rods into the cylindrical shape and attaching the end support plates to both ends.

Fuel Rod Manufacturing

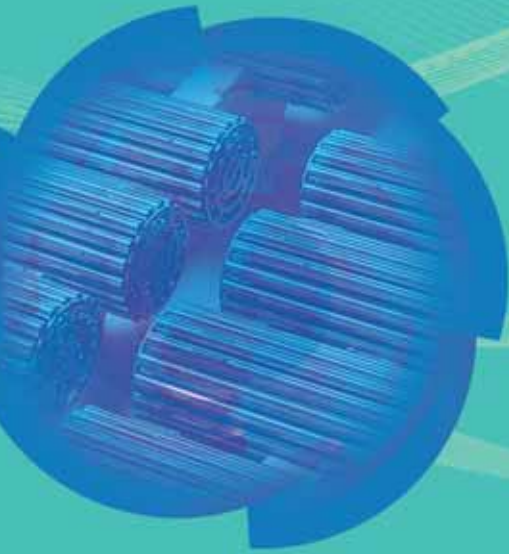
The manufacturing process to finish fuel rods by attaching small pads to zirconium alloy tubes, (1) to keep water channel between the fuel rods and the pressure tube (bearing pads) and (2) to provide spacing between the rods (spacer pads), loading the pellets into the tubes, and sealing both ends with end plugs.

| CANDU Fuel Assembly Fabrication Process |





RESEARCH & DEVELOPMENT



- PLUS7 Advanced Nuclear Fuel
- ACE7 Advanced Nuclear Fuel
- Patents for Reactor Cores and Fuel Designs
- Zirconium Alloy Tubes Manufacturing Technology
- Patented Manufacturing Technology
- Fuel Services
- Quality Assurance and Quality Control



PLUS7 Advanced Nuclear Fuel

PLUS7 is an advanced nuclear fuel assembly for Korean standard nuclear reactors. KNF successfully performed in-pile evaluation of LTA (Lead Test Assembly) following completion of its development in the year of 2002 and has been supplying this world-class nuclear fuel to local nuclear power plants since April 2006.

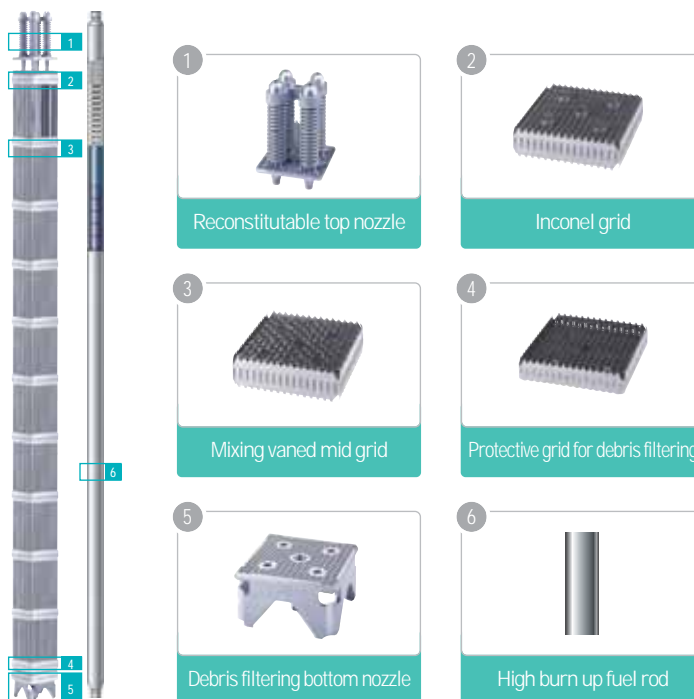
PLUS7 was developed from the previous fuel called Guardian which is supplied by Westinghouse Electric Company, and it has 7 improved performance factors:

- 1st, Improvement of neutron economy through optimized fuel rod diameter.
- 2nd, Improvement of seismic resistance through high strength grid design.
- 3rd, Improvement of grid-to-rod fretting wear resistance through mid-grid springs and dimple design.
- 4th, Improvement of fuel productivity through integral top nozzle.
- 5th, Improvement of debris filtering efficiency through protective grid and small hole/slot of bottom nozzle.
- 6th, Achievement of high burn-up capability from 45,000 MWD/MTU up to 55,000 MWD/MTU in comparison to Guardian, the conventional fuel.
- 7th, Enhancement of thermal margin by more than 10%.

The development of advanced nuclear fuel PLUS7 cuts down the fuel cost per plant nearly up to 1 billion Won per year, and its enhanced thermal margin is expected to bring economic benefits of about 3 billion Won annually when the power is uprated by 1% in a single nuclear reactor.

Features of PLUS7

Item	Guardian	PLUS7	Benefits
Fuel Rod	<ul style="list-style-type: none"> Zry-4 Clad 9.7mm Dia 	<ul style="list-style-type: none"> ZIRLO Clad 9.5mm Dia 	<ul style="list-style-type: none"> High Burnup Neutron Economy
Mid Grid	<ul style="list-style-type: none"> No Mixing Vane Wavy Strap Point Contact Spring 	<ul style="list-style-type: none"> Mixing Vane Straight Strap Conformal Surface Spring 	<ul style="list-style-type: none"> DNB Margin Seismic Resistance Fretting Wear Resistance
Top/Bottom Grid	<ul style="list-style-type: none"> Wavy Strap 	<ul style="list-style-type: none"> Straight Strap 	<ul style="list-style-type: none"> Seismic Resistance
Top Nozzle	<ul style="list-style-type: none"> Reconstitutable Part Nozzle 	<ul style="list-style-type: none"> Reconstitutable Integral Nozzle 	<ul style="list-style-type: none"> Easy Reconstitution
Bottom Nozzle	<ul style="list-style-type: none"> Standard Hole 	<ul style="list-style-type: none"> Small Hole 	<ul style="list-style-type: none"> Debris Filtering
Protective Grid	<ul style="list-style-type: none"> Guardian Grid 	<ul style="list-style-type: none"> Protective Grid 	<ul style="list-style-type: none"> Debris Filtering
Grid: Thimble Connection	<ul style="list-style-type: none"> TIG Welding 	<ul style="list-style-type: none"> Spot Welding 	<ul style="list-style-type: none"> Weld Integrity Manufacturing Productivity



ACE7 Advanced Nuclear Fuel

ACE7 is an advanced nuclear fuel assembly for WEC-type nuclear reactors. KNF launched the development of this international level fuel in 2001 and completed it in 2004; the achievement led us to commercial supply of ACE7 to 16x16 & 17x17 WEC-type reactors in Korea starting from June 2008 after the in-pile evaluation of LTA (Lead Test Assembly).

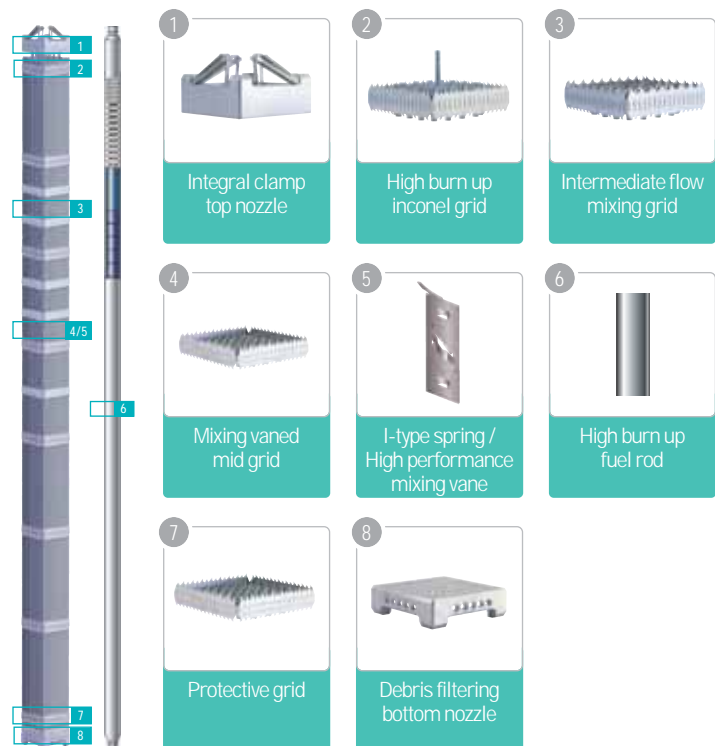
ACE7 was developed from the conventional fuel supplied by Westinghouse Electric Company, and it has 7 improved performance factors:

- 1st, Improvement of neutron economy through optimized fuel rod diameter.
- 2nd, Improvement of grid-to-rod fretting wear resistance through I-shaped spring and widened dimple design.
- 3rd, Prevention of incomplete RCCA insertion through straight and tube-in-tube type guide thimble.
- 4th, Prevention of spring screw failure through integral clamp top nozzle.
- 5th, Improvement of debris filtering efficiency through protective grid and small-hole bottom nozzle.
- 6th, Achievement of high burn-up capability to more than 55,000MWD/MTU in comparison to the conventional fuel.
- 7th, Enhancement of thermal margin by more than 10%.

The development of advanced nuclear fuel ACE7 cuts down the fuel cost per plant about 0.4 to 1.7 billion Won per year and its enhanced thermal margin is expected to bring economic benefits of about 2 to 3 billion Won annually when the power is uprated by 1% in a single nuclear reactor.

Features of ACE7

Item	RFA	ACE	Benefits
Fuel Rod	<ul style="list-style-type: none"> ZIRLO Clad Long End Plug 	<ul style="list-style-type: none"> ZIRLO Clad Long End Plug 	<ul style="list-style-type: none"> High Burnup Debris Filtering
Mid Grid	<ul style="list-style-type: none"> Diagonal Spring Modified Mixing Van 	<ul style="list-style-type: none"> I-Spring Optimized Mixing Vane 	<ul style="list-style-type: none"> Fretting Wear Resistance DNB Margin
IFM Grid	<ul style="list-style-type: none"> 3 IFMs 	<ul style="list-style-type: none"> 5 IFMs 	<ul style="list-style-type: none"> DNB Margin
Guide Thimble	<ul style="list-style-type: none"> Swaged Dashpot 	<ul style="list-style-type: none"> Tube-in-tube Dashpot 	<ul style="list-style-type: none"> Robust & IRI Free
Top Nozzl	<ul style="list-style-type: none"> RTN 	<ul style="list-style-type: none"> ICTN 	<ul style="list-style-type: none"> Spring Screw Failure Free
Bottom Nozzle	<ul style="list-style-type: none"> DFBN 	<ul style="list-style-type: none"> DFBN 	<ul style="list-style-type: none"> Debris Filtering
Protective Grid	<ul style="list-style-type: none"> Protective Grid 	<ul style="list-style-type: none"> Protective Grid 	<ul style="list-style-type: none"> Debris Filtering



Patents for Reactor Cores and Fuel Designs

KNF constantly works on R&D to secure our own patented technologies promoting export-oriented industrialization of nuclear fuel primarily in two parts: firstly, the development of high-performance nuclear fuel with secured technology ownership and secondly, the development of core design & safety analysis code system to achieve world-class patented code system and methodology.

Development of Export-driven High Performance Nuclear Fuel

As for the fuel development, KNF especially focuses on export-driven high performance nuclear fuel. We already succeeded to develop HIPER16 (High Performance with Efficiency and Reliability) for OPR1000 and APR1400 nuclear reactors, launched in September 2005 for the first as a national strategic priority to boost exports in nuclear power-related business and completed in August 2010 through the design finalization and out-pile verification. HIPER16 is prospected to be commercially supplied starting from 2017 after about 5 years of in-pile evaluation of LTA (Lead Test Assembly) at a domestic nuclear power plant. HIPER17, the fuel for WEC-type reactors, was started its development in January 2008, and the design was finalized in 2010; it is now under performance tests for commercial supply possibly from 2018. We believe that HIPER16 and HIPER17 will be approved as one of the best quality nuclear fuels worldwide in burn-up, thermal margin, seismic performance, reliability, and manufacturability.

Development of Core Design & Safety Analysis Code System

KNF has been developing high performance Reactor Core Design & Safety Analysis code system numbered among the best in the world, with no export restrictions under patented technology ownership. The reactor core design code is classified into the nuclear design code, the thermal-hydraulic design code, the fuel rod design code, and the fuel assembly & control rod design code. We successfully achieved the development of reactor core design code and licensing from Nuclear Safety and Security Commission for four codes such as two types of nuclear design codes, fuel assembly seismic analysis code, and thermal-hydraulic design code. As for the development of safety analysis methodologies, our main concern is not to have any restrictions on exports of nuclear power plants and fuels; the development and acquisition of license are expected to be completed by in 2015.



Zirconium Alloy Tubes Manufacturing Technology

KNF successfully completed localization of zirconium alloy tubes manufacturing technology and construction of the facility in December 2008, after about 6 years of trial since 2002. It was initially commenced to excellence in commercial nuclear fuel technology aiming for technological independence and to acquire stable supply of tubes with economy.

The success helped KNF achieve not only 100% of localization in fuel-components supply and but also establish the foundation of developing technology for advanced alloy, leading us to take on challenges in a global market as a competitive developer of nuclear fuel.

TSA with the most up-to-date equipment boasts a manufacturing capacity of 1,400km/year making about 20 different types of tube products that cover the full demand for 20 nuclear power plants.

We have met the aggregate demand of tubes needed for local nuclear industry since 2009 accelerating import substitute by around 40 billion Won a year and exported total 5 million of cladding tubes to the United States since 2011.

Furthermore KNF is now in progress of expanding the facility up to 2,000km/year to support the possible increase in demand both from domestic and international markets.



Patented Manufacturing Technology



KNF secures our own patented and advanced technology as a result of continuous automation in manufacturing process and constant technology development mainly in order to stabilize nuclear fuel supply and reduce manufacturing cost.



Pellet Loader



Skeleton Spot Welder



FA Assembling M/C



Advanced Laser Welder



Flange Welder



GT Plug Welder



GT Welder



Automatic Tube Cleaner



Graphite Coater



Pellet Stacking M/C



Oxidation Furnace



Crusher




Waste Treatment System

Fuel Services

In the initial stage of power plant, Korea relied on foreign technology, which cost long time and gigantic expense.

For this reason KNF newly organized a fuel service team in 1995 to perform fuel repair service and root cause analysis and investigation on fuel failures from February 2000 after spending 5 years of self-reliance in this field.

For quality integrity of supplied fuel, availability, and improvement on safety, KNF currently offers various nuclear fuel services to contribute to reduction of generating cost, safe operation of power plant, shortening of maintenance period for preventive plan, radiation exposure, primarily as follows:

- 
- In-Reactor Fuel Performance Examination & Evaluation
 - Fuel Repair and Root Cause Analysis of Fuel Failures
 - CRUD Removing using Ultrasonic Cleaning System
 - Spent Fuel Configuration Measurement

Quality Assurance and Quality Control



Safety is the priority in the nuclear industry, and thus the nuclear fuel with best quality is essential. The quality assurance policy by KNF is to provide safe, reliable and economic high-quality fuel to customers, and KNF is putting its best effort to provide sustainable quality improvement and development to fulfill customer satisfaction.

KNF manages quality assurance and quality control through establishing and operating our own quality assurance system to meet the customer and government's requirements such as the Atomic Energy Act, Korea Electric Power Industry Code (KEPIC-QAP), ISO9001, ASME NQA-1 and so on. We do our best to ensure the quality and reliability of nuclear fuel through all stages from design to delivery complying with our policy. KNF acquired ISO 9001 Certification for the quality management system from the UL Company, U.S. in 1997, and was also authorized by the Korea Laboratory Accreditation Scheme (KOLAS) in 2001 as a National Calibration Laboratory for the calibration quality system according to the National Standards Act and the ISO/IEC 17025 requirements.

Particularly, we submitted ISO application in 2010 for a method of measuring a gadolinia content and it was accepted as ISO International Standard in 2012. With its acceptance as the Korea's first ISO International Standard under ISO/TC 85 Nuclear energy standards, we contributed outstandingly to worldwide recognition for Korea's measurement technology. Since 2001, KNF has been consecutively certified as Excellent Quality Competitive Enterprise by the Ministry of Trade, Industry and Energy owing to prominent achievements in efficient quality management.



OVERSEAS BUSINESS



- Global KNF
- Joint Venture & Uranium Mining Projects

Global KNF



KNF now actively participates in nuclear power plant export with KEPCO group, under the name of One-KEPCO, aiming at countries across the globe considering the introduction of nuclear power. Nuclear fuel designed and fabricated by KNF will be supplied to nuclear power plants in UAE as a KEPCO-led consortium won the deal.

On the other hand, we unceasingly export nuclear fuel primary parts to the United States, the world's pioneering nuclear energy country, and other countries such as Brazil and China. Providing fuel engineering service and radioactive decontamination equipment is another stream of our overseas business which includes expanding the scope of export range from inspection and fuel service to manufacturing equipment.

There is continuing interest in the development and deployment of small and medium sized reactors and it is projected to drive the global market in the future. KNF was motivated by a success in acquiring patented technology for fuel assembly and design code; we made considerable achievements through winning a development contract for SMRs and as well as offering technicians accordingly. Based on the accomplishments, we build international cooperation with worldwide leading nuclear fuel companies and promote exports through established business networks comprising overall nuclear fuel business.

KNF will surely meet the needs of our customer with a global competitive edge as a supplier of best quality nuclear fuel products and services. We will never stop challenging ourselves to develop new ways of approaching to the international market.



Joint Venture & Uranium Mining Projects

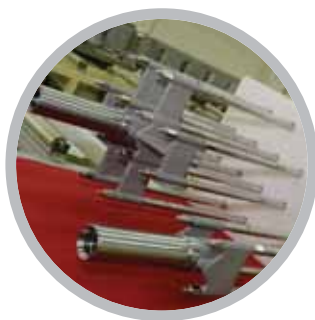
Manufacturing of Control Element Assembly

KNF expanded the business by forming KW Nuclear Components Ltd. (KWN), a joint venture with Westinghouse, the U.S., for manufacturing of CEA (Control Element Assembly) to be supplied to CE-type nuclear power plants in the U.S. and Korean standard type nuclear power plants in Korea.

The commercial production of the first KWN control element assembly line started in April 2011. KWN is competent enough to not only fulfill domestic demand, but also offer the CEAs to the customers over the United States and other countries operating CE-type nuclear power plants. It is expected to create about 10 million dollar-import substitution effect.

Development of Overseas Uranium Resources

KNF has been an active participant in exploring a uranium mine at Waterbury Lake, Saskatchewan, Canada since 2007 as a member of the KEPCO consortium organized for securing the stable supply of nuclear fuels. The development has continued up until now since September 2010 having a local corporation named KNF Canada Energy Ltd. to invest more detailed exploration of the area.



KNF's VISION 2020

Global Top 3 Fuel Cycle Company



"Communication, Innovation and One Voice. We are Global KNF."





KEPCO NF

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