for Electric Power Distribution Board Safety Improvement

Dust Cleaning Equipment Operation Manual

NWK-99(OUTSIDE POWER POLE)

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1. Purpose of Dust Cleaning & Features of Product features

A. Dust Cleaning Purpose

○ Electrical and Electronic Communication equipment is composed of a complex of electronic devices such as precision circuits and highly integrated semiconductors. When conductive or combustible dust or pollutant accumulates on the surface of semiconductor and charging parts, Malfunctions and Short failures occur.

○ The purpose of Dust Cleaning is to effectively remove dust from the switchboard to prevent electrical safety accidents, that is, corona, heat dissipation interference, and lowering of insulation resistance. This Manual is composed of cleaning agents, safety equipment and accessories.

B. Damage caused by Dust

1) Corona outbreak

○ What about corona discharge? It is an electrical phenomenon that occurs when the fluid (air) around the conductor (electric wire) is ionized. If you hear a crackling sound in a substation or under a high-voltage transmission line, you can think of it as a precursor to a corona discharge. On a foggy or cloudy day, the corona discharge becomes intense, and at night, the wires glow blue and white.

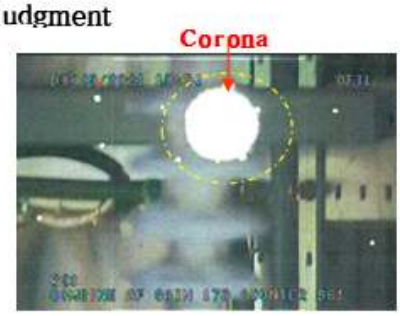
○ Damages include reduction in electrical efficiency, noise and disturbance in nearby carrier communication facilities, and acceleration of corrosion in wires.

○ In particular, in the case of continuous corona discharge, deterioration due to dust contamination of electrical insulators and connection parts may be the cause.

※ The photo below is a case where the root cause of the failure was resolved as a result of dust cleaning for electric insulators in the INCOMING ASS (22.9kV) where corona discharge continuously occurs.

(1) Dust Cleaning(Before) "Caution" judgment



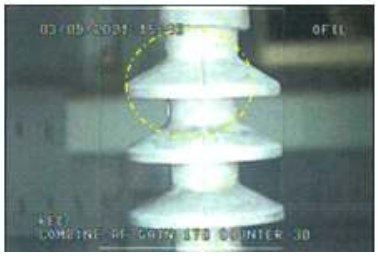


(Measuring instrument : OFIL)



(2) Dust Cleaning(After) "Normal" judgment

(Measuring instrument : OFIL)



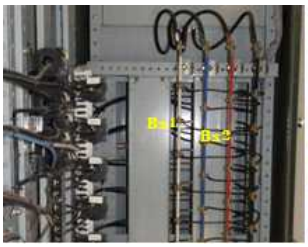


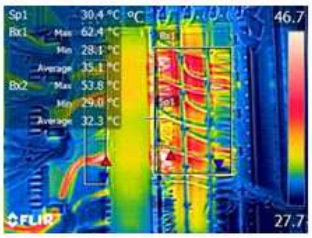


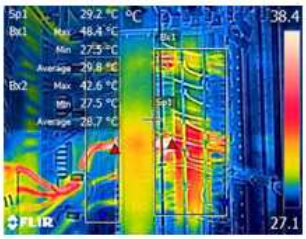
2) Interfere with heat dissipation

○ In general, if dust cleaning is performed in the case of electric switchboard, the generated heat is lowered as shown in the picture below.

※ It can be seen that the temperature has decreased by -4.5℃ (↓13.3%).



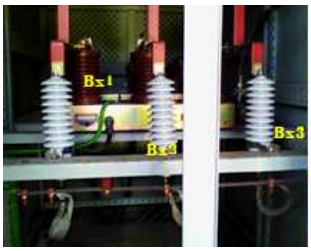


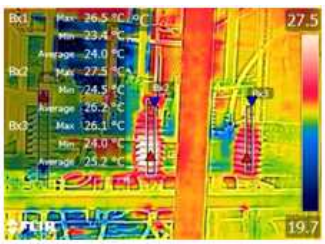


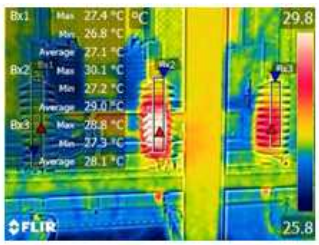
Division	Cleaning(℃)		Result	
	Before	After	Temperature	Decrease rate
Bx1	35.1	29.8	-5.3℃	↓15%
Bx2	32.3	28.7	-3.6℃	↓11%
average	33.7	29.2	-4.5℃	↓13%

○ However, there are cases where the temperature rises as shown in the picture below after dust cleaning (before and after). This has a fundamental cause such as aging of parts, and measures such as replacement of parts are necessary.

※ Even after dust cleaning, it can be seen that the generated heat increased by +3.0℃ (↑12%).







Division	Cleaning(℃)		Result	
	Before	After	℃	Worse
Bx1	24.0	27.1	+3.1	↑13
Bx2	26.2	29.0	+2.8	↑11
Bx3	25.2	28.1	+2.9	↑11
평균	25.1	28.1	+3.0	↑12

3) Decreased insulation resistance

○ The following was carried out at the 1st water pumping station in the 00 Waterworks Business Headquarters.

-6.6kV panel 2 sides,

-6.6kV 400, 800, 1200, 1300HP, SC panel, motor operation panel, etc. 11 sides.

○ It was also conducted at the 2nd water pumping station, and the details are as follows.

-6.6kV panel 1 side,

-6.6kV water supply main pump motor starter was carried out on 4 sides, and

this is the data comparing the insulation resistance value before and after dust cleaning.

※ The result shows that the insulation resistance (㏁) value is improved by ↑200% from 2000㏁ to 4000㏁ after cleaning.

(Cleaning Before, After)

Division	Details			Result
	water pump N0.7	Cleaning(Before)	After	
insulation resistance				Insulation resistance (㏁) improved by more than 200% after cleaning
	570HP	2000㏁	4000㏁	

Dust Cleaning	No1.Water pump station													No2.Water pump station					90.980	%
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Before/㏁	60	1500	5000	90	1500	210	2000	9000	2600	10000	520	1400	6000	2500	9000	20000	5000	14000	90.980	100%
After/㏁	130	12000	8000	4500	2000	300	4000	12000	2600	12000	4000	4500	12000	5300	12000	26000	20000	30000	171.880	188.9%

C. Cases of strengthening management standards for electrical and electronic devices in preparation for dust damage

1) Inverter

○ Since inverters are electrical and electronic devices composed mainly of semiconductor elements and are sensitive to environmental influences such as temperature, humidity, dust, and vibration, daily inspection is essential to prevent malfunctions in advance. In particular, when a lot of dust accumulates, insulation resistance is reduced and equipment malfunctions due to interference with heat dissipation, etc. Therefore, dust must be removed by setting a cleaning cycle.

※ The photo below is a case of solving the malfunction by removing the contaminated dust of the elevator inverter using NWK-99 (Spray type).

Inverter for elevator



Before



Cleaning



After



● **Manage the inverter temperature below 40℃**

○ According to the inverter management regulations, the rated current of the inverter decreases by 2.2% for every 1℃ rise above 40℃.

● **Inverter usage environment and cleaning cycle**

Division	Item/cycle	Details
environment of use	ambient temperature	-10℃~40℃ (without ice or frost)
	storage temperature	-20℃~65℃
	Ambient Humidity	Relative humidity 60% RH or less (no dew formation)
	Altitude and vibration	1,000m or less, 5.9m/sec (=0.6G) or less
	surrounding environment	No corrosive gas, flammable gas, oil mist, dust, etc.
cleaning cycle	12 months	Dust removal inside the inverter

D. Product features and specifications

1) Characteristics of detergent (NWK-99)

○ It is a non-conductive material with a breakdown voltage of 55,000V.
※ Dielectric breakdown voltage(KS C IEC 60156:2003) : 99,300V
○ Non-corrosive and does not damage the PCB and mounted components.
※ Corrosive (140℃ 19hr) (KS C 2101:2017): Non-corrosive
○ Flash point (ASTM D93-18) : 89℃
○ Easily removes dust between gaps in electronic parts with excellent penetrating power.
○ After removal of pollutants such as dust, it evaporates without residue within 40 minutes.
○ It is a product with reduced harmful substances (low toxicity) and certified eco-label (No. 4634).
※ Certification (January 1, 2006 ~ 11.5, 2020)

2) Product specification

Product Name	Type	Weight	Remark
NWK-99	Aerosol	539g	-Pressure: 5.2kg/㎠ -Absorbent cloth: 1000mm × 750mm
NWK-99(S)	Pail	20 L	
Recommendations	1) After cleaning, the residual cleaning solution evaporates in about 40 minutes in an environment of 20℃. 2) However, the cleaning solution that has penetrated between the gaps of electronic components (Magnet S/W, Relay, etc.) that is difficult to contact with air may have a slow evaporation. 3) Therefore, the operator conducts air blowing immediately after cleaning to promote evaporation of the cleaning solution that has penetrated between the gaps of electronic components such as magnet S/W and relay.		

2. Summary of Works and Supplies

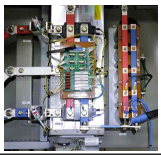
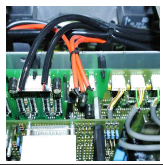
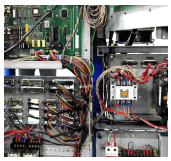
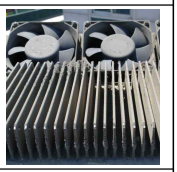
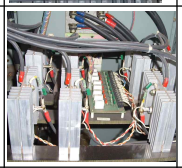
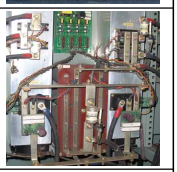
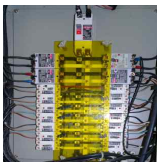
A. Summary of Works

○ The Operation Manual describing all the requirements in conducting works cleaning dust which may cause the troubles in "Electric Distribution Board" must be thoroughly digested prior to executing of works.
○ The equipment described in the Manual herein must be furnished in order to assure the safety, and even in the event of using alternative equipments, the equipment furnished shall comply with the functionality of equivalent level.
○ Electric switchboard cleaning should be performed by an electrician with more than 10 years of experience in switchgear, capable of facility inspection and emergency situations, to maintain and manage the highest quality.

B. Safety and Work Supplies

Item	Equipment Name	Manufacturer	Specification	Remark
Safety Supplies	Insulation Boots (Extra-high Voltage)		Over 26,500V	-Wear when power "ON" cleaning.
	Insulation Glove (Extra-high Voltage)		Over 26,500V	
	Insulation Glove (High Voltage)		Over 1,000V	
	Anti-static Cloth			
	Safety Hat(Insulated)		Over 7,000V	☞ Product provided live wire warning device.
	Mask	-3M	-Mask : 6800 -Filter : 6006	☞ Full face covering type
	Mask (Common)	-3M		☞ Carbon Mask
	Fire Extinguisher		-Halon Fire Extinguisher	☞ To use the fore extinguisher suitable for extinguishing electricity & oil related fires
Supplies	Compressor Ass`y 3.5HP(220V/60Hz)	-NWK	-To classify domestic/Inter-national Applications.	-Photo-1(No.4 equipment usage method) ☞ Southeast Asia : 3.5HP(220V/50Hz)
	Spray Machine (L),(S)	-NWK	-L :Over 64㎝	-Photo-2 ☞ Amount of spray : 490~550㎖/minute
		-NWK	-S :Over 38㎝	
	Air Spray Machine	-NWK	-Length : 40㎝	-Photo-2
	Coupring 2-prong Ass`y	-NWK	-A.D : 8mm -Length:10m(2ea) -Coupring(1ea)	-Work efficiency(detergent spraying & air hose) -Photo-3
	Filter & Hose Ass'y	-NWK	-A.D. : 10mm -Length : 7~10m	-Photo-4 ☞ Check valve+Filter installed.
	Air Hose Ass`y	-NWK	-I.D. : 8mm -Length : 10m	-Photo-5
	Reel Cable			☞ To use as unbundled due to the generation of heat.
Cleaner	NWK-99	-NWK	-Aerosol Type	-539g
	NWK-99(S)	-NWK	-Pail Type	-20 L
Other	Adsorption Cloth	-NWK	Size : 1000×750mm	☞ Surface of cloth to have absorbing & interrupting capability. (Sectionally coated.)
	Paper Towel		Industrial Type	☞ To have excellent absorption effect.

C. Applies and Precautions

<table>
<tr><th colspan="2">Division</th><th>Target Equipment</th><th colspan="2">Remark(Photo)</th></tr>
<tr><td rowspan="2">Power plant</td><td>Hydro, Thermal, Nuclear, Cogeneration</td><td>Instrumentation control, Electrical, Environmental equipment Communication, Other facility management</td><td></td><td></td></tr>
<tr><td>Solar power generation</td><td>Inverter</td><td></td><td></td></tr>
<tr><td>Elevator</td><td>Instrumentation control,</td><td>Inverter</td><td></td><td></td></tr>
<tr><td>Communication</td><td>Base transiver system, Communication relay,</td><td>PCB Card, Heat sink, Fan etc.</td><td></td><td></td></tr>
<tr><td>Railway, Subway</td><td>Electrical Switchboard</td><td>Signal, PCB Card, Electrical Switchboard etc.</td><td></td><td></td></tr>
<tr><td>Road, Traffic</td><td>Tollgate, Tunnel</td><td>Detection Sensor, VMI, CCTV</td><td></td><td></td></tr>
<tr><td>Cattle house</td><td>Poultry, Swine, Hanwoo, etc.</td><td>Electrical Switchboard etc.</td><td></td><td></td></tr>
<tr><td>Others</td><td>Public institution facility management, factories, buildings, etc.</td><td>Electric room, Communication, Signal, Control. etc</td><td></td><td></td></tr>
<tr><td>Precautions</td><td colspan="4">• Use the optical sensor parts after the cleaning solution is completely evaporated.
(Natural evaporation time : 40 minutes/20℃)
☞ Blow the compressed air immediately after cleaning to reduce evaporation time.
• Disassemble and clean the products or parts (PLC, Inverter, Magnet Switch, etc.) that contaminants cannot escape.
• Compressor may generate noise and cause malfunction of control circuit, so keep the distance more than 2m and clean it.

• Restrictions on product use
☞ Do not use on computer keyboard, LCD, LED instrument panel.
☞ Be sure to perform reaction test on fine coated plastic and rubber products before use.</td></tr>
</table>

3. Equipment Operating Procedure

A. Compressor and Moisture Eliminator (Photo-1)

○ The Moisture Eliminator provided is to automatically discharge water once fully filled up thanks to its automated function. Yet, press the Discharge Button for 2~3 times at once by every hour prior to starting of works allowing vent of water in advance.
☞ Even if the air hose length is 100m, the pressure is the same. So, do not move the compressor by force, but connect the length of air hose.
○ Release the Discharge Button located at the bottom of Tank for 3 times (Prior to work, lunch time & evening.) per day to remove water as well for the Compressor.
☞ Water filled up is to be discharged. Lock the Discharge Button up with the wind blowing sound indicating no presence of moisture.
(At this time, hold the handle and shake to allow water to escape toward the outlet.)
○ For Oil Type Compressor, routinely replace with the oil specified once by every 6 months for ideal life span management (8hr/day).

B. Connect Air hose and Cleaning solution supply hose to Spray gun. (Photo-2)

○ Use about 10meter length of Air Hose to connect with Spray Gun preventing that the work piece object gets close to Compressor.
☞ Even though the length of the air hose is 100m, the pressure is similar. Therefore, it is recommended not to move the compressor by force but to increase the length of the air hose.
○ Routinely check the condition of Moisture Eliminator at about 12months cycle based on 8 hours/day work, and replace as necessary.
☞ The Moisture Eliminator provided with equipment can be used semi- permanently unless damage of component is incurred.
○ The Check Valve installed at the end of the hose for supplying detergent is designed so that there is no problem in function even when spraying on an electric panel with a height of 3m or more.

C. Raising Air Pressure by Engaging Power Supply on Compressor

○ Use the input power by connecting the 220V/60Hz (Chinese, Southeast Asian 220V/50Hz) direct power (switchboard)
☞ When using reel wire, unwind all reel wire to prevent load.
○ In case of compressor, the pressure when air pressure is completed is 0.7 ~ 0.9MPa (kgf/㎠).

☞ The Compressor described herein is default set up as 0.7MPa~0.9MPa considering the efficiency of work.

D. Regulator

○ Regulate the pressure(0.7MPa~0.9MPa) and use fitting to the purpose of work.

E. Spray Gun

○ Check the pressure through the regulator before operation.
○ The spray gun is ① 65cm in length and ② 45cm in length. Keep at least 20 ~ 30cm away from the electric panel to be cleaned.
○ The cleaning work is done horizontally and it is effective if it is done from top to bottom.

F. Cleaning Agent

○ Make sure to only use the NWK-99(S) for Cleaning Agent.
○ Never invest any additives into NWK-99 product.
○ Firmly close the cover of container for raw material left over from work preventing infiltration of external moisture, and then place it under storage.

G. Collection and Treatment of Adsorption Cloth

○ Cleanly wipe the surrounding of equipments such as floor and panel using the adsorption cloth (Paper Towel), and collect the waste together with contaminated cloth for disposal.
☞ It is effective to remove pollutants outside the switchboard using a dedicated cleaning agent (HS-747).

H. Completion of work

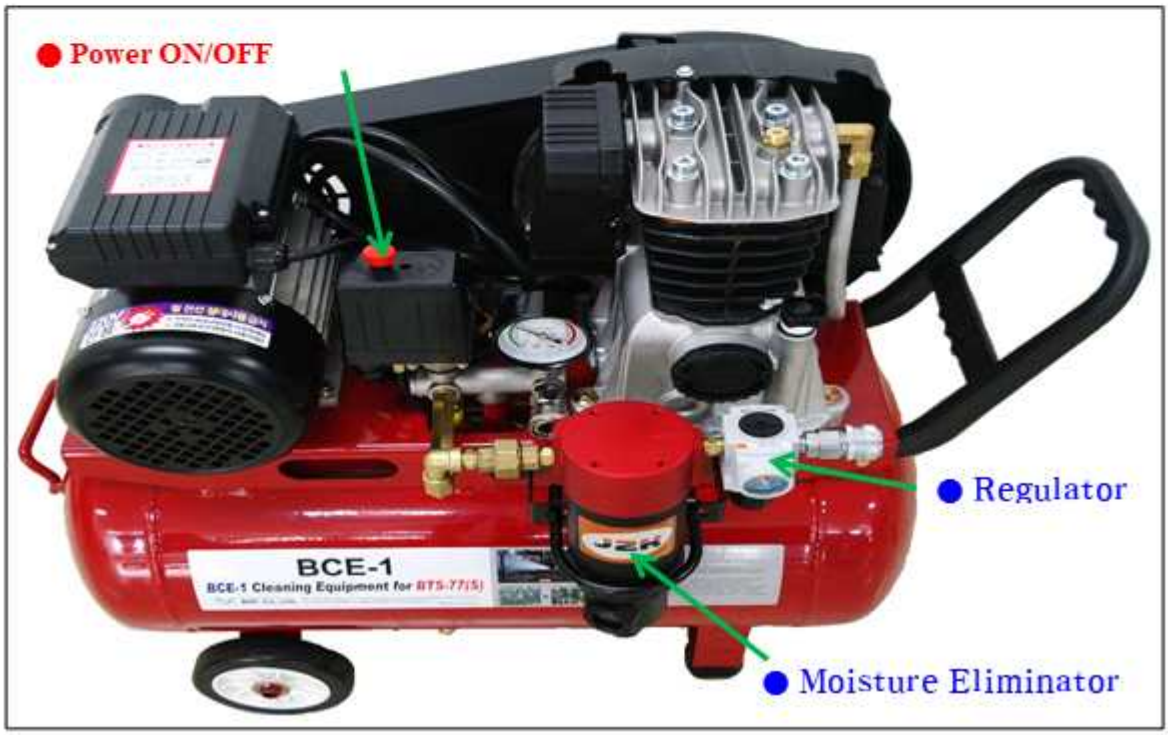
○ After cleaning, check if there are any abnormalities in the electrical panel.
☞ Take measures to prevent theft of nearby facilities and materials.
○ After cleaning, follow the instructions of the site manager.

4. Equipment Operating Instruction

A. Working Equipment Configuration



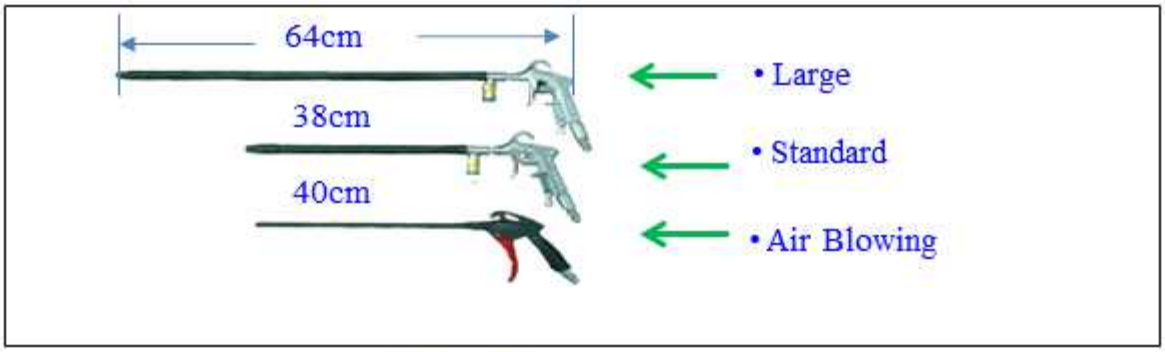
1) Moisture Eliminator (Photo-1)



※ When using any existing equipments other than shown above, separately purchase and install the Moisture Eliminator and Regulator specified.

B. Working Equipment Configuration

1) Sprayer & Air blowing Machine (Photo-2)



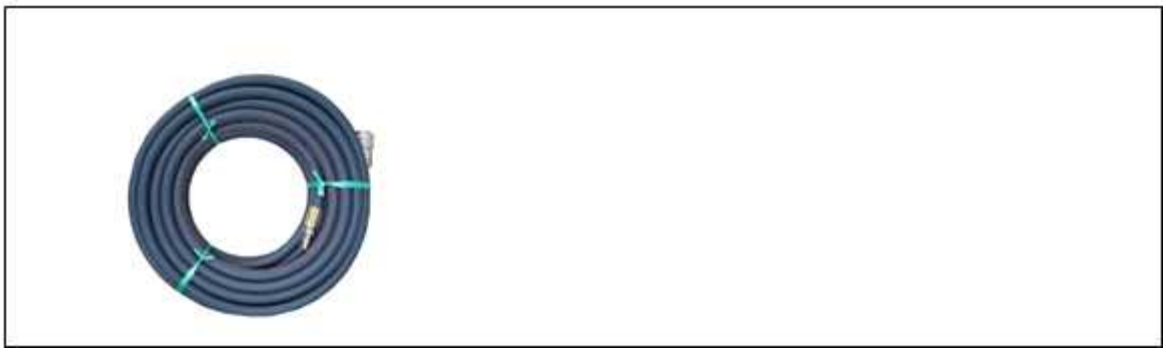
2) Coupler 2-prong Ass`y (Photo-3)



3) Cleaner supply hose Ass'y (Photo-4)



4) Air Hose Ass'y (Photo-5)



C. Assembling Procedure

1) Connect Check Valve + Raw Material Supply Hose.



2) Connect Raw Material Supply Hose to Spray Gun.



3) Connect Spray Gun + Air Hose.



4) Connect Compressor + Air Hose.



5) Engage Compressor Power Supply.



6) Execute washing work.



5. Preparation of Work and Checking of Environment

A. Preparation of Work

○ The Site Superintendent (Site Manager) shall visibly check the environment of job site prior to starting of work, and be well aware of the location of emergency exit and other safety related facilities.
○ The workers involved in site works shall put all the safety gears and apparatus, and enter into the places where the cleaning work piece objects are located.
○ The equipments required in works shall be duly and appropriately arranged fitting to each respective applications.

B. Installation of Job Site

○ When moving of work piece object is required, install the separate job site and ventilation/exhaustion devices at the site as necessary.

C. Attaching Identification Number

○ Provide and attach labels in order on the work piece objects requiring detaching (separation) during work process for safety in assembling.

D. Installation of Adsorption Cloth

○ To facilitate the collection of waste generated during work, an adsorbent cloth is installed at the bottom (floor) of the object to prevent contamination.

E. Generator installation and operation

○ Safety management of fuels (diesel, gasoline, etc.) used for power generation is important.
☞ Maintain and store at least a safe distance of 10M between generators and fuel, and during breaks, stop starting and check for safety, such as overheating.
☞ Do not overheat the generator by exposing it to sunlight.
○ Be sure to check the capacity of the generator and compressor in advance so that there is no overload.
☞ This compressor uses 3.5HP and the generator uses 5.5HP.

6. Caution on Works

○ Before cleaning, the manager must check the electric switchboard and the discharge of residual voltage in the condenser, etc.
○ Workers should be organized into a group of 4 people, but they should be a supervisor (1 person), special high-pressure washing worker (1 person), and auxiliary worker (2 people), and the following safety rules must be followed.
○ Supervisors must keep a close eye on the site and respond to the situation in real time.
☞ For safety, the supervisor must open and close the cubicle 30 minutes before work, check the safety violation factors, and immediately notify the safety manager and take action when any dangerous factors are discovered.
(Safety violation factors: faulty lines, equipment, and all possible defects that may cause danger)
○ For safety management, there shall be one cleaning worker in one work area.
○ The entry of outsiders into the workplace is prohibited. (Installation of control signs at the entrance)
○ If the work object is in an enclosed place, work with adequate ventilation.
○ Do not possess or attach conductive materials (including metallic accessories) in the workplace, and do not put items other than tools necessary for work.
(※ Cell phone not allowed)
○ Workers must follow the safety rules and must learn safety-related education and various measures related to safety accidents and operating equipment before work.
○ Workers must wear standard safety equipment.
○ If an abnormality occurs during work, stop the work immediately, report it to the safety manager, and restart it after the cause is found.
○ In particular, in the case of a compressor, it should be placed at a distance of at least 2m from the work object.
○ Work must be done in accordance with the instructions of the supervisor (site manager), but do not arbitrarily perform work other than the permitted work.
○ When a unit (PCB card, other parts, etc.) is disassembled during work, an identifiable mark or number tag should be attached to the unit to prevent the unit position from being changed during installation.
○ Activities unrelated to cleaning work (eg smoking, eating, etc.) are prohibited in the workplace.
○ Auxiliary workers safely wipe off contaminants inside and outside the work equipment, tidy up the work area, and deal with the generated contaminants.
○ Fire-fighting facilities such as fire extinguishers should be placed in a location that can be used immediately.
○ Do not use metal ladders, and make sure that the fall protection device is safe.

7. Cleaning cycle by electric equipment

☞ Korea Occupational Safety and Health Agency: General technical guidelines for the maintenance of electric facilities (cited by KOSHA GUIDE O-3-2011 / December 29, 2011)

Maintenance cycle for each electric facility

Equipment / Equipment Name		Task / function	Cycle
Power / Power Distribution Transformers	Transformer	Current and voltage measurement	Weekly~monthly unit
		Temperature measurement	Weekly~monthly unit
		Oil level measurement	Weekly~monthly unit
		Pressure and vacuum gauge	Weekly~monthly unit
		Transformer oil analysis	1 time / year
		Insulation test	3-5 years
		Winding test	3-5 years
		Combustible Gas Analysis	1 time / year
		Oil Dissolved Gas Analysis	1 time / year
	Dry Transformer	**Clean, check and test**	**2 Year**
Electronic equipment		Check	1 time / year
		Clean(Dust Clean)	**3 Year**
		Adjustment, calibration	3-5 years
Circuit breaker		Check, **Clean**	**3 Year**
		Mechanical testing	2 Year
		Electrical test	3-5 years
Fuse	Fuse Terminals and Clips	Visual check	3 Year
		Clip Contact Pressure	3 Year
		Contact surface Cleaning	**3 Year**
		Discoloration, damage	3 Year
Rotary machine	Stator and rotor	Vibration analysis	6 months
		Visual and mechanical check **Clean**	**1Cycle/Year**
	magnetwire	Electrical test	1 time / year
	Brush, current collector ring, commutator	Visual and mechanical check	1 time / year
Wiring equipment	Plug, shielded wire connector	Check	Monthly, when using
	Concent	Check	Monthly, when using
		Operation test	Monthly, when using
Mobile power tools		Check, **Clean**	Monthly, when using
		Electrical test	Quarter
UPS(Uninterruptible Power Supply System)		Visual inspection	Quarter
		Daily maintenance	6Monthly

☞ The maintenance intervals of the substation facilities vary depending on the installation environment, but should be checked at least once every 6 to 8 weeks in industrial areas or in coastal areas with high salt levels.

8. ESS Dust Cleaning cycle

A) ESS(Enhancement of Energy Storage System) Operational Management Standards

○ On June 12, 2019, the Ministry of Commerce, Industry and Energy announced that ESS fire accidents and industrial competitiveness support measures were to strengthen management of overvoltage, over current, leakage, and temperature rise of battery storage devices for solar cells.

○ The regular inspection interval will be shortened from the current four years to one to two years, and ESS is designated as a specific fire fighting target and mandatory installation of fire fighting facilities.

○ In particular, each business site decided to strictly manage the operating environment such as the prohibition of additional charging after charging the battery and the temperature, humidity and dust.

☞ In addition, the facilities installed indoors among the suspended business sites can be restarted only after additional measures such as installing a firewall and securing the separation distance.

(Operation and Management Standards Details)

<table>
<tr><th rowspan="2">Division</th><th rowspan="2">Item / Cycle</th><th colspan="2">Details</th></tr>
<tr><th>Before</th><th>After</th></tr>
<tr><td>Filling rate</td><td>Charge</td><td></td><td>No additional charge after full charge</td></tr>
<tr><td rowspan="3">Operating environment</td><td>Temperature</td><td rowspan="3">If dust accumulates in the battery module and condensation is generated and dried repeatedly, fire may occur due to insulation breakdown at the ground between the cell and the module enclosure.</td><td rowspan="3">Temperature, humidity and dust management of the battery compartment will be performed within the manufacturer's recommended range.</td></tr>
<tr><td>Humidity</td></tr>
<tr><td>Dust</td></tr>
<tr><td>Management system</td><td>Legal inspection cycle</td><td>4 Year</td><td>1~2 Year</td></tr>
</table>