Key contents of KEPCO specifications and analysis of other companies' products

Local Unit (LU)

Specification contents	progress	note
The enclosure material of the local unit must be SUS material with a thickness of 2.0 mm or more. (5.3.3)		
The DAU detection module must have the ability to transmit detection results to a higher level in real time. (5.3.4.1)		
A separate serial communication port must be provided for analysis and maintenance of detection results. (5.3.4.3)		
The detection device must meet EMI and EMC standards. (5.3.4.4)		
The detection device manufacturer's own precise analysis program must be provided, and the provided program must be run on the latest version of Windows OS. (5.3.4.5)		
DAU's power supply is AC single phase 220V, 60 Hz (5.3.4.6)		The detection area should be 100MHz to 1500MHz to suit the characteristics of the sensor.
The minimum detection signal of the DAU must be less than -65dBm (=0.316nW) and the		

maximum detection signal must be more than 0dBm.		
Signals from all sensors connected to the DAU must be synchronized with the GIS power phase and be able to be detected simultaneously. Noise channels in the DAU must be installed per bank for 23kV, per 3 Bay for 154kV, per 1 Bay for 345kV, and top/bottom per Bay for 765kV. shall.		
All channels are synchronized by one synchronization signal, and the signals of each channel must be sampled and acquired simultaneously.		
The front part of the DAU must be able to check whether the power, communication, and data acquisition functions are operating normally with an LED lamp or LCD screen display. (5.3.4.7)		
The number of channels per GLU must be able to accommodate at least 32 channels.		
PRPS data should be 128 samples per cycle, and the size of the signal should be displayed in log scale.		
Each channel must generate 15 minutes of PRPD data.		
When partial discharge signals and noise signals		

flow into the partial discharge sensor and noise sensor, the noise signal and the partial discharge signal must be separated through high-speed sampling.		
The communication module receives information through Ethernet, RS-232, and RS-485 communication and must be equipped with a general-purpose communication port of 4 channels or more. (5.3.4.8)		
Signals acquired from all sensors connected to the DAU are synchronized with the power phase and time within the substation and transmitted to the diagnostic unit. (5.3.4.9)		
As a result of the optimal arrangement of the overall configuration, if IED is more economical than GLU and MLU, it can also be applied as IED. (5.3.7)		
The DAU must be able to set the detection area to suit the characteristics of the input sensor. (5.3.10.1, 5.3.11.1)		
The detection cycle must be within 1 time/2 hours, and there must be a function to adjust the analysis cycle by hour through user settings.		
The front of the CU must be able to acquire data and check communication	LED, console can be checked	It seems to refer to confirmation through an

status from the outside. (5.3.12.2)		LED or console rather than a separate LCD.
Communication between the CU and the diagnostic unit must be configured to comply with the IEC 61850 standard to ensure continuity of long-term accumulated data, separate data collection and analysis, and smooth data exchange of measurement results. (5.3.12.3-(1))		
Communication data must be transmitted and received smoothly with heterogeneous diagnostic units by applying a standard data format that complies with the IEC 61850 standard. (5.3.12.3 -(2))		
Communication between the CU and the diagnostic unit must be configured through radial optical communication. (5.3.12.3-(3))		

Diagnostic Unit

Specification contents	progress	note
The diagnostic unit is responsible for system control and operation, power control of individual devices that make up the device, synchronization with the voltage where the sensor is installed, self-diagnosis function, watch-	The real time alarm data, abnormal signal occurrence history and detected signal data storage and transmission to the web system has been completed.	System control and operation status, remote access logging and other system usage logs need to be generated.

dog, data display, data storage (at least 1 year), and various records of all devices (It must have the ability to transmit information such as operation, control, remote access logging), real-time alarm data, abnormal signal occurrence history, detected signal data, and system operation status. (5.4)		
CPU: Quad Core or better (5.4.1.1)	A quad core cpu is available in the panel server.	More core cpu is needed in production environment to better handle the new 1024 samples per cycle requirement
Main memory: 64 GByte or more (5.4.1.2)	64 giga byte of main memory is available in the system	We need 128 gb of memory to better run the virtual machines inside the system.
Hard disk: Equipped with dual-type mirroring to store at least one year's worth of data (notification of back-up time) (5.3.1.3)	Dual mirroring within hard disk is implemented.	OS and data storage are separated and installed with capacities of 1TB and 4TB respectively. In normal times, various logs and DBs are stored on two hard disks at the same time for at least one year.
The diagnostic unit must be equipped with an uninterruptible power supply (UPS) with a backup time of at least 30 minutes that can stably supply power, and the power consumption of each diagnostic server device connected to the uninterruptible power supply (UPS) must be specified. In addition, the		The ups needs to be installed in the production environment. Work needs to be done to recognize UPS operation whether it is being used at software level. The functionality to transmit alarms to SCADA needs to be implemented.

HMI must be able to recognize the UPS operation, and it must have the function to transmit alarms to SCADA. (5.4.2)		
The diagnostic unit must detect abnormal situations such as network abnormalities, data communication device abnormalities, local unit abnormalities, watch-dog operation, etc., when device abnormalities are determined from various sensors. An alarm must be implemented so that it can be recognized visually by accessing the Diagnostic Unit Web Server through a web browser, and there must be a function to save it.	Local unit abnormalities and watch dog has been implemented. Alarm is implemented and it can be recognized visually though the web system and it is being saved.	Network abnormalities and data communication device abnormalities need to be recognized, stored and shown through the web system.
The diagnostic unit's operating software, diagnostic software, and Web Link must be in the latest Korean Windows server 2012 r2 or higher environment that is user-friendly and convenient to use.	the diagnostic unit operating software is in 2019 korean windows server.	2022 korean windows server is needed for better operation of the system.
It must be possible to receive substation operation information (voltage, load current, transformer winding and tap location, etc.) from Web SCADA. (5.4.6.1)		This needs to be implemented as there is no way at the moment to communicate with SCADA.
The data acquisition cycle is based on once/5 minutes. (5.4.6.2)		

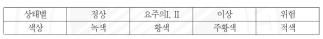
There must be an algorithm to analyze and diagnose facility conditions using substation operation information. (5.4.6.3)		This needs to be implemented as there has been no connection with SCADA until now so the substation information received has not been used to do any processing.
The transformer state analysis algorithm must include voltage, load current, switching time, and temperature relationship analysis. (5.4.6.3-1)	Three points in these have been implemented. the transformer state analysis includes voltage, load current and switching time.	The temperature relationship analysis of the transformer needs to be implemented.
The circuit breaker status analysis algorithm must include voltage, load current, switching time, and temperature relationship analysis. (5.4.6.3-2)	Three points in these have implemented including voltage, load current and switching time	The temperature relationship analysis of the circuit breaker needs to be implemented.
Details of the state analysis algorithm and analysis examples must be presented in the system operation manual upon delivery. (5.4.6.3-3)		System manual needs to be written in easier language for the operator to understand.
The diagnostic unit must be able to monitor, analyze, and diagnose data for each preventive diagnosis element of the transformer and GIS, and set events and alarms for each sensor. Instructions for use must be presented in the system operation manual at the time of delivery. However, when adjusting the setting standard, user information recording function and remote access log permission function must be provided. (5.4.7.1-1)	The system is able to diagnose the preventive diagnosis data for diagnosis element of the transformer and GIS and is able to set conditions for each events alarms for each sensor. Permission levels are being set in the web system	A user manual needs to be written with the documentation of this functionality Recording of user operations, user information and remote access logging information needs to be stored

As a result of system self-diagnosis, faults such as communication errors and system errors must be recorded. (5.4.7.1-2)	System Logging is implemented of any faults happening in the system.	
Local units and sensor locations should be intuitively displayed on the substation single-line diagram so that operators can easily identify the locations of related facilities and sensors, such as T/L names, transformer names, and bay names. (5.4.7.1-3)	This has been implemented. The substation diagram is available in the web system to show to the use the locations of each sensor and their names	
Alarm data must be able to be searched using the diagnostic unit's monitor and must have a report output function. (5.4.7.1-4)	This is implemented. the alarm data can be searched using the diagnostic monitor and has a report output function	
All data must be automatically backed up to a separate storage device. (5.4.7.1-5)	All data is automatically backed up to a separate storage device.	
All data must be classified by substation, transformer, GIS, and sensor so that real-time data can be displayed. (5.4.7.2-1)	Data is being classified by substation, transformer, GIS and sensor.	Data is not real time updating. On page refresh data updates.
All operations performed by the user through the keyboard and mouse must be able to be displayed on the monitor. (5.4.7.2-2)	All user performed by user are displayed through the monitor	
The screen displayed on the monitor must be expressed in partial page format for each substation, facility, and sensor, starting from the full screen at the	All of these have been implemented.	

top, so that it can be monitored for each sensor, and must be able to show the following contents. (5.4.7.2-3) Equipment schematic diagram, symbolic peripheral transformer, GIS picture Peripheral voltage sensor, GIS-specific sensor location map, and current value and status information of sensors Change trends caused by event data stored in the database Recently occurred alarms and events Menu or icon for each page		
The current status screen is composed as follows. (5.4.7.2-4-a) When you click on the relevant device on the main monitoring screen, the sensor's location is displayed and must be classified by diagnostic item. The alarm range and reference value are auxiliary data, and the current value acquired from the sensor must be able to be displayed in table form. The data acquired from the sensor must generate a “critical proximity message” when it reaches the range of 95 to 100% of the set caution level, and an	when you click on the relevant device on the main monitoring page the sensor location and information is displayed. The alarm range and reference value are displayed in table format.	Critical proximity message functionality has not been implemented yet

“alarm” when it exceeds the range.		
The change trend screen is composed as follows. (5.4.7.2-4-b) You must be able to move to a screen of the same level by clicking a menu or icon on the current status screen. It should be possible to check recent change trend data acquired from the sensor for each diagnostic item. It should be possible to select and compare multiple data simultaneously, such as data for each phase, each tank, and each sensor, and display normal, cautionary, and abnormal data on a graph. Each analysis value must be able to be shown as a maximum or average value, if necessary. The analysis results must be able to be visualized in three dimensions and analyzed visually.	All of this has been implemented.	
The comprehensive trend analysis screen is composed as follows. (5.4.7.2-4-c) The comprehensive trend analysis screen must be able to analyze over a longer period of time than the change trend screen, and must be able to graph	the comprehensive trend analysis is able to the display trends by hours, day and month over a longer period of time.	Critical arrival information based on long term analyzed data has not been implemented

change trends by hour, day, month, and period. Based on long-term analyzed data, critical arrival prediction information for each sensor must be provided.		
When configuring the system operation status screen, a screen must be configured to comprehensively monitor abnormalities for each system component, from sensors installed in the field to the diagnostic unit. (5.4.7.2-4-d)	A screen to comprehensive monitor abnormalities for each system component has been implemented	
The alarm screen is composed as follows. (5.4.7.2-4-e) An alarm must be generated when the sensor output exceeds the set value or when the trend changes at a certain rate or higher. Up to 200 alarms must be displayed at all times in the order of recent occurrence, can be viewed using a scroll bar, and alarm contents must be stored for up to one year. Alarm contents include date information of year/month/day/hour/minute/second and judgment result values for each device and sensor. Alarm notifications must be provided visually and audibly.	An alarm has been implemented when the sensor output exceeds the set value. Alarm information includes date and time and judgment result. the alarm flashes visually and audibly until the user recognizes it.	Alarm when the trend changes at a certain rate needs to be implemented. Up to 200 alarms at one time needs to be set as range

The alarm must flash with the device's sensor icon and not stop until the user recognizes it and resets it.		
It must set criteria for judging abnormal signs, judge and analyze them according to the criteria for judging abnormal signs, output the analysis results as a report, and have a function to send alarms and event data to HMI. Setting values such as period and number of times can be set by the user. It must be changeable. (5.4.7.2-5)	This has been implemented	
The color of abnormalities is defined as follows. (5.4.7.2-6) 		the color needs to set according to the requirement.
Saved event data must be sent to the central analysis center or HMI at least once a week to the relevant server so that it can be used in the asset management system in the future. (5.4.7.2-7)		This needs to be implemented. there is no communication at the moment with any external system to send data.

partial discharge

Specification contents	progress	note
GIS, transformer partial discharge display, and analysis functions each follow the general purchasing standards for element technology. (5.4.7.3-1)		

When designing the UHF sensor location, the output of the UHF built-in sensor is calculated based on -20dBm and the output of the external sensor is -40dBm.		
The sensor margin is designed based on the minimum detection signal of -55dBm for both internal and external sensors.		Trend files are created every 15 minutes, and the partial discharge signal size of 0 to -55dBm is divided by the amplitude number of 128 to obtain [128 phases * 128 levels of PRPD] data.
Sensors are installed to monitor detection sections overlapping to ensure that there are no undetected sections.		
Real-time data (PRPS), event data (PRPS), and trend data (PRPD) must be transferred using the File Transfer function.		When a new file is created, the server that provides data changes TrendTransF, EvtTransF, and RTTransF among the LN data to match the time of the created file to notify the higher level of the file's creation, and the higher level uses Directory Service and File Transfer Service to notify the higher level of the file. Check and receive newly created files
Since the actual certification is a conformity test, if more information is needed in addition to the certified data model, changes can be made with agreement between the manufacturer and KEPCO.		dataNs (data namespace): When new data is added other than the DO indicated in the specification, a concise basis for the data is indicated ex) “KEPCO PDDiag spec 1.0”

Build a library of various noise and discharge types so that operators can directly infer the cause of partial discharge signals		It must be possible to compare it with the partial discharge signal on the same screen.
There must be a function to add stored event data to the library and perform comparative analysis and learning.		The partial discharge waveform analysis engine must be structured so that it can be **upgraded** through consultation between the manufacturer and the user .
There must be a function that allows users to accumulate and analyze PRPS and PRPD data by setting **an arbitrary time unit .**		
It must be configured to enable library updates **remotely , update the holding library learning** and measurement data libraries, and have an **expansion structure** to remotely report learning results .		
It must be possible to adjust event and alarm settings for each sensor.		
The system has a **self-diagnosis function** and after self-diagnosis , faults such as communication problems and device problems **are recorded .**		
A single-line diagram showing the location of the sensor and the location of the local unit **must** be displayed when selecting a		

substation, and is displayed so that the operator can intuitively match the facility location on the single-line diagram of the substation.		
Alarm data must be able to **search for details** and have a report **output function .**		
The measured data must be able to be displayed in **synchronization with the power phase of the MTR site where the sensor is installed.**		
All data must be able to be classified by substation and sensor.		
The threshold value for detecting signals and the level of signal size for event occurrence must be adjustable for **each sensor .**		
Display data must be capable of **phase shift .** Place it in **the upper right corner** of the initial screen to enable phase change for **each sensor .**		
PRPS and PRPD must be categorized based on a certain size and number of discharges (number of discharges per unit time) and displayed by color, and the measured data must be displayed as 128*60 (Bin*Cycle).		
Trend data for each sensor must be displayed divided		

into maximum and average values according to the operator's command.		
It must be equipped with the function to set the criteria for judging MTR abnormal signs, analyze based on the criteria for judging abnormal signs, output the analysis results as a report, and transmit alarm and event data to remote KEPCO PC and SEDA server. Setting values such as period and number of times must be set. The driver must be able to change it.		
The data measured from each sensor must be capable of trend analysis on signal size, number of discharges per unit time, etc., and must have 3D visualization and analysis functions. At this time, the signals measured from each Ch sensor must be acquired simultaneously without time delay **.** All channels must be synchronized through **the synchronization signal .**		
Real-time data and event information must be stored for all valid channels.		1. Real-time data from the sensor must be saved as a file in the CU. 2. Real-time data files follow the PRPS format of 128 phases x 60 periods x 60 seconds. 3. Partial discharge real-time data for at least 7 days must be stored.

		4. Real-time data must be extractable from the diagnostic unit in file format. 5. A separate program that can analyze real-time data must be provided.
Users must be able to download partial discharge measurement data as dat and csv files, and play the files in a separate player to facilitate data management.		
When a partial discharge event is generated, the signal of the most recent noise channel in the same time period must be saved and compared.		For example, let's say 1, 2, and 3 are PD channels and 4 is a noise channel. If partial discharge is judged based on the data detected through channel 1, it must be possible to compare the raw data of channel 1 and channel 4 for that time period.

- Data files are transmitted using the File Service of IEC 61850.
- The extended name plate (EEName) indicates the installation location of the sensor, and the Location item follows the following format.

  Location format: [Substation name]_[Voltage]kV_GIS/M.Tr [BAY/Tank number]_[LU/CH number]

  ex) “Yousung_154kV_GIS/M.Tr_D01_1A”: First (A) channel of D01 LU installed in D01 bay of Yuseong substation 154kV GIS/Mtr.
- Event files are created according to events that occur according to the set threshold, and are made up of [PRPS of 128 phases x 60 cycles x 60 seconds] data.
- Realtime files are created every second and consist of {128 phases x 60 cycles x 1 second PRPS] data. However, only data within 3 minutes of creation is valid. (Data exceeding 3 minutes is processed as no file)

IEC 61850-based preventive diagnosis system configuration

Specification contents	progress	note

The diagnostic unit must be able to receive, store, and monitor data measured and analyzed by the local unit, and transmit the received and stored data at the request of the integrated server using the IEC 61850 communication protocol according to the model presented by KEPCO. .		
The Local Unit transmits real-time data to the diagnostic unit through MMS and File Transfer functions.		
The expansion of the system is made easy by matching the data models of the local unit and the diagnosis unit regardless of the diagnosis location.		
Basic analysis data, excluding diagnostic values, is transmitted using IEC 61850 MMS, and real-time, trend, and event data are transmitted to the local server using the file transfer function.		
Because diagnosis is not performed in the Local Unit, datasets related to diagnostic values do not exist in the Local Unit, but exist only in the Local Server.		
The information from one partial discharge sensor is defined and used as one LN. (In the case of an L/U with 8 sensors, 1 Logical		

Device exists within 1 Physical Device, and 8 Logical Nodes exist within 1 Logical Device.)		
Information from the transformer gas sensor is defined and used as one LN.		
The circuit breaker operating characteristic coil current information is defined and used as one LN.		
One L/U is defined and used as one LD. (In the case of a diagnostic unit with 10 L/Us connected to the lower level, 10 logical devices exist within 1 physical device.)		
According to the standard, LLN0 and LPHD must exist in each LD.		
The data model of the Local Unit and the Diagnostic Unit should be set the same, but values (Flag, etc.) that are not created in the LU or must be changed are created and used in the Diagnostic Unit.		

File for data exchange

- The file name should be written as follows, but the total length should be less than 128 bytes.
  - Local unit → Diagnostic unit: [/channel_waveform_code_generation_date.dat]
- Diagnostic unit → HMI: [/LU number_CH number/Extension name plate name_Waveform code_Creation date.dat]
- When a new file is created, the server that provides data changes TrendTransF, EvtTransF, and RTTransF among the LN data to match the time of the created file to notify the higher level of the file's creation, and the higher level uses Directory Service and File Transfer Service to notify the higher level of the file. Check and receive the newly created file.

OLTC diagnostic system

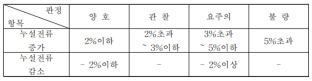
Specification contents	progress	note
OLTC measurement signal display and analysis functions follow the general purchasing standards of element technology. (5.4.7.3-5)		
The diagnostic software must be able to analyze the acquired OLTC motor drive current and operation time to diagnose OLTC abnormalities and analyze operational change trends.		
It must be possible to compare and analyze the **initial transient** current value when driving the OLTC motor and the current value during the OLTC **operation stroke period .**		
It is possible to set the operating current reference value of the motor drive device and there must be an algorithm to determine whether there is an electrical or mechanical abnormality of the OLTC through continuous comparison with the reference value in the form of a **graph .**		
The operation time and number of times must be calculated using the OLTC motor drive contact.		

OLTC monitoring must be able to display the current value and change trend of operation current and operation count for each **bank and perform comparative analysis** for **each phase** and **bank .**		
If the OLTC motor drive operation current and operation time exceed the set values, information must be generated immediately.		
It must be possible to receive substation operation information (tab location) from Web SCADA and analyze tab discrepancies and tab location change trends.		

1. Criteria for judging OLTC partial discharge
   a. When the following two conditions are simultaneously satisfied in one sensor:
      i. The number of event data (1 minute) of the same type persists more than 10 times within 1 hour.
      ii. When the number of event data (1 minute) of the same type is more than 20 in 24 hours.
   b. The same type of event data (1 minute) persists more than 60 times in 24 hours from one sensor.
      i. Event data: PRPS 1 minute, based on 128 sampling

Bushing leakage current monitoring device

Specification contents	progress	note
The bushing leakage current for each transformer tank is expressed as normal or abnormal using numbers and colors. (5.4.7.3-4-a)		The diagnostic software displays the leakage current of each phase from the acquired bushing leakage current signal.
The measured data for each transformer must		

express the magnitude and phase of the current in a vector diagram, and must have an analysis function according to the reference value. (5.4.7.3-4-b)		
The level of signal size that generates an alarm must be adjustable for each bushing. (5.4.7.3-4-c)		
The standard value calculated using the bus voltage must be comparable to **the leakage current of each phase , and the judgment criteria are as follows.** 		
Trend analysis of stored data (converted leakage current, etc.) must be possible for the selected period.		

Circuit breaker operation characteristics analysis device

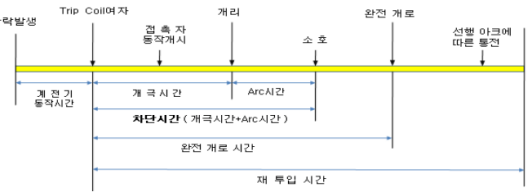
Specification contents	progress	note
Circuit breaker operating characteristic signal display and analysis function follows general purchase specifications of element technology (5.4.7.3-3)		
The number of GLUs can be additionally installed depending on the number of Closing/Trip contact inputs among the GCB circuit breaker operation		

characteristic monitoring signals.		
Diagnostic software must monitor and analyze the status of the circuit breaker's main actuating part from the acquired circuit breaker operation characteristic signals (Trip/Close coil current and contact operation) to diagnose any abnormalities.		
An activated circuit breaker must have a structure that allows the user to recognize it through **a color change** or **a pop-up on the single-line diagram of the relevant substation.**		

1. Analysis items are based on the table below.
   a.

구 분	분 석 항 목		비 고
코일 상태분석	과도전류의 크기와 패턴변화		1)그래프 표현 2)시간 변화율 분석기능 3) 전류 및 접점변화의 오버랩핑 기능
	정격전류의 변동여부		
차단기 동작시간	Start	Stop	
	코일 여자	코일 여자완료	
		상전류 변화 시점	
		"a" 접점 변화 시점	
		"b" 접점 변화 시점	

2. Blocking time is defined as shown below.
   a.



3. In the following cases, an alarm signal must be provided.
   a. When detecting a signal above the standard level value
   b. When detecting a signal exceeding the standard trend displacement value
   c. When component equipment malfunctions

Oil gas diagnosis device

Specification contents	progress	note

Diagnostic software must monitor and diagnose internal abnormalities in the transformer using acquired data such as hydrogen, multiple gases, and moisture values generated inside the transformer measured from oil gas sensor signals. The type of results according to the analysis is provided in the system operation manual at the time of delivery. must be presented in (5.4.5.3-a)		The detection cycle must be within 1 time/2 hours, and there must be a function to adjust the analysis cycle by hour through user settings.
There must be a function to convert absolute humidity (g/m3) to relative humidity (%). (5.4.5.3-b)		
Through continuous data acquisition information, change trend analysis and comparative analysis by transformer phase or bank should be possible. An alarm should be generated when the set standard value and trend standard value are reached, and the standard value should be presented in the system operation manual at the time of delivery. (5.4.5.3-c)		
The output signal of the device uses Ethernet or an analog signal line communication method of 4~20mA. (5.4.5.3-d)		
The current value, the previous day's value, and the increase compared to the previous day, obtained from the H2 or multi-gas,	• Current value, Min/Max value implemented • Previous day's value and increase compared	

moisture sensor, etc. of the main transformer for each tank, must be displayed. (5.4.7.3-2-a)	to previous day not yet implemented	
The oil gas analysis results for each transformer tank must be expressed in color for each stage. (5.4.7.3-2-b)		
In a structure linked to related data such as transformer winding temperature, the cause of occurrence must be presented by comparing the change trend of oil gas. (5.4.7.3-2-c)		
Based on the oil-in-gas analysis results, criteria for judging abnormal signs are set, judgments and analyzes are made according to the criteria for judging abnormal signs, and the analysis results are output as a report. Alarms and event data are sent to remote KEPCO PCs and SEDA servers through the diagnostic unit. must have the function. (5.4.7.3-2-d)		
The analysis target for each transformer must be able to detect at least 7 types of gas and moisture, including H2, CH4, C2H2, C2H4, C2H6, CO, and CO2, for the 345kV class and 765kV class. The error range for each gas and moisture is as follows. The table must be satisfied.		

No.	분석가스 종류	검출범위	오차범위
1	H2	5 ~ 2,000 ppm	지시치의 10% 이내
2	CH_4	2 ~ 5,000 ppm	
3	C_2H_2	0.5 ~ 500 ppm	
4	C_2H_4	1 ~ 5,000 ppm	
5	C_2H_6	1 ~ 5,000 ppm	
6	CO	10 ~ 5,000 ppm	
7	CO_2	20 ~ 10,000 ppm	
8	H_2O	~~50 ppm 이상~~ 0~100ppm	

The oil-in-oil gas analysis device must be able to directly measure and analyze individual gases.		
The analysis cycle must be at least once within 3 hours, and there must be a function to adjust the analysis cycle by hour through user settings.		
The analysis cycle should be measured as follows according to the oil-in-gas measurement results.		
Measurement and analysis data must be able to be stored in a storage device in the form of a file. Dual-type mirroring is provided to store data for at least 10 years (notification of back-up time). If the storage device capacity is insufficient, it is deleted and stored by first-in-first-out (FIFO). It has to be.		
The oil-in-gas analysis device must have the ability to perform real-time self-diagnosis and generate an alarm when an abnormality occurs.		
An LED or LCD that can display abnormal conditions must be installed		Gas status in oil: normal, observation, caution abnormality, serious

유중가스 상태	정상	관찰, 주의	이상, 심각	비고
분석 주기	1일 1회	1일 2회	1일 4회	

on the front of the oil gas analysis device, and the following conditions must be checked.		Status of oil-in-gas analysis device: normal failure
To connect with the substation comprehensive preventive diagnosis system, the diagnostic unit must have at least one communication port, either Ethernet or Optic Fiber.		
To enable monitoring of measured values, the IEC61850 communication protocol must be provided through a data communication unit (CU), and it must be possible to check whether monitoring of measured values is performed normally.		• The diagnostic unit must be able to control the settings of the oil-in-gas analysis device. • A communication protocol must be provided to receive analysis and status data from the diagnostic unit.

WEB SCADA information linkage and diagnosis

1. It must be possible to receive substation operation information (voltage, load current, transformer winding and tap location, etc.) from Web SCADA.
2. The data acquisition cycle is based on once/5 minutes.
3. There must be an algorithm to analyze and diagnose facility conditions using substation operation information.
   a. The transformer state analysis algorithm must include comparative analysis of load and temperature relationships (load current, internal temperature, external temperature, etc.).
   b. The circuit breaker status analysis algorithm must include voltage, load current, switching time, and temperature relationship analysis.
   c. Details of the state analysis algorithm and analysis examples must be presented in the system operation manual upon delivery.

Program for database management

Specification contents	progress	note
The latest version of a commercial database management system must be used and must be		

equipped with a diagnostic unit and HMI. (5.5.1)		
Data is stored based on the storage cycle set for each sensor, and the cycle must be modifiable. (5.5.2)		The data acquisition cycle is based on once/5 minutes.
When necessary, the designated administrator must be able to work by directly accessing the DBMS using the SQL program in the Operating System. (5.5.3)		
Database editing must be able to be performed without interfering with online work, and it must be easy to update the database after work. (5.5.4)		
Database editing work should be done in a question-and-answer format, and error detection and processing functions should be provided to prevent errors from occurring due to misoperation. (5.5.5)		
An auxiliary program that can back up stored data must be provided, and an environment must be established in which data can be stored in an auxiliary storage device for backup at regular intervals. (5.5.6)		

Data stored in DBMS must be transmitted to IEC 61850 MMS to enable integrated operation with other facility preventive diagnosis systems. (5.5.7)		The transmitted data structure refers to the file data structure of the IEC 61850-based standard data format.

connection terminal

Specification contents	progress	note
The connection between the sensor and the Local Unit uses the standard coaxial cable and N-type connector specified in Sections 4.2.1 and 4.3.2 to ensure connection compatibility between the heterogeneous sensor and the Local Unit (impedance 50 ohm). (5.6.1)		
The communication connection between the local unit and the diagnostic unit must be transmitted and received in the standard data format specified in IEC 61850, and data compatibility and continuity must be secured even between heterogeneous systems. (5.6.2)		
The communication connection between the diagnostic unit and the HMI server uses the KEPCO communication network and applies a standard data format based on IEC 61850. (5.6.3)		

Scalability with other facility preventive diagnosis systems

Specification contents	progress	note
When installing a diagnostic unit, scalability must be secured to enable comprehensive operation with other systems such as Web SCADA and central analysis center in the future. (5.7)		
Diagnostic Unit ↔ Web SCADA: DNP KEPCO 1.0 (5.7.1)		
Diagnostic Unit ↔ HMI, Central Analysis Center: IEC61850 (5.7.2)		

access rights

Specification contents	progress	note
This function is to maintain the security of system operation data, and must be able to limit the scope of system use by accepting the operator ID and password (8 or more Korean/alphanumeric characters) for each level. (5.8.1)		
The scope of authority must be configurable for each function and user, and operator ID registration and editing must be performed only by the system administrator (Super User) through the access permission setting screen. (5.8.2)		

Authority is divided into about 4 levels, and the highest level should be Super User. (5.8.3)		

test

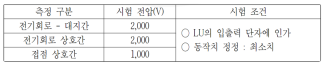
Specification contents	progress	note
The certification test is to confirm the quality of the product and recognize the manufacturer's ability to maintain quality. It is conducted according to the table below, and the judgment is based on the test report conducted by an authorized testing agency or an affiliated organization of KEPCO. (6.1.1)		**(Edit: Jibon)** **Collect the list of affiliated organizations and test required certificate names or reference number.**
The inspection test is conducted as shown in the table below only to guarantee the performance confirmed by the approval test of the product at the time of purchase or when the user requires it, and is based on test procedures, partial loading functions, performance verification data, test equipment, and test standards. Submit two copies of the test report that specifically specifies (basis), test procedures, test methods, etc. when requesting inspection. (6.1.2)		
Field testing is a procedure to check whether any abnormalities occur after		

transporting and on-site installation of a product that has completed an inspection test and includes a trial run test. (6.1.3)		
Diagnostic units are excluded from electrical tests, environmental tests, and EMC tests. (6.1.4)		
The main items of the functional test of the entire system and each part are as follows. (6.2.2) 1. System start/stop a. OS booting by power on and system startup by command b. OS down by command and system stop by power off c. Automatic OS down and system stop due to temporary power off d. System startup, OS operation and normal operation upon random power return 2. System management function 3. network function a. Remote monitoring function using in-house network b. Event alarm forwarding function to HMI server		

4. Sensor data acquisition and processing function 5. Sensor data classification display function 6. Event and trend display function 7. Report generation and output function		
Among the diagnostic performance of the diagnostic unit, partial discharge must be diagnosed with a blind test method of more than 20 discharge cells and experimental data each, and the judgment accuracy must be more than 90%. Other diagnostic performance must meet the performance standards set separately and presented during the verification test. Should be. (6.2.5)		
The compatibility test between heterogeneous systems checks transmission, reception and diagnosis based on IEC61850 between LocalUnit and diagnostic unit and between diagnostic unit and HMI, and generates partial discharge signals for five types of GIS partial discharge and partial discharge signals for six types of transformer partial discharge. The judgment accuracy must be 80% or		

more, and compatibility tests for other diagnostic performance must meet the performance standards set and presented separately during the verification test. (6.2.6-1)		
During the first certification test of a system developed according to this standard, compatibility for all heterogeneous systems between the senior developer and the two junior developers must be verified. However, thereafter, the junior developer is responsible for verifying compatibility with the senior developer. (6.2.6-2)		
The insulation resistance test follows the test method specified in IEC60255-5, and is measured with a DC 500V insulation resistance meter and must be higher than the value in the table below. (6.2.7) 		
The commercial frequency withstand voltage test follows the test method specified in Article 8.3.3.4 of IEC 60947-5-2 or IEC 60950-1, and the commercial frequency voltage shown in the table below is tested between electric circuits and ground, between electric circuits, and between contact circuit terminals. It must last for 1		

측정 구분	절연 저항 (MΩ)	시험 조건
전기회로 - 대지간	10	○ 주위 상대습도 90% 이하에서 측정
전기회로 상호간	5	○ LU의 입출력 단자에서 측정

minute after application and there should be no abnormality in performance. (6.2.8-a) 		

측정 구분	시험 전압(V)	시험 조건
전기회로 - 대지간	2,000	○ LU의 입출력 단자에 인가 ○ 동작치 정정 : 최소치
전기회로 상호간	2,000	
접점 상호간	1,000	

The following environmental tests are performed on the LU system. (6.2.9) 1. vibration test 2. Cold resistance test 3. heat resistance test 4. moisture cycle test		
The following EMC test is performed on the entire system under the condition that the control power is applied at the rated value. (6.2.10) 1. Electro-self-discharge immunity test 2. Electromagnetic radiation immunity test 3. Electrical fast transient immunity test 4. Surge immunity test 5. Radio frequency conduction immunity test 6. Power frequency magnetic field immunity test 7. Control power failure test 8. confidentiality test		
The coaxial cable test is a test to check whether signals can be measured stably by laying a cable		

with a cable loss of less than 4dB at 1000 MHz. When connecting and laying the cable, make sure there are no bends to prevent signal attenuation. (6.2.13-3)		
The commissioning test involves installing the system's hardware and software, installing sensors (if external), testing with the diagnostic unit - remote diagnosis center, central diagnosis center, and completing a comprehensive system test. After the system is in a stable state, the operator applies the system's functions. This is a test to check whether normal operation is possible in the environment. The test run test period is 30 days from the start date of test run. If errors are discovered during this period, they are corrected and supplemented, and after the equipment is stabilized, a test run is performed again for 30 days from that point. . (6.2.13-6-a)		
The system operation rate during the commissioning test period must be 99.9% or higher for 30 days. (6.2.13-6-b) Operation rate formula: operating time/(operating time + stopping time) * 100(%) (6.2.13-6-c)		

1. Operating time: Total test operation period excluding stop time 2. Downtime: Duration of a fault condition that interferes with online real-time processing 3. “No disruption to online processing” means that even if some device in the system breaks down, the device causing the problem can be removed or repaired without stopping online or stopping the system.		
The test run test begins immediately after the completion of the functional and comprehensive adjustment test, and is conducted after approval by submitting a document to the relevant KEPCO department one week before the test run start date. Re-run tests are also subject to this. (6.2.13-6-c-4)		
1. If the contractor determines that stable and normal operation is possible, the contractor reports the completion of the test run to KEPCO and completes the test run test with KEPCO's confirmation. (6.2.13-6-c-5)		

시험 및 검사항목	인정 시험	검수 시험	현장 시험	비 고
1. 구조 외관검사		○		6.2.1항
2. 기능 시험		○		6.2.2항
3. 센서 감도시험	◇※	○※		6.2.3항
4. 시스템 감도 시험	○	○※		6.2.4항
5. 진단성능 검증 시험	○			6.2.5항
6. 이종(異種) 시스템간 호환시험	○			6.2.6항
7. 절연저항 측정		○		6.2.7항
8. 전기적 시험				6.2.8항
가. 상용주파 내전압 시험	○	○※		
9. 환경시험				6.2.9항
가. 진동시험	○	○※		
나. 내한성 시험	○	○※		
다. 내열성 시험	○	○※		
라. 내습 사이클 시험	○	○※		
10. EMC 시험				6.2.10항
가. 전기자기 방전내성시험	○	○※		
나. 전기자기 방사내성시험	○	○※		
다. 전기적 빠른 과도현상 내성시험	○	○※		
라. 서지 내성시험	○	○※		
마. 무선주파 전도내성시험	○	○※		
바. 전원주파수 자계내성시험	○	○※		
사. 제어전원 이상시험	○	○※		
11. 기밀시험	○	○※		6.2.11항
12. 통신 프로토콜 시험	○	○※		6.2.12항
13. 설치후 시험				6.2.13항
가. 구조 및 외관검사			○	
나. 기능시험			○	
다. 동축케이블 및 센서 시험			○	
라. 시스템 감도시험			○	
마. 진단 성능검증 시험			○	
바. 시운전 시험			○	
사. 절연저항 측정			○	

◗ 센서 감도 시험에 관한 인정시험(◇※표시항목)은 우리 회사 산하기관에서 시행한 시험성적서에 의하며 "※" 표시항목(3, 8, 9, 10, 11, 12항)은 인정시험성적서로 대체한다.

Documents to be submitted when bidding

Specification contents	progress	note
Bidders must submit the bidding technical specifications and pass KEPCO's technical review. (7.1)		
The bidding technical specifications document must include the following items. (7.2)		
Supplier material specifications and specifications for each material		
Comprehensive process plan including design, manufacturing and testing plan		

Training plan for users and related staff		
Substation comprehensive preventive diagnosis system comprehensive specifications and manual 1. Substation comprehensive preventive diagnosis system manual 2. system block diagram 3. Device (system) structure divided by function and block 4. Software related matters a. Summary of functions by application (data acquisition, information processing, etc.) b. Monitoring, analysis, and diagnosis program algorithms and monitoring, analysis, and diagnosis methods c. Data format and transmission specifications to upper system 5. Configuration diagram for each operator HMI screen menu and sub-menu (including sample screen printouts for each menu)		

6. How to input operating data, edit settings, and manage 7. Technical data on system expandability (including comprehensive preventive diagnosis system for other substations) 8. Technical data on compatibility between heterogeneous systems 9. Data on diagnostic performance (accuracy) suitability 10. Data on other bidder system features		
Quality Assurance Plan		
List of measuring equipment for data calibration and precise diagnosis		
Substation comprehensive preventive diagnosis system function and performance verification data		

(가) 진단Unit

분 야	항 목	세부 제출 항목
진단Unit	진단Unit에 관한 기술검토서	- 진단Unit의 감시·분석·진단 및 종합관리 기능구비 및 요약 설명서
신호 분석	진단소프트웨어에 관한 기술검토서	- 각 진단 항목별 진단소프트웨어에 대한 기술검토서

(나) 변전소

분 야	항 목		세부 제출 항목
센서	센서의 도면 및 시험성적서	부분방전 센서	- 센서의 가상 설치도 - 센서의 검출 주파수 대역 표시한 Data/기설, 신설 포함 (예: 반사손실, GTEM 측정 등) - 5pC 부분방전에 대한 센서의 출력 전력 Data (외장형 센서의 경우 해당 스페이서에 장착하고 근처에서 발생하는 5pC 부분방전에 대한 측정 Data) - 각 센서간의 감도 편차를 주파수 영역과 출력에 대해 표시한 자료 - 각 센서별는 고유번호를 부여하고 제조회사, 제작일자를 센서외면에 견고하게 표시하여야 한다.
		가스분석, 부싱 누설전류, OLTC 구동전류, 차단기 코일전류, 온도 센서	- 센서의 가상 설치도, 센서의 검출영역 및 고유 특성 - 센서의 시험성적서 및 성능을 입증할 수 있는 자료 - 각 센서별는 고유번호를 부여하고 제조회사, 제작일자를 센서외면에 견고하게 표시되어 있어야 한다.
		기 타	- 센서의 가상 설치도 및 연결 구성도
Local Unit	Local Unit의 감도 시험성적서 (검출 대역 및 동시측정기능 포함)		- Local Unit의 검출 주파수 영역 데이터 - 최소 검출 가능 전력의 크기와 이때의 SNR (신호대 잡음비) - 동시 측정 기능에 대한 데이터 - 입력 Pulse shape, 측정 조건 등
동축 케이블	동축케이블의 신호 손실 측정표		- 현장 설치용 동축 신호선의 주파수에 대한 단위 길이 당 손실 측정 Data/기설, 신설 포함

Please go to original 한전 규격서 주요 내용 및 타사 제품 분석 document for attached PDF documents.