

ADVANCED AND PROVEN O&M
TECHNOLOGIES FOR NUCLEAR POWER PLANT



ADVANCED AND PROVEN O&M TECHNOLOGIES FOR NUCLEAR POWER PLANT



Head office | 1655, Bulguk-ro, Gyeongju-si, Gyeongsangbuk-do, Korea 38120, Republic of Korea
Tel | +82-54-704-7620~7625

www.khnp.co.kr



INTRO

INSTRUMENT & CONTROL

- 10

Digital Rod Control System
- 14

Digital Rod Position Indication System
- 18

Diagnostic Equipment for Control Rod Drive Coil
- 22

Control Rod Drive Mechanism (CRDM) Simulator
- 26

Plant Annunciator System
- 30

Plant Monitoring System
- 34

NSSS Integrity Monitoring System
- 38

Digital Reactivity Computer System
- 42

Dips Flux Mapping System
- 46

I n-Core Flux Detector Amplifier (ICA)
- 50

Radiation Monitoring System
- 54

Post-Accident Sampling System
- 58

Generator Excitation System
- 62

Generator Excitation System Test Simulator
- 66

VibrationMonitoring System
- 70

Automatic Seismic Trip System
- 74

Nuclear Qualified Intelligent Pressure Transmitter
- 78

Nuclear Qualified Ultrasonic Level Transmitter
- 82

Nuclear Qualified Controller
- 86

Nuclear Qualified Digital Bar-graph Indicator
- 90

Nuclear Qualified Auto Manual Station
- 94

Graphic Recorder

MECHANICAL ENGINEERING

- 100

Magnetic Sludge Removal Device in Condenser
- 104

Maintenance of Bottom Mounted Instrument Leakage
- 108

Permanent Seal Ring for Reactor Cavity
- 112

Shielded Work Station and Flask for CANDU-6 Spent Fuel
- 116

Underwater Facility Inspection Robot
- 120

Management Solution for Small Bore Piping Socket Welds
- 124

Mechanical Seal for Primary Heat Transport Pump
- 128

Graphite Bonnet Gaskets Reinforced with Braided Yarn
- 132

Precision Load Positioner
- 136

Lightweight Door for Securing Safety Equipment
- 140

Steam Generator Sludge Removal Equipment
- 144

Radiation Tolerant CCTV system

ELECTRICAL ENGINEERING

- 150

Portable DC Ground Detector
- 154

Remote Insulation Resistance Measuring System
- 158

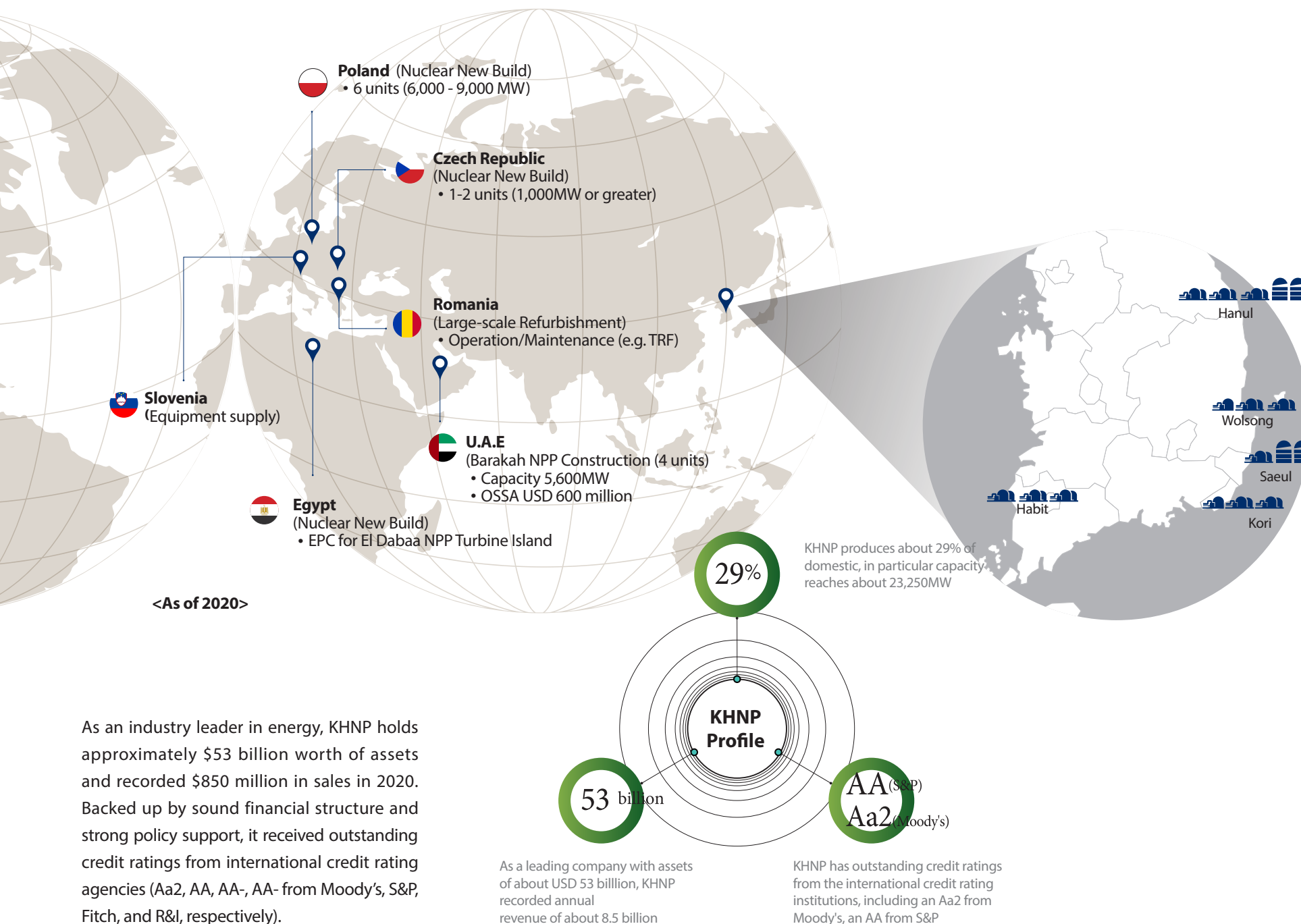
Fault Recorder
- 162

Integrated Circuit Breaker Test Set
- 164

Dissolved Gas Monitor for Oil-immersed Transformers

GLOBAL TOP 3 ENERGY PROVIDER

Korea Hydro and Nuclear Power (KHNP) is the world's third-largest energy supplier, generating electricity from nuclear and hydro power, renewables, and pumped storage hydropower. KHNP spearheads Team Korea in the nuclear sector and has 24 nuclear power plant units in operation and four in construction across Korea. Its impact is felt globally, with the signing of the agreement to build four units in the U.A.E., one of which is completed and the other three under construction. Team Korea has also signed a long-term maintenance service agreement (2019) and a routine preventive maintenance service agreement (2021) with the U.A.E. nuclear operator, taking the lead in all phases of the nuclear project, from design and construction to operation and maintenance. KHNP/Team Korea is further expanding its business, engaging in nuclear projects suited to the needs of each country. Two such examples are large-scale equipment refurbishment in Romania and equipment supplies to Slovenia.



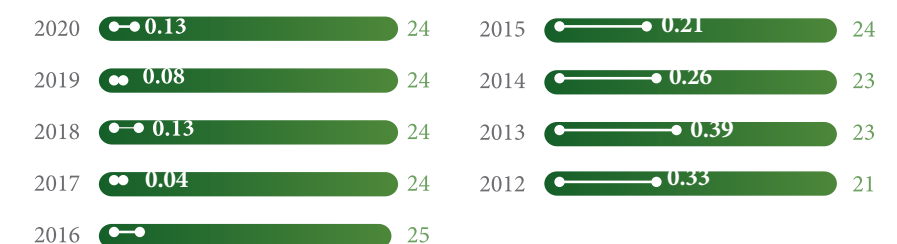
As an industry leader in energy, KHNP holds approximately \$53 billion worth of assets and recorded \$850 million in sales in 2020. Backed up by sound financial structure and strong policy support, it received outstanding credit ratings from international credit rating agencies (Aa2, AA, AA-, AA- from Moody's, S&P, Fitch, and R&I, respectively).

ADVANCED NUCLEAR TECHNOLOGY DEVELOPMENT LEADER

Ever since the commercial operation of the WH-type reactor Kori Unit 1 in 1978, KHNP has committed itself to developing indigenous technologies and equipment. KHNP developed a home-grown OPR1000 reactor and has since built and run 12 of the same kind. This led to the development of APR1400 and the subsequent construction and operation of six more in Korea. It achieved a significant milestone when Korea exported the reactor to the U.A.E., becoming the world's fifth exporter of nuclear reactors. KHNP has continued its efforts in developing operation and maintenance technologies for the reliable operation of plants by means of replacing discontinued products, improving performance, and ensuring price competitiveness. These efforts ultimately bore fruit, and Korea has become a global leader in the safe operation and performance of plants.



● Number of units in operation
 ● Number of unplanned shutdowns per unit





ADVANCED O&M TECHNOLOGY AND REFURBISHMENT EXPERIENCE

Over the past 40 years, KHNP has acquired a wealth of experiences and technologies from operating 24 reactors of different types, including WH, CANDU, FRAMATOME, as well as the indigenous OPR1000 and APR1400. Powered by such expertise, it has conducted over a thousand improvement works on equipment at the power plants in Korea in the last decade alone, between 2011 and 2020. Most notably, it has successfully undertaken large-scale refurbishment projects, such as extending the lifespan of WH-type Kori Unit 1, performing power uprating, substituting steam and turbine generators, and replacing CANDU-type pressure pipes.

Refurbishment Experience



● Kori Unit 1,2 (WH 2 Loop)

- Life Extension for Kori Unit 1 (2007)
- Refurbishment of Steam Generator for Kori Unit 1 (1997)
- Refurbishment of Reactor Head for Kori Unit 1 (2013)
- Improvement of Remote Shutdown System for Kori Unit 2 (2018)
- Replacement of Plant Monitoring System for Kori Unit 2 (2000)



● Kori Unit 3,4 and Hanbit Unit 1,2 (WH 3 Loop)

- Power Uprating for Kori Unit 3,4 and Hanbit Unit 1,2 (2010)
- Refurbishment of Main Generator for Kori Unit 3 (2008)



● Hanul Unit 1,2 (CP1)

- Refurbishment of Steam Generator for Hanul Unit 1,2 (2011)
- Refurbishment of HP/LP Turbine for Hanul Unit 1,2 (2012)

● Wolsong Unit 1 (CANDU)

- Replacement of Fuel Channel for Wolsong Unit 1 (2011)

TEAM KOREA

Led by KHNP, Team Korea provides a comprehensive supply chain solution in building and running nuclear power plants, offering plant designs derived from world-class technologies, operation and maintenance services, equipment supply, and much more.

Robust Supply Chain & Abundant Experience

Plant Design & Engineering

KEPCO E&C plays a leading role in the engineering field such as reactor development and refurbishment of operating plants.



Nuclear Fuel

KEPCO NF has advanced technologies in the nuclear fuel and fuel engineering sector.



Key Equipment Supplier

Doosan is a global equipment supplier that provides the reactor, steam generator, turbine, and generator to companies at home and abroad.



Maintenance Service

KEPCO KPS has outstanding technologies in the field of nuclear equipment diagnosis, performance improvement, and maintenance.



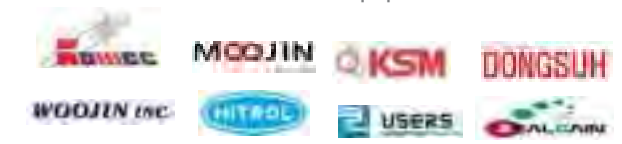
Construction companies

Korean construction companies have leading-edge technologies for construction of nuclear power plants.



Equipment Supplier

Approximately 600 listed vendors in Korea supply mechanical/electrical/I&C equipment.



Global Nuclear Integrator

Responsible for 29% of electricity generation in Korea, KHNP is the largest power generation company in the country. KHNP operates 24 nuclear power plant units, with the total capacity of 23,250MW.

ADVANCED AND PROVEN O&M TECHNOLOGIES
FOR NUCLEAR POWER PLANT



INSTRUMENT &
CONTROL

10	Digital Rod Control System	62	Generator Excitation System Test Simulator
14	Digital Rod Position Indication System	66	VibrationMonitoring System
18	Diagnostic Equipment for Control Rod Drive Coil	70	Automatic Seismic Trip System
22	Control Rod Drive Mechanism (CRDM) Simulator	74	Nuclear Qualified Intelligent Pressure Transmitter
26	Plant Annunciator System	78	Nuclear Qualified Ultrasonic Level Transmitter
30	Plant Monitoring System	82	Nuclear Qualified Controller
34	NSSS Integrity Monitoring System	86	Nuclear Qualified Digital Bar-graph Indicator
38	Digital Reactivity Computer System	90	Nuclear Qualified Auto Manual Station
42	Dips Flux Mapping System	94	Graphic Recorder
46	I n-Core Flux Detector Amplifier (ICA)		
50	Radiation Monitoring System		
54	Post-Accident Sampling System		
58	Generator Excitation System		

Digital Rod Control System

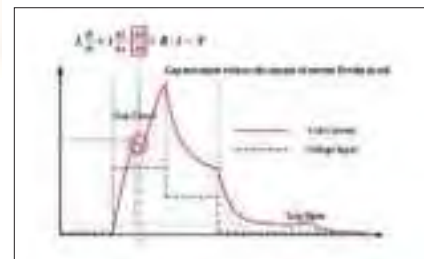
Zero SPV

Low Failure Rate

The Digital Rod Control System (DRCS) is an essential equipment featuring Zero SPV design, and controls the reactivity of the reactor by moving the control element assembly (CEA) within the reactor.

BACKGROUND

The rod control system exerts a direct effect on controlling the core reactivity. As such, a breakdown of this system leads to a transient state of the plant. Despite the importance of the system, the conventional rod control system installed in nuclear power plants in Korea did not take into consideration the single point vulnerability (SPV), causing 18 reactor trips in eight plants from 1994 to 2014.



PROVEN TECHNOLOGY

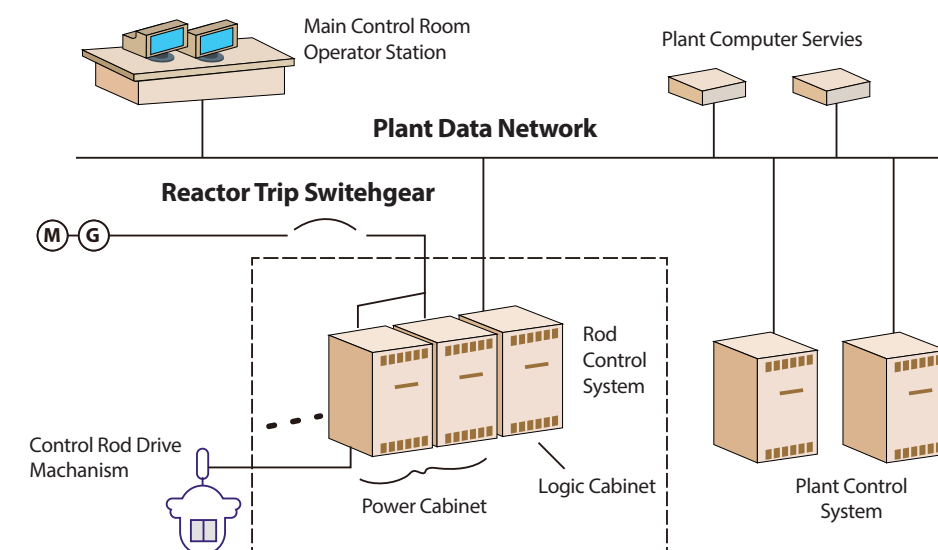
After implementation of the improved DRCS with zero SPV in Kori Unit 2 and other plants, there has not been a single case of a plant transient initiated by the failure of this equipment.

Through IAEA's Independent Engineering Review of I&C Systems in 2010, this system has been selected as a best practice. (IERICS-ROK-2010)

FEATURES

- This system features a specialized redundant architecture that has incorporated the zero SPV design.
- This product offers a solution that prevents rod slipping due to crud buildup.
- A dual holding technology (use of movable and stationary grippers) has been applied to prevent unexpected rod drop.
- This product allows easy equipment replacement and seamless integration with the existing systems using existing input/output signals.
- This system has been designed to improve maintenance convenience.
 - Enables hot swapping of all control modules
 - Improves maintenance staff's access to main components including the SCR
 - Provides man-machine interface for maintenance support, tailored to both the MCR and the local panel
- This product has enhanced self-diagnostic functions.
 - Other CPU Failure
 - Memory Failure
 - I/O Failure
 - ADC Failure, Timer Failure
 - Card Removal, Cable Removal

CONFIGURATION



Logic Cabinet

performs logical operation to actuate the control rods

Power Cabinet

supplies power to the control rod drive mechanism to implement the result calculated by the logic cabinet

Rod Drop Protection Cabinet

supplies DC power to the rod drive mechanism for prevention of unexpected rod drop in the event of an abnormal event

Relevant Main Control Board Equipment via Data Link

provides rod actuation status and data to operators and maintenance staff

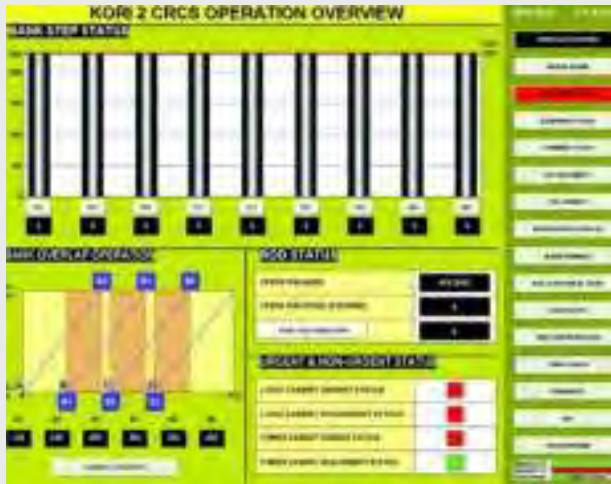
SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2(2011), Kori Units 3&4(2021), Hanbit Units 1&2 (2021)
- **FRAMATOME-type** : Hanul Units 1&2(2012)
- **OPR1000** : Hanbit Units 3-6(2011-2014), Hanul Units 3-6(2014-2015), Shin Kori Units 1&2(2020-2021), Shin-Wolsong Units 1&2(2019-2020)
- Nuscale – In Progress

OPERATION ON SITE



[DRCS – Kori Units 1&2]



[MMI Screen – Kori Unit 2]

KEY BENEFITS

- The single control circuit of the discontinued analog system can be replaced with the digital redundancy system, enhancing equipment reliability and increasing plant safety.
- This system helps prevent initiation of a plant transient by avoiding unexpected rod drop.
- This product has been designed to improve maintenance convenience (i.e., maintenance staff's improved access to main components), leading to reduction in maintenance time.

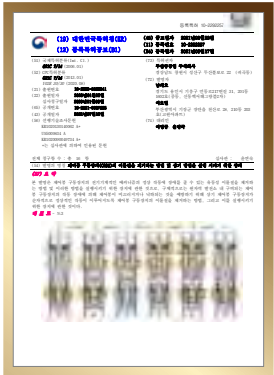
SPECIFICATION

[Logic Cabinet Specifications]		[Power Cabinet Specifications]	
Item	Description	Item	Description
Size	800Wx900Dx2278H	Size	899Wx130Dx240H
Power for Controller, etc.	120VAC ± 10%, single phase, ungrounded 60Hz ± 5%	Power for CEDM Power	240/139VAC ± 10%, 3 Phase 4 Wire (ungrounded) 60Hz ± 5%
Panel PC	19" Rackmount (9U) Touch Screen panel PC Input Power : 24Vdc, LAN : 6 Ports (RJ45)	Power for Controller, etc.	120VAC rms ± 10%, ungrounded 60Hz ± 5%
CPU AND COMMUNICATION MODULE	Core@450MHz, CPM@300MHz, SDRAM 96MB, EPROM 1MB, Flash 4MB,SRAM 2MB	Data Communication Method for Logic Cabinet MTP	EtherNet (Internal)

CODE & STANDARDS

- Equipment Qualification
 - IEEE Std. 323
- Seismic Qualification
 - IEEE Std. 344
- EMC Qualification
 - RG 1.180
- Software Verification and Validation
 - IEEE Std. 1012
- Human Factor Engineering
 - NUREG-0700

PATENT & CERTIFICATION



10-2292257



www.doosanheavy.com
155, Jeongjail-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea
Tel : 031-5179-2316 Fax : 031-5179-2398
email : hawon.jung@doosan.com

Digital Rod Position Indication System (DRPI)

Equipment Reliability

Cost-Efficient

This system offers improved self-diagnosis and provides operators with the accurate position of the control rod, which has been transmitted by a control rod position detector.



BACKGROUND

The control rod position indication system for the WH 2 Loop- and WH 3 Loop-types in Korea was introduced over 30 years ago. Due to long-term operation of the system, spare parts costs increased and system failures occurred more frequently, leading to an increase in maintenance costs. Against this backdrop, a reliable and affordable system with the state-of-the-art technology has been developed.



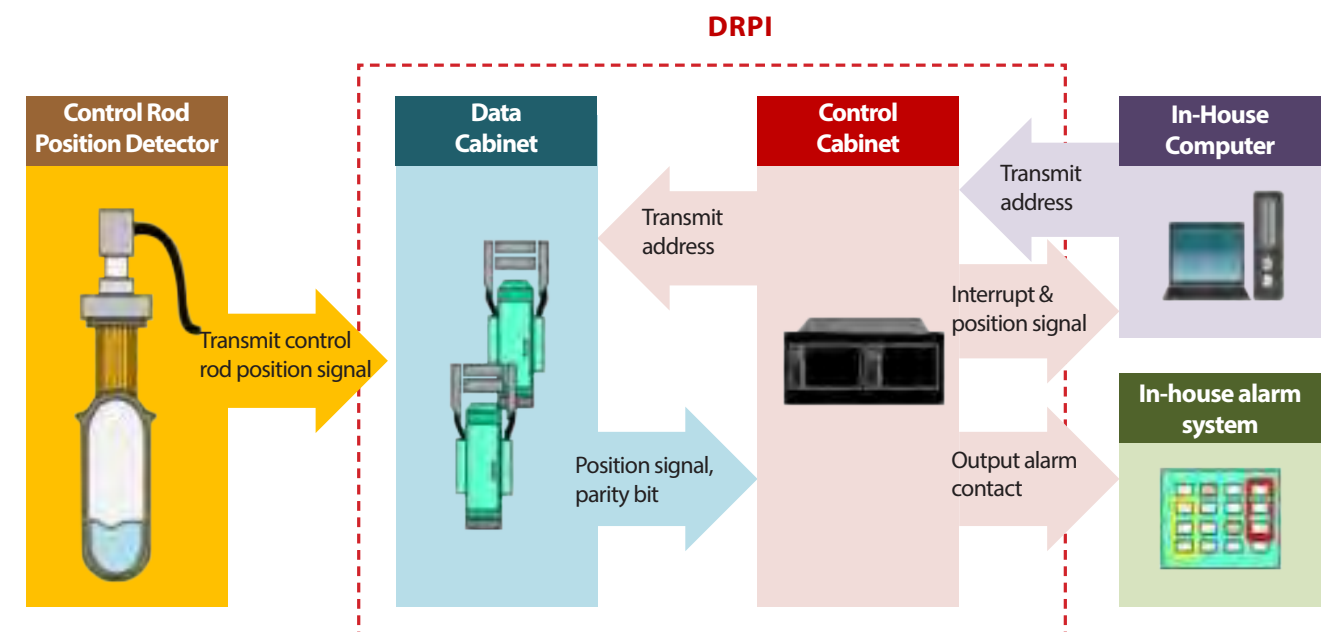
PROVEN TECHNOLOGY

The WH 3 Loop-type reactor Kori Units 3 and 4 replaced their existing system with this reliable system by applying redundancy to the main components and the communication network, resulting in improved plant safety. Using self-diagnostic features saved trouble-shooting time and spare parts were supplied at a competitive price, thereby reducing maintenance costs.

FEATURES

- This product offers redundancy features for major components, such as the CPU.
- Through the dual LCD display, this system delivers various detailed information to the operators.
- This system has improved self-diagnostic functions.
- This product provides seamless interface with the existing plant equipment.

COMPOSITION



SUPPLY EXPERIENCE

■ WH-type : Kori Units 3&4 (2014), Hanbit Units 1&2 (2017)

OPERATION ON SITE



User Interface Screen (Kori Unit 3 Main Control Room)

KEY BENEFITS

- This system, which has demonstrated its effectiveness through long-term operation, helps enhance plant safety.
- The existing DRPI system can be replaced with this product at a competitive price.
- By providing information optimized to the operator, human errors can be prevented.
- With application of the new technologies (e.g., self-diagnosis and hot swapping), maintenance convenience can be improved.

SPECIFICATION

Item	Description
Part No.	RG-3601
Size	908W×457D×324H (Cold rolled steel plate)
Data communication method inside the data cabinet	Multiplexing by Data I/O Card
Data communication method between data cabinet and control cabinet	RS-422 communication of Data I/O Card
Data communication method inside the data cabinet	Ethernet communication of VME System (CPU Card)
Processing of control rod position data	Calculation through S/W of VME System (CPU Card)
Display of control rod position	Display graph and counting format by providing UI of Display PC (Dual LCD Display)
Processing alarm signal	Calculation through S/W of VME System (CPU Card)
Operation of alarm signal relay	VME System(DO Card)> UA, NUA, RB1, RB2, RD alarm relay Driving
Transmission of control rod position data to in-house computer	Ethernet communication of VME System (CPU Card)

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000
- Software Verification and Validation
 - IEEE 1012, IEC 60880
- Human Engineering
 - USNRC NUREG-0700

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



REALGAIN CO.,LTD.

www.realgain.co.kr
SEONGSU ACE HIGH END TOWER, 14, Seongsuil-ro 10-gil,
Seongdong-gu, Seoul, 04784, Republic of Korea
Tel : +82 2 885 4781 Fax : +82 2 885 4782
Email : realgain@realgain.co.kr

Diagnostic Equipment for Control Rod Drive Coil

Equipment Reliability

Preventive Maintenance

This diagnostic equipment measures the DC/AC resistance, inductance, Q factor and other numerous variables to determine the integrity of the control rod drive coil and the digital rod position indication (DPRI) coil.



[Coil Diagnostic Equipment]

BACKGROUND

Conventionally, the only way to check the integrity of a control rod coil was through manual measurement of the DC resistance. This diagnostic equipment has been developed to improve this conventional approach, with the aim of making a comprehensive diagnosis.



[Rod Measurement Program]

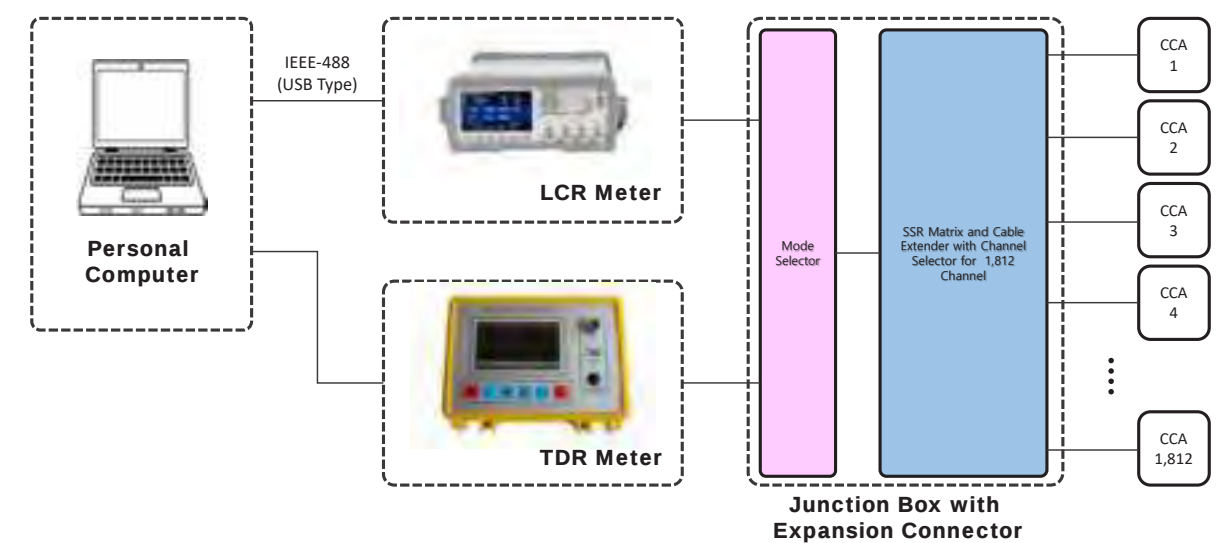
PROVEN TECHNOLOGY

With the first installation in 2005, this diagnostic equipment has been applied to 22 nuclear power plants in Korea and two Barakah nuclear power plant units in the UAE. The 151 reactor years of operating experience demonstrates that this equipment is safe and reliable.

FEATURES

- To prevent hunting when measuring the DC resistance of a control rod drive coil, the Wheatstone Bridge module has been adopted. Hunting prevention circuits that use a Zener diode and a capacitor have been formed on both sides of the coil resistance.
- This product provides trend analysis of the coil variables, such as the DC/AC resistance, inductance, and Q factor.
- With the hardware and software designs for zero point calibration and self-testing features (on the applied instrument and the junction box), equipment malfunctions can be eliminated at an early stage.

CONFIGURATION



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2 (2007), Kori Units 3&4 (2005, 2018), Hanbit Units 1&2 (2009, 2020)
- **FRAMATOME-type** : Hanul Units 1&2 (2005)
- **OPR1000** : Shin-Kori Units 1&2 (2009, 2020), Hanbit Units 3&4 (2005) Hanbit Units 5&6 (2011, 2020), Hanul Units 3&4 (2005), Hanul Units 5&6 (2006), Shin-Wolsong Units 1&2 (2009)
- **APR1400** : Shin-Hanul Units 1&2 (2015), Barakah Units 1&2 (2015)

OPERATION ON SITE



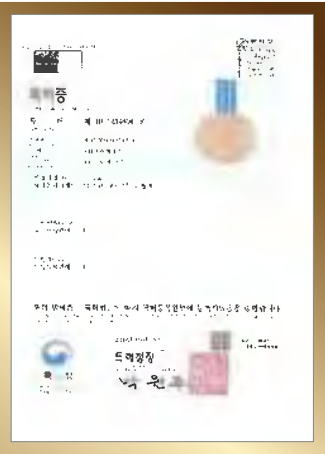
KEY BENEFITS

- The DC/AC resistance, inductance, Q factor, and other coil variables are taken into consideration to allow early diagnosis before critical damage is inflicted.
- The computer-based system enables systematic data analysis and makes it easy to manage the data history.
- This equipment can detect obsolescence of the coil of the rod control system, preventing reactor trips.
- This product reduces coil examination time during an outage, enhances examination efficiency and saves maintenance costs.

SPECIFICATION

Measurement Device	Description
LCR Meter	· Accuracy : Within 0.1% · Measurement Time : Within 25ms · Resistance Range : 0.001-1MΩ · Inductance Range : 1μ-100H
TDR Meter	· Distance Range : 0.25-500m · Distance Accuracy : 40±1% · Resistance Range : 1-1000Ω · Resistance Accuracy : ±10% · Delivery Speed Range : 0.3-0.99 · Delivery Speed Accuracy : 0.01±1%
DC Resistance Precise Measurement Device	· Range : 0-20Ω · Range (Precise Measurement) : 0-10Ω

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1239804



REALGAIN CO.,LTD.
www.realgain.co.kr
SEONGSU ACE HIGH END TOWER, 14, Seongsuil-ro 10-gil,
Seongdong-gu, Seoul, 04784, Republic of Korea
Tel : +82 2 885 4781 Fax : +82 2 885 4782
Email : realgain@realgain.co.kr

Control Rod Drive Mechanism (CRDM) Simulator

Comprehensive Test

Without Control Rod Operation

This Control Rod Drive Mechanism (CRDM) simulator has been developed to comprehensively examine the integrity of the CRDM and control rods under normal operation during an outage, without having to actuate the control rods.



BACKGROUND

The CRDM is an essential equipment of a nuclear power plant. Although identifying potential risks during an outage and carrying out preventive maintenance is important, it is impossible to examine the CRDM and the loops (related to operation of the control rod group) under normal operating conditions. Thus this product has been developed to address this particular issue.

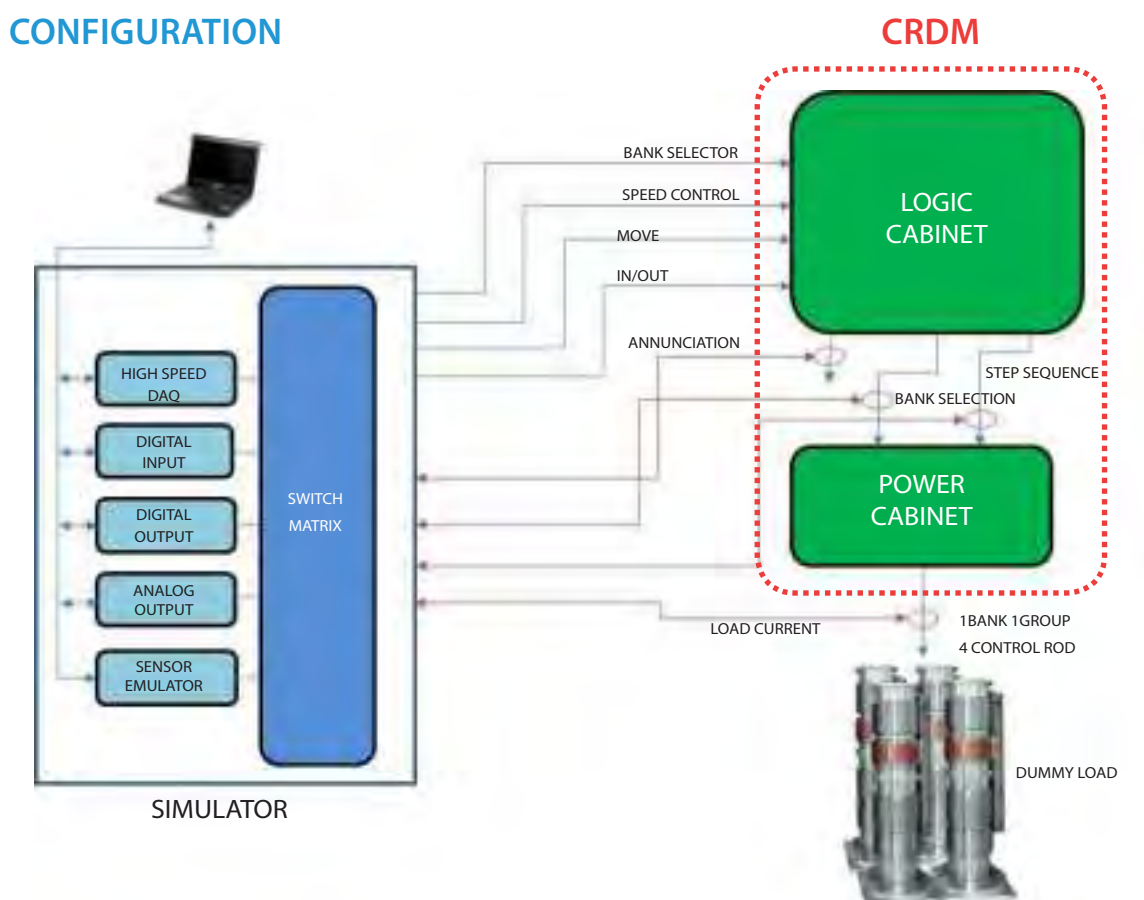
PROVEN TECHNOLOGY

Most of the nuclear power plants in Korea have implemented this product to examine the control rod drive loop during an outage under normal operating conditions, without having to actually operate the control rods. By identifying the factors that may lead to a breakdown and carrying out maintenance, we could ensure the reliability of the control rod control facility, thereby enhancing plant safety.

FEATURES

- A comprehensive drive loop test can be performed for each control rod group.
- Using this simulator allows diagnosis of the actual control rod coil based on the test result.
- Input and output values for each CRDM control card can be recorded and managed.
- This product enables consecutive rod insertion and withdrawal tests, which are difficult to be performed in an actual setting, as various factors (e.g. control rod position and coil status) need to be taken into consideration.

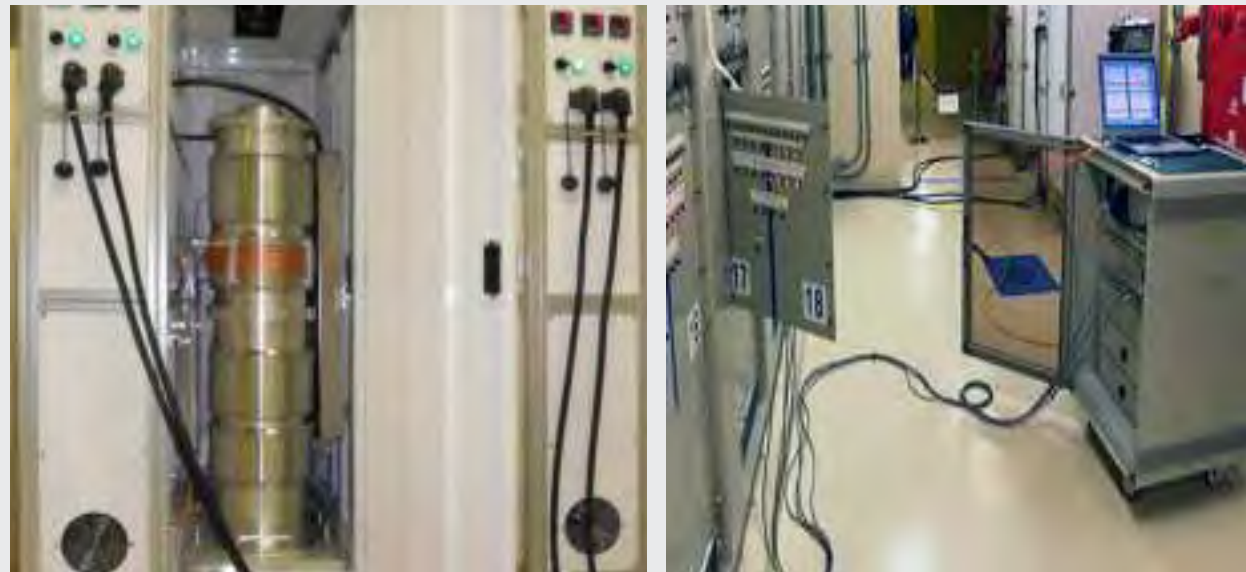
CONFIGURATION



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 3&4 (2020), Hanbit Units 1&2 (2020)
- **OPR1000** : Habit Units 3-6 (2012), Hanul Unit 3-6 (2010),
Shin-Kori Units 1&2 (2011),
Shin-Wolsong Units 1&2 (2020)
- **APR1400** : Shin-Kori Units 3&4 (2015)
- **Barakah Units 1&2 (2015)**

OPERATION ON SITE



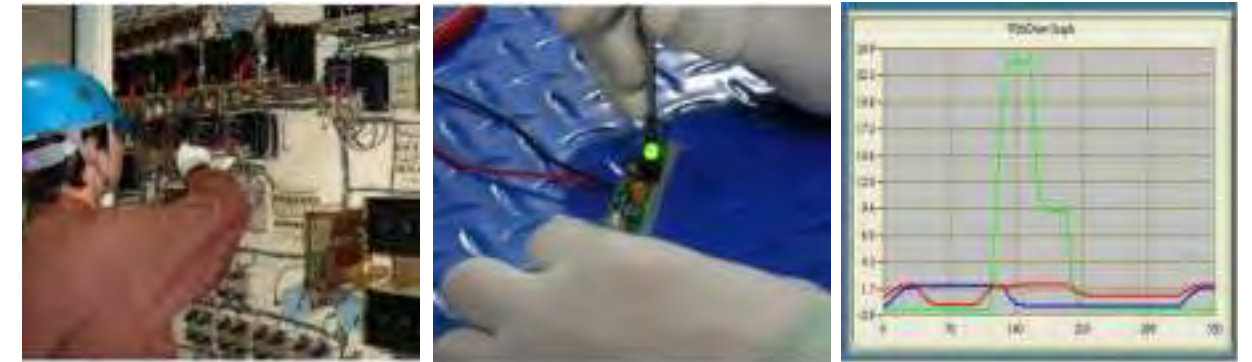
Conducting Comprehensive Test

KEY BENEFITS

- By checking for potential failure factors and taking measures in advance, plant safety can be enhanced.
- Predictive maintenance can be performed based on quantified data.
- Analysis of CDRM failure cases leads to prevention of recurrence.
- Providing simulator training increases employee competency.

ENGINEERING SERVICE RELATED TO CRDM SIMULATOR

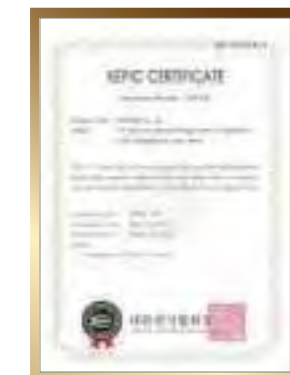
Based on the maintenance experiences and data accumulated in various reactor types (i.e., WH 2 Loop and WH 3 Loop) for over 20 years, we are able to conduct thorough inspections on the control rod driving coil and the control rod position indication transmitter.



SPECIFICATION

Size	750*930*1500mm(W*D*H)
Weight	220kg
Driving current	21KVA MAX
Power	480VAC/60Hz/3PHASE
Input	150V

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



PATENT CERTIFICATE
10-0914437



REALGAIN CO.,LTD.

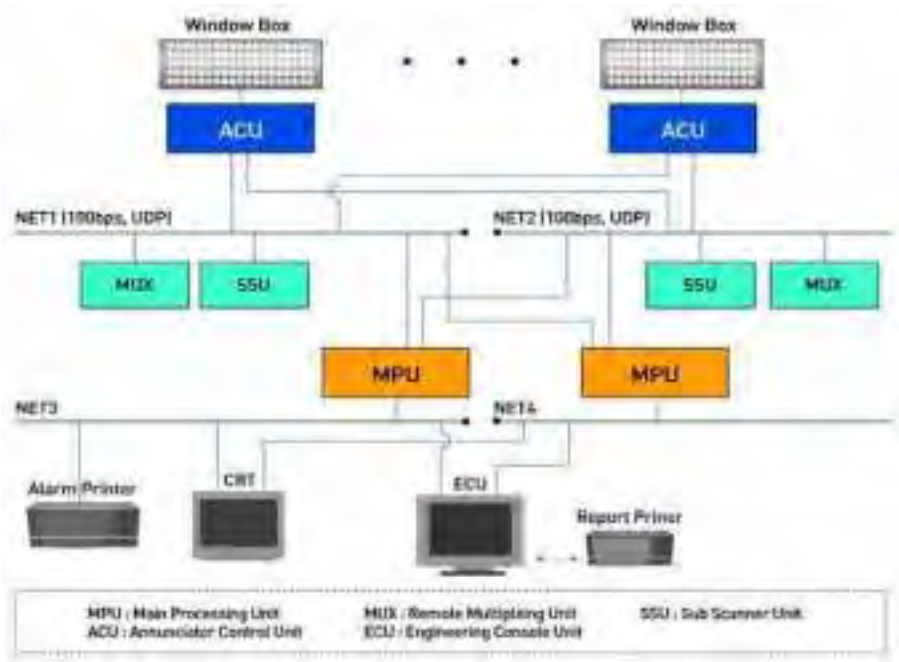
www.realgain.co.kr
SEONGSU ACE HIGH END TOWER, 14, Seongsuil-ro 10-gil,
Seongdong-gu, Seoul, 04784, Republic of Korea

Tel : +82 2 885 4781 Fax : +82 2 885 4782
Email : realgain@realgain.co.kr

Plant Annunciator System

- High Speed Communication
- Human Factors Engineering

The Plant Annunciator System quickly and accurately notifies the Main Control Room operator in the event of abnormal conditions at the plant by using 100Mbps Ethernet communication and a user friendly system configuration to prevent human errors. This system also provides data for tracking the cause of a plant transient.



BACKGROUND

Replacement of the Plant Annunciator System was required due to the long-term operation of the system and the original manufacturer's discontinuation of spare parts. The latest technologies including human factors engineering and enhancements to maintenance convenience have been incorporated to develop and implement this high-performing system.

PROVEN TECHNOLOGY

WH-type nuclear power plants in Korea that have been under operation for a long period of time have implemented this system with the latest technology (i.e., redundancy of major components and human factors engineering), thereby enhancing plant safety. Accurate cause analysis of abnormal conditions based on reliable data helped prevent recurrence of the same accident.

FEATURES

- The distributed alarm system offers highly reliable time synchronization and is capable of recording an alarm down to the millisecond.
- Input signals are distributed by each rack unit.
- Its safety capabilities include redundancy of the power supplier and other major components.
- This system has been designed to prevent malfunctions caused by disturbances.
- This product requires shorter maintenance time as a result of using various self-diagnostic functions.

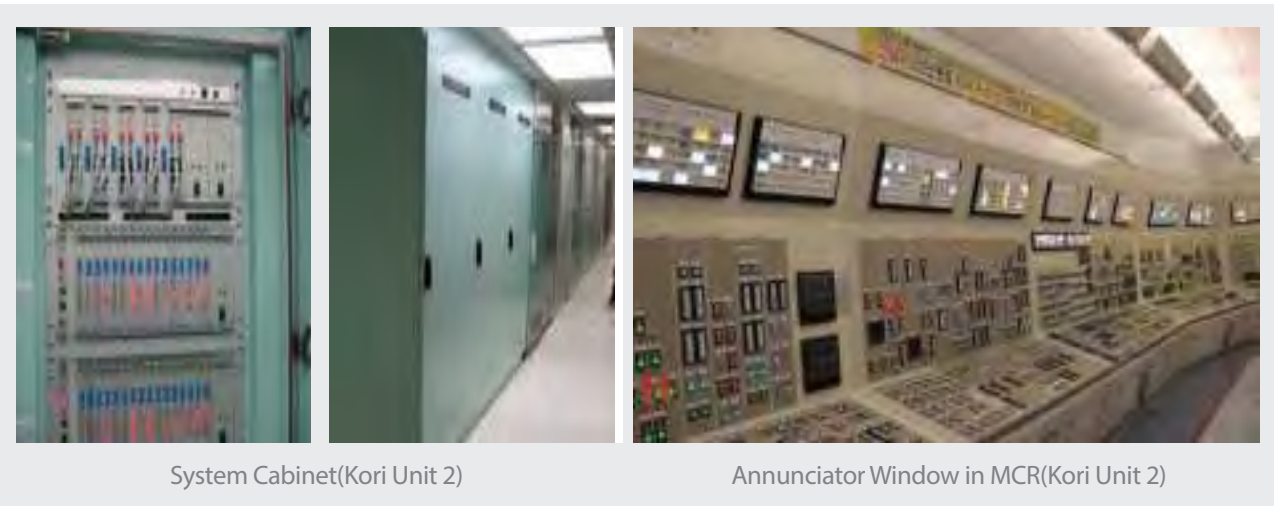
COMPOSITION

Component	Characteristics
SSU/MUX	512 signals/1SSU or MUX, Max. 16 SSU/MUX expandable Consists of a CPU card, DIM card (contact signal input), power module, and 19-inch rack Offers redundancy
ACU	Independent and redundant structure for each alarm window box, drive alarm lamp after alarm logic execution Consists of an alarm window controller and power module
Window Box	Two types: ACU-mounted and ACU externally mounted type LED of various colors (i.e., white, yellow, and red)
Status Light Box	Directly connected to the field signal to drive the LED lamp
Horn	Horn and ring-back functions simultaneously performed 16 kinds of sound built in / selection switch used
Pushbutton Station	Composed of silence, ack , reset, and test buttons
Network	100Mbps Ethernet
ECU/CRT	Window 10-based computer, engineering alarm logic, and system configuration Display alarm windows for operators

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2007), Hanbit Unit 1&2 (2019)
- **OPR1000** : Hanbit Units 3-6 (2000), Shin-Kori Units 1&2 (2005), Shin-Wolsong Units 1&2 (2005)

OPERATION ON SITE



KEY BENEFITS

- By installing this system that has demonstrated its effectiveness through long-term operation, plant safety and reliability can be enhanced.
- Operators can avoid making human errors.
- The existing system can be replaced with this system at a competitive price.
- Modularization of major components leads to improvement in maintenance convenience.

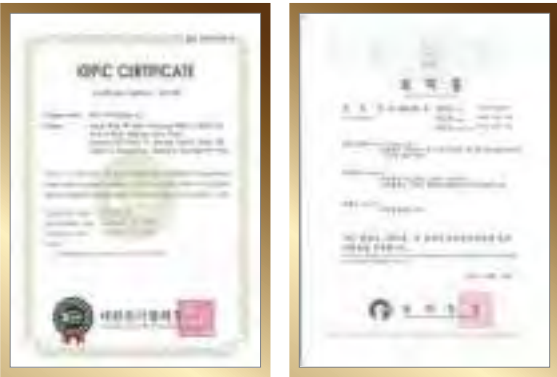
SPECIFICATION

Features	Characteristics
Distributed processing	Independent structure of rack units minimizes errors
High speed communication	100 Mbps Ethernet communication / Not multi-drop communication / Failure of one network does not damage other components
Single/Multiple mode failure	Power redundancy and independence / Rack can cope with multiple failures
AC induction voltage	Eliminates false alarms caused by AC induction voltage
Alarm window LED lamp	LED efficiency guaranteed by applying constant current circuit and through the use of red, yellow and white LED
Input signal processing	Normal Open/Close, Alarm Disable/Enable and Time Delay configuration provided
Self-diagnostic function	Self-diagnostic functions: power/communication/electronic card failure Reduced trouble shooting time through visual display of the fault location in the operator CRT
Alarm procedure support	Provides alarm procedures in PDF files for generated alerts
Convenient operator display	Provides convenient operator display such as system overview, alarm list, alarm window simulation, and diagnosis
Input signal filter processing	Filter processing for false signals that may occur due to catering or surge, etc.

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000
- Software Verification and Validation
 - IEEE 1012, IEC 60880
- Human Engineering
 - USNRC NUREG-0700

PATENT & CERTIFICATION



WOORI WOORI TECHNOLOGY INC.

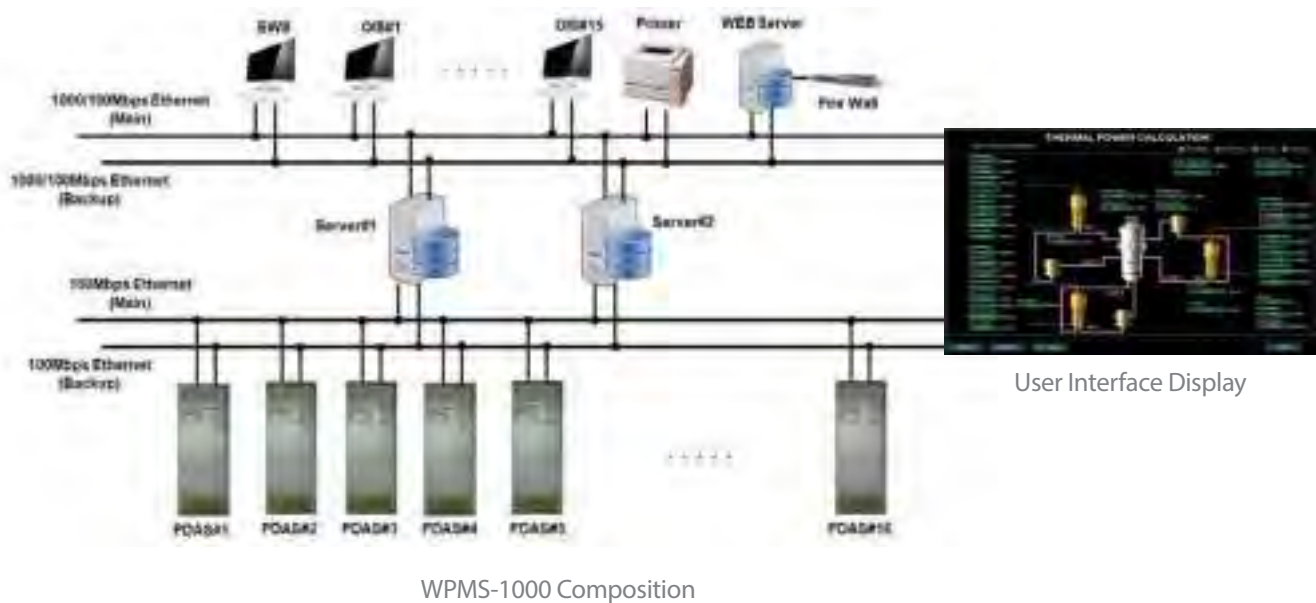
www.wooritg.com
9, World Cup buk-ro 56-gil, Mapo-gu, Seoul, Republic of Korea

Tel : +82 2 2102 5100
Fax : +82 2 2102 5111
Email : director@wooritg.com

Plant Monitoring System (PMS)

- Accurate Accident Analysis
- Effective Variable Monitoring

Plant Monitoring System (PMS) is a completely digitized equipment capable of accurate accident analysis. This system collects and monitors in real time the operation status and test data of various equipment in the plant, as well as the safety variables of major systems. In doing so, it provides vital information and supports analysis for plant operation.



BACKGROUND

Collecting important data and status information on various systems and leveraging them for efficient operation are essential to ensure plant safety. But it has become difficult to collect and store status information due to aging equipment and product discontinuation, which is why PMS fully digitized the analog equipment.

PROVEN TECHNOLOGY

Since 2006, PMS has been in operation at ten WH-, FRAMATOME-type, and OPR1000 reactors. With approximately 110 reactor years of experience at an operating plant, the system has demonstrated its safeness and reliability.

FEATURES

- The system offers high resolution and accuracy—the recognition time among the components differs by only 1 ms.
 - Digital: 1 ms resolution
 - Analog: 100 ms resolution, 0.1% accuracy
- Processing of a variety of input signals (e.g., voltage, current, and resistance) is available.
- Its safety capabilities include redundancy of the controller, module, network and server; hot swapping; self-diagnosis; and failure alarm.

COMPOSITION

Component	Description
Server	- Commercial computer; OS: Windows or Linux - Ensures reliability through physical redundancy - Saves plant signals sent by PDAS - Sends data displayed on the OIS HMI
Network	- Ensures safety through separation and redundancy of PDAS-server network and server-OIS network - PDAS-Server: 100 Mbps Ethernet - Server-OIS: 1000 Mbps Ethernet
PDAS	- Collects plant data - Guarantees reliability of the PDAS racks with CPU and power redundancy - Racks can be stacked up to 288 units
OIS	- Commercial computer; OS: Windows or Linux - HMI provided to operators
Web Server	- Commercial computer; OS: Windows or Linux - Implements the OIS through the web using the wide area network

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 3&4, Hanbit Units 1&2 (2007)
- **FRAMATOME-type** : Hanul Units 1&2 (2009)
- **OPR1000** : Shin-Kori Units 1&2(2008),
Shin-Wolsong Units 1&2(2010)

OPERATION ON SITE



[Plant Monitoring System]

KEY BENEFITS

- The existing analog modules have all been digitized, improving space utilization and reliability.
- Replacement of the PMS does not interfere with the integrated system, allowing continuous use of the existing system.
- Customer demands can be incorporated into the system design, enhancing utilization when building equipment.
- The system provides accurate accident analysis, down to the millisecond, in case of equipment failure or issue.

COMPARISON

Components	Main Specifications
PDAS	CPU Module CPU: PC8270(Core@450MHz) Communication: 100Mbps Fast Ethernet and serial Memory (SDRAM) 64MB + 32MB
	Digital Input Module 32 Channels, 24V/48V Digital Input
	Digital Output Module 16 Channels, Normal Open/Close, Failsafe
	Digital Output Module High-Voltage Digital Output, AC120/DC125 type
	Analog Input Module 8 Channels, Voltage/Current Input
	Thermocouple Input Module 7 Channels, B,R,S,K,E,J,T,N Type, CJC feature
	RTD Input Module 8 Channels, 3-wire/4-wire RTD Input Module
	Analog Output Module 8 Channels Analog Voltage/Current Output Module
	Power Supply Module (Input) AC85 ~ AC264 (Output) DC48V/13A, 24V /14A, 12V/27A Power-Fail Output, Dual Diode
Server	CPU: Itanium 2 Memory: 256GB(per system) HDD: Max 5.4T Communication: 10/100/1000 Base-T ethernet
OIS	Samsung syncmaster 214TS CPU: Xeon 3.33GHz Memory 4GB HDD: 146GB SAS x 3Ea Network: 1000 Base-T 6Ea

CODE & STANDARDS

- IEEE 323 (Class 1E Equipment Qualification)
- IEEE 344 (Seismic Qualification)
- IEEE 1012 (Software Verification and Validation)
- NUREG-0700 (Human Engineering)
- RG 1.180 (EMC Qualification)

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



WOORI WOORI TECHNOLOGY INC.

www.wooritg.com
9, World Cup buk-ro 56-gil, Mapo-gu, Seoul, Republic of Korea

Tel : +82 2 2102 5100
Fax : +82 2 2102 5111
Email : director@wooritg.com

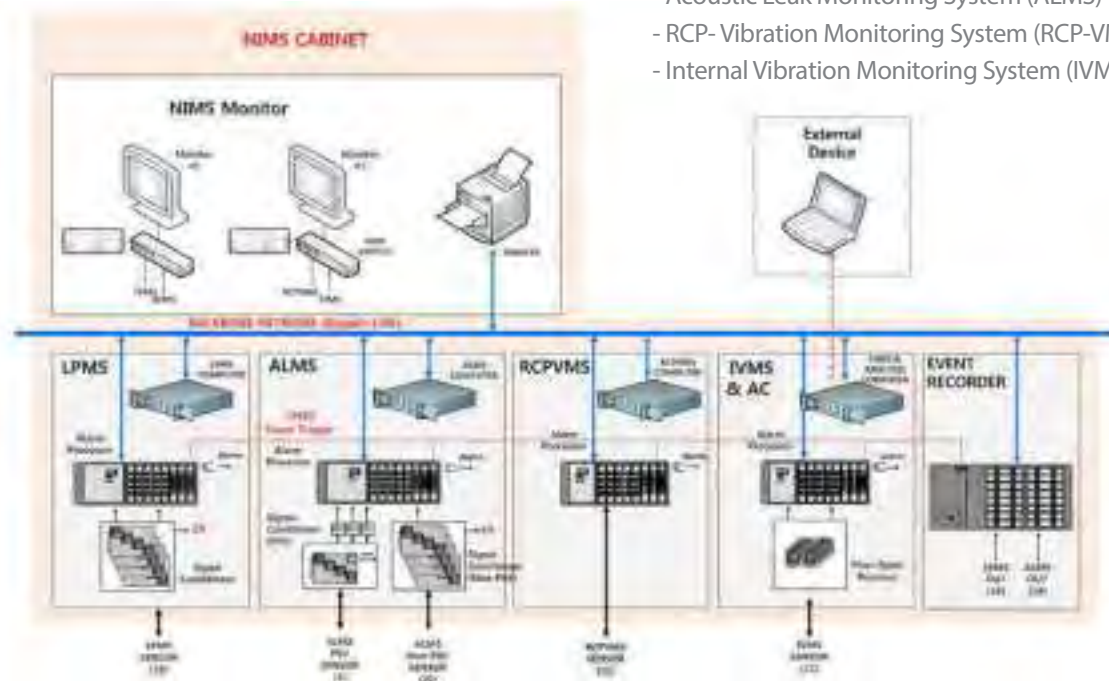
NSSS Integrity Monitoring System

Equipment Reliability

User Convenience

With application of the latest hardware and software, the NSSS integrity monitoring system (NIMS) monitors all signals of each system listed below before comprehensive analysis, thereby monitoring and determining the structural integrity of the NSSS with enhanced accuracy.

- Loose Parts Monitoring System (LPMS)
- Acoustic Leak Monitoring System (ALMS)
- RCP- Vibration Monitoring System (RCP-VMS)
- Internal Vibration Monitoring System (IVMS)



BACKGROUND

The NSSS integrity monitoring system has been in operation for over 20 years. However, the operating system, completely different from the currently used Windows, was not convenient for use and the low performing hardware caused frequent system shutdowns and failures. Moreover, due to obsolescence and discontinuation of essential devices, the system required replacement for safe operation of the plant. This led to the development of the upgraded NIMS that provides integrated monitoring, backed up by the latest software and hardware.

PROVEN TECHNOLOGY

Hanbit Units 3&4 replaced four systems—LPMS, ALMS, RCP-VMS, and IVMS—with the NIMS, a mixture of the latest hardware and diagnostic software. This led to a higher level of accuracy and increased user convenience. The WH-type reactors replaced the LPMS and the ALMS with the systems developed in Korea, increasing the operational reliability of the plant.

FEATURES

- Integrated monitoring of the LPMS, ALMS, RCP-VMS, and IVMS enables efficient monitoring and diagnosis of the structural integrity of the NSSS.
- The Windows-based operating system allows personnel to work on the monitored data in a commercial software setting, improving data utilization.
- The operation screen that has incorporated human factors engineering as per NUREG-0700 provides a convenient work environment.
- The self-diagnosis feature, failure alarms, and mutual monitoring function provide convenience for maintenance.
- This system features an improved data processing capability and a large-size volume capacity with high precision.

COMPOSITION



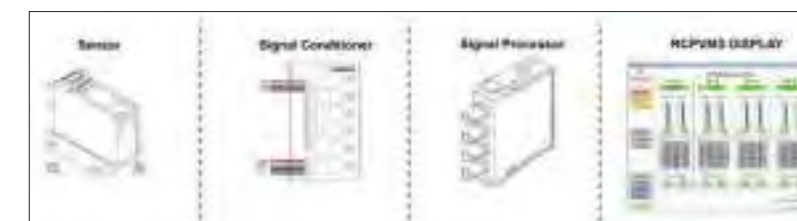
LPMS

Detects metal debris within the pressure boundary of the primary system by using the acceleration sensor



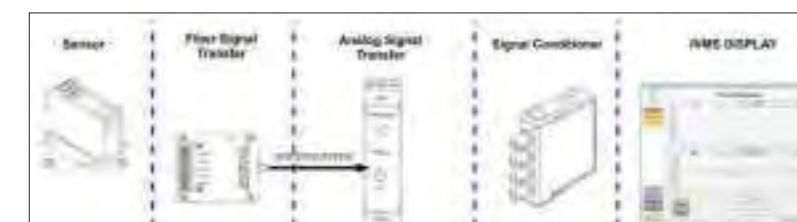
ALMS

Detects leakage and cracking in the primary pressure system by using the accelerometer and AE sensor



RCPVMS

Monitors abnormality of the rocking axis and bearing of the RCP by using the proximity and acceleration sensors



IVMS

Detects defects in the support of the structure within the reactor by using the noise signal from the excore neutron detector

SUPPLY EXPERIENCE

LPMS

- **WH-type** : 2 loop - Kori Unit 1 (2001-2002), Unit 2 (2001-2002)
3 loop – Kori Unit 3 (1999-2000), Unit 4 (1999-2000), Hanbit
- **FRAMATOME-type** : Hanul Unit 1 (2001-2002), Unit 2 (2001-2002) (ALMS)

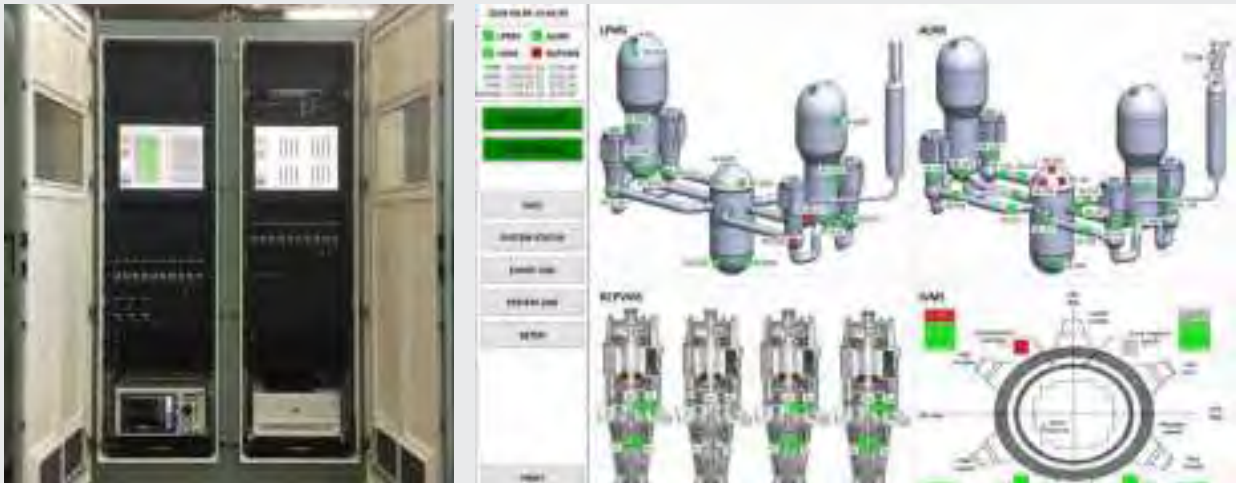
ALMS

- **WH-type** : 2 loop - Kori Unit 1 (2011), Unit 2 (2011)
3 loop – Kori Unit 3 (1999-2000), Unit 4 (1999-2000)
- **FRAMATOME-type** : Hanul Unit 1 (2001-02), Unit 2 (2001-2002)

ALMS

- **CE-type** : Hanbit Unit 3 (2018), Unit 4 (2018)

OPERATION ON SITE



[Hanbit Nuclear Power Plant Units 3&4]

KEY BENEFITS

- Integrated monitoring of the LPMS, ALMS, RCP-VMS, and IVMS leads to more accurate level of monitoring and diagnosis of the NSSS and improves plant safety.
- The interface designed to incorporate human factors engineering enhances user convenience.
- Acquired data can be processed and be put under thorough analysis in a commercial software setting in the event of an operation accident or failure, leading to maintenance efficiency.
- The four systems can be supplied individually according to the user's needs.

SPECIFICATION

System	Component	Main Specifications	System	Component	Main Specifications
LPMS	LSCU (LPMS Signal Conditioner Unit)	• Can load up to 10 LSCMs (XS800A) • Signal input/output terminal module (XSR800A) installed on the back of the LSCU • Sends signal to LAPU, ASU, and ERU	RCPVMS	RSCM (RCPVMS Signal Conditioner Unit)	• Possible to load up to 8 XSP800As or XSP800Bs for 1 RSCM • Input Power: +24VDC ±5% • Accuracy: Within ±0.05%
	LAPU (LPMS Alarm Processor Unit)	• Program developed with LabView • Signal acquired with sampling speed of 200KHz		RAPU (RCPVMS Alarm Processor Unit)	• Signals from 12 proximity sensors and 8 acceleration sensors are taken at the sampling speed of 10KHz to be sent to RPC
ALMS	PSCU (PSV Signal Conditioner Unit)	• Possible to load up to 3 PSCMs (XS800C) • Signal input/output terminal module (XSR800C) installed on the back of the PSCU • 3U, 19-inch subrack • High/low pass filter embedded	IVMS	FOR (Fiber Optic Receiver)	• Input Power: +15VDC ±5% • Analog Output Signal Rating : 0 - 10.2V • Wavelength: 650nm • Response Time: Within 4ms • Accuracy: Within ±0.05%
	AAPU (ALMS Alarm Processor Unit)	• Program developed with LabView • 20 non-PSV and 3 PSV signals taken at the sampling speed of 1MHz		IAPU (IVMS Alarm Processor Unit)	• Analog signals generated from FOR at the sampling speed of 5KHz are sent to IPC

CODE & STANDARDS

- IEEE 323 (Class 1E Equipment Qualification)
- IEEE 344 (Seismic Qualification)
- IEEE 1012 (Software Verification and Validation)
- NUREG-0700 (Human Engineering)

PATENT & CERTIFICATION



PATENT CERTIFICATE (EN)



WOORI WOORI TECHNOLOGY INC.

www.wooritg.com
9, World Cup buk-ro 56-gil, Mapo-gu, Seoul, Republic of Korea

Tel : +82 2 2102 5100
Fax : +82 2 2102 5111
Email : director@wooritg.com

Digital Reactivity Computer System

High Compatibility

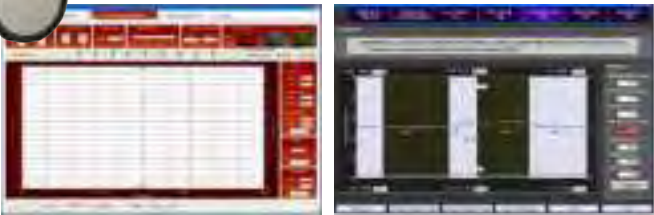
Short Test Time

This Digital Reactivity Computer System is an essential equipment used during low-power physics testing (LPPT). With the excore detector located outside the reactor, it measures the neutron flux signal to calculate the core reactivity. The calculated value is compared with the design value of the Nuclear Design Report to confirm the validity of the nuclear design. Applicable to various techniques (i.e., dynamic control rod measurement, boron dilution, and rod swap) and all types of excore detectors (i.e., ion chamber and fission chamber), this system is highly convenient.



BACKGROUND

Discontinuation of the existing reactivity computing equipment gave rise to the need for development of a new reactivity computing system. This reactivity computing system has been specifically designed to support data acquisition and analysis with the dynamic control rod measurement (DCRM), a technique that measures control rod worths more quickly compared to conventional methods such as boron dilution and the rod swap technique (time reduced from 16 to four hours).



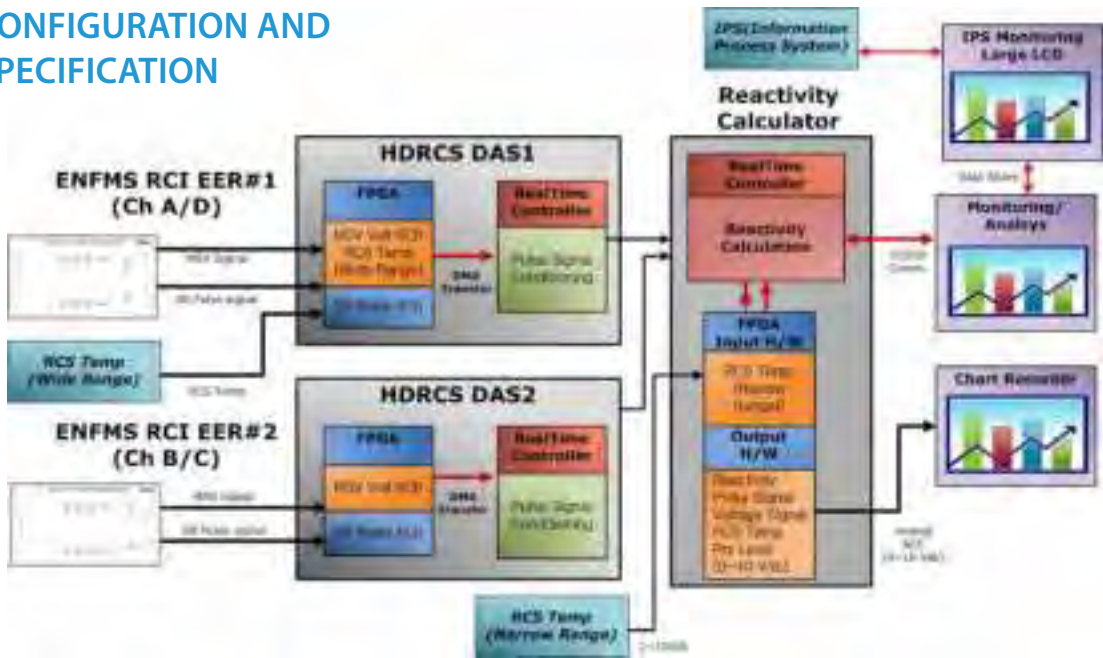
PROVEN TECHNOLOGY

First installed in 2004 in 24 units across Korea (reactor manufacturer: WH, OPR, and FRAMATOME), this system has also been installed in Barakah Nuclear Power Plant Unit 1 and 2 in the UAE. With 173 reactor years of operation experience, this reactivity computer system has been proven to be safe and reliable.

FEATURES

- This reactivity computing equipment is highly compatible with all other types of reactors and excore detectors. (i.e., ion chambers and fission chambers)
- This system can be used for any of the techniques including rod swap, boron dilution, and DCRM. In particular, when applied to the DCRM, the system saves 12 hours of critical path time during outage.

CONFIGURATION AND SPECIFICATION



Signals/Equipment	Description
Range of Input Signals for Neutron Flux Measurement	- Linear Current Signal: 0.1 - 1000 nA - Pulse Signal: 1 - 9 Mhz (9M cps) - MSV Signal: 0 - 10 Vdc
Reactivity Computing Equipment	- Real-Time Processor: RT CPU(1.91 Ghz, Quad Core). RT WIN O/S - IPKE Delta T: 0.1 - 1 Sec. - Delay Neutron Data: 6 Groups - Reactivity Accuracy (%): Within ± 2% max
Output Signals	- Input Voltage : -10 ~ +10 Vdc - Resolution : 16 bit - Sampling rate : 100 kS/sec

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2 (2005, 2016), Kori Units 3&4 (2004), Hanbit Units 1&2 (2005, 2012)
- **FRAMATOME-type** : Hanul Units 1&2 (2005, 2011)
- **OPR1000** : Shin-Kori Units 1&2 (2009), Hanbit Units 3&4 (2004), Hanbit Units 5&6 (2005), Hanul Units 3&4 (2005), Hanul Units 5&6 (2004), Shin-Wolsong Units 1&2 (2010)
- **Research** : Kyunghee University Reactor Research and Education Center (AGN-201K)

OPERATION ON SITE



<Installed in the field>



<Measurement Software>

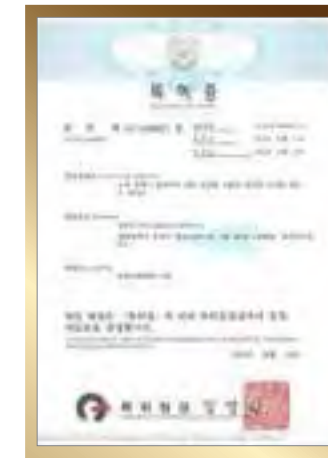
KEY BENEFITS

- The hardware and software of the reactivity computer can be customized upon test staff's requests.
- Long-term use of the reactivity computer system does not lead to severe distortions of the result. In particular, a verified numerical analysis method has been applied to the reactivity calculation module, lending credibility to the result.
- Maintenance is easier as installing the testing equipment is easy and the test results are automatically analyzed.
- When conducting DCRM, control rods can be inserted and removed at the maximum speed to calculate the control rod reactivity worth. Additional benefits arise from shortened test time compared to conventional test methods (i.e., boron dilution and rod swap), saving 14 hours of critical path time.

PATENT & CERTIFICATION



PATENT CERTIFICATE
No. 10-1216608



PATENT CERTIFICATE
No. 10-1436021



www.users.co.kr
65, Techno3-ro, Yuseong-gu, Daejeon, Republic of Korea

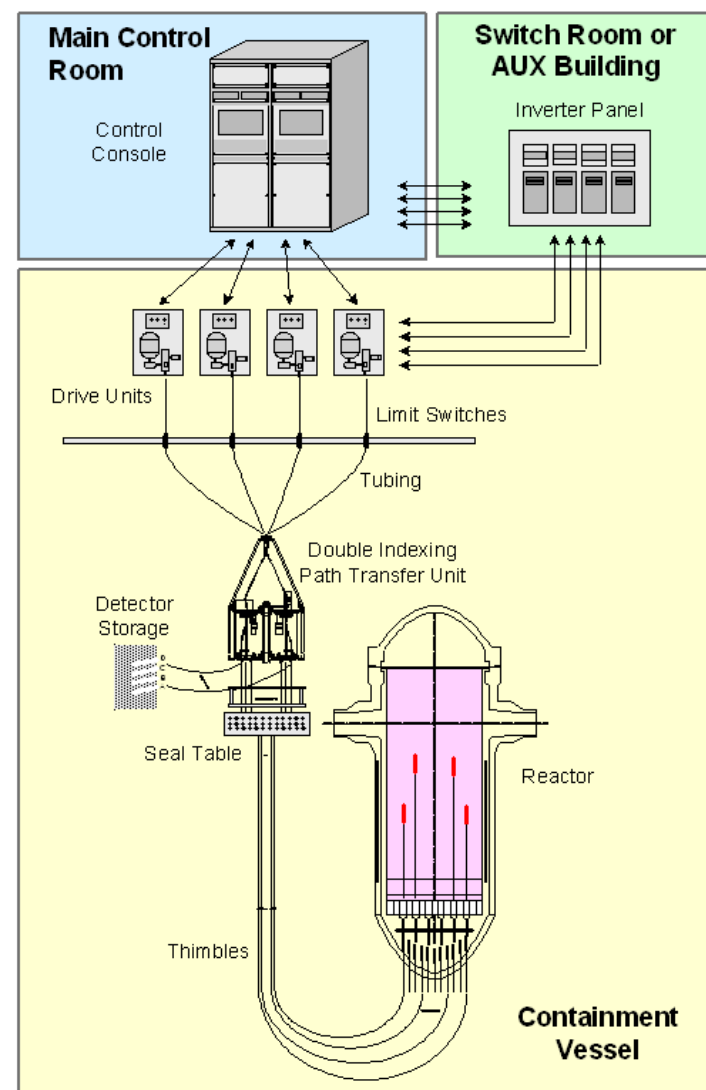
Tel : 042-934-5793
Fax : 042-861-7894
email : shoh@users.co.kr

Double Indexing Path Selector (Dips) Flux Mapping System (DFMS)

Obsolescence Solution

Work Efficiency

This system measures the distribution of the neutron flux in the reactor core during operation and provides the data to the operator. Its simplified structure has led to a decrease in failure rates and reduction in maintenance time. Also, by improving the drive mechanism, it has become possible to measure all reactor cores with one drive unit.



BACKGROUND

This DFMS for WH- and FRAMATOME-type reactors in Korea was introduced more than 30 years ago. A long period of operation caused aging and deterioration of the system, leading to a reduction in reliability. Discontinuation of spare parts by the original manufacturer further created a need for an overall refurbishment. Against this backdrop, this product has been developed and installed in nuclear power plants across Korea.

PROVEN TECHNOLOGY

This digitized system has been installed in all WH- and FRAMATOME-type reactors in Korea, enhancing system reliability. New features were added to the system to raise maintenance efficiency and reduce maintenance time in high radiation areas, thereby drastically reducing worker exposure to radiation.

FEATURES

- The system has been simplified using a single layered, double indexing path selection mechanism.
- This product can measure all four areas of the core by using one drive unit.
- With the use of a reverse torque generating device, the system prevents distortions of detectors.
- Using the 16-path position control method, this system provides a higher degree of precision in path selection.
- This product provides various self-diagnostic data.

COMPOSITION



DIPS

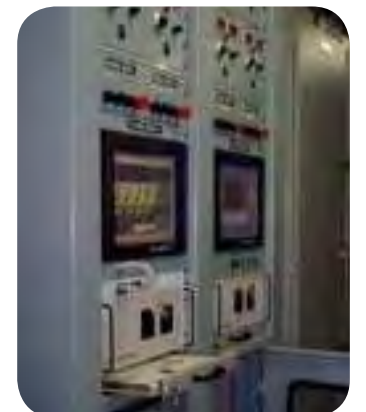
The double indexing path selector is composed of four inner path selectors, an outer path selector and an anti-twister for guide tubes



Drive Unit

Four drive units move their dedicated detectors

- The 3-D fabricated helical gear is well engaged with spiral wire-wound detector cable to maximize force transfer efficiency
- A torque-generating device in the storage reel provides a proper tension to the detector cable



Control Panel

The system adopts industrial standard components and open system architecture to enhance maintainability

- Precision control for drive units and path selector is essential in the system
- Enhanced GUI based functions for Auto/Semi-auto/Manual operations are provided

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2005), Hanbit Units 1&2 (2007)
- **FRAMATOME-type** : Hanul Units 1&2 (2009)

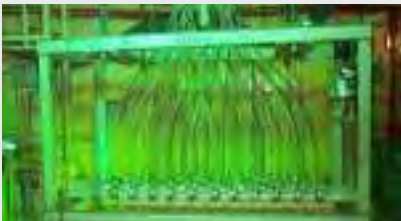
OPERATION ON SITE



Drive Units (Kori Unit 2)



Path Selector (Kori Unit 2)



User Interface Screen

KEY BENEFITS

- By installing the DFMS, which has demonstrated its efficiency through long-term operation, plant safety can be enhanced.
- The existing FMS can be replaced with this system at a competitive price.
- Simplification of the system leads to lower maintenance costs.
- Improvements to maintenance have been applied, leading to less time spent in high radiation areas, subsequently reducing worker exposure to radiation.

SPECIFICATION

Item	Specification
Path Selector	Dips (4/16)
Mapping Speed (High/Low, cm/s)	60.96 / 6.096
Driver Gear	Helical
Number of Drivers	4
Detector Guide	Guide Roller
Control of Reel Tension	Torque Motor
Thimble Type	U / L (about 35~39m)
Number of Thimble	50
Thimble Diameter (Inner/Outer, mm)	5.43 / 7.92

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - EPRI TR-102323
- Software Verification and Validation
 - IEEE 7-4.3.2, IEC 60880

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



SOOSANENS

www.soosanens.co.kr
21, Maegoksaneop-ro, Buk-gu, Ulsan, 44222, Republic of Korea

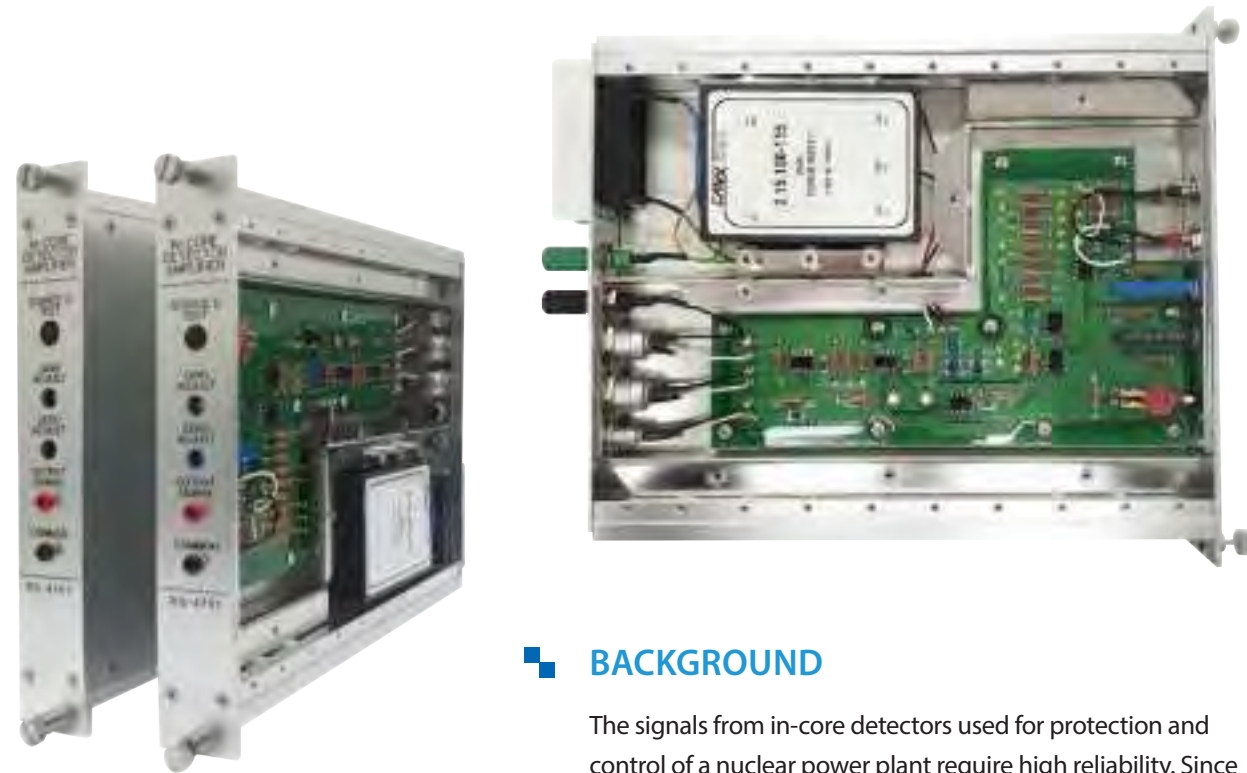
Tel : +82 52 258 3860
Fax : +82 52 58 3865
Email : kykwom@soosan.co.kr

In-Core Flux Detector Amplifier (ICA)

Equipment Reliability

Cost-Efficient

This is a module that amplifies and transfers microcurrents from an in-core detector to the Shutdown System (SDS) and the Digital Control Computer (DCC) with increased disturbance tolerance and linearity for protection and control of a nuclear power plant.



BACKGROUND

The signals from in-core detectors used for protection and control of a nuclear power plant require high reliability. Since the signals are microcurrents that are vulnerable to disturbance, a circuit design with enhanced tolerance to disturbances was required. In addition, it was difficult to control the inventory of the spare modules due to long delivery, and maintenance costs increased due to the aging of the existing modules' electronic devices.

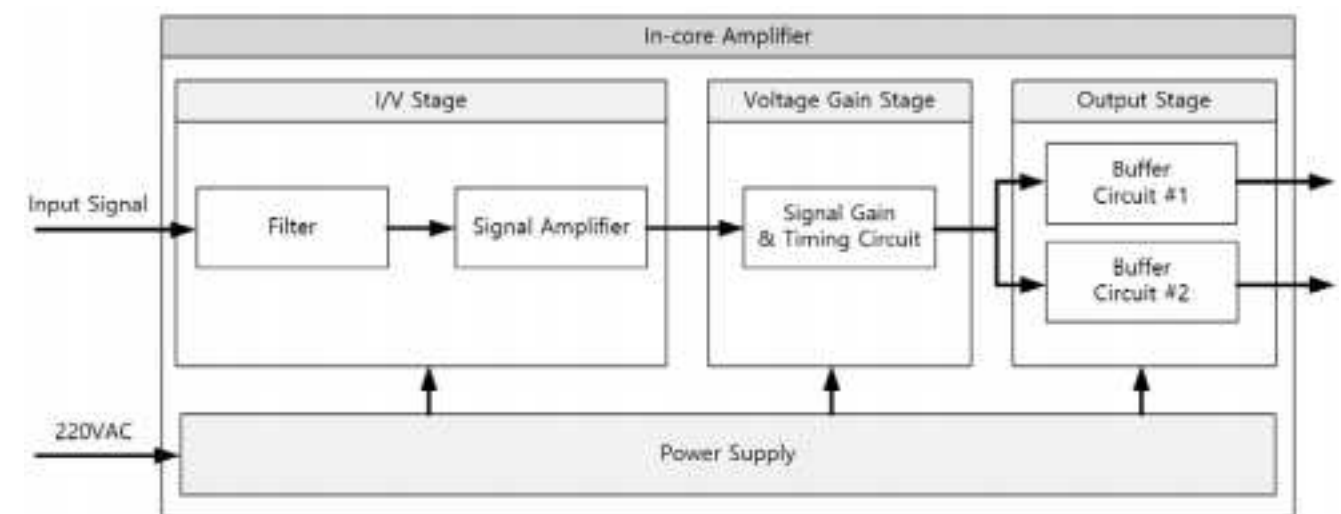
PROVEN TECHNOLOGY

The CANDU-type reactor Wolsong has improved the reliability of signal loops of in-core detectors by applying the new modules with the improved disturbance tolerance and linearity. In addition, we have reduced maintenance costs by offering a competitive price and were able to efficiently control the inventory of spare modules with short delivery time.

FEATURES

- This product allows seamless integration and interface with the existing modules.
- The circuit has been designed to incorporate enhanced tolerance to disturbance.
- Enhanced linearity of the circuit has led to improved accuracy. (0.02% of full scale)
- This product enables application of alternative devices in replacement of obsolete electronic devices.

COMPOSITION



Functional Block Diagram of ICA

I/V Stage

- Filter input signal(current) and convert current to voltage through OP-AMP

Voltage Gain Stage

- Amplify the voltage signal
- Adjust the response time of output signal

Output Stage

- Isolate electrically to prevent ICA failure due to connected external equipment failure

SUPPLY EXPERIENCE

- CANDU-type : Wolsong Units 1-4 (Approximately 410 units have been supplied since 2015), Cernavoda Units 1&2 in Romania(2021)

OPERATION ON SITE



Wolsong Unit 1 and 2



Functional Test for In-Core Amplifier

KEY BENEFITS

- This module, which has demonstrated its effectiveness through long-term operation, helps enhance plant safety.
- The existing amplifier modules can be replaced at a competitive price.
- Shortened delivery time increases the efficiency of inventory control.

SPECIFICATION

Item	Description
Model No	RG-4701
Dimensions	D 1.35 X W 9.80 X H 8.72 (in) D 34.3 X W 248.9 X H 221.4 (mm)
Current Range	440nA ~ 2.6uA
Source Capacitance	15,000pF. Max.
No. of Buffered outputs	2
Output voltage Range	0.5 ~ 4.5 VDC
Output Current	5mA
Response Time	10ms
Drift	< 0.05%. F.S. / 24h
Linearity	< 0.5%

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
 - IEEE C37.98-1988
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



REALGAIN CO.,LTD.
www.realgain.co.kr
SEONGSU ACE HIGH END TOWER, 14, Seongsuil-ro 10-gil,
Seongdong-gu, Seoul, 04784, Republic of Korea
Tel : +82 2 885 4781 Fax : +82 2 885 4782
Email : realgain@realgain.co.kr

Radiation Monitoring System

Obsolescence Solution

Equipment Reliability

This radiation monitoring system (RMS) continuously monitors radiation levels of a major system or a particular area in a nuclear power plant, thereby preventing radiation leakage and limiting worker exposure to radiation. Gas, liquid, and area radiation monitors have been integrated into one system.



BACKGROUND

Continuous maintenance and repair are important for maintaining the reliability of the RMS. However, frequent mergers and acquisitions of RMS suppliers caused difficulties in receiving technical assistance for maintenance and securing spare parts. Against this backdrop, this radiation monitoring system and equipment units have been developed to ensure that the components of this system are supplied in a stable manner and to improve the integrity of the equipment.

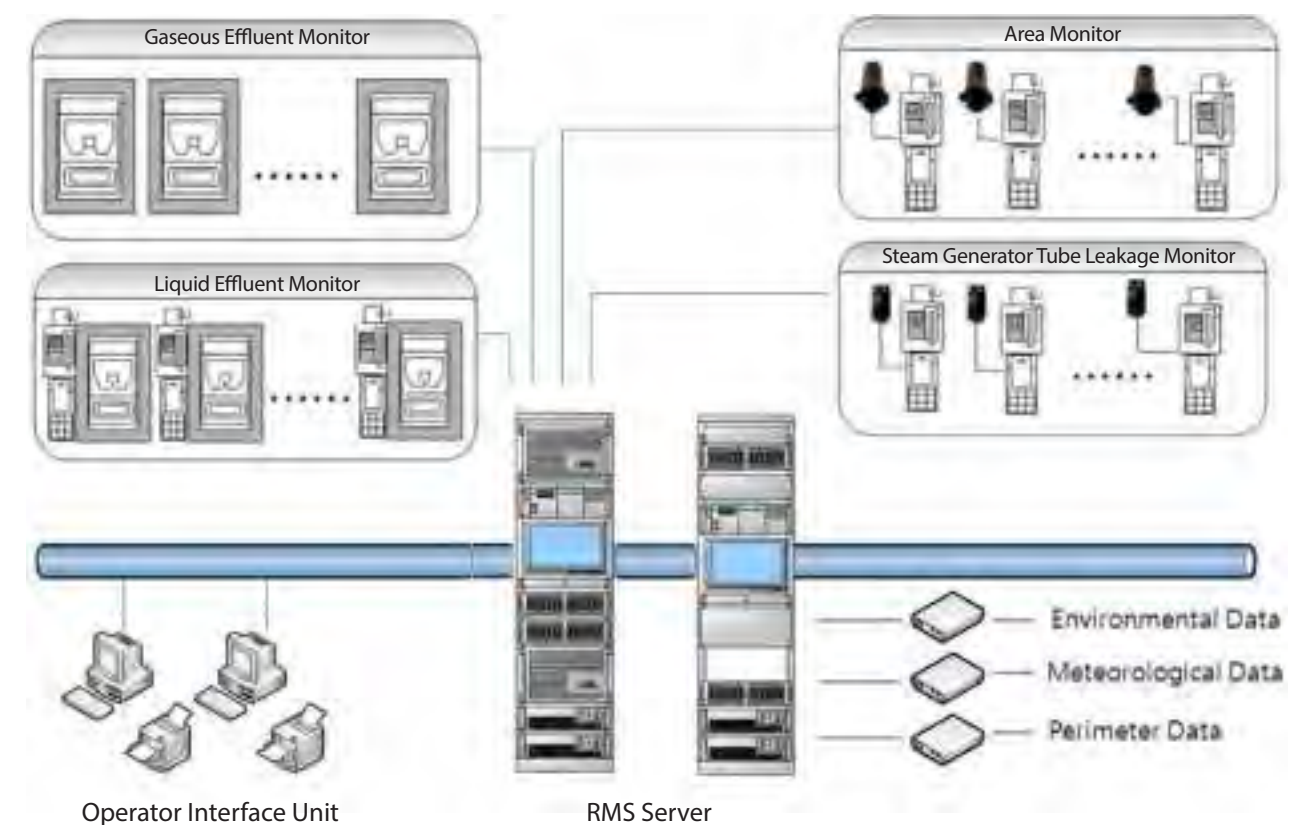
PROVEN TECHNOLOGY

This product has been in operation at many plants (i.e., WH-, CANDU-type reactors) since 2009, demonstrating its reliability. In between 2012 and 2017, the entire system has been implemented in Barakah Units 1 through 4, proving the high performance of the integrated RMS. Over the period of ten years, we have supplied necessary components in a prompt manner and provided maintenance and repair services, thereby supporting stable operation of the RMS. Moreover, we have gradually implemented the latest devices and upgraded the design to improve system performance.

FEATURES

- Optimization of the components layout has improved maintenance convenience.
- As individual modules that interact with each function have been applied and a self-diagnosis feature is provided, maintenance comes easy.
- As a dedicated server optimized for the RMS is used, this product is intuitive enough to use.
- Seamless integration with the existing system enables only certain components to be replaced.
- By applying the latest hardware, the accuracy and reliability of the system have improved.

CONFIGURATION



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2(2012), Hanbit Units 1&2(2021)
- **CANDU-type** : Wolsong Units 1&2(2016)
- **CPI-type** : Hanul Units 1&2(2005)
- **OPR1000/APR1400** : Hanbit Units 3&4(2017), Hanul Units 3-6(2021), Barakah Units 1-4(2017)

OPERATION ON SITE



Wolsong Unit 1 Liquid Effluent Monitor



KEY BENEFITS

- Both the system as a whole and equipment units can be supplied at a competitive price. This is especially advantageous in the long run, when purchasing major components that need to be replaced frequently.
- As a major RMS supplier to a company that operates 24 nuclear power plant units across Korea, stable supply of material and technical assistance of high quality are guaranteed.
- Equipment upgrade is ongoing to meet the latest technical standards, thereby ensuring high performance and reliability of the RMS.

SPECIFICATION

Item	Gaseous RMS	Liquid RMS	Area Monitor
Detector Type	P: Beta Scintillation I: Gamma Scintillation G: Beta Scintillation	Gross Gamma	Ion Chamber GM Tube
Radiation Range	P: 3.7E-6 ~ 3.7E+1 [Bq/cc] I: 3.7E-5 ~ 3.7E+1 [Bq/cc] G: 3.7E-2 ~ 3.7E+5 [Bq/cc]	3.7E-2 ~ 3.7E+3 [Bq/cc]	1.0E-3 ~ 1.0E+2 [mSv/hr]
Energy Range	P: 50 KeV ~ 3 MeV I: 70 KeV ~ 3 MeV G: 50 KeV ~ 3 MeV	70 KeV ~ 3 MeV	80 KeV ~ 1.5 MeV

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC61000

PATENT & CERTIFICATION



PATENT CERTIFICATE
No. 10-0915532



PATENT CERTIFICATE
No. 10-1604306



REALGAIN CO.,LTD.
www.realgain.co.kr
SEONGSU ACE HIGH END TOWER, 14, Seongsuil-ro 10-gil,
Seongdong-gu, Seoul, 04784, Republic of Korea
Tel : +82 2 885 4781 Fax : +82 2 885 4782
Email : realgain@realgain.co.kr

Post-Accident Sampling System

Minimum Radiation Exposure

User Convenience

The Post Accident Sampling System was introduced in the aftermath of the TMI accident, to be used in case of severe accidents that cause damage to the core. It is designed to identify the status of the Reactor Coolant System and the containment building while minimizing radiation exposure. It provides functions such as reliable post-accident sampling and real-time monitoring of concentration levels via online analyzer.



BACKGROUND

The PASS was developed to meet the regulations set forth by the Nuclear Regulatory Commission, namely NUREG-0737 and RG 1.97, taking into consideration the characteristics of each reactor type. By configuring integrated sampling panels, digitizing control and monitoring panels, and incorporating radiation shielding designs for safe and quick post-accident sampling, it provides higher user convenience and reliability than conventional systems.

PROVEN TECHNOLOGY

After the first installation of the PASS in Hanul Units 5&6 (2007), the system has been supplied to ten units, together with the primary and secondary sampling system. The PASS has also been successfully installed in all four units of the Barakah nuclear power plant in the UAE (2018). Operation of this system in multiple units over 15 years has demonstrated its safety and reliability. At the same time, the performance of the PASS and the sampling system has gradually improved.

FEATURES

- Integration of the two sampling systems for the Reactor Coolant/Residual Heat Removal and the Containment Air leads to an increase in user convenience and reduction in sampling time.
- Configuring sample cooler racks in a separate shielded area apart from the normal primary sampling system reduces worker exposure to radiation.
- Incorporating instrumentation and solenoid panels in the post-accident sample sink enhances space efficiency and user convenience.
- The system is streamlined by directly supplying service water from the plant's demineralized water system without having to run a separate flush/dilution water skid system.

CHARACTERISTICS



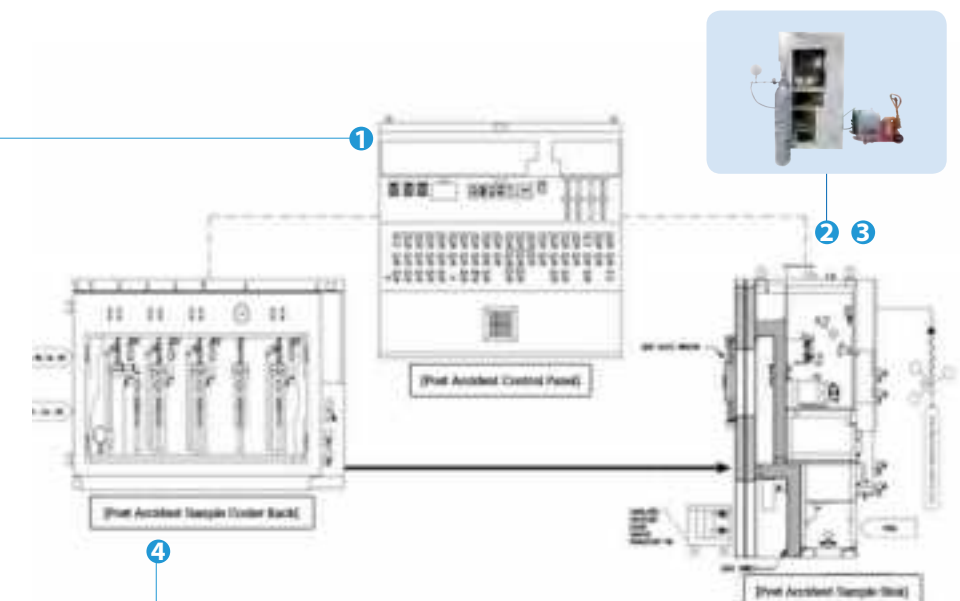
① Post-Accident Sample Control Panel

This control panel remotely controls and monitors the post-accident sample sink and the sample cooler rack.



④ Post-Accident Sample Cooler Rack

The transferred liquid samples are cooled down to a temperature suitable for sample handling and are transferred to the post-accident sample sink.



② Post-Accident Sample Sink

Before the samples are supplied, they undergo a pretreatment (i.e., dilution, pressurization) process to be available for use at the lab and online analyzer. The sink is completely shielded, taking into consideration the post-accident sample's high radiation level.

③ Sample Transport Vessel

This shielded sample transport vessel is for transfer of the samples from the post-accident sample sink to the radio-chemical lab. A lift car has been attached for convenience and stability.

SUPPLY EXPERIENCE

Supply of PASS in NPP

- **OPR1000** : Hanul Units 5&6(2007)
- **APR1400** : Barakah Units 1-4(2018), Shin-Hanul Units 1&2(2017), Shin-Kori Units 3&4(2012)

Feasibility Study on PASS Replacement

- **WH-type** : Slovenia Krsko Unit 1(2021)

OPERATION ON SITE



Sample Sink (Rare) & Cooler Rack



Post-Accident Sample Sink (Front)

KEY BENEFITS

- This product enables reliable sampling in the event of a severe accident with minimum radiation exposure.
- This product provides a customized system by drawing on both its operational experience with various types of reactors and expertise with supplying an array of equipment; gives specific directions on how to refurbish the aging plant's equipment (either in parts or the whole of the system).
- Efficient equipment layout and its digitization lead to enhanced user convenience for maintenance and reduction in costs.

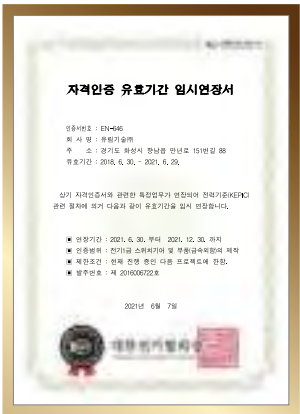
SPECIFICATION

	Sample Cooler Rack	Sample Sink	Sample Control Panel
Length(in/mm)	78/1,981	65/1,651	99/2,515
Height(in/mm)	48 13 / 16 1,240	78 / 1,981	82 / 2,083
Depth(in/mm)	18 / 457	49 / 1,245	52 / 1,321
Weight, total(lb/kg)	688 / 312	20,062 / 9,100	3,300 / 1,500
Heat loss, total(Btu/h/kW)	2,960 / 0.86	5,007 / 1.46	4,807 / 1.40

CODE & STANDARDS

- NUREG-0737 Section II.B.3
- Regulatory Guide (RG) 1.97

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



www.yurimtech.co.kr
88, Mannyeon-ro 151beon-gil, Hyangnam-eup, Hwaseong-si, Gyeonggi-do, Republic of Korea

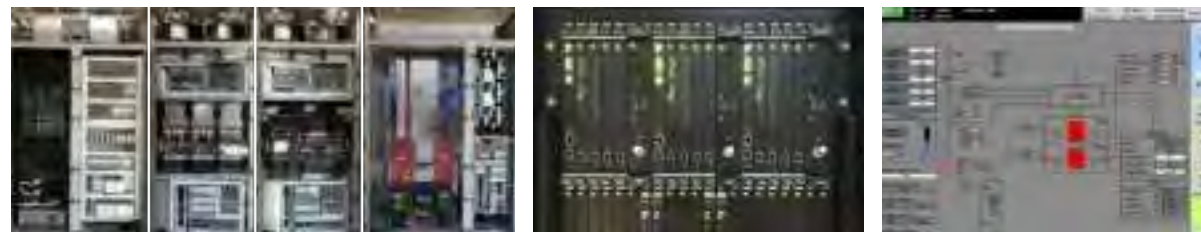
Tel : 031-432-4721
Fax : 031-376-4724
Email : sales@yurimtech.co.kr

Generator Excitation System

Triple Modular Redundancy

Completely Digitized

This excitation system reliably controls and supplies the excitation current of a generator based on the fully digitized triple redundancy modules, thereby maintaining consistent output.



FEATURES

- The completely digitized control system has three independent modules, ensuring fast transient response and high output reliability.
- This system features a user-friendly man-machine interface (MMI) system that provides real-time operation data, facilitating motion monitoring and diagnosis.
- This system can be applied to both brush and brushless types, which means it can be installed without replacing the exciter.

COMPOSITION

DS-DEX PANEL Configuration



DS-DEX HM



BACKGROUND

After the existing system was discontinued, there arose a need to develop an upgraded system. Against this backdrop, Doosan developed an excitation system with triple modular redundancy, which has the capability to avoid transients of a generator caused by malfunction.

A fully digitized control system with a high response rate that met the high initial response requirements was developed to minimize transients in a generator.

PROVEN TECHNOLOGY

This excitation system has been installed (newly installed or replaced as part of refurbishment) in 28 nuclear power plants (i.e., FRAMATOME, CANDU, WH, OPR, and APR reactors) and 45 non-nuclear power plants (i.e., thermal, PSPP, and hydro) around the world for over 25 years, demonstrating its reliability.

SUPPLY EXPERIENCE

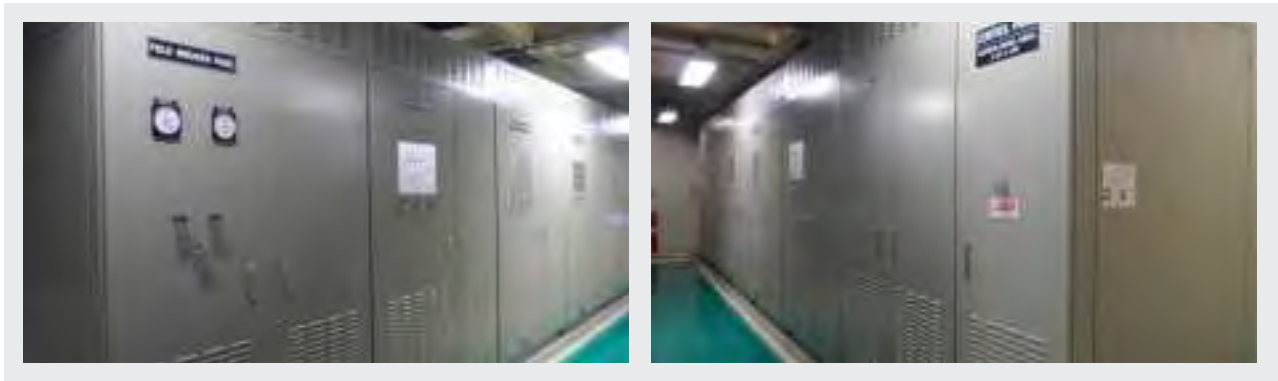
Nuclear Power Plants

- **WH-type** : 2 loop - Kori Unit 1 (2004), Unit 2 (2008)
3 loop – Kori Unit 3 (2008), Unit 4 (2008),
Hanbit Unit 1 (2007), Unit 2 (2007)
- **FRAMATOME-type** : Hanul Unit 1 (2012), Unit 2 (2011)
- **CANDU-type** : Wolsong Unit 1 (2010), Unit 2 (2010), Unit 3 (2010),
Unit 4 (2009)
- **OPR1000** : Hanbit Unit 5 (2009), Unit 6 (2010), Hanul Unit 3(2008),
Unit 4 (2009), Unit 5 (2009), Unit 6 (2008)
- **APR1400** : Shin-Hanul Unit 1 (2015), Unit 2 (2016), Barakah Unit 1
(2015), Unit 2 (2016), Unit 3 (2017), Unit 4 (2018),
Shin-Kori Unit 5 (2019), Unit 6 (2020)

Non-nuclear Power Plants

- **Korea** : Samchenpo Units 1&2 (2000), Boryeong Units 1&2 (2009),
Pochen Units 1&2 (2013) — 49 Projects in total
- **Abroad** : (Saudi Arabia) Marafiq Units 5&6,
(Vietnam) Songhau Units 1&2, (India) Raipur Units 1&2,
(Egypt) Cairowest — 24 Projects in total

OPERATION ON SITE



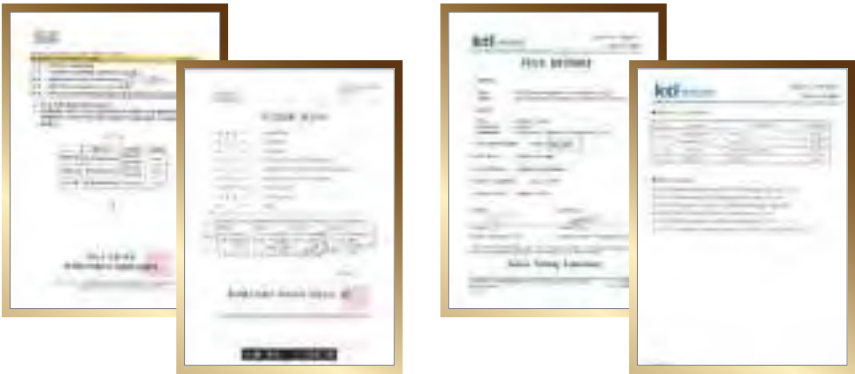
KEY BENEFITS

- This system visually presents a range of data on the operation status,
increasing the convenience of operation and maintenance personnel.
- This product reliably produces optimal output through calculation and
independent analysis of control signals, minimizing reactor trip.
- This system requires less time and lower costs for installing and maintaining
the system compared to other suppliers.

SPECIFICATION

General		Sensing Potential Transformer	
Initial Starting Mode	AC/DC Flashing	PT Connection	Open Delta
Enclosure (3 PCRs)		Nominal Voltage (Burden)	100~120Vac (Less than 1VA)
Overall Dimensions	N : 8000*1140*2455mm / T : 5900*1140*2455mm	Nominal Frequency	50/60Hz
Overall Weight	N : 9.6 ton / T : 6.6 ton	Sensing Current Transformer	
IP Degree	N : IP42 / T : IP42	Number Of CTs	Two(Phase A & Phase B)
Environmental		Nominal Current (Burden)	1 to 5Aac (Less than 1VA)
Operation / Storage Temp.	0 – 50°C / 0 - 70°C	Nominal Frequency	50/60Hz
Operation Humidity	95% Non-Condensing	Control Power Input	
Automatic Voltage Regulator		AC Source	110~230 Vac UPS
Accuracy	±0.5% From No Load to Full Load	DC Source	100~230 Vdc Station
Range	±10% at Rated Terminal Voltage (User adjustable)	Nominal DC Voltage	Battery 125Vdc
Field Current Regulator			
Accuracy	±1% From No Load to Full Load		
Range	20% - 1120% of Rated Field Current (User adjustable)		

PATENT & CERTIFICATION



KEPIC-CERTIFICATE
SGS-R15-2015

KEPIC-CERTIFICATE
PIS10212-2

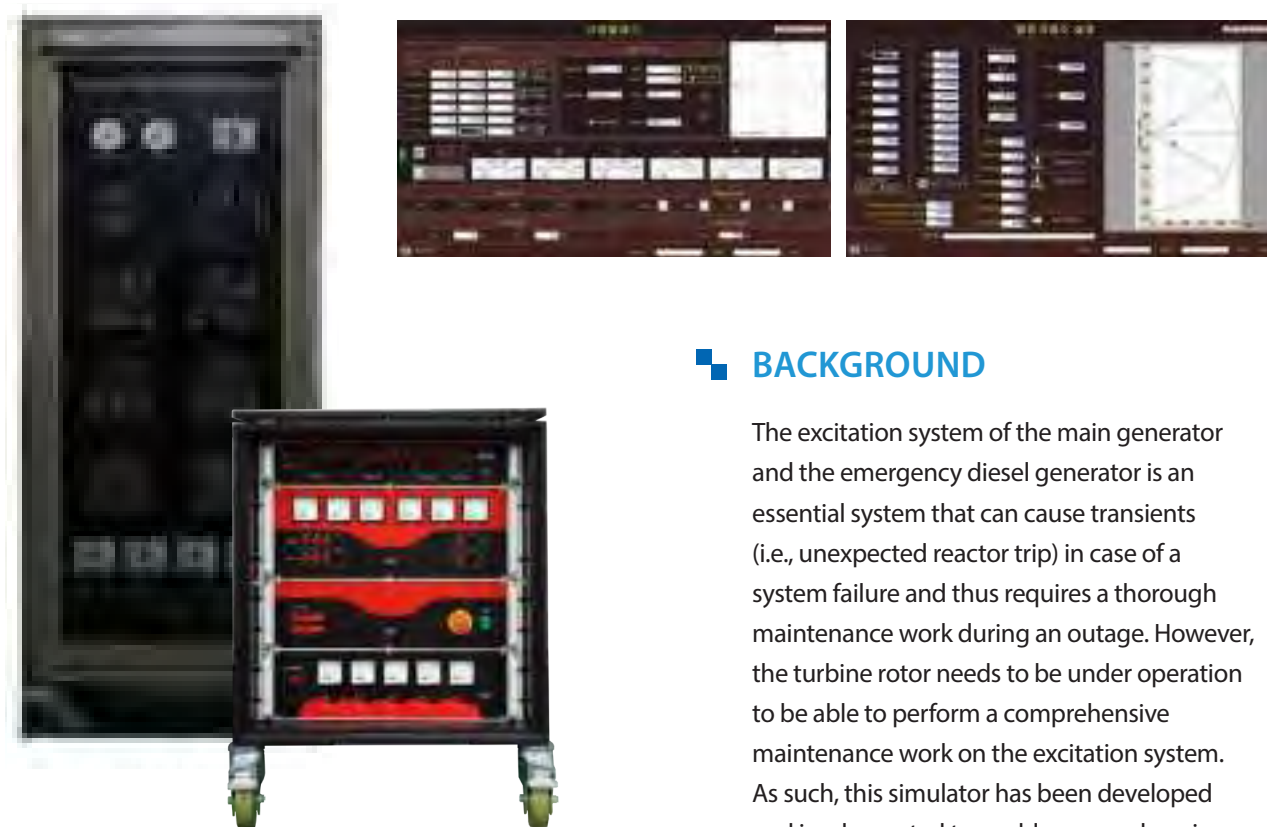


www.doosanheavy.com
555, Guigok-dong, Changwon, Gyeongsangnam-do, 641-792, Korea

Tel : +82-55-278-6114, 7114
Fax : +82-55-264-5551, 5552
email : sangpill.min@doosan.com

Generator Excitation System Test Simulator

This product has been developed to enable simulation of the excitation system of the main generator and the emergency diesel generator under normal plant conditions during an outage, without having to actually run the turbine.



BACKGROUND

The excitation system of the main generator and the emergency diesel generator is an essential system that can cause transients (i.e., unexpected reactor trip) in case of a system failure and thus requires a thorough maintenance work during an outage. However, the turbine rotor needs to be under operation to be able to perform a comprehensive maintenance work on the excitation system. As such, this simulator has been developed and implemented to enable comprehensive maintenance on the excitation system during an outage.

PROVEN TECHNOLOGY

This product has been applied to all nuclear power plants in Korea to conduct a comprehensive performance test on the excitation system of the main generator and the emergency diesel generator. Maintenance could be carried out in a more thorough manner and equipment reliability was secured. Also, maintenance staff were able to identify risks, which used to require the turbine to be up and running, and take preemptive measures. This contributed to adherence to the outage schedule. In addition, the plant safety was enhanced by verifying the design changes through simulation in advance.

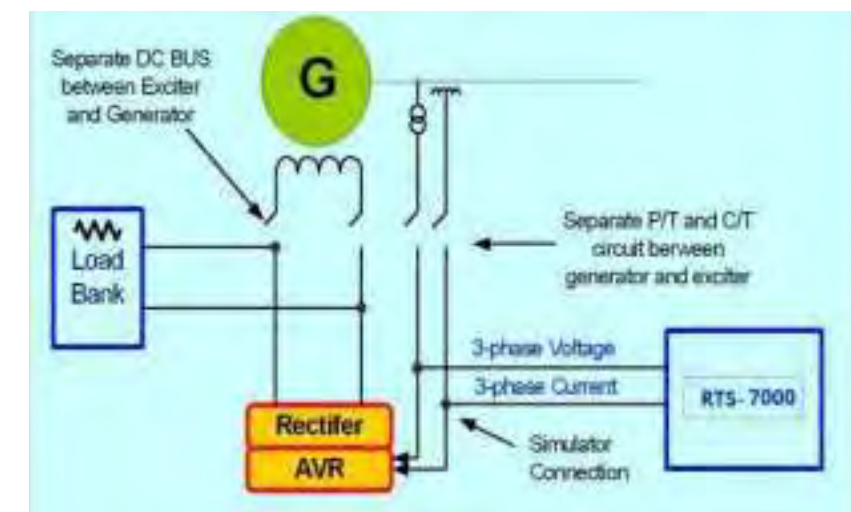
Comprehensive Test

Without Turbine Start-up

FEATURES

- A comprehensive performance test on the excitation system can be performed without having to start the turbine.
 - PT/CT Input and Output Test
 - AVR/MVR Operating Test
 - Auto/Manual Mode Transfer Test
 - V/Hz Limit Test, PSS Test
 - Over Excitation Limit (OEL) and Under Excitation Limit (UEL) Test

COMPOSITION

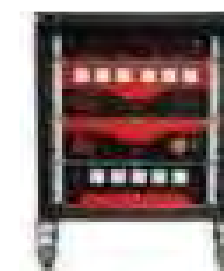


Block Diagram of Excitation System Simulator Configuration



**Load Bank
(Dummy Load)**

This load bank generates a field current and transmits feedback signal to the simulator.



Simulator

In replacement of the generator, this simulator sends simulation signals to the excitation system.

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2009), Hanbit Units 1&2 (2009)
- **CANDU-type** : Wolsong Units 3&4 (2019)
- **OPR1000** : Hanbit Units 3-6 (2010), Hanul Units 1-6 (2012), Shin-Kori Units 1&2, Shin-Wolsong Units 1&2 (2018)
- **APR1400** : Shin-Kori Units 3&4 (2011), Barakah Units 1&2 (2014)

OPERATION ON SITE



Conducting Comprehensive Test



Result of Comprehensive Test

KEY BENEFITS

- By performing a comprehensive test on the excitation system and checking for potential risks, the safety of the plant can be enhanced.
- With this simulator, design changes (i.e., changes to the control program) can be verified through demonstrations.
- Through empirical analysis of excitation failure cases, recurrence can be prevented.
- This product can serve as a training equipment, enhancing the capability of the responsible personnel.

SPECIFICATION

Dimension	533*600*625 (mm)
Weight	60kg
Material	Steel
Input Power	120Vac / 220Vac and 50Hz / 60Hz
Operating System	Windows 10
Supply I/O Channel	DI-4ch, DO-4ch, AI-2ch, AO-1ch

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



PATENT CERTIFICATE
10-1414276



E2S (주)이투에스

www.e2s.co.kr
(05307) 26, Sangam-ro 41-gil, Gangdong-gu, Republic of Korea

Tel : +82 2 488 0586
Fax : +82 2 487 6718
Email : e2s@e2s.co.kr

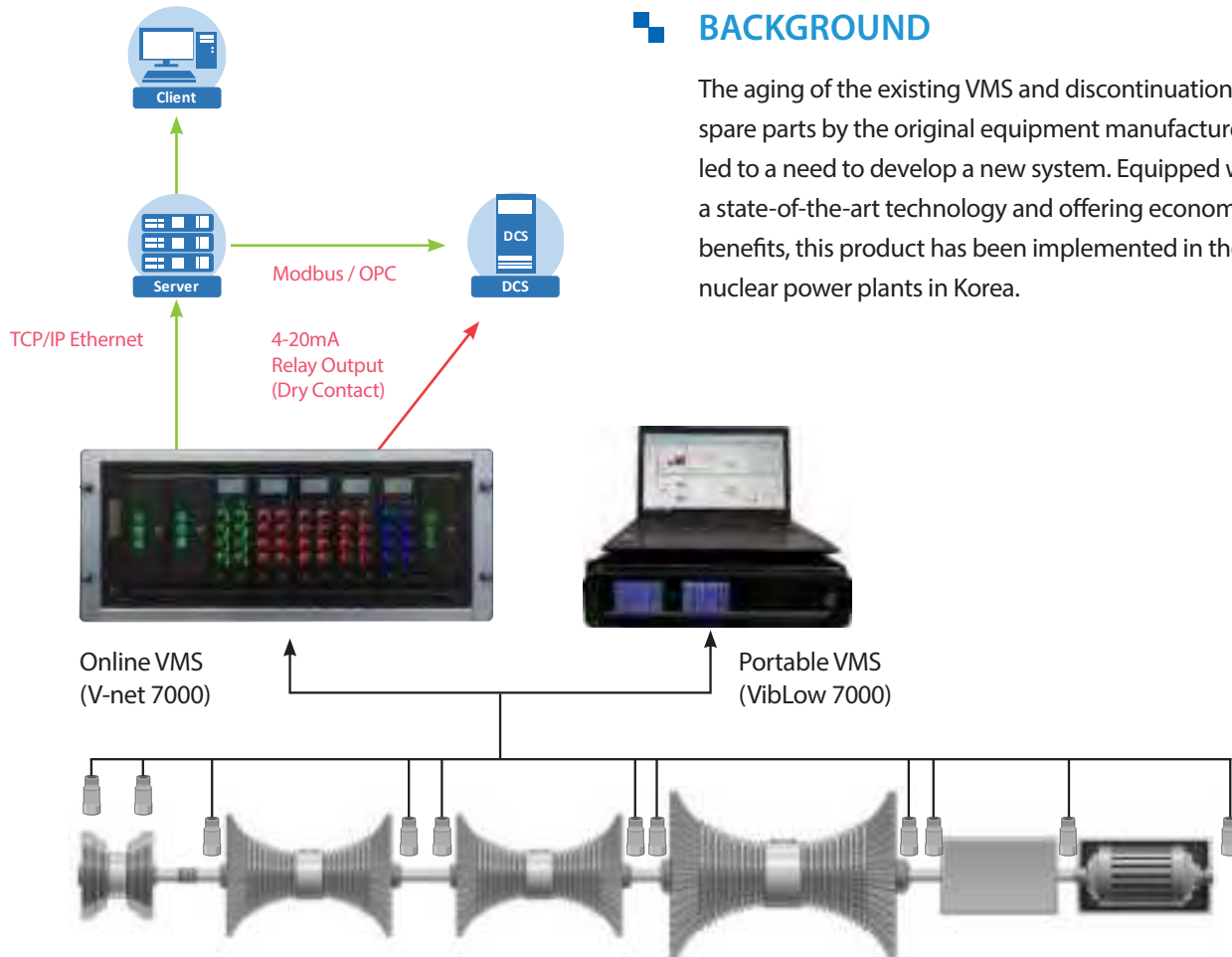
Vibration Monitoring System

- API670 Compliance
- Universal Module

The Vibration Monitoring System (VMS) collects and processes vibration data in real time from all types of vibration sensors by utilizing universal modules and a state-of-the-art database technology, thereby allowing clients to monitor, analyze, and protect the critical rotating machines.

BACKGROUND

The aging of the existing VMS and discontinuation of spare parts by the original equipment manufacturer led to a need to develop a new system. Equipped with a state-of-the-art technology and offering economic benefits, this product has been implemented in the nuclear power plants in Korea.



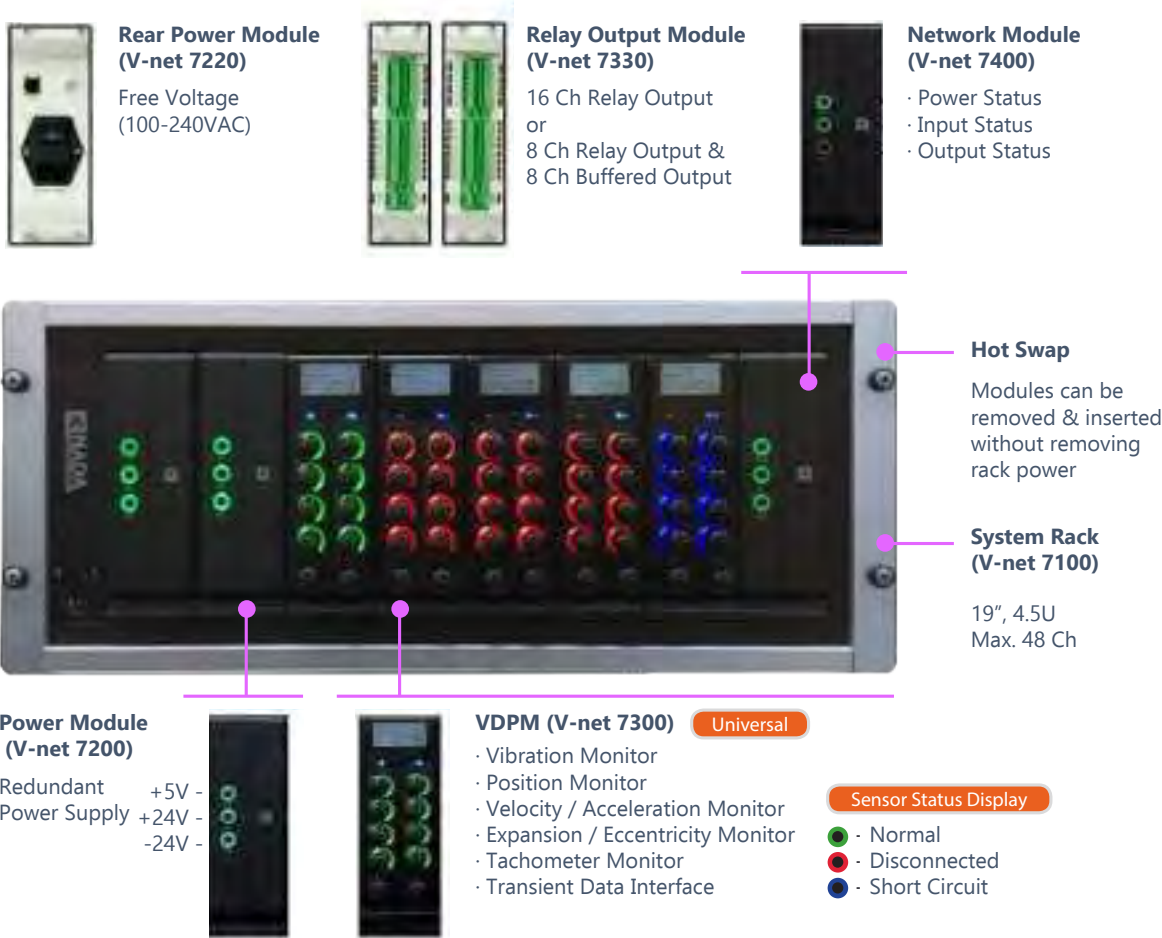
PROVEN TECHNOLOGY

The WH-type reactor Kori Units 3 and 4 have installed this high-performing product in the main turbine monitoring equipment, which led to enhancement of equipment reliability. Unlike the conventional VMS that used a dedicated module for each parameter type, this new VMS uses a universal-type module. This led to an increase in costs for spare parts management, subsequently saving maintenance costs.

FEATURES

- This product is in compliance with the API 670 and nuclear standards.
- This system uses a versatile single-type monitor module for all types of parameters and features an intuitive LED sensor status display.
- Its safety capabilities include redundancy of the power supply and hot swapping, which allows modules to be removed and inserted without interrupting system operation.
- This system allows seamless integration with other control systems.

COMPOSITION



SUPPLY EXPERIENCE

■ WH-type : Kori Units 3&4

- Turbine-Generator (2013)
- Reactor Coolant Pumps (2015)
- Main Feedwater Pumps (2015)

■ APR1400 : Shin-Kori Units 5&6

- Main and Auxiliary Feedwater Pumps (2016)
- Essential Service Water Pumps (2016)
- Component Cooling Water Pumps (2016)
- Condensate Pumps and others (2016)

OPERATION ON SITE



User Interface Screen



System Cabinets

KEY BENEFITS

- This product protects critical machinery from an unexpected catastrophic failure, enhancing the safety of the plant and the environment.
- Applying optimized operation practices contributes to improved productivity.
- Installing this system increases machine reliability through predictive and proactive maintenance, leading to reduction in maintenance costs and unplanned (or forced) downtime.

SPECIFICATION



Classification	Specification
# of Analog Channels	8
# of Tacho Channels	2
A/D Resolution	24 bit
Frequency Range	DC - 25,600 Hz
Frequency Resolution	25,600 Lines
Sampling Rate	65,536
Dynamic Range	110 dB
Input Range	Max. $\pm 24V$
Input Impedance	1 M Ω
Input Signal	Voltage Input (AC, DC, AC+DC), Current Output, Etc.
Anti-Aliasing Filter	8 Pole Elliptic Low Pass Filter (25.6kHz Frequency Prevention)
AC/DC Filter	0.1Hz Low Pass & High Pass Filter
Gain	X1, X2, X5, X10, X20, X100, X200
Amplitude Accuracy	$\pm 1\%$
Data Collecting Interval	0.1 Seconds

CODE & STANDARDS

- Machinery Protection System
 - API 670 (5th Edition)
- Electromagnetic Compatibility
 - IEC 61326, EN 61326
 - IEC 61000

PATENT & CERTIFICATION



CE Certificate

FCC & ICSS Certificate



<http://www.nada.co.kr>
 #803, Innovalley C, Pangyo-ro 253, Bundang-gu, Seongnam-si,
 Gyeonggi-do, Republic of Korea

Tel : +82 31 8017 7820
 Fax : +82 31 8017 7824
 Email : marketing@nada.co.kr

Automatic Seismic Trip System

Protection from Earthquake

Easy Diagnosis & Maintenance

The Automatic Seismic Trip System (ASTS) is a digitized redundant equipment that has already gained credit for its reliability. The system automatically trips the reactor in the event of an earthquake whose magnitude exceeds a certain threshold to ensure plant safety. The ASTS installed in Shin-Hanul Units 1&2 is set to trip at the ground acceleration of 0.27 g, but the operating company can change the set point after taking into consideration the seismic characteristics of the site.

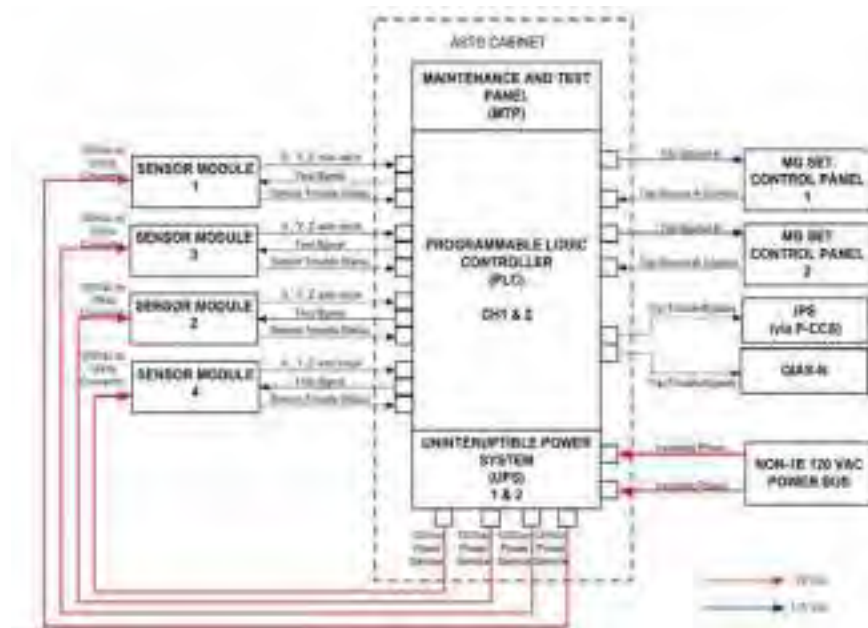
BACKGROUND

Plant safety concerns grew significantly in recent years with the rise in earthquake frequency. Accordingly, countries around the world are strengthening regulations, with the United States, Japan, and many others implementing a seismic scram (trip) system. Korea has also installed the ASTS in all of its nuclear power plants to minimize the impact of earthquakes, and the results of the Failure Modes and Effects Analysis (FMEA) on the ASTS proved that ASTS failure did not lead to reactor shutdown.



PROVEN TECHNOLOGY

Since 2013, 26 units of the ASTS have been installed in WH-, FRAMATOME-, CANDU-, and OPR/APR-type reactors, in which there were zero malfunction cases. With the operation history of approximately 200 reactor years, the system has been proven to offer safety and reliability. As no earthquake with a magnitude large enough to trip a reactor has occurred, there is no case of the ASTS causing plant shutdown. However, the seismic waveform (shown in the image) recorded upon occurrence of an earthquake in Gyeongju (Sep. 12, 2016) demonstrates normal operation of the ASTS. (Seismic waveform is automatically recorded in the event of an earthquake with a ground acceleration of 0.05 g or larger.)



FEATURES

- Designed as seismic Category 1 (earthquake-resilient) and with software class "important to safety," the ASTS ensures high reliability, availability and operability.
- The system also includes a dual, high-speed controller and uses 2/4 concurrent logic to enhance reliability.
- Embedded with uninterruptible power supply, the ASTS provides stable power supply in the event of an earthquake.
- Human factor engineering has been incorporated into the system when designing the maintenance and test panel (MTP); verification and validation of the software have been conducted.

CHARACTERISTICS



[Sensor Module]

- **Sensor**
Triaxial accelerometer mounted orthogonally on an internal deck plate
- **Sensor module enclosure**
SUS 304 or SUS 316



[Cabinet]

- **Controller**
Fully redundant processor, I/O, power supply and communication module
- **MTP**
Diagnostic test and I/O checkout
Calibration and maintenance function for all I/O modules
Online Self-diagnostic function
- **UPS**
Uninterrupted power for 30 mins



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2013-2014), Hanbit Units 1&2 (2014)
- **FRAMATOME-type** : Hanul Units 1&2 (2013)
- **CANDU-type** : Wolsong Units 1-4 (2013)
- **OPR1000** : Hanbit Units 3-6 (2013-2015), Hanul Units 3-6 (2013-2015), Shin-Kori Units 1&2 (2013), Shin-Wolsong Units 1&2 (2013)
- **APR1400** : Shin-Hanul Units 1&2 (2016), Shin-Kori Units 3&4 (2013-2014), Shin-Kori Units 5&6 (under construction)
- **VVER1200** : Tianwan Units 7&8 (under construction), Xudapu Units 3&4 (under construction)

OPERATION ON SITE



ASTS Cabinet



User Interface Display

KEY BENEFITS

- As stated in NRC's NUREG CR-2513, the ASTS lowers the likelihood of core meltdown by preventing heat generation at an early stage in the event of an earthquake with a level exceeding the design standard.
- By rapidly shutting down the reactor, the system prevents equipment damage or malfunction that may result from an earthquake.
- During operation, the system allows easy inspection of each sensor and feature from the MTP, making maintenance easier.

SPECIFICATION

[Cabinet Specification]		[Sensor Assembly Specification]	
Item	Description	Item	Description
Size	800Wx900Dx2273H	Size	380Wx380Dx130H
Controller	Microprocessor controller based RedundancyCPU/Communication Configuration	Full Scale	± 2g
Display	17"(1280x1024) color TFT LCD(Touch Screen)	Acceleration	0 ± 0.5g
Power	120VAC	Accuracy	1%
		Power	120VAC

CODE & STANDARDS

- Equipment Qualification
 - IEEE Std. 323
- Seismic Qualification
 - IEEE Std. 344
- EMC Qualification
 - RG 1.180
- Software Verification and Validation
 - IEEE Std. 1012
- Human Factor Engineering
 - NUREG-0700

PATENT & CERTIFICATION



KEPIC-CERTIFICATE
EN_210629



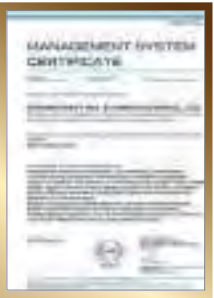
KEPIC-CERTIFICATE
EN_210514



ISO 9001



ISO 14001



ISO 45001



www.doosanheavy.com
155, Jeongjail-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea
Tel : 031-5179-2316
Fax : 031-5179-2398
email : hawon.jung@doosan.com

Nuclear Qualified Intelligent Pressure Transmitter

Obsolescence Solution

Cost-Efficient

Featuring the latest digital technology, this intelligent pressure transmitter measures the process and differential pressures at a nuclear power plant, converts the data into an electrical signal, and provides it to the operator and the control system.



BACKGROUND

As the existing analogue-based devices used in the nuclear industry were becoming digitized, we found it necessary to apply the latest digital technologies to field instruments as well. In particular, there was a need to develop a safety grade intelligent pressure transmitter at an affordable price, as large numbers of pressure transmitters were being used to monitor and control the power plant.

PROVEN TECHNOLOGY

This intelligent pressure transmitter that has incorporated the latest technology has been implemented in all nuclear power plants in Korea. The high level of accuracy and resolution this product offers led to an enhancement of the reliability in terms of control and monitoring. In addition, the costs associated with replacement could be saved dramatically, as the large quantity of analog pressure transmitters were replaced at a reasonable price. The ever-changing nuclear technical requirements were promptly incorporated as well to enhance plant safety.

FEATURES

- This pressure transmitter used in a mild environment is nuclear qualified and has undergone equipment verification.
- This transmitter features self-diagnostic functions for analyzing error codes.
- Digital communication is possible through the use of the HART protocol.
- This transmitter can be easily replaced with another manufacturer's products.
- The temperature compensation functions contribute to higher accuracy and more reliable performance.

COMPOSITION

SUS Housing
Stainless Steel Housing

Normal
Hole to Hole 54 mm
as international standard



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 2-4 (Since 2007), Hanbit Units 1&2 (Since 2008)
- **CANDU-type** : Wolsong Units 2-4 (Since 2008)
- **OPR1000** : Hanbit Units 3-6 (Since 2010), Shin-Wolsong Units 1&2 (Since 2009), Shin-Kori Units 1&2 (Since 2008)
- **APR1400** : Shin-Kori Units 3-6 (Since 2010), Shin-Hanul Units 1&2 (Since 2014), Barakah Units 1-4
- **Indian NPP owned by NPCIL (2013)**
- **Indian NPP owned by NPCIL (2013)**

OPERATION ON SITE



Wolsong Unit 1 & 2 Turbine Building

KEY BENEFITS

- Using an intelligent pressure transmitter that has demonstrated its effectiveness through long-term usage leads to enhancement of plant safety.
- This product can replace the existing transmitter at a competitive price.
- This transmitter enables seamless integration with the other existing control systems.
- By applying the state-of-the-art technology, maintenance time is reduced.
- This product meets the new technical requirements.

SPECIFICATION

Output	4 to 20mA @ 24 Vdc + Hart, 2 wired Loop powered
Radiation TID	Up to max. 100 Gy (normal/ accident)
Duration	40 years + Accidental 1 year
Pressure	Min. -14.5 psi to Max. 6000 psi
Ambient Temperature	-40 to 120 degC w/o LCD, 10 to 50 degC w LCD in safety area
Response Spectrum	OBE 2%, SSE 3%
Accuracy	Accuracy +/- 0.25% of CS @ 20 degC & 0 psig(normal/ accident)
Stability	+/- 0.2% per 24 months
Function	Self-diagnostic function, Temp. Compensation

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000
- Software Verification and Validation
 - IEEE 7-4.3.2, IEC 60880

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



AUTROL DUON System Co., Ltd.
The brand AUTROL is a name of transmitters & manufactured by DUON System 1989 DUON System Co., Ltd

www.autrol.com, autrol@duon.co.kr
298-29, Gongdan-ro, Gunpo-si, Gyeonggi-do, 15809 Republic of Korea

Tel : +82 31 389 6127
Fax : +82 31 429 7200
Email : autrol@duon.co.kr

Nuclear Qualified Ultrasonic Level Transmitter

Safety Enhancement

Post-Fukushima

This product is a non-contact type level transmitter that uses ultrasonic waves, optimal for detecting the level of a storage tank and a sump in a nuclear power plant. This product will replace the thermal diffusion type level transmitter that has been installed in the spent fuel storage pool (SFSP) in the aftermath of the Fukushima nuclear accident.



BACKGROUND

Since the Fukushima accident, ensuring the safety of the SFSP has been raised as an important issue. This safety-class ultrasonic level transmitter that meets the seismic, environmental, and electromagnetic compatibility (EMC) test requirements has been implemented in nuclear power plants across Korea for stable operation of the SFSP in the event of a severe accident.

PROVEN TECHNOLOGY

This product has been applied to the WH-type reactors and most of the nuclear power plants in Korea, enabling operators to monitor the SFSP level even in the event of a severe accident, thereby enhancing plant safety.

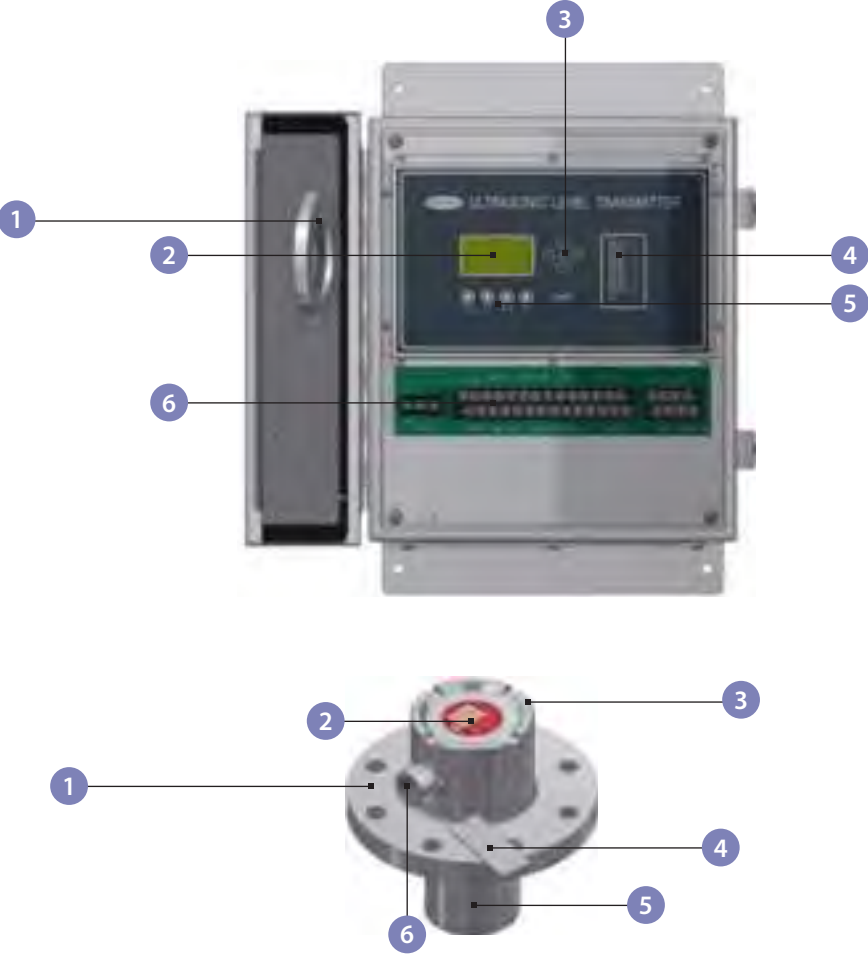
FEATURES

- This product is the only nuclear qualified ultrasonic level transmitter that meets seismic, environmental, and EMC test requirements.
- This level transmitter stores data and monitors data trends.
- This product is capable of filtering out abnormal signals.
- This product offers a wide measurement range (18 m max).

COMPOSITION

- ❶ Window
- ❷ Display
- ❸ Cursor Button
(Up, Down, Left, Right)
- ❹ Bar Meter(%)
- ❺ Menu, Signal, Alarm, Enter Button
- ❻ I/O Terminal Block

- ❶ Flange
- ❷ Nameplate
- ❸ Cover
- ❹ Tag Plate
- ❺ Sensor
- ❻ Cable Entry



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2013), Hanbit Units 1&2 (2015)
- **CANDU-type** : Wolson Units 1-4 (2013)
- **OPR1000** : Hanbit Units 3-6 (2017), Hanul Units 1&2 (2015)
- **APR1400** : Shin-Kori Units 3-6 (2020), Shin-Hanul Units 1&2 (2020), Barakah Units 1-4 (2015)

OPERATION ON SITE



Kori Unit 2 Spent Fuel Pool

KEY BENEFITS

- Plant safety and reliability are improved by installing a proven nuclear qualified ultrasonic level transmitter.
- Existing level transmitters can be replaced with this safety class contact type level transmitter at a competitive price. (80% of the total price of non-safety level transmitters)
- Due to the longer lifespan and higher work efficiency, using this product will save more maintenance costs in comparison with a contact type level transmitter.
- By applying this transmitter to storage tanks containing corrosive and toxic fluid, workplace accidents can be prevented.

SPECIFICATION

TRANSMITTER (HUT-2000 SERIES)		
Model	HUT-2000N	HUT-2000T
Quality Class	Q	A
Resolution	1mm	
Accuracy	±0.25% of F.S.	
Operating Temp.	-30 ~ +70 °C	
OUTPUT	Current Output	DC 4~20mA, Max. 250Ω
	Relay Output	8-SPDT or 4-DPDT
Display	Level, Distance, Temperature, %, Time	
	Measured Value, Echo Profile, Data Trend	
Enclosure	NEMA 4	
Material	Stainless Steel	
Data Logging	Max. 400days	
Power Supply	AC 90~240V 50/60Hz	
Mounting Method	Wall Mounting	

SENSOR (HUL-2000 SERIES)		
Model	HUL-2100N	HUL-2100T
Quality Class	Q	A
Measuring Range	0.3 ~ 8m	
Beam Angle	4°±2°	10°±2°
Operating Frequency	50KHz±4%	
Operating Temperature	-30 ~ +60 °C	-30 ~ +93 °C
Enclosure	NEMA 4	
Signal Cable	2-Wire Shielded	
Mounting Method	4", 6" Flange or Bracket Mounting	

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electric Calbles Qualification
 - IEEE 383
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(MN) KEPIC-CERTIFICATE(EN)



HITROL HITROL Co.,Ltd.

<http://www.hitrol.com>
141, Palhagol-gil, Jori-eup, Paju-si, Gyeonggi-do, Republic of Korea

Tel : +82 31 950 9700
Fax : +82 31 943 5600
Email : hitrol@hitrol.com

Nuclear Qualified Controller

- Redundancy
- Human Factors Engineering

Equipped with safety capabilities like redundancy, this device controls the temperature, pressure, flow, and liquid level of the systems in a nuclear power plant.



BACKGROUND

Since the controllers applied to the major systems in CANDU-type reactors in Korea were not designed to be redundant, Wolsong Unit 2 experienced transients due to failures of controllers. In addition, low visibility posed a problem and some types of controllers became obsolete.

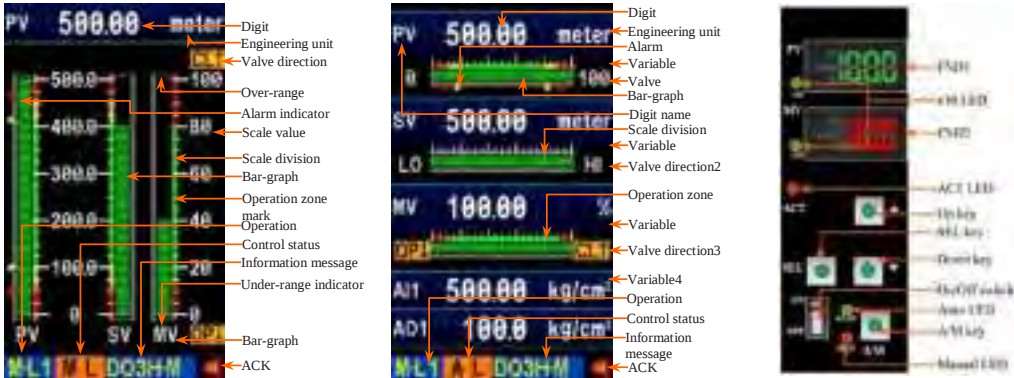
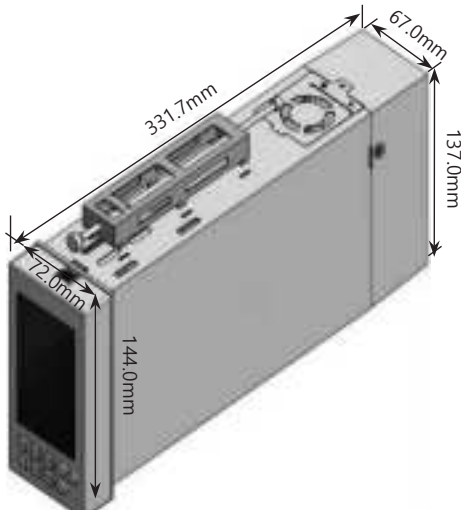
PROVEN TECHNOLOGY

Wolsong Unit 2 has seen improvements in plant safety after replacing the existing controllers with this redundant controller. Also, improved visibility led to prevention of human errors and being able to separately replace the thin film transistor-liquid crystal display (TFT-LCD) module in the event of a display module failure reduced maintenance costs.

FEATURES

- The control board and other major components of this product feature redundancy.
- To improve plant safety, the latest codes and standards regarding equipment qualification and cyber security have been applied.
- Human factors engineering has been incorporated into this product to prevent human errors, thereby providing accurate information to users.
- In case of a display module failure, the display module can be separately substituted, without having to replace other components.
- A backup display enables continuous monitoring even when the display module fails.
- This controller can be easily replaced with another manufacturer's product.

COMPOSITION



Display

Backup Display

SUPPLY EXPERIENCE

- CANDU-type : Wolsong Unit (2020)

OPERATION ON SITE



KEY BENEFITS

- By using this redundant design controller, system reliability can be enhanced.
- This controller helps improve plant safety and security by preventing human errors and applying the latest cyber security requirements.
- As the display module can be separately replaced, maintenance costs can be saved by approximately 20%.
- A backup display allows continuous monitoring, even in the event of a display module failure.

SPECIFICATION

Analog input		
Channel	4 ch	
Input type	AI1, AI2	mA, VDC, mV, TC, RTD
	AI3, AI4	mA, VDC
Input range	VDC	-10 ~ +10VDC
	mA	-50 ~ +50mA
	mV	-50 ~ +152mV
	RTD	-200 ~ +850℃
	TC	K, J, E, E, R, S, B, N, U, L, C, P, W-WRe26
Accuracy	mV, VDC, mV	±0.2% of full span (at reference condition)
	TC	±0.5% of full span, CJC : ±1.0℃ (at reference condition)
	RTD	±0.5% of full span (at reference condition)

Analog output		
Channel	4 ch	
Output type	mA, VDC	
Output range	VDC	0 ~ +10VDC
	mA	0 ~ +20mA
Accuracy	±0.2% of full span (at reference condition)	
Digital input		
Channel	2 ch	
Input type	Voltage, Contact, Frequency	
Digital output		
Channel	4 ch	
Type	DO1, DO2	Open collector type
	DO3, DO4	Relay
Rating	DO1, DO2	60VDC max. 500mA max.
	DO3, DO4	250VAC, 5A max., 30VDC 5A max. (at resistive load)

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000
- Software Verification and Validation
 - IEEE 7-4.3.2, IEC 60880
- Human Engineering
 - USNRC NUREG-0700

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN-130)



WOOJIN INC

www.woojininc.com
110, Dongbu-daero 970beon-gil, Hwaseong, Gyeonggi, Republic of Korea

Tel : +82 31 379 3316
Fax : +82 31 379 3133
Email : twlee@woojininc.com

Nuclear Qualified Digital Bar-graph Indicator

Human Factors Engineering

Cost-Efficient

This indicator quickly and accurately provides the process variables, which are measured by an instrument in the field, to the operators in the Main Control Room in the form of an analog bar-graph and a digital version.



BACKGROUND

The poor visibility of analog indicators installed in the Main Control Room of a nuclear power plant raised a possibility of operators making human errors. Even the existing LED digital indicators that have been implemented to resolve this issue did not have human factors engineering incorporated and failed to meet the latest regulatory requirements such as those related to cyber security. To address these issues, this LED digital bar-graph indicator has been developed and applied to the power plants across Korea.

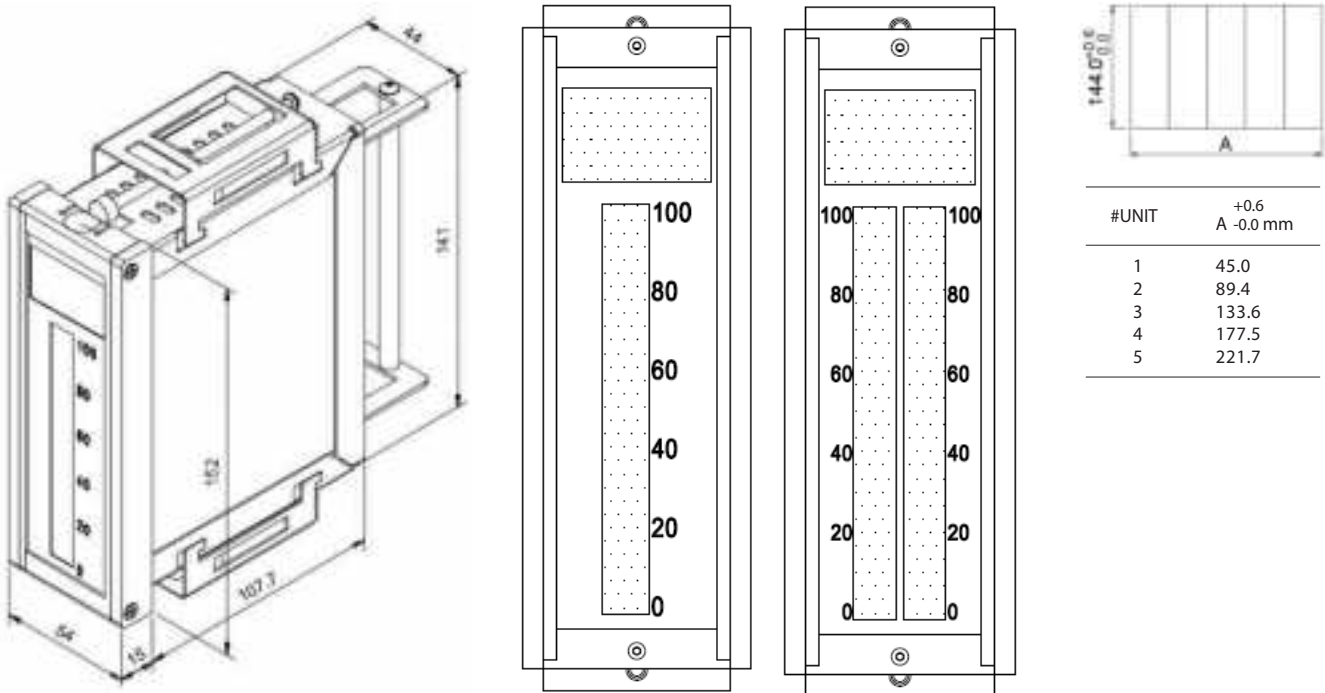
PROVEN TECHNOLOGY

The analog indicators installed in the Main Control Room of nuclear power plants in Korea, such as Kori Unit 2 (WH 2 Loop), have been replaced with this product to improve plant safety through prevention of human errors. When replacing the indicator, it is possible to only remove the LCD display for replacement. This leads to reduction in maintenance costs.

FEATURES

- To improve plant safety, the latest codes and standards regarding equipment qualification and cyber security have been applied.
- Human factors engineering has been incorporated into this product to prevent human errors, thereby providing accurate information to users.
- Application of a thin film transistor-liquid crystal display (TFT-LCD) has led to an enhancement in visibility.
- In case of a display module failure, the display module can be separately substituted, without having to replace other components.
- The safety capabilities including hot swapping help improve maintenance convenience.

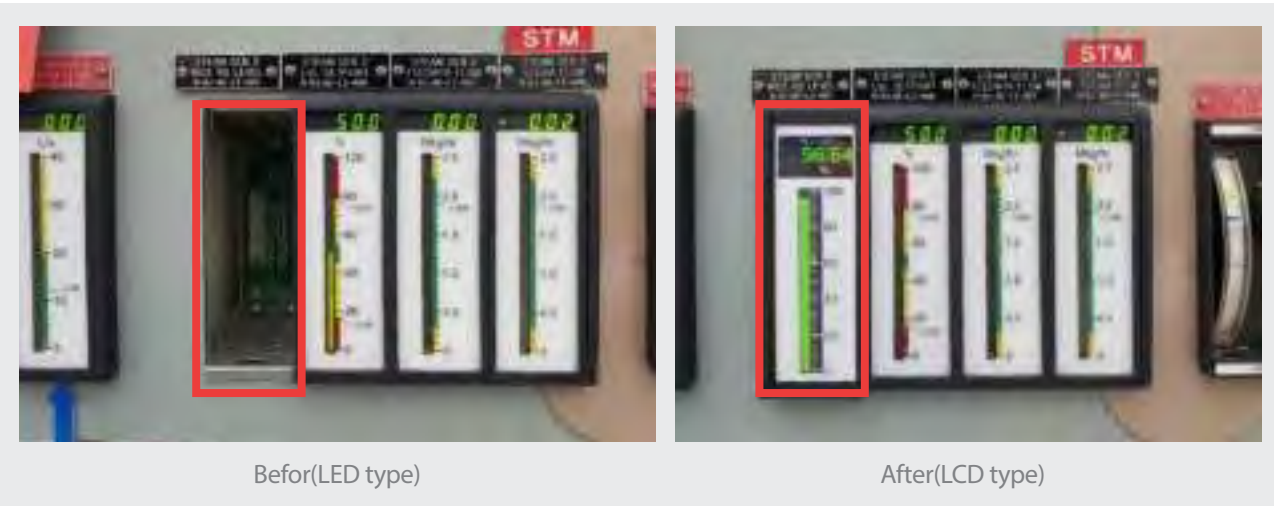
COMPOSITION



SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2013), Hanbit Units 1&2 (2015)
- **OPR1000** : Hanbit Units 3-6 (Since 2013)
Hanul Units 3&4 (Since 2020)
Shin-Kori Units 1&2 (Since 2011)
Shin-Wolsong Units 1&2 (Since 2012)

OPERATION ON SITE



KEY BENEFITS

- This digital indicator helps improve plant safety and security by preventing human errors and applying the latest cyber security requirements.
- Existing analog and digital indicators can be replaced at a competitive price.
- As the display module can be separately replaced, maintenance costs can be saved by approximately 20%.
- Using this product will improve maintenance convenience.

SPECIFICATION

LCD Type Indicator Model Classification						
Size	Model Number		Quality Class	Seismic Category	Safety Category	Electrical Class
	Single Type	Dual Type				
6 Inch	PS-LBI01Q	PS-LBI02Q	Q	I	Safety Related	1E
	PS-LBI01AQ	PS-LBI02AQ	A	II	Non-Safety Related	Non-1E
3.5 Inch	PS-hLBI01Q	PS-hLBI02Q	Q	I	Safety Related	1E
	PS-hLBI01AQ	PS-hLBI02AQ	A	II	Non-Safety Related	Non-1E
Specification(6 Inch Standard)						
Bar Display			DIGIT DISPLAY			
Type	Full color TFT-LCD			Type	Full color TFT-LCD	
Size	3.7" display			Size	0.3" for single type 0.2" for dual type	
Resolution	0.85% full scale for expanded bar 0.21% of full scale for moving point			Resolution	-99999~99999 for single type -19999~99999 for dual type	
Color	Tri-color (Red/Yellow/Green)			Color	Green	
INPUT SENSITIVITIES			ACCURACY			
Standard Input			DC Amps & Volts			
DC Volts -10 ~10V / DC Amps -20mA ~20mA			0.01% of full span ± 1 count			
CASE MATERIAL			POWER			
Non-glare black PC or ABS case complying with UL94 V-0			Line Voltage 120VAC, 60Hz(Free Voltage)			
OPERATING CONDITIONS						
Condition	Normal Limit		Storage Limit		Normal Reference	
Ambient Temp	10~40℃		-40~85℃		23±2℃	
Ambient Humidity	≤95%RH (Non-Condensing)		≤95%RH (Non-condensing)		40~60%RH (Non-Condensing)	

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000
- Software Verification and Validation
 - IEEE 7-4.3.2, IEC 60880
- Human Engineering
 - USNRC NUREG-0700

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



WOOJIN INC

www.woojininc.com
110, Dongbu-daero 970beon-gil, Hwaseong, Gyeonggi, Republic of Korea
Tel : +82 31 379 3316
Fax : +82 31 379 3133
Email : twlee@woojininc.com

Nuclear Qualified Auto Manual Station

Obsolescence Solution

Cost-Efficient

This auto/manual station provides an interface between a process controller and operators in the Main Control Room. Information from the process controller is sent to an operator and the operator gives commands using this auto/manual station.



BACKGROUND

The existing auto/manual station was difficult to use due to low visibility and a short lifespan of display modules. Also, some types of auto/manual stations installed in nuclear power plants in Korea were discontinued. This led to the development of this product, in which a thin film transistor-liquid crystal display (TFT-LCD) has been applied to resolve the existing problems.

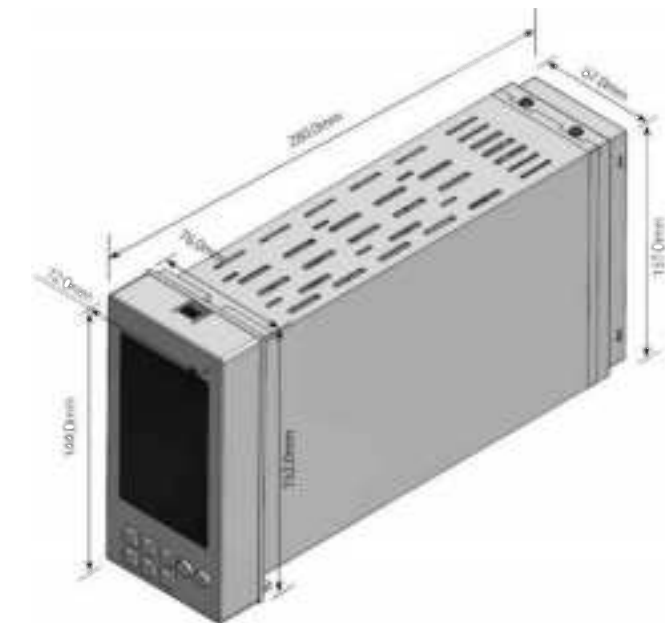
PROVEN TECHNOLOGY

This product has been successfully implemented in Hanbit Units 1 and 2 and Kori Units 3 and 4. Even in the event of a display module failure, this product can continue to operate. Also, unlike other products, it is possible to take out the display module only, without having to replace other components. This saves maintenance and repair costs.

FEATURES

- The latest codes and standards regarding equipment qualification and cyber security have been incorporated to improve plant safety.
- Human factors engineering has been incorporated to prevent human errors, thereby allowing delivery of accurate information to users.
- Applying the TFT-LCD provides improved visibility and allows various information to be displayed.
- In case of a display module failure, the display module can be separately replaced, and the backup display enables continuous monitoring.
- This product can be easily replaced with another manufacturer's product.

COMPOSITION



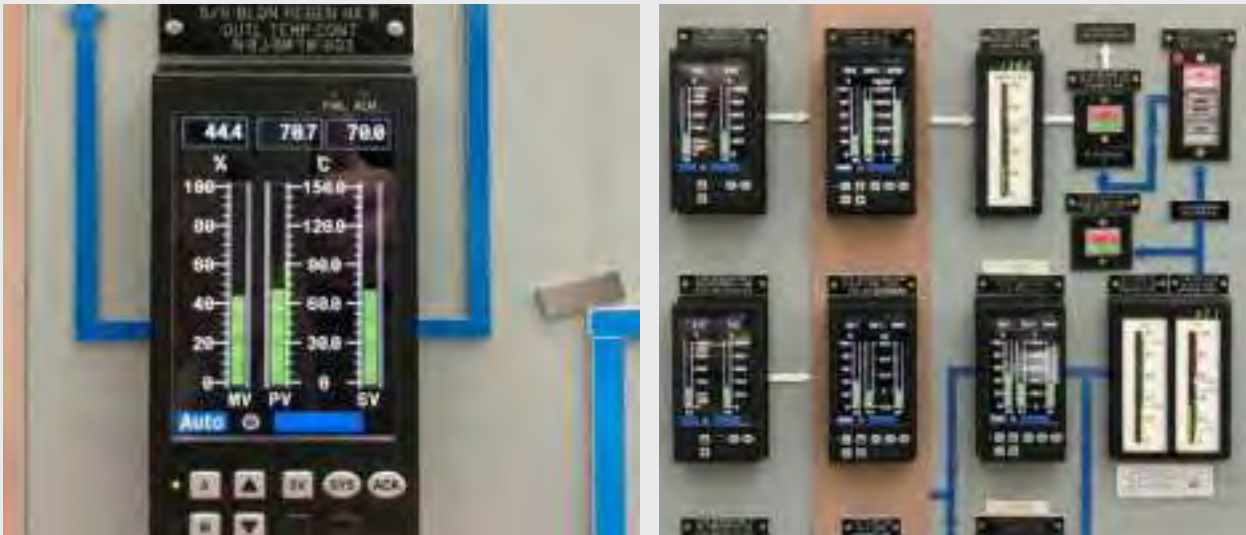
Display

Backup Display

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 3&4 (Since 2009),
Hanbit Units 1&2 (Since 2018)

OPERATION ON SITE



Hanbit Units 1&2 Main Control Room

KEY BENEFITS

- This product helps prevent human errors, thereby improving plant safety.
- The latest cyber security requirements have been applied to improve the security of the plant.
- This product can be replaced with the existing station at a competitive price.
- As the display module can be replaced separately, without the need to replace other components, maintenance costs can be saved by approximately 20%.
- The backup display allows continuous monitoring even in case of a display module failure.
- By applying the state-of-the-art technologies such as hot-swapping, this product improves maintenance convenience.

SPECIFICATION

MODEL					
WJ-IAMS-F					
Analog input			Analog output		
Channel	2 ch		Channel	1 ch	
Input type	mA, VDC		Output type	mA, VDC	
Input range	VDC	-10 ~ +10VDC	Output range	VDC	-10 ~ +10VDC
	mA	-50 ~ +50mA		mA	0 ~ +20mA
Accuracy	±0.2% of full span (at reference condition)		Accuracy	±0.2% of full span (at reference condition)	
Digital input			Digital output		
Channel	3 ch		Channel	4 ch	
Type	Voltage		Type	Voltage	
Level	High : 0VDC / Low : -15VDC		Level	High : 0, 5.6VDC / Low : -15VDC	
Dimension			Environmental Requirements		
+15VDC ±0.75VDC			Reference condition	• Temperature : 23 ±2℃ • Humidity : 50 ±10% RH (no condensation) • +15VDC ±0.75VDC	
Dimension					
Outline size	72.0mm(W)X144.0mm(H)X280.0mm(D)		Operation condition	• Temperature : -10 ~ 50℃ • Humidity : 5 ~ 95% RH (no condensation) • +10 ~ 36VDC	
Front size	72.0mm(W) X 144.0mm(H) X 25.0mm(D)				
Panel cutout	72.2.0(+1.6/-0)mm X 147.0(+1.6/-0)mm				
Weight	about 1.3kg (except Mounting bracket)				

CODE & STANDARDS

- Equipment Qualification
 - IEEE 323, IEC 60780
- Seismic Qualification
 - IEEE 344, IEC 60980
- Electromagnetic Compatibility
 - USNRC RG 1.180
 - IEC 61000
- Software Verification and Validation
 - IEEE 7-4.3.2, IEC 60880
- Human Engineering
 - USNRC NUREG-0700

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



WOOJIN INC

www.wojininc.com
110, Dongbu-daero 970beon-gil, Hwaseong, Gyeonggi,
Republic of Korea

Tel : +82 31 379 3316
Fax : +82 31 379 3133
Email : twlee@wojininc.com

Graphic Recorder

Safety Standards

Lower Maintenance Cost

The KR2000 series paperless recorder displays high-speed and accurate data collected in the plant, making it easier for operators to monitor operating variables.



BACKGROUND

Conventional recorders used in the nuclear power plant were paper-based. However, to address the discontinuation of analog instrumentation systems and the digitization process, this digital graphic recorder was developed. This product complies with the technical standards regarding safety and provides increased convenience.

PROVEN TECHNOLOGY

This recorder has been installed in 24 reactors in Korea. Installation in four WH-type, two FRAMATOME-type, 14 OPR1000 and four APR1400 reactors attest to the reliability and high performance of the recorder. This product saves costs of consumable (i.e., recording sheet and cartridge) and is excellent for monitoring operation variables by reading the real trend or bar graphs of the collected data.

FEATURES

- Woojin is the only supplier in the world to have its paperless graphic recorder conform to the safety standards. (Q class)
- Designed as per the seismic and environmental requirements, the recorder ensures reliability and safety under any operating conditions.
- The recorder's data storage capability enables analysis of operating variables.

CONFIGURATION



5.6 TFT LCD

the display with excellent visibility allows operators to easily monitor operation variables; displays 12 variables and real trend all together

Control Key

a designated key is allocated for each function to enable easy operation (e.g. Start, Stop, Menu, Esc, Enter, Cursor)

Compact Flash Card Insertion Slot

saves data in the CF Card (8GB max)

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2 (2019), Kori Units 3&4 (2021), Hanbit Units 1&2 (2021)
- **FRAMATOME-type** : Hanul Units 1&2 (2017)
- **OPR1000** : Hanbit Units 5&6 (2021), Hanul Units 3&4 (2021), Hanul Units 5&6 (2018), Shin-Kori Units 1&2 (2021), Shin-Wolsong Units 1&2 (2020)
- **APR1400** : Shin-Kori Units 3&4 (2021)
- **CANDU-type** : Wolsong Units 1&2 (2014), Wolsong Units 3&4 (2016)

OPERATION ON SITE



KEY BENEFITS

- This product saves maintenance costs through the use of a paperless digital recorder.
- Seismic and environment verification have been completed, enabling accurate monitoring through the acquisition of high-speed and accurate data in any operating conditions.
- By digitizing an array of analog input values, including temperature, pressure, flow rate, and water level, it is now possible to intuitively monitor operating variables.
- Human factors engineering has been integrated into the design, leading to increased convenience for operators. In case of an alarm, the person in charge will be notified via email.

SPECIFICATION

Item	Description
Type	paperless graphic recorder
Internal Memory	4MB Flash Memory
External Memory	Compact Flash Card (8 GB max.)
Display	5.6 Inch TFT color LCD (320*240 Dot)
Size (mm)	144 × 144
Panel Cutting Size (mm)	138 (+1) × 138 (+1)
Power	100 ~ 120 Vac, 50/60 Hz
Pressure Type	0~10 VDC, 4~20 mA DC, T/C, RTD
Display Type	percentage, temperature, pressure, etc.
Recording Points (Variables) and Measurement Cycle	12 points, 0.1 sec.
Display Color	12 different colors, arbitrarily set up
Accuracy	±0.1% ±1 digit

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1040698



WOJIN INC

www.wojininc.com
110, Dongbu-daero 970beon-gil, Hwaseong, Gyeonggi,
Republic of Korea

Tel : +82 31 379 3316
Fax : +82 31 379 3133
Email : twlee@wojininc.com

ADVANCED AND PROVEN O&M TECHNOLOGIES
FOR NUCLEAR POWER PLANT



MECHANICAL ENGINEERING

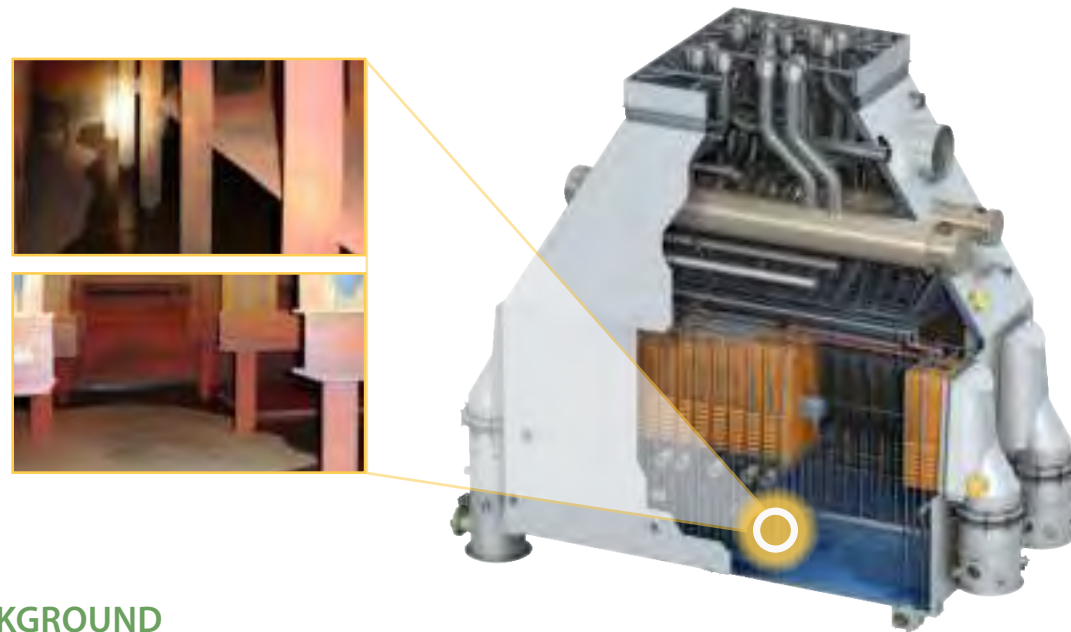
- 100 Magnetic Sludge Removal Device in Condenser
- 104 Maintenance of Bottom Mounted Instrument Leakage
- 108 Permanent Seal Ring for Reactor Cavity
- 112 Shielded Work Station and Flask for CANDU Spent Fuel
- 116 Underwater Facility Inspection Robot
- 120 Management Solution for Small Bore Piping Socket Welds
- 124 Mechanical Seal for Primary Heat Transport Pump
- 128 Graphite Bonnet Gaskets Reinforced with Braided Yarn
- 132 Precision Load Positioner
- 136 Lightweight Door for Securing Safety Equipment
- 140 Steam Generator Sludge Removal Equipment
- 144 Radiation Tolerant CCTV system

Magnetic Sludge Removal Device in Condenser

No Influence On Existing Equipment

Feedwater Quality Control

This device removes fine iron-based magnetic substances present in the feedwater system of a nuclear power plant during normal operation without affecting the fluid flow of the system.



BACKGROUND

Magnetic debris generated in the main equipment (i.e., steam generators, moisture separators, heat exchangers, pipes, and valves) as a result of erosion is adsorbed on particular parts of a major equipment, becoming one of the major culprits for shortening the equipment's lifespan. Against this backdrop, this product has been developed to effectively remove magnetic sludge and prevent erosion of equipment and pipes.

PROVEN TECHNOLOGY

A year after installation of this product at Kori Unit 2 (WH 2 Loop), the amount of magnetic debris within the steam generator and the main feedwater system decreased by 21% and 36%, respectively. Also, this product was selected as a WANO Good Practice in 2017.

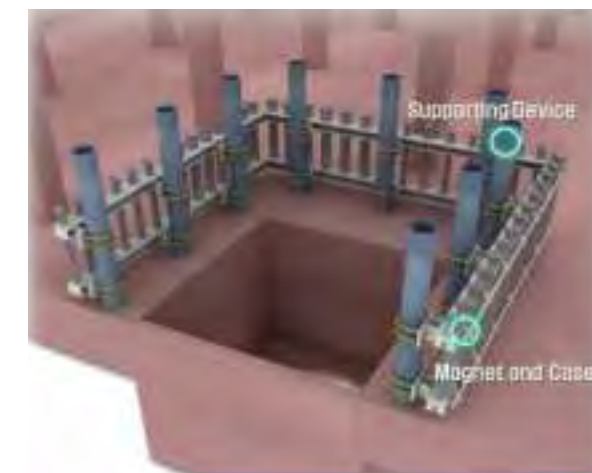


WANO Good Practice

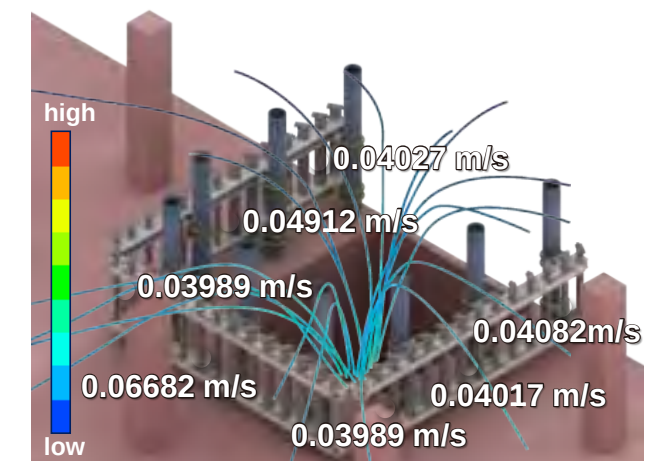
FEATURES

- This product enables magnetic sludge to be removed without affecting the fluid flow in the system during normal operation.
- Composed of 300 series stainless steel, this product is highly corrosion resistant.
- As this device does not require periodic replacement of components, it has a very long life span.
- Magnetic sludge comes off easily when separating the magnetic bar from the case.

COMPOSITION



Installation



Flow Analysis Service

Magnetic bar, case and supporting device

This product consists of magnetic bars and supporting devices. Magnetic bars are core components that collect magnetic sludge mixed in the fluid, whereas the supports and bolts provide a secure fixing of the magnetic bars to the hotwell of the condenser.

Design and Engineering Service

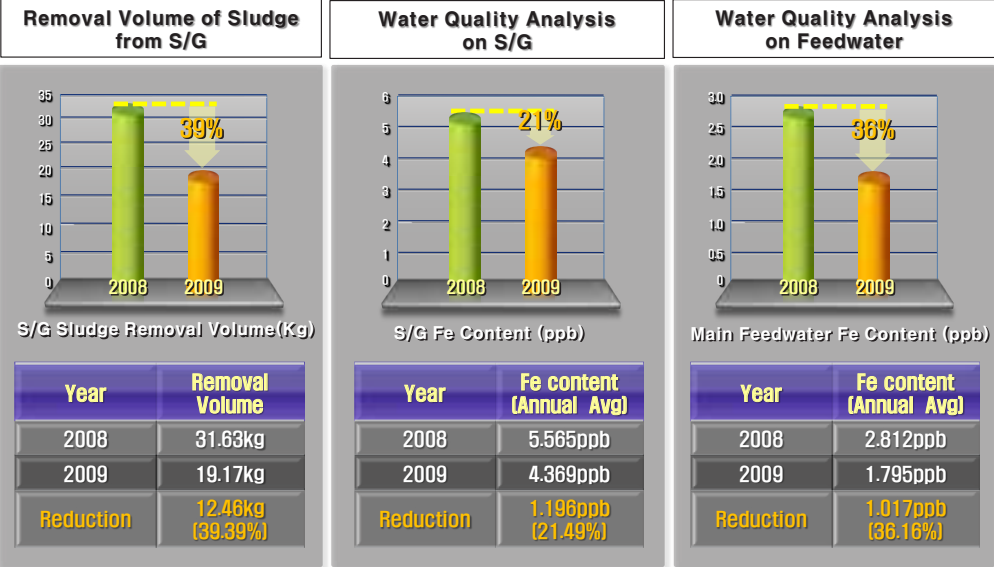
Locations for installing the device in the hotwell will be selected for each power plant to draw the best performance. Also, a magnetic field analysis and a structural stability analysis resulting from a flow analysis inside the hotwell will be performed. These customized engineering services will be provided and a tailored design will be created based on the results of these services.

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2 (2011), Krsko Nuclear Power Plant in Slovenia (2021)
- **APR1400** : Shin-Kori Units 3&4 (2012)

OPERATION ON SITE

Effect of sludge removal device on Kori Unit 2 Operation



KEY BENEFITS

- This product helps improve the water quality, thereby improving the performance of the plant.
- By preventing erosion of the equipment and pipes, the lifespan of the plant is extended and maintenance costs can be saved.

SPECIFICATION

- Magnet**
- The ferrite type magnet is outstanding in economic feasibility and performance
- Structures, etc.**
- All parts are made and processed with stainless steel (304) except for magnet

Curie Temperature	℃	310 Min.
Maximum Operating Temperature	℃	100 Min.
Vickers Hardness	Hv	480 Min.

Plate

Tensile Strength (N/mm ²)	520 and above
Yield Strength (N/mm ²)	205 and above
Elongation (%)	40 and above

Round bar

Tensile Strength (N/mm ²)	520 and above
Yield Strength (N/mm ²)	205 and above
Elongation (%)	40 and above
Reduction of Area (%)	60 and above

CODE & STANDARDS

- Stainless Steel Standard Spec
 - ASTM A240
 - ASTM A276

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1005517



DAEDONG PI Co., Ltd.

40-6, Jwacheon-ro, Jangan-eup, Gijang-gun, Busan, Republic of Korea

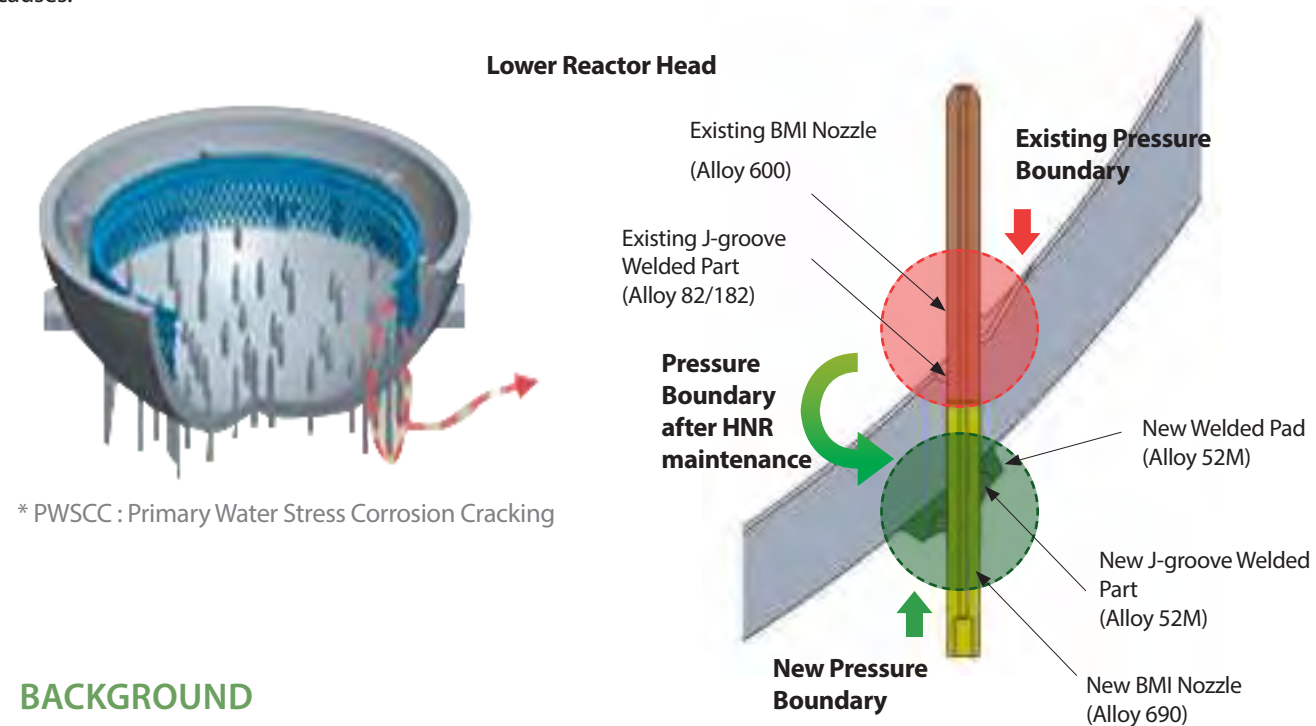
Tel : +82 51 303 0100
Email : dpic11@hanmail.net

Maintenance of Bottom Mounted Instrument Leakage

Latest Maintenance Experience

Speedy Solution

Half-nozzle repair (HNR) is a repair technique that removes half of the existing pipe penetrating the lower reactor head (bottom mounted instrument: BMI) and inserts a new pipe on the surface of the head to create a new pressure boundary. This technique is used when primary coolant is leaked from the pressure boundary due to PWSCC or other causes.



BACKGROUND

In Kori Unit 2, leakage of primary coolants through the welded surface (comprised of two different metal types) of the BMIs was detected. PWSCC was the cause, and cracks on the surface of the welded parts were found through ultrasonic testing and enhanced visual testing (EVT). By applying remote robotics and conducting a simulation test to minimize radiation exposure, the HNR technique was applied to complete maintenance work in the shortest period of time (approximately three months).

PROVEN TECHNOLOGY

When BMI leakage was detected in Kori Unit 2, the HNR technique was applied to conduct repair work in a short period of time (March-June, 2020; approximately three months).

FEATURES

- This technique features cutting-edge diagnostic technology for analyzing the cause of leakage.
- Remote robotics enable repair work to be conducted in high radiation areas.
- Experienced personnel will be dispatched to establish the most optimal work process in consideration of the characteristics of each plant.

CHARACTERISTICS



Confirm the location of the cracks through EVT (on all 36 BMIs)



Cut out BMIs with defects for replacement



Prepare to form a new pressure boundary (J-groove welding, etc.)



Weld the pad for a new pressure boundary



Polish the pad and insert the new half-nozzle



Conduct final welding and non-destructive testing

SUPPLY EXPERIENCE

- **OPR1000** : Hanul Unit 3 (2016) - Provided maintenance services for leakage of the sampling nozzles of the RCS hot leg.
- **WH-type** : Kori Unit 2 (2020) - Provided maintenance services for leakage of BMI.

OPERATION ON SITE



Kori Unit 2 BMI no. 36 Nozzle (Before)



Kori Unit 2 BMI no. 36 Nozzle (After)

KEY BENEFITS

- Predictive maintenance (approx. three months) allows minimization of maintenance costs.
- Remote robotics and simulations by running mock tests minimize workers' exposure to radiation.

CODE & STANDARDS

- ASME Section III, NCA(2004)
- ASME Section III, NB(2004)
- ASME Section II, Part B(2004)
- ASME Code Case N-474-1

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



www.doosanheavy.com
22, Doosan Volvo-ro, Sungsan-gu, Changwon, Gyeongnam, Korea

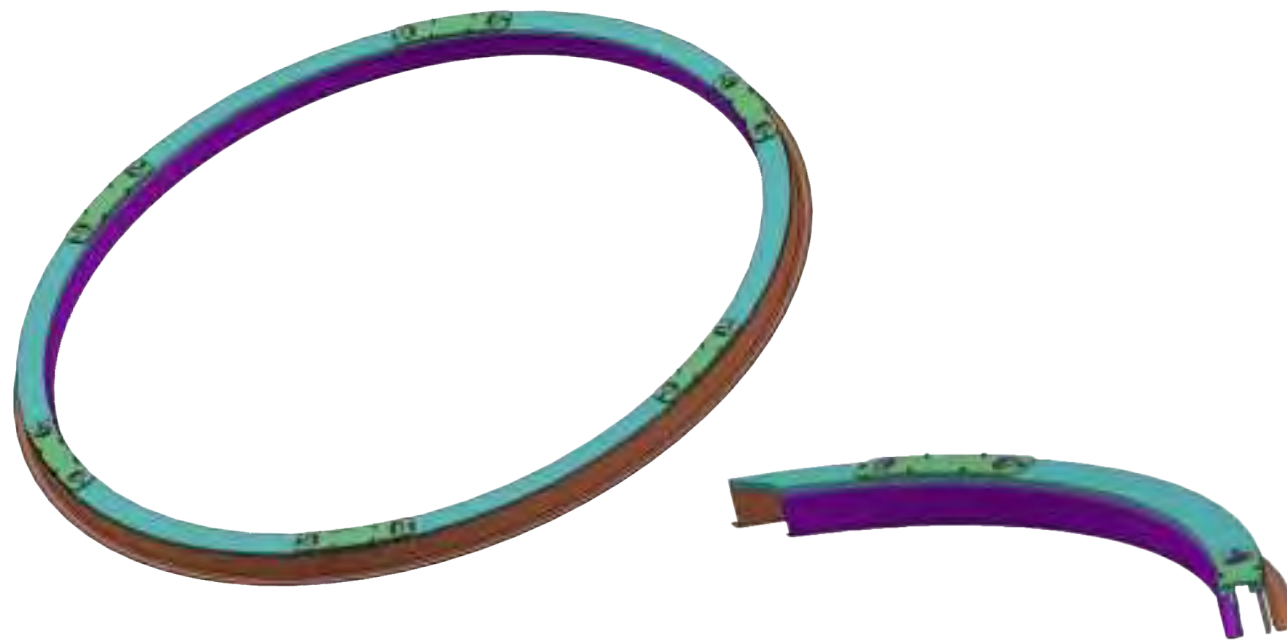
Tel : +82-55-278-6530
Fax : +82-55-278-8546
Email : jaebong.lee@doosan.com

Permanent Seal Ring for Reactor Cavity

Minimum Work Time

Minimum Radiation Exposure

This permanent seal is welded in place to seal the gap between the reactor vessel and cavity, minimizing sealed surfaces. It is easy to install and reduces critical path time and worker exposure during refueling outages.



BACKGROUND

Conventional cavity seal rings are installed to fill the cavity during outages and removed to allow ventilation in the bottom part of the cavity during normal operation. The installation of these seals is one of the main activities during outage. Setting up and drying the seals take time and workers are exposed to radiation from working close to the reactor vessel. The permanent seal rings were developed to address these issues.

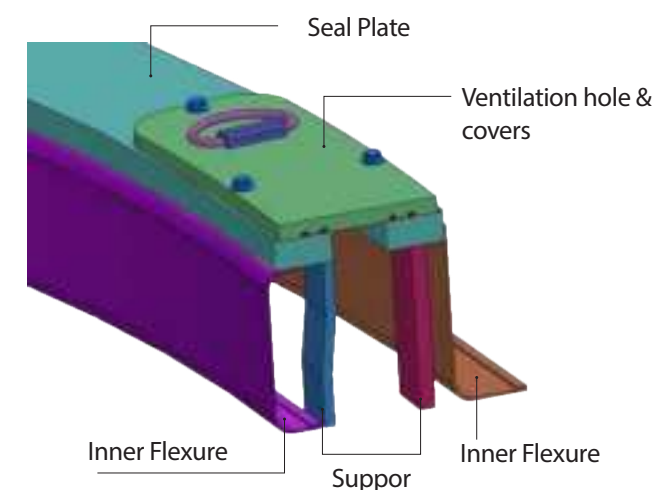
PROVEN TECHNOLOGY

With a simple sealing method of assembling the ventilation flange during outage, tightness and leakage tests can be conducted, leading to safe operation of the nuclear power plant without leakage. These seals have been applied to WH 2 Loop and WH 3 Loop nuclear power plants in Korea.

FEATURES

- The ventilator, acting as a passage through which cooling air flows in the bottom part of the reactor, is equipped with a cover. This cover can be removed during reactor operation and installed during refueling.
- The cover, which is installed during outages, has two seal rings for preventing leakage. A test tab is installed between the rings to conduct the testing of the seals.

COMPOSITION



Seal Plate

A seal plate is installed in the ring-shaped area in between an embedment plate and a seal ledge of the reactor vessel. Six ventilation holes are installed to allow cooling down of the lower part of the reactor during operation.

Flexures

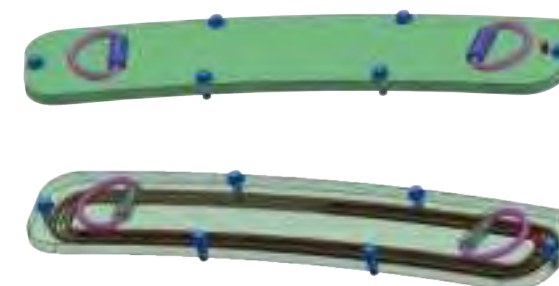
Inner and outer flexures composed of stainless steel are installed, withstanding the changes in thermal behaviors and horizontal seismic load.

Support

Internal and external supports (six each) are installed under and around the seal plate. These supports withstand the head pressure, the empty weight of the permanent seal and the seismic load.

Ventilation Hole and Cover

The six ventilation holes installed at equal distance on the seal plate are used to cool down the lower part of the reactor during operation. During refueling, the double-layered seal rings on the cover ensure a proper seal.



SUPPLY EXPERIENCE

- WH-type : Kori Unit 1 (2013), Kori Unit 2 (2012), Kori Units 3&4 (2013), Hanbit Units 1&2 (2013)

OPERATION ON SITE



Vent Cover Installed



After Installation

KEY BENEFITS

- This seal ring reduces critical path time by approximately 17 hours, which leads to higher profits, by simplifying the sealing process between the reactor vessel and cavity for refueling.
- Applying this product reduces the annual worker dose by around 50 man mSV by shortening working time in high radiation area.
- This product eliminates leakage risks due to sealing uncertainty by testing the seals before refueling.

SPECIFICATION

Specifications	Material
O.D 4658.8mm x I.D 4174.4mm x 185.5mm (Kori Unit 2)	Main material: ASTM A240 TP 304 (Austenite Stainless Steel)



MOOJIN
KORYEONG

734-7, Ancheong-dong, Gwangsan-gu, Gwangju, 506-258,
Republic of Korea

Tel : 062-719-8300
Fax : 062-719-8383
email : moojin@newmoojin.com

Shielded Work Station and Flask for CANDU Spent Fuel

Obsolescence Solution

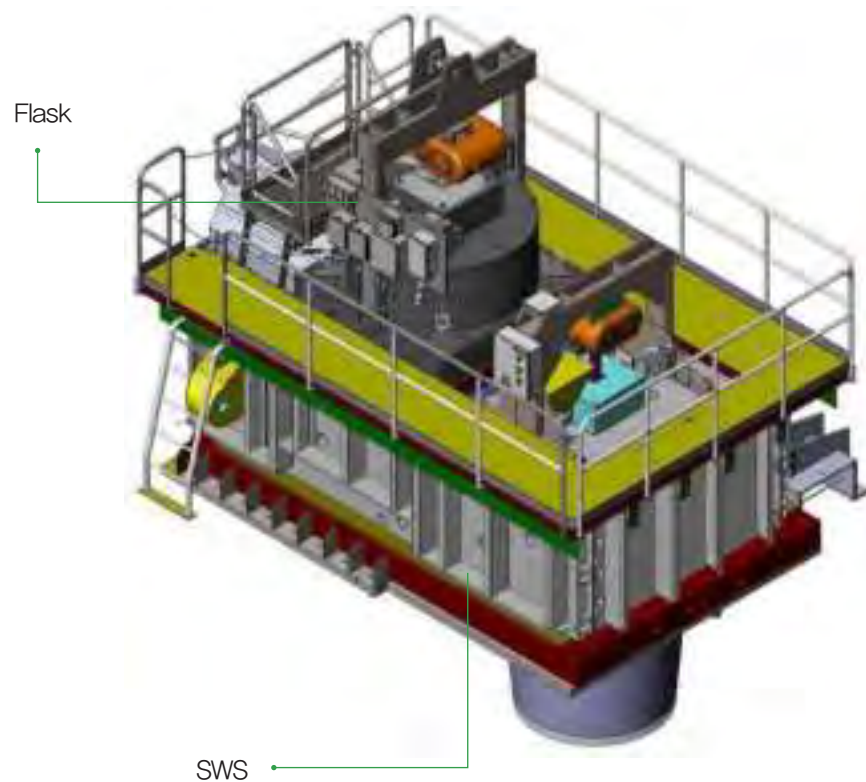
Equipment Reliability

Baskets that store CANDU spent fuel are lifted out of the storage pool into the Shielded Work Station (SWS). The baskets are then cleaned, drained, and dried before seal is welded.

A flask is used to transport spent fuel sealed in baskets from the SWS to storage facilities.

BACKGROUND

The discontinuation of the main parts of the SWS and flask led to a need to develop replacements. The hot and humid working environment with high radiation levels accelerated the aging of the SWS. To address this issue, a Korean SWS and flask was developed to enhance the safety of spent fuel handling and to ensure the seal welding of baskets.



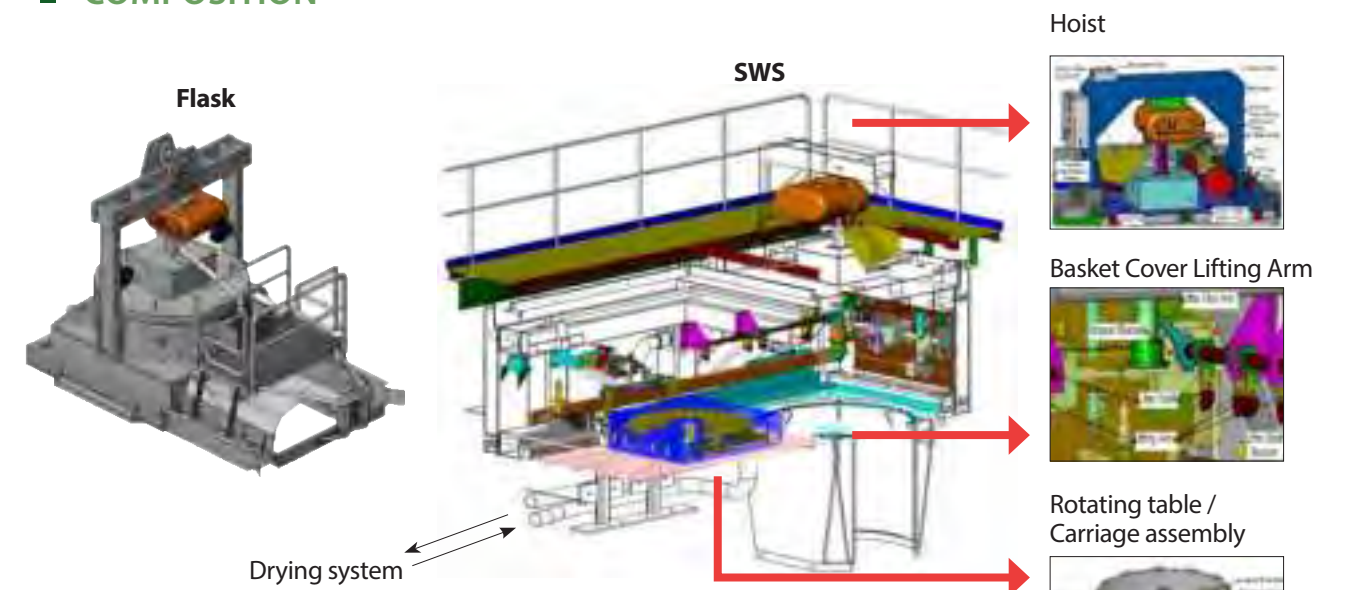
PROVEN TECHNOLOGY

The SWS and the flask developed in Korea have been applied to CANDU-6 reactor Wolsong Units 3&4 in 2004. Customer demands from China's Jinshan Phase III (2009), Romania's Cernavoda Unit 2 (2014) and Wolsong Units 2-4 (2020) have been incorporated into this product. The upgraded equipment has demonstrated its high level of technology.

FEATURES

- Replacement of the main and auxiliary parts are available.
- Improvements have been made to the SWS control system.
 - Improvements to the HMI: provides task status and real-time diagnosis when an alarm goes off during operation, and offers more convenient configurations
- This product offers higher transfer performance (basket transportation speed) of the SWS carriage.
- Improvements have been made to the waterproof capability of the turntable actuator of the SWS and the instrumentation system.

COMPOSITION



Flask

Integral hoist : handles the basket
Grapple : installed at the
end of the hoist : handles the basket
Sliding floor door : a passage for lifting the basket from SWS

SWS

Cleaning equipment : sprays demineralized water to clean the outer basket
Draining equipment : drains by lifting the basket cover with an lifting arm
Drying equipment : dries up the inner basket using hot air
Welding equipment : allows welding to be performed using a wire and welds top and bottom parts of the basket
Actuator : a carriage assembly for moving the position of the basket
Operation control panel : controls the actuator and welding equipment inside the SWS

SUPPLY EXPERIENCE

Conventional SWS and Flask

- Wolsong Units 3&4 (2004)

Improved SWS and Flask

- Wolsong Units 3&4 (2004)
- Wolsong Units 2-4 (2020)
- China's Jinshan Phase II (2009)
- Romania's Cernavoda 2 (2014)

OPERATION ON SITE



Flask



Shielded Work Station

KEY BENEFITS

- Equipment parts have been upgraded to meet user demands, enabling long-term operation.
- This product allows higher work efficiency following HMI enhancements to the control system.
- The product requires shorter task time as a result of faster carriage transfer speed.
- This product requires lower maintenance costs following improvements to the instrumentation's waterproof capability and the subsequent decrease in the number of equipment malfunction cases.

SPECIFICATION

Equipment	Specifications
Flask	•Net Weight : 53,000/24,040 (lb/kg) •Overall Dimension : 136/347(L) × 79.7/202(W) × 115.4/2,293(H) (in/cm) •Shipping Weight : 57,200/25,946 (lb/kg) •Shipping Volume : 939/27 (lb/kg & ft3/m3)
SWS	•Welding power supply : Deltaweld 652 •Dual welding wire feeder : D-74MPa •Video system : Network Camera •Welding system control & Instrumentation : PLC AB Series •Data acquisition system : CWT DART sensor •Rotating table and carriage assembly(Plate) : ASTM A240 TP304 •SWS basket lifting equipment : Electric Chain Hoist, 3ton

PATENT & CERTIFICATION



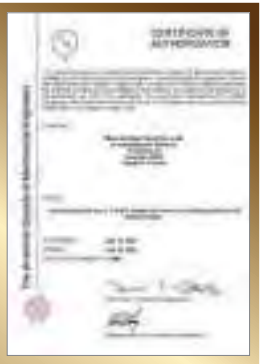
ASME N



ASME N3



ASME NPT



ASME NS



734-7, Ancheong-dong, Gwangsan-gu, Gwangju, 506-258, Republic of Korea

Tel : 062-719-8300
Fax : 062-719-8383
email : moojin@newmoojin.com

Underwater Facility Inspection Robot

Workplace Safety

Equipment Reliability

The underwater visual inspection robot (UVIR) and intake sediment measurement underwater drone (ISMUD) each conduct a visual inspection (UVIR) and sediment measurement at intakes, large storage tanks, and other underwater facilities in a nuclear power plant. By replacing the work of a human diver (maintenance personnel), underwater inspection can be conducted more effectively and safely.



BACKGROUND

For stable operation of a nuclear power plant, periodic inspections of underwater facilities are required. As the limited work area and conditions made it difficult to inspect underwater facilities, there were limitations to obtaining reliable results and possibilities of causing work related accidents. As such, the latest robotics was applied to develop a drone for sediment measurement and a robot for underwater inspection.

PROVEN TECHNOLOGY

After implementation of the underwater drone at Hanbit Units 1&2 (WH 3 Loop) and other nuclear power plants in Korea for monitoring sediments at the intake, no additional accidents while carrying out underwater activities have been reported. In addition, we are in the process of establishing a facility management plan based on reliable inspection results using Sonar sensors. The robots are used to carry out a thorough inspection of the spent fuel storage pool and other large storage tanks, where human access is difficult.

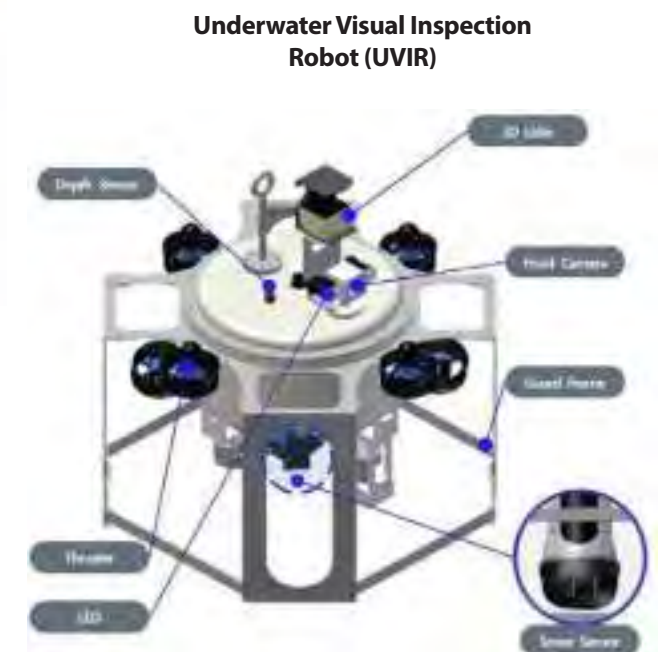
FEATURES

- Equipped with eight thrusters, this robot can move and rotate in all directions.
- The inertia measurement unit and depth sensor enable stable maneuvering of the robot.
- ISMUDs provide real-time 3D mapping of the topography of seabed sediment layers.
- UVIRs offer real-time inspection and storage using a high-performance camera.

COMPOSITION



Intake Sediment Measurement Underwater Drone (ISMUD)



Underwater Visual Inspection Robot (UVIR)

SUPPLY EXPERIENCE

Intake Sediment Measurement Underwater Drone

- **WH-type** : Kori Units 1-4 (2021), Hanbit Units 1&2 (2016)
- **OPR1000** : Hanbit Units 5&6 (2020), Shin-Wolsong Units 1&2 (2019)

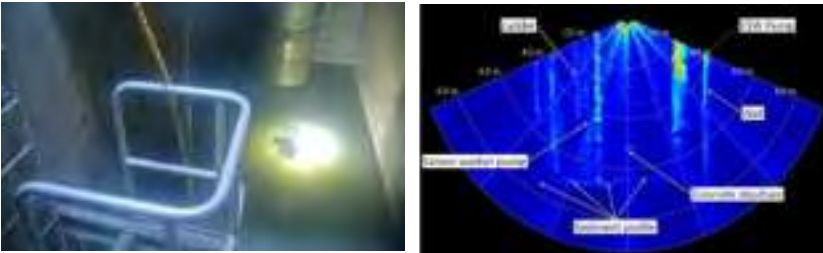
Underwater Visual Inspection Robot

- **APR1400** : Shin-Kori Units 3&4 (2018)

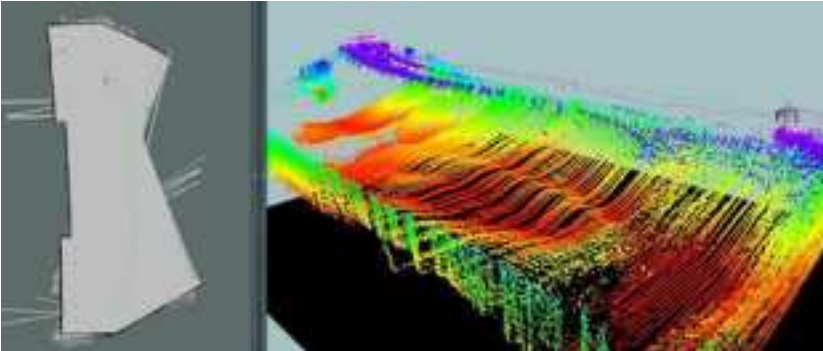
OPERATION ON SITE

ISMUD

Hanbit Units 1&2 Intake Structure Inspection



Shin Wolsong Units 1&2 Intake Structure Inspection



UVIR

Shin-Kori Units 3&4 Water Tank



ENGINEERING SERVICE RELATED TO THE ISMUD AND UVIR

Based on a wealth of inspection experiences, engineering services can be provided to give a diagnosis and inspect intakes and large storage tanks using this equipment.

KEY BENEFITS

- This product enables inspection of underwater facilities with restricted access.
- By replacing human divers, workplace accidents can be prevented.
- Quantified measurement results ensure reliability of the inspection.
- Maintenance costs and time are reduced.
 - Reduces the costs spent on hiring divers
 - Enables inspection without draining and filling of large storage tanks

SPECIFICATION

ITEM	ISMUD	UVIR
Size	Ø680 × 800 H (mm)	Ø680 × 1100 H (mm)
Max Speed	0.5m/s	
Weight	30kg	27kg
Power	120Vac / 220Vac and 50Hz / 60Hz	
Waterproof	30m	

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1789259

PATENT CERTIFICATE
10-0816005



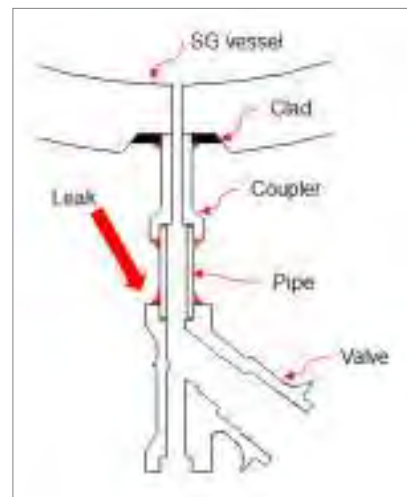
<http://www.iyp.co.kr>
21, Hwajeonsandan 60-ro 102beon-gil, Gangseo-gu, Busan, Republic of Korea
Tel : +82 51 303 2782
Fax : +82 51 301 5661
Email : sales@iyp.co.kr

Management Solution for Small Bore Piping Socket Welds

Equipment Reliability

Preventive Maintenance

We are the only company in the world that provides a multilayered approach for managing small bore pipes that are two inches or less in diameter. We do everything from conducting a Phased Array Ultrasonic Testing (PAUT) and a state assessment to establishing a management plant and carrying out repair works on defects.



BACKGROUND

The socket welds of small bore pipes that are vulnerable to vibrations are generally located near vibration sources, such as pumps. This may cause leakage on the welded part due to fatigue cracking. Although cracks on the socket welds, which cannot be isolated, can cause a reactor trip, the codes and standards do not require in-service inspections on the socket welds. As such, based on over ten years of maintenance experience, KHNP has established a system for managing the socket welds of small bore pipes for plants across Korea.

PROVEN TECHNOLOGY

In the past, leakage from the socket welds of the drain pipe in the steam generator water box tripped the reactor at Kori Units 3 and 4 (WH 3 Loop). After this incident, approximately 1,000 socket welds of major systems (i.e., RCS, CVCS, and MSIV) have been inspected and appropriate measures have been taken, thereby preventing additional reactor trips. Also, a plan for managing these areas has been established, leading to enhancement of plant safety.

FEATURES

- We offer the world's only management solution for small bore piping at nuclear power plants.
- With a management experience of over ten years, we provide a one-stop solution for the socket welds, from target selection to carrying out repair works.
- Our ring scanner is optimal for performing non-destructive testing.

COMPOSITION

PAUT System Configuration



Consultation Services for Management of Small Bore Piping Socket Welds

Target selection and pipe classification
 - Supervision and evaluation of vibration measurement
 - Identification of risk groups and establishment of long-term plan

PAUT System with Optimized Ring Scanner

PAUT is the most efficient and accurate inspection method for small bore piping socket welds.

PAUT Inspection and Repair Services

SUPPLY EXPERIENCE

Applied to all plants Since 2018

- **WH-type** : Kori Unit 2 Reactor Coolant System, Kori Units 3&4, Hanbit Units 3&4 (WH 3 Loop) Reactor Coolant System
- **FRAMATOME-type** : Hanul Units 1&2
- **OPR1000** : Hanbit Units 3-6, Hanul Units 3-6 Reactor Coolant System, Shin-Wolsong Units 1&2
- **APR1400** : Shin- Kori Units 3&4 Reactor Coolant System

OPERATION ON SITE



KEY BENEFITS

- Detecting defects and taking relevant measures at an early stage leads to enhancement of plant safety.
- A systematic maintenance plan can be established based on reliable examination results.
- By establishing an optimized maintenance cycle, maintenance costs can be saved.

SPECIFICATION

Compact Low Profile Scanner		Phase Array Probe & Wedge	
Covering range	0.5"~2.0"	Frequency	3.5MHz
Height/Width	15mm / 25.4 mm	Number of Element	16
Position Encoding	Enable	Height / Width	25.4mm / 11.25mm
Probe contact force control	Enable	Wedge angle	35
Contact point	3-point contact (without probe)	Optimum steering	35 ~ 80
Driving force	manual	Others	Curved wedge contact surface for beam focusing

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(MN)



PATENT CERTIFICATE (USA)
10036732



www.kps.co.kr/eng/index.do
211, Munhwa-ro, Naju-si, Jeollanam-do, 58326 Republic of Korea

Tel : +82 61 345 0523
Email : ldm5220@kps.co.kr

Mechanical Seal for Primary Heat Transport Pump

Durability

Cost-Efficient

This is a mechanical seal for preventing leakage of the reactor coolant from the shaft of the Primary Heat Transport Pump (PHTP).



BACKGROUND

A PHTP is a core facility of nuclear power plants and requires a thorough inspection and maintenance during an outage. To be specific, it is especially important to periodically replace the mechanical seal. However, the existing product is expensive, has a short lifetime, and takes a long time to deliver.



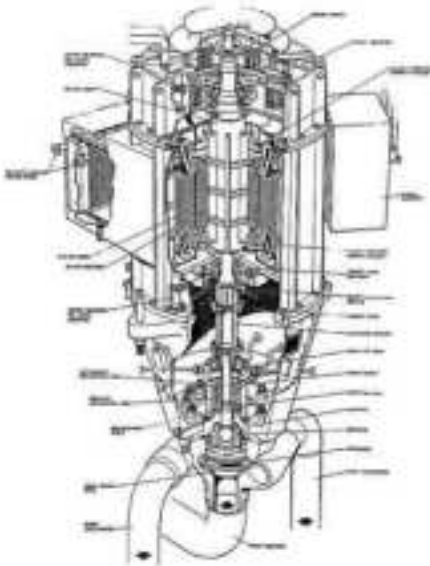
PROVEN TECHNOLOGY

The CANDU-type reactors in Korea saw a drastic reduction in maintenance costs by replacing all of the existing mechanical seals with this product, as the newly replaced seals lasted longer and were more affordable. In addition, short delivery meant that the efficiency of inventory control could be improved.

FEATURES

- This mechanical offers an extended operation lifetime (50,000 hr).
- Applying improved materials to the stator and the rotor led to an enhancement in the wear resistance and lubricity.
- The three-stage design has improved the reliability of this product.
- A spring on the stator side has been applied to eliminate deformation by centrifugal force.

CHARACTERISTICS



PHT Pump



Mechanical Seal

Pump Manufacturer	Sulzer (Bingham)	Motor Rating	6,700 kW
Shaft Size	7.250 inch	Shaft Seal Type	CAN- Seal
Pressure	1450 psi	Temperature	65℃

SUPPLY EXPERIENCE

- CANDU-type : Wolsong Unit 2 ~ 4
 - 41 sets are supplied, since 2007
 - (Wolsong NPPs have been operated stably without any failure)

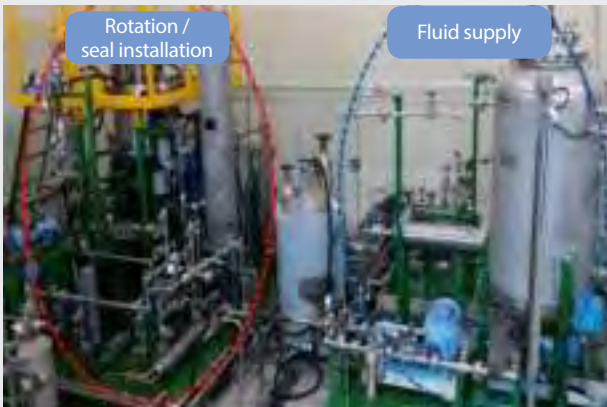
OPERATION ON SITE



Wolsong Unit 2

VERIFICATION

Performace of all mechanical seals is verified through the performance test performed under the simulated operating conditions, which are the same as the normal operating conditions.

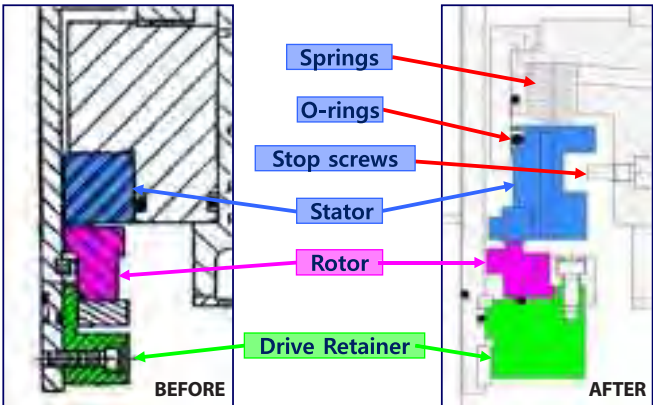


KEY BENEFITS

- Plant safety can be enhanced by applying the redundant mechanical seal design.
- Extended operation lifetime will lead to a reduction in maintenance costs.
- Existing mechanical seals can be replaced at a competitive price.
- Reduced delivery time will lead to an improvement in the efficiency of inventory control.

COMPARISON

BEFORE	VERSION	AFTER
TC vs Carbon	Face Material	SiC vs SiC
Boundary Lub.	Lubrication	Full Fluid Lub.
Rotor	Flexible Part	Stator
8,000 hours	Life Time	50,000 hours
Max. 114 cc/min	Leak Rate	Max.114 cc/min



PATENT & CERTIFICATION



PATENT CERTIFICATE
10-0454040



PATENT CERTIFICATE
0444408



www.ksm.co.kr
66, Sorae-ro, Daegot-myeon, Gimpo-si, Gyeonggi-do, Republic of Korea

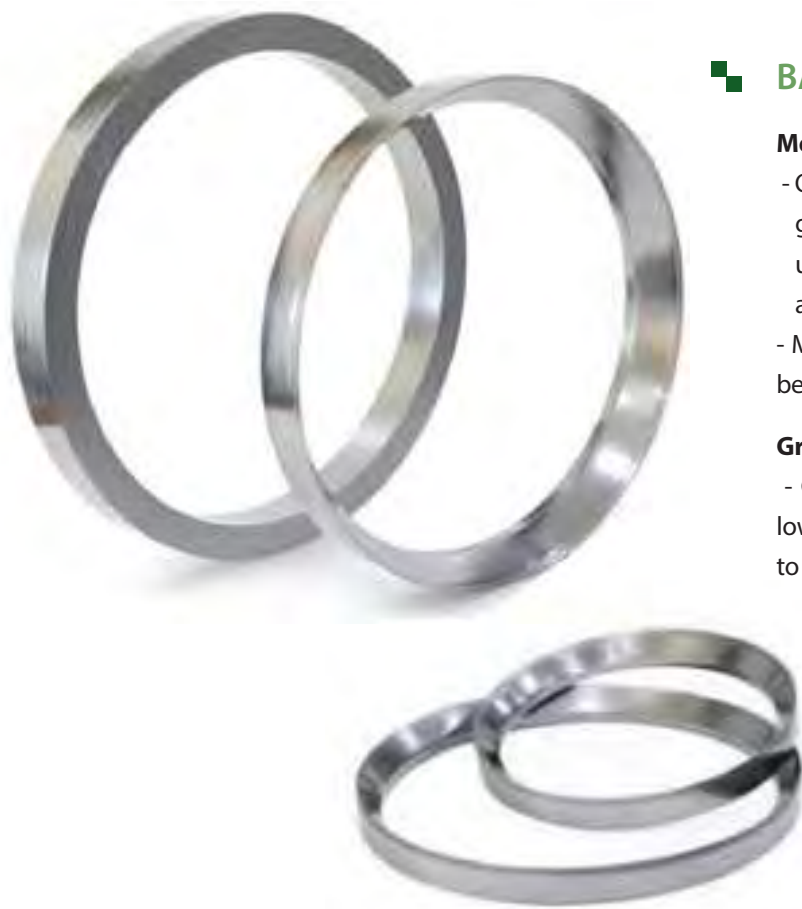
Tel : +82 31 980 0308
Fax : +82 31 629 6912
Email : sangjunkim@flowserveksm.co.kr

Graphite Bonnet Gaskets Reinforced with Braided Yarn

Equipment Reliability

Cost-Efficient

This pressure seal combines reinforced graphite yarn and graphite gasket, which is attached to a high-pressure valve bonnet of a plant equipment. It has the hardness of a metal, yielding effective sealing. Also, coupled with the flexibility of graphite, it resists extrusion and crushing, making it ideal for equipment protection.



BACKGROUND

Metal-type Gasket

- One of the limitations with traditional metal gaskets is that they seal at the sealing point using a metal's hardness, resulting in corrosion and tightness.
- Metal gaskets cause damage to the valve body because of friction during removal.

Graphite-type Gasket

- Graphite gaskets have greater flexibility but lower hardness than metal gaskets, and so need to be reinforced with metal end caps and mesh.

The reinforced metal parts do not offer good sealability, reducing sealing performance.

To solve the aforementioned problems, a new product was developed that has the advantage of a metal's hardness while maintaining the properties of graphite. It provides outstanding heat resistance and its particles are close together, reducing damage to the valve body and minimizing corrosion.

PROVEN TECHNOLOGY

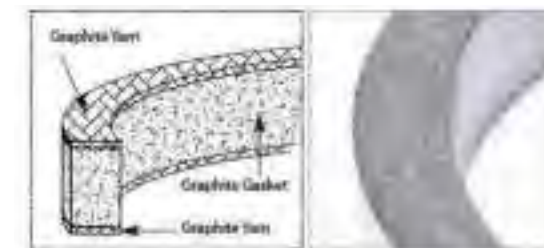
This product has been applied to Kori Unit 3 (WH 3 Loop, 2020) and Hanul Unit 4 (OPR1000, 2021).
This product is to be applied to Shin-Kori Units 3&4 (APR1400) in 2022.

FEATURES

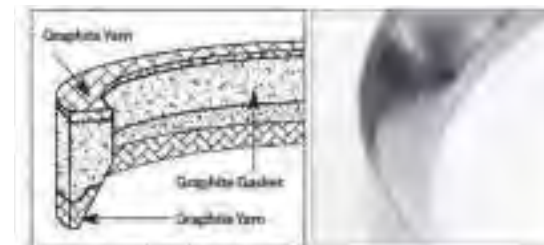
- Combining a graphite gasket with thin strands of reinforced graphite yarn, this product offers the best of both materials, the hardness of a metal and large contact area.
- The graphite yarn used as reinforcement is constructed with braided graphite strips that are surrounded by a knitted inconel wire, assuring superior flexibility and leading to high pressure capability and tensile strength.
- Acting as a sealant itself, graphite yarn perfectly replaces traditional metal reinforcements (i.e., cap and mesh). As a result, the sealed surface area increases by more than 70%, leading to higher sealing performance of a valve.
- This product has the hardness of a metal, making it resistant to extrusion and crushing.
- With excellent flexibility and compressibility, fluorocarbon is embedded into the reinforcement, reducing corrosion and abrasion to the valve body.
- This product offers lower material and processing costs than metal gaskets

CHARACTERISTICS

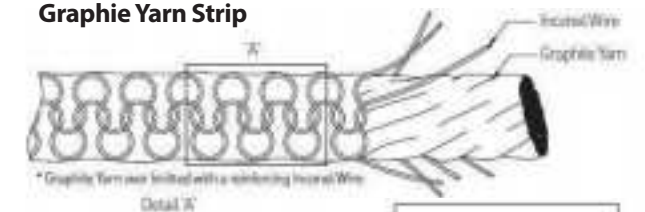
square type



wedge type



Graphite Yarn Strip



Braided Graphite Yarn



SUPPLY EXPERIENCE

Nuclear Industry

■ **WH-type** : Kori Unit 3 (2020)

■ **OPR1000** : Hanul Unit4 (2021)

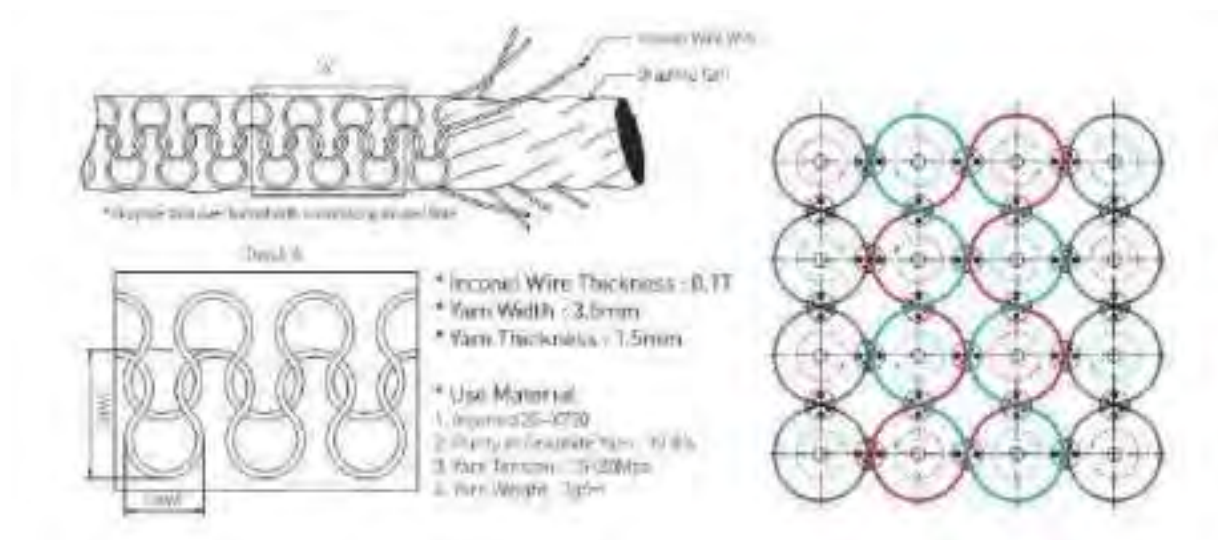
Non-nuclear Industry

■ **Thermal Power Plant** : Yeongheung, Samcheonpo, Hadong, Samcheok, Dangjin, Taean, etc. (Since 2016)

■ **General Industry** : Thailand, Indonesia and the Middle East (Since 2018)

SPECIFICATION

Pressure	Chemical Resistance	Workin Temperature
350bar	pH0-14	From-240℃ to 430℃ in air From-240℃ to 3000℃ in non oxidizing From-240℃ to 650℃ in Steam



KEY BENEFITS

- A pressure seal that has the advantages of both a metal and graphite
 - Prevents unexpected leakage with outstanding sealing performance that comes from the expansion of the sealed surface area
 - Saves on additional maintenance costs by preventing damage to the valve
- More economical than metal gaskets with the use of advanced materials

PATENT & CERTIFICATION



NEP-MOTIE-2020-067



PATENT CERTIFICATE
10-1594786



DONGSUH

www.dongsuhco.co
1157, Gijangdaero, Ilgwang-myeon, Gijang-gun, Busan, Republic of Korea

Tel : + 82-51-724-4851
Fax : + 82-51-980-6604
email : psg@dongsuhco.com

Precision Load Positioner

Work Efficiency

Workplace Safety

This precision load positioner moves heavy loads safely with extreme precision during nuclear power plant construction and outage.



BACKGROUND

A precision load positioner is essential for handling heavy loads when dismantling and assembling the reactor head, reactor components, and main equipment within the containment building. However, due to the monopoly of the existing precision load positioner in the global market, costs were high and supply conditions were hard to meet. With the aim of supplying the precision load positioner at a reasonable price, this product has been developed as part of a nuclear research project for commercialization.



PROVEN TECHNOLOGY

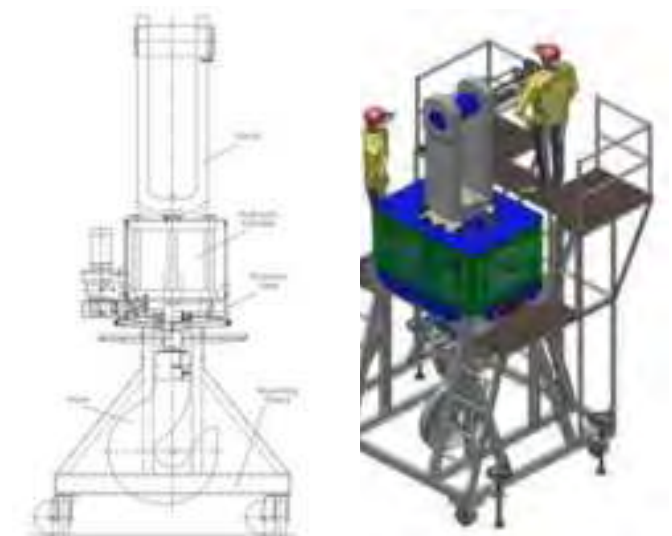
Since 2009, this product has been supplied to be used with the polar cranes at the containment building of two OPR1000 units and four APR1400 units. Over 12 years of operation demonstrates its safety and reliability.

FEATURES

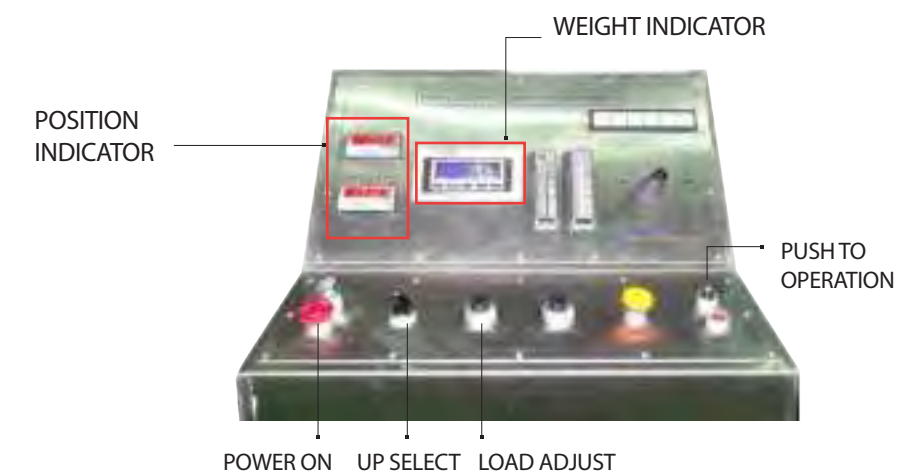
- Tested to twice its rated capacity, this product is proven to be safe for use and with simple attachment to your crane, installation, removal and maintenance come easy.
- An inverter is applied to the rotating motor on the hook to enable easy change of rotation speed.
- The pressure sensor with mA output having excellent noise characteristics allows loads to be moved up and down with precision to within 0.02 mm. Also, weight readouts are accurate to within 0.5% of full scale.

CHARACTERISTICS

Precision Load Positioner with Hook & Storage Cart



Control Console Assembly



SUPPLY EXPERIENCE

■ **OPR1000** : Shin-Wolsong Units 1&2 (2014)

■ **APR1400** : Shin-Kori Units 3&4 (2009), Shin-Hanul Units 1&2 (2012)

OPERATION ON SITE



KEY BENEFITS

- This equipment removes oscillations produced by sudden starts and stops in crane cables, thereby preventing accidents.
- This product prevents equipment damage resulting from impact collision by reading the weight of the heavy loads.
- The movable cart-type control panel has improved usability.
- Precise and accurate control means reduction in work hours, requiring a smaller workforce and improving productivity.
- Shortened working hours in the radiation area leads to reduction in radiation exposure and waste.

SPECIFICATION

General	
Model	PLP
Working Capacity	250 or 300USton
Safety Factor	5 times
Proof Load Test	2 times
Electric Source	AC 440~480V, 3 Phase, 60Hz
Hydraulic System	
Fluid Medium	ISO VG46
Oil Tank Capacity	65Liter
Cylinder Strok	305 mm
Working Pressure	140~210bar
Performance	
Accuracy of Load	±0.3% of Full Scale
Travel Control Resolution	within 0.02 mm
Rotation Control Resolution	within 1 degree
Travel Speed	0.025~1.2mm/s
Rotating Speed	0.5rpm

PATENT & CERTIFICATION



ISO 9001:2015

ISO 14001:2015

ISO 45001:2018

KEPIC-MN



<http://www.powermnc.com/>
8, Cheoyongsaneop5-gil, Cheongnyang-eup, Ulju-gun, Ulsan

Tel : + 82-52-955-5920
Fax : + 82-52-955-5930
email : pw@powermnc.com

Lightweight Door for Securing Safety Equipment

Ultra Lightweight

Earthquake-resistant / Waterproof / Fire-rated

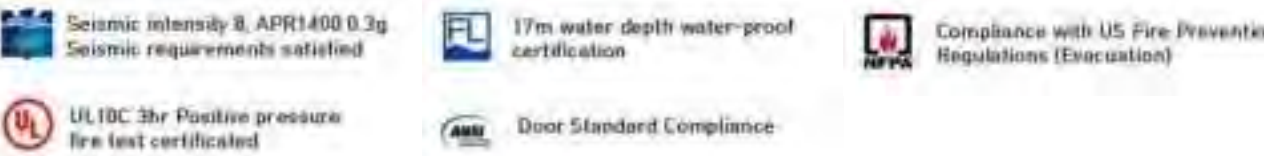
This is a lightweight door for securing the emergency power system and other essential safety equipment when multiple disasters—earthquakes, floods, and fires that exceed the design standards of nuclear power plants—strike at once.

- Easy escape
- Self-closing
- Passive protection



BACKGROUND

The demand for special equipment in securing the emergency power system and other essential safety equipment has increased in response to the increasing occurrence of large-scale earthquakes, tsunamis, fires, and other natural disasters that led to the Fukushima nuclear disaster. This special door was developed to meet all of the requirements (earthquake, water, and fire-proof capabilities) for extreme natural disasters, an improvement from conventional doors with only a single capability to prevent the disasters separately.



PROVEN TECHNOLOGY

This lightweight door has been installed in 16 nuclear power plant units in Korea (reactor type: WH, OPR1000, FRAMATOME, and CANDU) and one unit (reactor type: Siemens) outside of Korea. Installed in five different reactor types across 17 nuclear power plants, this product contributes to safe operation of the plant.

FEATURES

Earthquake-resistant

Peak Ground Acceleration: 0.3g

Waterproof

Static Pressure: 17 m

Fire-rated

Tested as per UL 10C

- The first in the world to pass a series of field tests (earthquake → fire → water)
- Meets the egress requirements stipulated in the International Building Code

CONFIGURATION AND SPECIFICATION

Single Door

Passive Protection technologyShowing extraordinary power against floodand tsunami, yet having appearanceand operation of ordinary doors

Tsunami series
Single door

Seismic intensity 8, APR1400 0.3g
Seismic requirements satisfied

UL10C 3hr
Positive pressure fire test certified

Width	900 to 1219mm
Height	1800 to 2438mm (3000mm Non-Fire Rate)
Inundation height	3m or less
Material	Steel, Stainless steel
Reference price	4,000,000 Korean won(per m²) (without consumption tax, installation cost, transportation cost and overhead)
Usage	- Ground level facility flooding protection - Entrance flooding protection - Underground power and safety equipment flooding protection

Pair Door

Reverse beam structure technologyPassive Protection technologyShowing extraordinary power against floodand tsunami, yet having appearance andoperation of ordinary door

Tsunami series
Pair door

Width	1800 to 2438mm
Height	1800 to 2438mm (3000mm Non-Fire Rate)
Inundation height	3m or less
Material	Steel, Stainless steel
Reference price	4,000,000 Korean won(per m²) (without consumption tax, installation cost, transportation cost and overhead)
Usage	- Ground level facility flooding protection - Entrance flooding protection - Underground power and safety equipment flooding protection

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4, Hanbit Units 1&2 (2020)
- **FRAMATOME-type** : Hanul Units 1&2 (2020)
- **CANDU6-type** : Wolsong Units 1-4 (2020)
- **OPR1000** : Kori Units 5&6, Hanbit Units 5&6 (2020)
- **Siemens-type** : Spain Trillo Unit 1 (2019)

OPERATION ON SITE

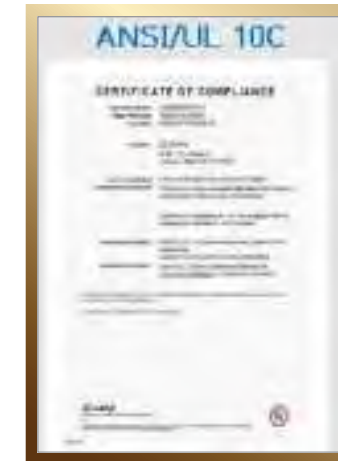


Hanbit Unit 5 & 6 Access Control Building

KEY BENEFITS

- Existing doors can be replaced with minimum design changes, keeping the existing structure.
- Multiple disaster prevention functions are integrated into a single door, enabling reduction in costs for installation, purchase, and maintenance compared to the existing door.
- This door features integrated disaster prevention functions, enabling prevention against extreme disasters and response to safety regulations.

PATENT & CERTIFICATION



www.esdasan.com
2nd FL Nong-Hyup 872, Haemaji-ro, SeosangMyunUlju-Gun,
Ulsan. Korea

Tel : +82 54 750 9990
email : hwang@esdasan.com

Steam Generator Sludge Removal Equipment

Customized

Cleans All Areas

This sludge removal equipment aims to keep steam generator tubes clean and increase heat transfer efficiency by using the lancing robot, which has automatic control capability and rotates its spray nozzles to remove sludge on top of the steam generator tubesheet.



BACKGROUND

The sludge removal equipment was developed to prevent damage to tubes, such as denting. It effectively removes soft sludge on top of the tubesheet to prevent hard sludge from accumulating.

The equipment was introduced to resolve corrosion and aging issues that were present in conventional equipment and to allow automatic control of lancing equipment.

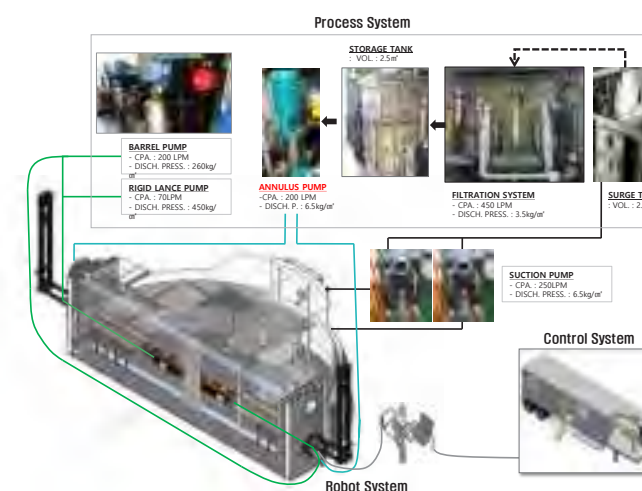
PROVEN TECHNOLOGY

This lancing robot was applied to two WH F-type reactors, 12 OPR1000 reactors and four APR1400 reactors. Operation without a single issue during outage has demonstrated its safety and excellent performance.

FEATURES

- This equipment supports customized production, taking into consideration the design of steam generators (e.g., gap between tubes and their location)
- The lancing robot is designed to operate in the annulus region and the no-tube lane of the steam generator.
- The straightness from the spray nozzle to the target (the spread of water is within 5 degrees for lengths between 0 and 2.2 m) and the adjusting of the nozzle injection angle can improve sludge removal efficiency.

CONFIGURATION



[WEC-F type Lancing System used in No Tube Lane]

ROBOT SYSTEM

A robot is inserted into the handhole of the steam generator to spray high-pressure washing water in between the tubes.

CONTROL SYSTEM

The control system manually or automatically controls and monitors the lancing robot.

PROCESS SYSTEM

High-pressure pumps are used to supply washing water to the lancing robot. A suction pump is used to take back the water and the sludge for purification using a filter. The purified washing water is supplied back to the robot.

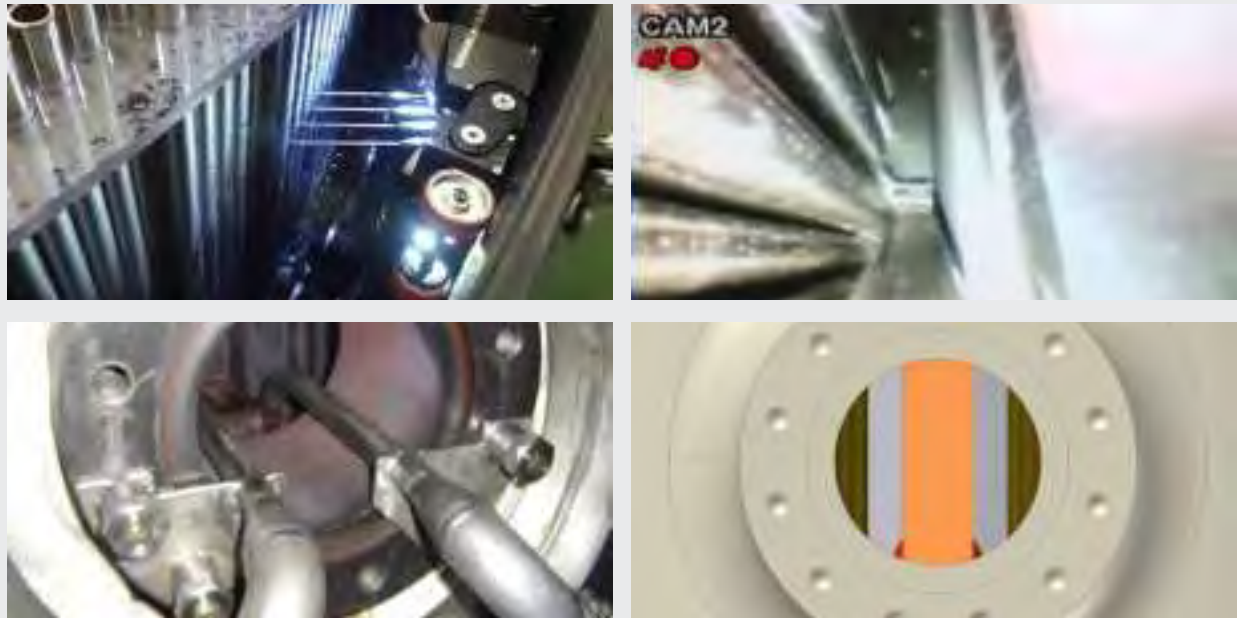


[Lancing System used in Annulus area]

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 3&4 (2012)
- **OPR1000** : Shin-Kori Units 1&2 (2012), Hanbit Units 3-6 (2012), Shin-Wolsong Units 1&2 (2013), Hanul Units 3&4 (2012), Hanul Units 5&6 (2016)
- **APR1400** : Shin-Kori Units 3&4 (2017), Shin-Hanul Units 1&2 (2021)

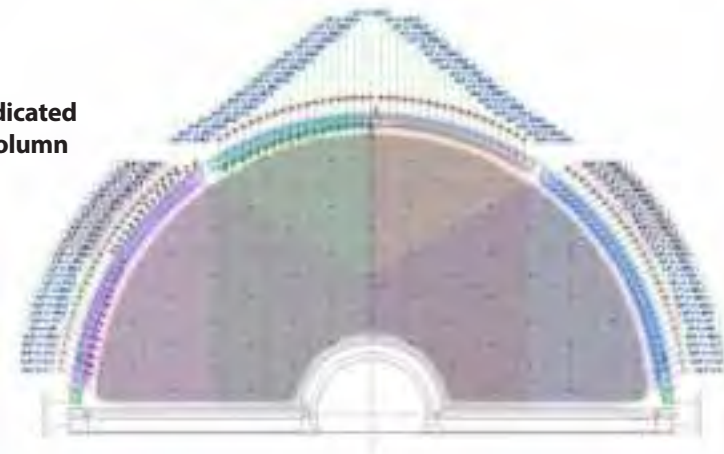
OPERATION ON SITE



KEY BENEFITS

- The lancing robot is remotely operated and automated, leading to decreased personnel exposure to radiation and increased operational convenience.
- New tilting and rotating features are added to the spray nozzle, increasing soft sludge removal efficiency and enabling the cleaning of all regions of tubes.

Angles indicated for each column



SPECIFICATION

Item	Description
Robot Assembly	deployed in the annulus area or no-tube lane
Robot Motor	four units (trans : two, tilting : one, rotating : one)
Robot Camera	four units (front, back, column setting, downward)
Nozzle	four nozzles for one lance robot assembly
Nozzle Straightness	measures the angle of the water spreading for lengths between 0 and 2.2 m
Suction System	fixed-type, suction fit (camera installed)
Annulus Fit	fixed-type
Cable Guide System	auto, camera installed
Operating Program	3D modelling, C#

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1147356

PATENT CERTIFICATE
10-1120428

PATENT CERTIFICATE
10-1046589



79-13, A Samlac-dong, Sasang-gu, Busan, Republic of Korea

Tel : 051-302-4979
Fax : 070-4105-4547
email : komec777@gmail.com

Radiation Tolerant CCTV System

Surveillance Efficiency

Cost-Efficient

This radiation tolerant CCTV camera offers real time monitoring of high radiation areas in nuclear power plants. Being highly resistant to radiation, the display of this CCTV camera includes a high-resolution color screen, thereby enabling efficient monitoring and stable operation in the long term.

BACKGROUND

Nuclear power plants require CCTV cameras for monitoring the inside of high radiation areas such as the reactor containment building (RCB). However, the conventional lead-shielded cameras that use a camera tube have low image quality, are not radiation tolerant, and are not easy to conduct maintenance. As such, this high performing camera that has incorporated improvements has been developed and installed in power plants across Korea.



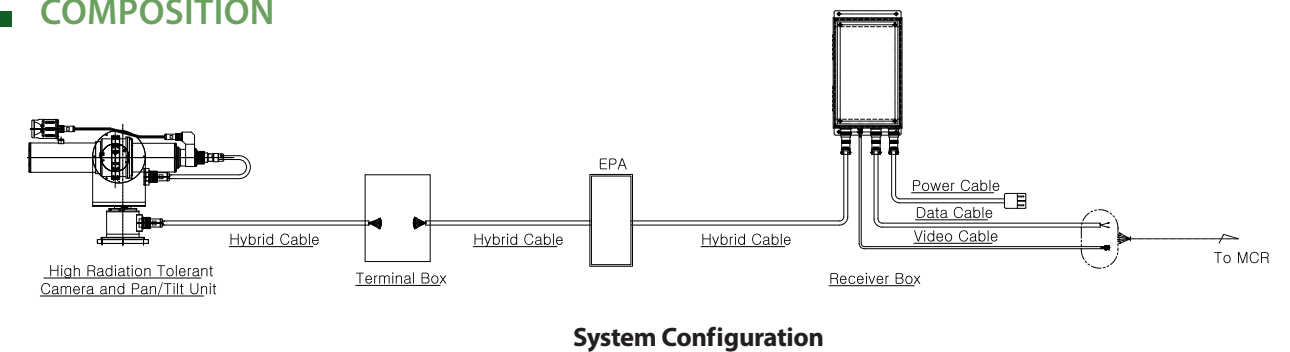
PROVEN TECHNOLOGY

For most of the nuclear power plants in Korea, the existing black and white CCTV cameras installed in high radiation areas (i.e., RCB and spent fuel storage tank) have been replaced with this high-definition color CCTV, which led to higher efficiency in monitoring the plant. Also, because this camera is highly resistant to radiation, maintenance costs were reduced.

FEATURES

- This is the world's first CMOS APS-based radiation-tolerant color CCTV.
- This product is highly resistant to radiation (1x10⁷ rads).
- The system is compatible with the existing CCTV camera system.

COMPOSITION



Radiation Tolerant CCTV

Color camera and pan/tilt assembly



Receiver Box

Communicates with each component of the entire CCTV system



Camera Control Unit (CCU)

Controls the CCTV movement

SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1-4 (2021), Hanbit Units 1&2 (2020)
- **CANDU-type** : Wolsong Units 1-4 (2020)
- **OPR1000** : Hanbit Units 3-6 (2017), Hanul Units 3-6 (2017), Shin-Kori Units 1&2 (2021), Shin-Wolsong Units 1&2 (2013)
- **APR1400** : Shin-Kori Units 5&6 (2018), Shin-Hanul Units 1&2 (2018), Barakah Units 1-4 (2014)

OPERATION ON SITE



Wolsong Unit 2 Reactor Building

KEY BENEFITS

- This high-definition CCTV camera raises monitoring efficiency.
- Existing CCTV cameras can be replaced with this product at a competitive price.
- Maintenance costs can be saved, as this camera is highly resistant to radiation and has a long lifespan.
- Using this product leads to improvement in maintenance convenience.

SPECIFICATION

Item	CMOS APS Camera (Developed Camera)	CCD Camera	Tube Camera
Radiation Resistance	1 x 10 ⁷ Rad	3 x 10 ⁴ Rad	2 x 10 ⁸ Rad
Image Quality	Normal (No problem under the radiation environment)	Good (Image becomes bad under the radiation environment)	Normal (Image lag and smear can occur)
Life Time	Semi-permanent	Semi-permanent	Approx 15,000 hour
Sensitivity	Normal (About 4 Lux)	High (About 0.1 Lux)	Low (About 10 Lux)
Maintenance	Easy	Easy	Difficult
Image Color	Color	Color	Black & White/Color

PATENT & CERTIFICATION



KEPIC-CERTIFICATE(EN)



PATENT CERTIFICATE
10-1613605



REALGAIN CO.,LTD.

www.realgain.co.kr
SEONGSU ACE HIGH END TOWER, 14, Seongsuil-ro 10-gil,
Seongdong-gu, Seoul, 04784, Republic of Korea
Tel : +82 2 885 4781 Fax : +82 2 885 4782
Email : realgain@realgain.co.kr

ADVANCED AND PROVEN O&M TECHNOLOGIES
FOR NUCLEAR POWER PLANT



ELECTRICAL ENGINEERING

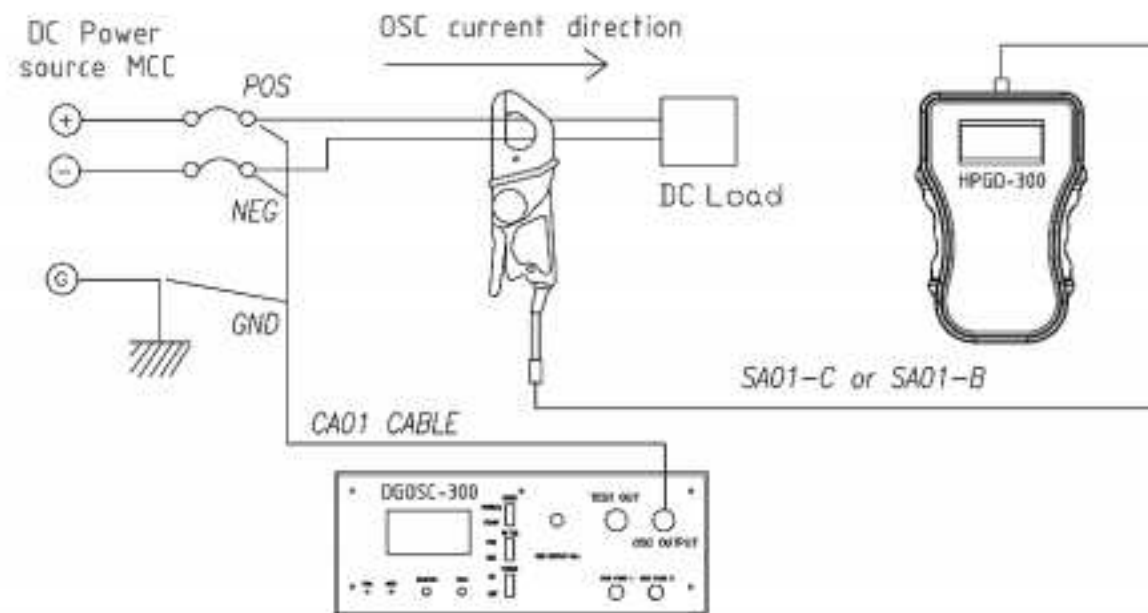
- 150 Portable DC Ground Detector
- 154 Remote Insulation Resistance Measuring System
- 158 Fault Recorder
- 162 Integrated Circuit Breaker Test Set
- 164 Dissolved Gas Monitor for Oil-immersed Transformers

Portable DC Ground Detector

Short Detection Time

User Convenience

This portable detector detects ground faults that occur in an ungrounded power system. Ground faults can be quickly and easily detected anywhere in the direct current (DC) power line, either in the field or in a distribution panel.



BACKGROUND

The DC power system needs to be maintained in a stable and reliable manner for normal operation of the equipment within a nuclear power plant. As such, prompt inspection is required to prevent unexpected equipment malfunctions and plant transients caused by ground faults. Against this backdrop, this product has been developed to easily identify ground points when current is flowing.

PROVEN TECHNOLOGY

This detector has been applied to most of the nuclear power plants in Korea, including the WH-type reactors. A few grounding points among hundreds of distribution panel loads where ground faults occurred have been quickly and accurately detected, thereby significantly reducing the time spent on taking necessary measures.

FEATURES

- This product detects high resistance ground faults using a high-sensitivity, high-precision sensor (10 Ω-200 kΩ).
- Detected values are displayed in quantified ground resistance values, allowing users to immediately make decisions.
- The grounding status of the direct current is displayed digitally in real time.
- Leakage current can be measured in real time.
- This product comes in a compact size, to be used in the local panel.

COMPOSITION

Portable DC Ground Oscillator

This oscillator generates 3.75Hz, 6Vrms signals supplied to the DC power supply line.



Portable Ground Detector

A portable ground detector can be used anywhere to detect ground resistance of DC power.



Clamp sensor

This is a ground sensor for the portable ground detector.

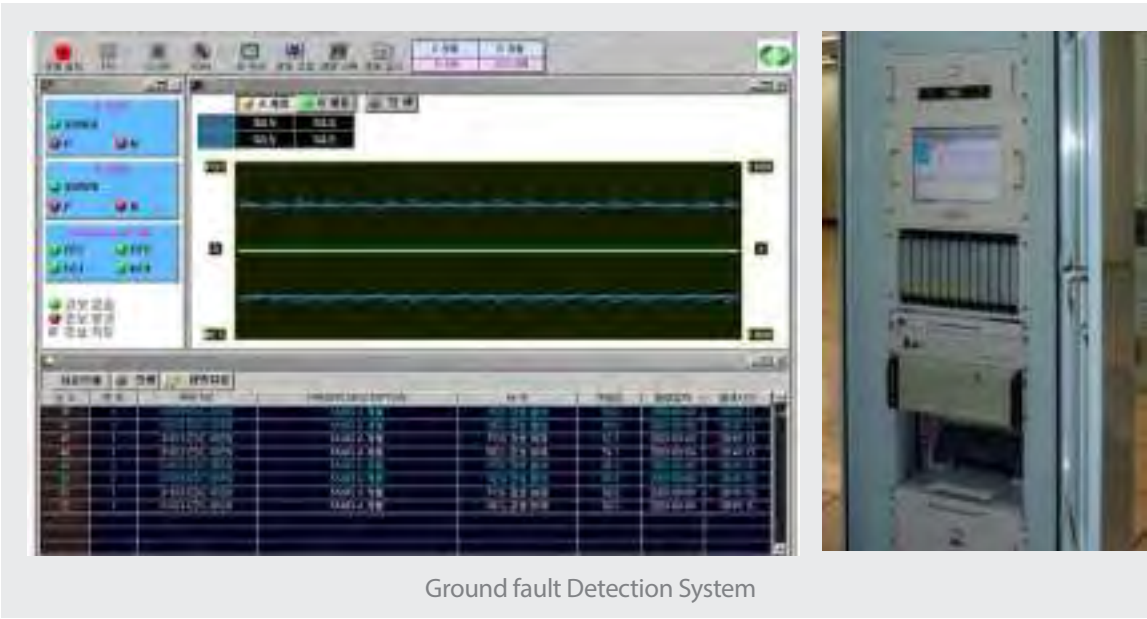


SUPPLY EXPERIENCE

- **WH-type** : Kori Units 1&2 (2017)
- **CANDU-type** : Wolsong Units 3&4 (2019)
- **OPR1000** : Hanbit Units 3-6 (2016), Hanul Units 5&6 (2017), Shin-Wolsong Units 1&2 (2019),
- **APR1400** : Shin-Kori Unit 3-6 (2013), Shin-Hanul Units 1&2 (2014), Barakah Units 1-4 (2015)

EQUIPMENT RELATED TO THE PORTABLE DETECTOR

A ground detection equipment has been developed to allow continuous use of portable ground detectors. This equipment detects and monitors ground faults that occur in the DC power system in real time and sends data to operators and maintenance staff.



Ground fault Detection System

KEY BENEFITS

- Using this system significantly reduces the time to detect ground fault locations of the DC power system.
- With this proven detector, plant safety can be enhanced.
- Ground detection can be performed within a 4-km radius from a portable oscillator, without the influence of 2R resistance.

SPECIFICATION

Oscillator
(DGOSC-300)

Unit	Item	Type and Standard	Tolerance
1	Size	H121 x W315 x D228 mm	
2	Weight	6Kg	±0.2Kg
3	Size of oscillating signal	6Vrms	±0.2V
4	Frequency of oscillating signal	3.75Hz	±0.02Hz
5	Maximum output	200mW less than	
6	Blocking way of DC power	Blocking condenser type	
7	Impedance of internal output	100 Ohm	
8	Power	AC 120 and 220V,50/60Hz	

Detector
(HPD- 300)

Unit	Item	Type and Standard	Tolerance
1	Size	H190 x W123 x D50mm	
2	Weight	Within 1Kg	±0.2Kg
3	Range of ground detection	10 Ω ~ 200kΩ	±10%
4	The method of detection	AMP detection method	
5	Impedance of internal output	Less than 1Kohm	
6	Power battery type	AA 1.5V X 4EA	

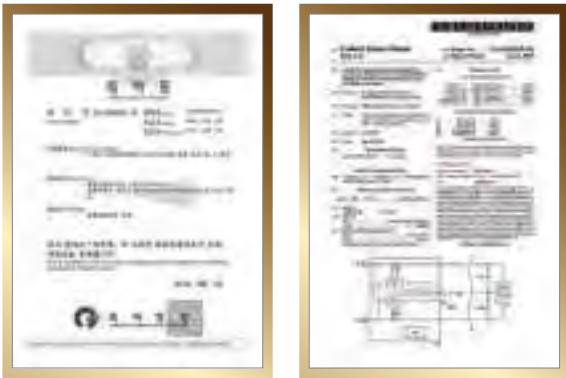
Sensor
(SA01-C)

Unit	Item	Type and Standard	Tolerance
1	Size	H74 x W145 x D42mm	
2	Range of detection frequency	1 Hz ~ 1000Hz	±10%
3	Range of detection measurement	Less than 2mA	
4	Using of cable diameter / cable length	50Φ / 3M	

CODE & STANDARDS

- Design of DC Auxiliary Power System
- IEEE 946

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1009595

PATENT CERTIFICATE(USA)
8928330 B2

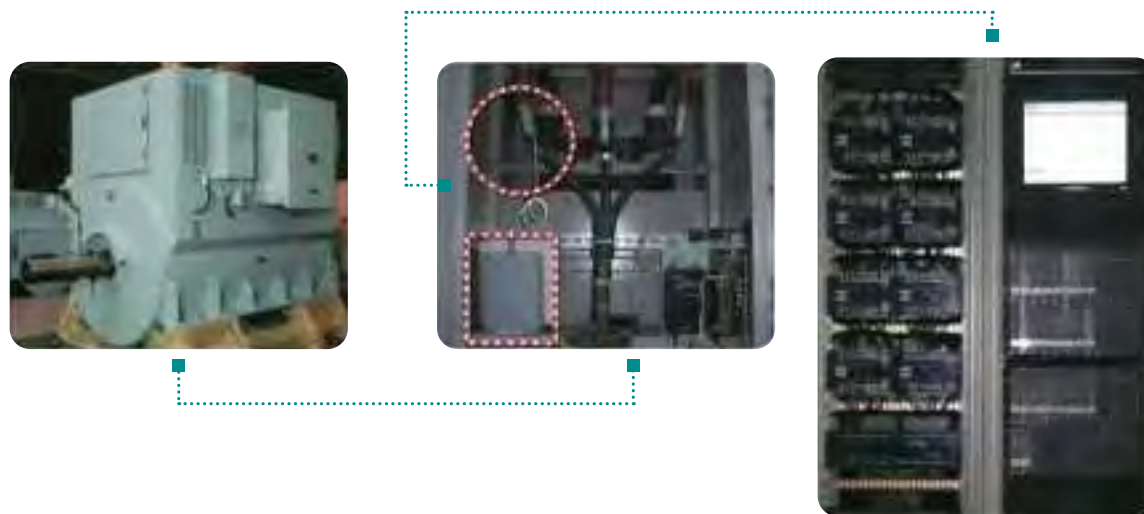


WEAL ELECTRIC INDUSTRY CO., LTD.

273-15, Sung-su 2 ga, Sungdong-gu, Seoul, Republic of Korea
Tel : +82 2 466 5620
Fax : +82 2 466 5621
Email : jin1149@nate.com

Remote Insulation Resistance Measuring System (RIRS)

This system has been developed to remotely measure insulation resistance, one of the standards for determining the integrity of high voltage circuit breakers. With this product, workers can measure insulation resistance without being involved in an electrical accident. Also, the measured data can be easily managed.



BACKGROUND

High-voltage motors are essential to operation of a nuclear power plant. To ensure their reliability, swap operation of these motors are performed periodically and insulation resistance is measured and managed. Conventionally, maintenance staff were dispatched to the field to measure insulation resistance. This method entailed a risk of accidents due to the high voltage and took a long time. As such, this product has been developed to remotely and quickly measure insulation resistance and has been installed in power plants across Korea.

PROVEN TECHNOLOGY

This Remote Insulation Resistance Measurement System has been applied to most of the nuclear power plants in Korea, preventing electrical accidents that may occur while measuring insulation resistance of a high-voltage motor. Also, using this product has dramatically reduced the measurement time, compared to the manual approach. In addition, systematic management of reliable measurement values for predictive maintenance has become possible.

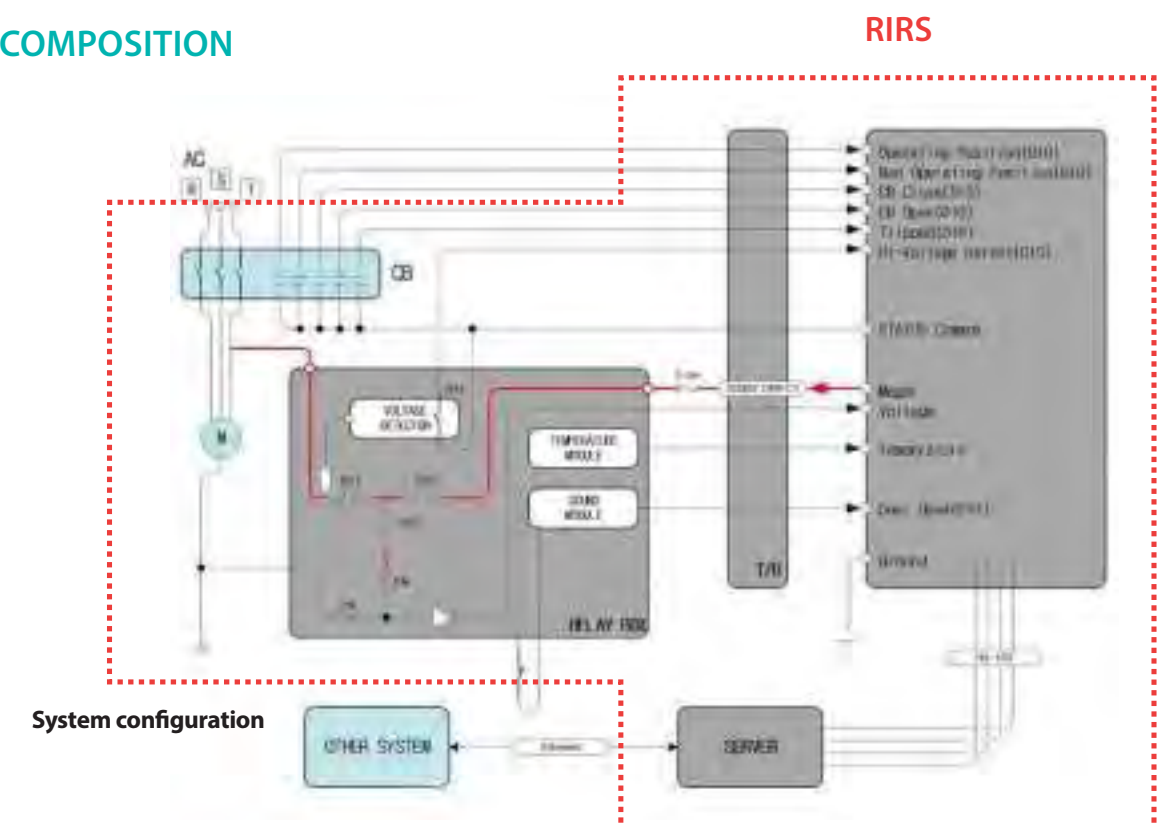
Workplace Safety

Short Measuring Time

FEATURES

- Highly reliable insulation resistance values can be drawn from remote measurement.
- Users can use this system to check the location and operation status of each circuit breaker.
- The history and trends of insulation resistance values can be managed systematically.

COMPOSITION



RELAY BOX

- Insulation from high-voltage motor
- Detects high voltage of motor line
- Checks remote insulation resistance measurement conditions



Signal Processing Module

- High voltage generation for measurement (DC 2500V)
- Performs measurement algorithm such as relay box control
- Communicates with DAQ unit

SUPPLY EXPERIENCE

■ **WH-type** : Kori Units 1-4 (2010), Hanbit Units 1&2 (2010)

■ **CANDU-type** : Wolsong Units 1-4 (2010)

■ **OPR1000** : Hanbit Unit 3-6 (2011), Hanul Units 3- 6 (2009)

OPERATION ON SITE



User Interface Screen

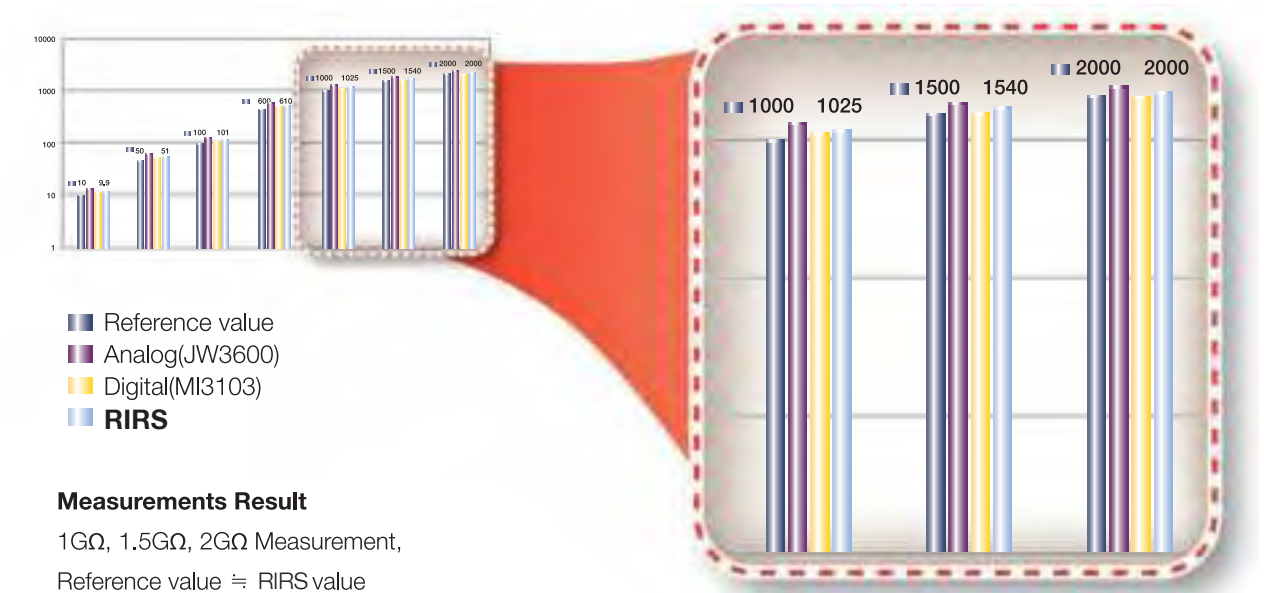


System cabinet (Kori unit 1)

KEY BENEFITS

- This system helps prevent electrical injuries caused by human error.
- Using this product reduces measurement time and improves maintenance convenience.
- Predictive maintenance can be performed based on reliable measurement results, thereby improving equipment reliability.

COMPARISON OF MEASUREMENT RESULT (MANUAL VS REMOTE)



CODE & STANDARDS

- Insulation Resistance Test
- IEEE 43

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1086024

PATENT CERTIFICATE
10-1096792



ORBIS ORBIS Co., Ltd.

www.orbis1.co.kr
(13204) 14, Sunhwan-ro 226beon-gil, Jungwon-gu, Seongnam-si,
Gyeonggi-do, Republic of Korea

Tel : +82 31 739 6100
Fax : +82 31 735 6168
Email : orbis@orbis1.co.kr

Fault Recorder

Shortened Maintenance Time

Precise Recording

This fault recorder is a device that monitors actuation of main breakers to reduce the examination scope in the event of an emergency shut-down resulting from an accident. This device also enables effective cause analysis by precisely recording the monitoring variables (i.e., voltage, frequency, and phase).

BACKGROUND

It has always been difficult to carry out an effect analysis on equipment in the event of an electronic oscillation of the plant power system or a cause analysis in the event of switchover failures, or closing and tripping of major breakers. This frequently affected normal operation for a long period of time. To address this issue, a fault recorder that effectively monitors actuation of major breakers and keeps a record of the status has been developed.



PROVEN TECHNOLOGY

This fault recorder has been used in over 70% of the nuclear power plants in Korea for approximately 16 years. The device provides records taken at the time of an accident (e.g., turbine/generator automatic shutdown), enabling an in-depth analysis of the cause. Such capability leads to reduction in maintenance time and contributes to establishment of recurrence prevention measures.

FEATURES

- This recorder measures instantaneous values from 64 analog input and 128 digital input samples, automatically saving values between one second before an accident to ten seconds after an accident. This enables rapid cause analysis.
- This device precisely measures the voltage, current, phase and other numerous variables, allowing cause analysis from all angles.
- The dual backup system (DBS) has been applied so that the recorder can keep monitoring and save data, leading to increased usability.
- Although Linux is used as the operating system, this device offers a Windows-type interface, giving greater user convenience.
- The compact-type fault recorder can be installed on the existing panel without installation of an additional panel, leading to enhanced space efficiency and user convenience.

CHARACTERISTICS

The desktop of the fault recorder is installed on the rack of the front side of the panel and is comprised of ten modules, a TFT-LCD monitor, storage media, a keyboard, and a mouse. Four types of card-type modules—power, CPU, analog input (AI), and digital input (DI)—are inserted on the back.

Fault Recorder Desktop



The fault recorder program allows the user to look at information including analog/digital input channels and feeders at a glance. Although the operating system is Linux, it offers the same work environment as the Windows, enhancing the man-machine interface.

Fault Recorder Program



SUPPLY EXPERIENCE

- **WH-type** : 2 loop - Kori Unit 1 (2009), Unit 2 (2009)
3 loop - Kori Unit 3 (2011), Unit 4 (2011), Unit 5 (2020), Unit 6 (2020) / Hanbit Unit 1 (2009), Unit 2 (2009)
- **FRAMATOME-type** : Hanul Unit 1 (2019), Unit 2 (2019)
- **CANDU** : Wolsong Unit 1 (2008), Unit 2 (2008), Unit 3 (2020), Unit 4 (2020), Unit 5 (2010), Unit 6 (2010)
- **CE-type** : Hanbit Unit 3 (2020), Unit 4 (2020)
- **CANDU** : Hanul Unit 3 (2012), Unit 4 (2012), Unit 5 (2018), Unit 6 (2018) / Hanbit Unit 5 (2020), Unit 6 (2020)
- **APR1400** : Shin-Hanul Unit 1 (2015), Unit 2 (2015) / Shin-Kori Unit 3 (2011), Unit 4 (2011), Unit 5 (2020), Unit 6 (2020)

OPERATION ON SITE



Fault recorder installed in Hanul Plant 1 (Front/Back)

KEY BENEFITS

- This device provides various data (e.g., voltage, current, frequency waveforms, relay contact signal, and control signal status of the power system) for analysis in the event of an accident. This allows prompt and accurate cause analysis, leading to shortened breakdown period.
- Recurrence prevention measures can be established through analysis of the detailed data history.
- An alarm is raised in the MCR in the event of failures or abnormality of the high voltage switchgear. This allows prompt response by operators, leading to safe operation of the plant.

SPECIFICATION

Component	Characteristics
Analog Input (64 channels max, Changeable)	- Measurement Range • Voltage: 0.1V to 150V (±0.5%), 150V or higher (±1.0%) • Current: 0.06A to 50A (±1.0%), 50.0A or higher (±1.0% or more) - Zero sequence voltage (Internal operations are possible for 3-phase voltage) - Current (Rated: 5A or 1A)
Optional	- DC current: 4 to 20mA - DC voltage: -10V to +10V - Up to 40 analog input channels possible
Digital Input Channel (128 channels max, Changeable)	- Dry contact (DC 24V) - Wet contact (DC48V, DC125V) - Input power consumption: below 1 VA
Digital Output Channel (4 channels)	- Trigger - Printer error - Communication error - System error
Relay Output (A or B contact)	- 125 VAC/0.6A - 110 VDC/0.6A - 30 VDC/2.0A

PATENT & CERTIFICATION



PATENT CERTIFICATE
1722156



PATENT CERTIFICATE
1452980



PATENT CERTIFICATE
1452979



PATENT CERTIFICATE
0439686



www.procom.co.kr
40-11, Techno 6-ro, Yuseong-gu, Daejeon, Republic of Korea

Tel : 042-253-7007
Fax : 042-253-7009
email : Procom@procom.co.kr

Integrated Circuit Breaker Test Set

Short Measuring Time

One Device Multiple Tests

This integrated circuit breaker test set is designed to automatically test the proper operation of the major breakers in the plant during maintenance. This test set performs a comprehensive check on coil resistance, actuation time, main circuit contact resistance and insulation resistance; and conducts minimum voltage actuation, UVTA and overcurrent relay tests.

BACKGROUND

In the past, different testing equipment had to be used for different types of breaker tests and test items. This required many experienced personnel and took a long time because tests had to be conducted consecutively. Centrally managing test data is difficult because they are distributed, and information processing, such as viewing performance history and detecting aging equipment, is impossible. An integrated test set was developed to test all maintenance items of major breakers at once. Test data is automatically centralized and stored for data processing.

PROVEN TECHNOLOGY

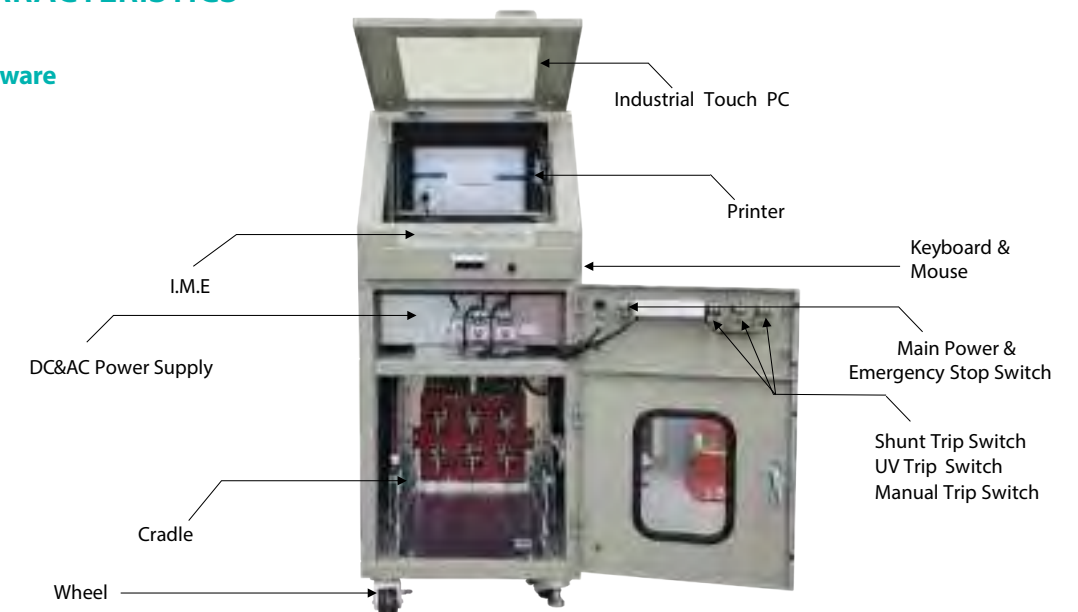
The integrated test set is a proven equipment that has been applied to WH 2 Loop (Kori Units 1&2), WH 3 Loop (Kori Units 3&4), FRAMATOME (Hanul Units 1&2) and other various reactor types since 2017. This test set is suitable for conducting a wide variety of maintenance tests on the reactor trip switchgear (RTSG), switchgear, air circuit breaker (ACB), and etc.

FEATURES

- Test is performed automatically and promptly following the initial setup.
- All maintenance on main breakers can be carried out with this test equipment alone.
- This all-in-one test equipment simplifies preparation and reduces testing time; and is intuitive enough for inexperienced personnel to use.

CHARACTERISTICS

Hardware



Software



SUPPLY EXPERIENCE

RTSG Testing Equipment

- Hanul Units 5&6 (2019), Hanul Units 3&4 (2020),
- Wolsong Units 5&6 (2021), Hanbit Units 1&2 (2021),
- Hanul Units 1&2 (2021), Kori Units 5&6 (2022),
- Saeul Units 3&4 (Planned)

SWGR Testing Equipment

- Hanul Units 5&6 (2017), Wolsong Units 1&2 (2019),
- Wolsong Units 5&6 (2019), - Kori Units 3&4 (2019),
- Saeul Units 3&4 (2020), - Shin-Hanul Units 1&2 (2020)

ACB Testing Equipment

- Hanul Units 5&6 (2017), Wolsong Units 5&6 (2019)

OPERATION ON SITE



Hanul Unit 3&4 Common

KEY BENEFITS

- This test set only takes seven minutes to go through the test items, saving time and personnel costs.
- This product replaces multiple testing equipment with just one and reduces maintenance costs.
- The test set leverages the centralized test data that is automatically stored to detect aging breakers.

SPECIFICATION

Mechanical data

Dimensions	1400(H) X 650(W) X 860(D)mm, Depending on breaker size
Weight	350 kg, Depending on cradle weight

Control Specification

TYPE	17" capacitance-type touchscreen 19" rack mount type
CPU	Intel qual-core N4200 onboard (1.1-2.5 Ghz)
RAM	8 GB
Storage	128 GB
Display	17" TFT LED Display 1280 x 1024 resdution
Communication	6 RS-232 & 6 USB

Output – Electric motor control and UVTA (2-channel use)

Power	Voltage	Current	Accuracy
0W ~ 3000W (basic specifications)	DC 0V ~ 150V	0A ~ 20A	0.5 % FS
0W ~ 3000W (basic specifications)	DC 0V ~ 300V	0A ~ 10A	

Charging Motor Current Measurements

Source	Range	Accuracy
DC	0A ~ 10A	1 %FS

Resistance Measurements

RangeΩ	Voltage	Current	Accuracy
1 μΩ ~ 2 mΩ	DC 0V ~ 5V	100 A	1% FS
1 Ω ~ 200 kΩ	DC 0V ~ 12V	0.2 A ~ 3 A	
1 MΩ ~ 4000 MΩ	DC 0V ~ 1000V	-	

Timing Test

Phase	Voltage	Current	Accuracy
Phase A/B/C	10 kHz	20 μs ~ 500ms	0.1 %FS

Check OCR Operation

Power	Voltage	Current	Accuracy
0 W ~ 100 W	AC 0 V ~ 1 V	0 A ~ 100 A	0.5 %FS

PATENT & CERTIFICATION



PATENT CERTIFICATE
10-1773433



PATENT CERTIFICATE
10-1697178



PATENT CERTIFICATE
10-1673903



PATENT CERTIFICATE
10-1673902



www.ener-sys.co.kr
716,614, Dongtangileung-ro, Hwaseong-si, Gyeonggi-do,
Republic of Korea

Tel : + 82-31-377-2064
Fax : + 82-31-323-2065
email : skh@ener-sys.co.kr

Dissolved Gas Monitor for Oil-immersed Transformers

Multiple Gas Detection

Fault Diagnosis

This device monitors and diagnoses the oil status inside an oil-immersed transformer in operation by checking fault gases and moisture generated in the transformer by using the PAS method, which measures the change of light energy through acoustic detection.

※ Photoacoustic Spectroscopy (PAS) is the measurement of the change of light energy absorbed by gas through acoustic detection. It allows for a simple structure, excellent sensitivity, high accuracy, and reliable output.



BACKGROUND

Fault gases are generated due to thermal decomposition of the insulating oil in cases of arc discharge, local overheating, and partial discharge, leading to a serious electrical accident. A gas monitor is essential in the plant as a preventive diagnosis equipment for the oil-immersed transformer because it measures the components and concentrations of these fault gases.

※ Traditional dissolved gas monitors for oil-immersed transformers required high maintenance costs, and it was difficult to receive technical support.

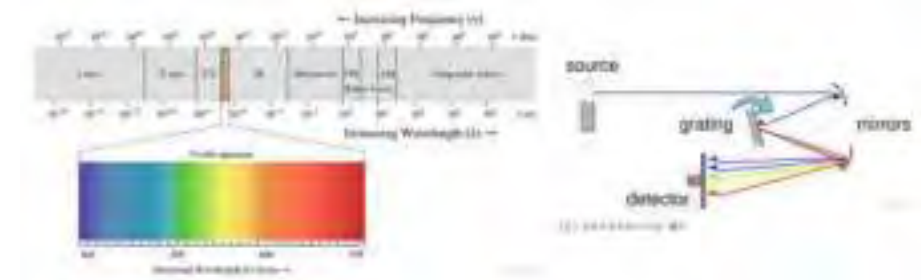
※ Fault Gas: H₂, C₂H₂, C₂H₄, C₂H₆, CH₄, CO, CO₂ + [H₂O]

PROVEN TECHNOLOGY

Since 2019, the dissolved gas monitor has been applied to seven transformers in three nuclear power plants in Korea. Over three years of operation demonstrates its safety and reliability.

FEATURES

- This monitor uses the PAS method, providing highly accurate and precise measurements even at low concentrations of dissolved gases.
- With built-in algorithms for fault diagnosis, the monitor allows you to perform detailed analysis of why and where the faults occurred and to centrally manage a transformer's operation data.
- The gas monitor can be installed in existing transformers without having to make large-scale changes to the design.



CHARACTERISTICS



SUPPLY EXPERIENCE

- **WH-type** : Kori Unit 2 power-outlet transformer (2018)
- **FRAMATOME-type** : Hanul Unit 2 main/aux. transformer (2021)
- **OPR1000** : Hanul Unit 4 main/aux. transformer (2021)
- **To be installed** : main/aux. transformers in 13 plants

OPERATION ON SITE



- Normal
- Caution
- Abnormal



KEY BENEFITS

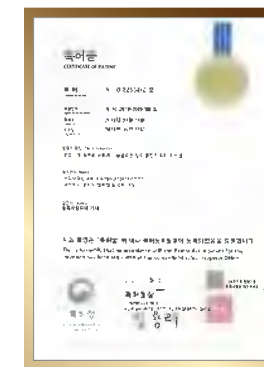
- Fault gases can be detected at low concentrations, enabling early diagnosis of transformer malfunctions.
- Membranes and calibration gases are not required, reducing maintenance and repair costs.
- Tailored device configurations are available according to the gas type that a customer wishes to measure.
- The device can be easily installed in a variety of oil-immersed transformers at low installation costs.

SPECIFICATION

Item	Range
Gas	H2 (Hydrogen)
	CH4 (Methane)
	C2H6 (Ethane)
	C2H4 (Ethylene)
	C2H2 (Acetylene)
	CO (Carbon monoxide)
	CO2 (Carbon dioxide)
	O2 (Oxygen) N2 (Nitrogen)
Moisture	H2O (Moisture)
	0 ~ 100 % (RH)

Item	Description	
Measuring Method	H2 : Semiconductor type CH4, C2H6, C2H4, C2H2, CO, CO2 : PAS method	
Precision & Accuracy※	Less than ± 5%	
Size	WXHxD (mm)	460 X 650 X 332
Display	LCD	7.0"
	LED	Normal / Caution / Abnormal
Communication	Protocol	IEC 61850
	Communication Port	Ethernet

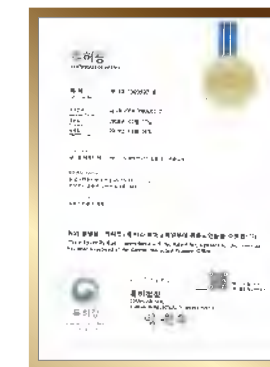
PATENT & CERTIFICATION



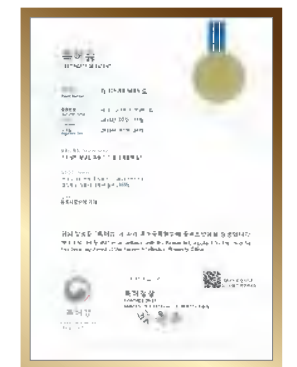
PATENT CERTIFICATE
10-2005486



PATENT CERTIFICATE
10-2009997



PATENT CERTIFICATE
10-2071569



PATENT CERTIFICATE
10-1414276



Hanbit EDS Co., Ltd

www.hanbiteds.co.kr
44-10, Techno 10-ro, Yuseong-gu, Daejeon, Republic of Korea

Tel : + 82-42-607-8030
Fax : + 82-42-932-9624
email : sales@hanbiteds.co.kr



ADVANCED AND PROVEN O&M TECHNOLOGIES
FOR NUCLEAR POWER PLANT

Production

New Nuclear Business Department, Business Growth Division

Tel. +82-54-704-7620 ~ 7625

Fax. +82-54-704-7698

E-mail. youngsoo.kim@khnp.co.kr
w12sonbj@khnp.co.kr

The Products and Technologies on this brochure were developed by KHNP in cooperation with supply chain. KHNP introduces the proven technologies in Korea to your Nuclear Power Plant.
