NAE WOI KOREA

for Electric Power Distribution Board Safety Improvement

Dust Cleaning Equipment Operation Manual

NWK-99 / Auxiliary tool type

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1. Purpose and Features of Product

A. Purpose of Product

○ Electricaland Electronic Communication equipment is composed of a complex of electronicdevices suchas 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 switch -board to prevent potential safety accidents caused by electricity, that is, Corana, interference with heat dissipation, and lowering of insulation resistance. This Manual is composed of cleaning agents, safety equipment and accessories.

B. Damage caused by Dust

1) Corona outbreak

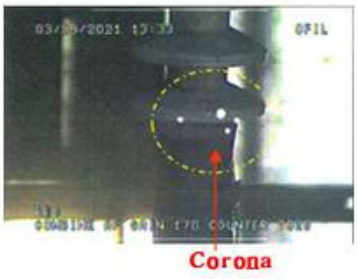
○ What about corona discharge? It is an electrical phenomenon that occurs when the fluid (air) around the conductor (electric wire) is ionized. If you hear a crackling sound in a substation or under a high-voltage transmission line, you can think of it as a precursor to a corona discharge. On a foggy 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 picture belowis a case in whichthecause ofthemalfunction was resolved asa result of dust cleaning for electric insulators in the INCOMING ASS (22.9kV) where corona discharge continuously occurs.

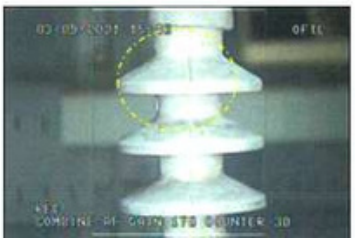
(1) Dust Cleaning(Before) "Caution" judgment



(Measuring instrument : OFIL)

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

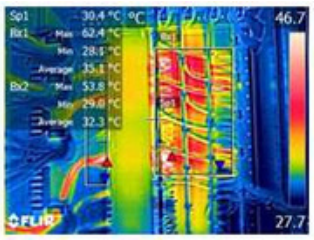
(Measuring instrument : OFIL)

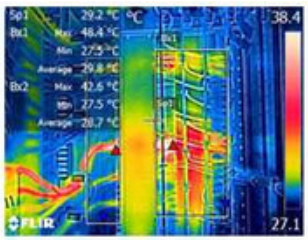


2) Interfere with heat dissipation

○ In general, if dust cleaning is performed in the case of electric switchboard, the generated heat is loweredasshowninthepicturebelow.

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

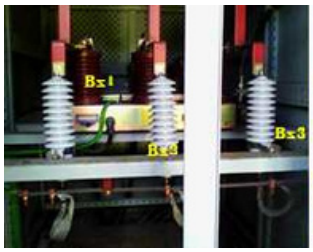


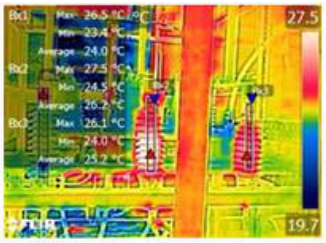


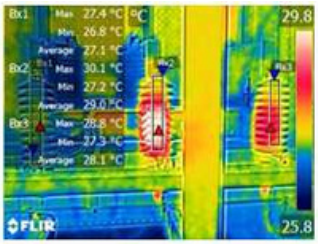
Division	Cleaning(℃)		Result	
	Before	After	Temperature	Decrease rate
Bx1	35.1	29.8	-5.3℃	↓15%
Bx2	32.3	28.7	-3.6℃	↓11%
average	33.7	29.2	-4.5℃	↓13%

○ 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 ofparts,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.

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

(Cleaning Before, After)

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

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/ MΩ	60	1500	5000	90	1500	210	2000	9000	2600	10000	520	1400	6000	2500	9000	20000	5000	14000	90.980	100%
After/MΩ	150	12000	8000	4500	2000	300	4000	12000	2600	12000	4000	4500	12000	5000	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.

※Thephoto below is acase ofsolving themalfunction 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)

○ There is no risk of fire due to sparks and arcs generated from relays and magnet switches that are being supplied with electricity, and cleaning is possible up to 35000V without shutting off the power being supplied. ※ Dielectric breakdown voltage (KS C IEC 60156): 56000V ○ It is a disaster safety certified product that is not flammable and can be extinguished by spraying it on a fire when an electric fire occurs. ※ Flash point (KS M ISO 2592) : None ○ It does not damage the PCB and mounted electronic components. ○ Easily removes dust between gaps in electronic parts with excellent penetrating power. ○ After removal of contaminants such as dust, it evaporates without residue within 3 to 8 minutes.

2) Specification

Product name	Type	Weight	Re mar k
NWK-99	Spray type	500g	-Under 20kV: Can be cleaned without shutting off the power.
NWK-99(S)	Pail	20kg	-Under 35kV: Can be cleaned without shutting off the power.

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.

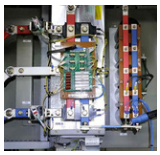
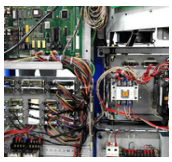
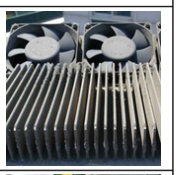
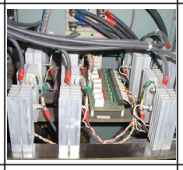
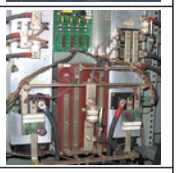
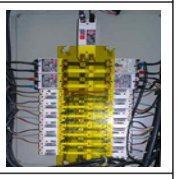
○ The equipment described in the Manual herein must be furnished in order to assure the safety, and even in the event of using alternative equipments, the equipment furnished shall comply with the functionality of equivalent level.

① 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	Manufac tur er	Specification	Remark
Safety Supplies	Insulation Boots (Extra-high Voltage)		Over 26,500V	-Wear when power "ON" cleaning.
	Insulation Glove (Extra-high Voltage)	-U.S.A (NOVAX)	Over 26,500V	
	Insulation Glove (High Voltage)		Over 1,000V	
	Arc protective suit (Upper, Lower, Neck protection)	- Cat u (France)	Over 20,000V	-Prevention of safety accidents in Spark and Arc ※ International regulation IEC 61482-1-2 certified product
	Safety Hat(Insulated)	- Cat u (France)	Over 7,000V	-Arc, flash protection helmet (20kV) · Products with live wire approach alarm
	Mask	-3M	-Mask : 6800 -Filter : 6006	☞ Full face covering type
	Mask (Common)	-3M		☞ Carbon Mask
Supplies	CompressorAss`y 3.5HP(220V/60Hz)	-NW		-Photo-1 ☞ Southeast Asia : 3.5HP(220V/50Hz)
	Auxiliary tool	-NW	-Weight: 12.3kg	· Photo-2 ※ Settingat spray pressure 1.7kg /㎠
	Moisture Removal Filter	-NW		· Photo-1 / Photo-2 ※ Itisnot necessary when it is connected to the compressor.
	Sprayer (L),(S)	-NW	-L :Over 64 ㎝	-Photo-3 ☞ Amount of spray : 490~550㎖/minute
		-NW	-S :Over 38 ㎝	
	Air Hose Ass`y	-NW	-I.D. : 8mm -Length : 10m	-Photo-5
	Hose for supplying cleaning agent	-NW	-O.D. : 6mm -Length : 10m	-Photo-4
	Reel Cable			☞ To use as unbundled due to the generation of heat.
Cleaner	N WK-99	-NW	-Aerosol Type	-5 00 g
	NWK-99(S)	-NW	-Pail Type	-20kg
Other	Adsorption Cloth	-NW	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 Equipmentnt</th><th colspan="2">Remark(Photo)</th></tr>
<tr><td rowspan="3">Power plant</td><td>Hydro, Thermal, Nuclear, Cogeneration</td><td>Instrumentation control, Electrical, Environmental equipment Communication, Other facility management</td><td rowspan="2">  </td><td rowspan="2">  </td></tr>
<tr><td>Substation</td><td>Underground and overhead switches, Substations, switchboards, Telecommunications, etc.</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>Communicat ion</td><td>Base transiver system, Communication relay,</td><td>PCB Card, Heat sink, Fan etc.</td><td>  </td><td>  </td></tr>
<tr><td>Railway, Subwa y</td><td>Electrical Switchboard</td><td>Signal, PCB Card, Electrical Switchboard etc.</td><td>  </td><td>  </td></tr>
<tr><td>R o a d , T r a f f i c</td><td>Tollgate, Tunnel</td><td>Detection Sensor, VMI, CCTV</td><td>  </td><td>  </td></tr>
<tr><td>Cattlehouse</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, buildings, etc.</td><td>factories, Electric room, Communication, Signal, Control. etc</td><td></td><td></td></tr>
<tr><td>Precautions</td><td colspan="4">. . Optical sensor parts, etc.: After turning off the power, clean the dust.
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)

o The Moisture Eliminator provided is to automatically discharge water once fully filledup thanks to its automated function. Yet, press the Discharge Button for 2~3 timesat 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 thecompressor by force, but connect the length of air hose.

o Release the Discharge Button located at the bottom of Tank for 3 times (Prior work, lunch time & evening.) per day to remove water as well for the to Compressor.

☞ Water filled up is to be discharged. Lock the Discharge Button up with the windblowing sound indicating no presence of moisture.
(Atthistime, hold the handle and shake to allow water to escape toward the outlet.)

o For Oil Type Compressor, routinely replace with the oil specified once by every 6months for ideal life span management (8hr/day).

B. How to use the Dust Cleaner

1) Auxiliary tool type(Auxiliary container to improve spraying power)

○ Open the inlet of the auxiliary tool, inject the cleaning solution using a bellows pump or a funnel (see: 4. How to use the equipment), and then close the inlet immediately to prevent evaporation of the cleaning agent. The capacity of the pressure tank is 20 kg, but 10 to 15 kg of cleaning solution is suitable for one time.
☞ In the case of filling the pressure tank with no space, the desired spraying effect may not be achieved during the first 1~30 seconds.
○ Connect the air-hose of the compressor to the auxiliary container, connect the the hose for supplying detergent and the air-hose to the spray-gun, then open locking device of the hose for supplying the detergent and remove contaminants. ○ If you pull the trigger of the spray gun slightly, the cleaning liquid and air are sprayed in a 50:50 ratio. ☞ Do not apply excessive force to the trigger part of the spray gun during operation to prevent malfunction. In particular, it must be managed so that there is no impact or deformation during movement and storage.

◯ There is no need to adjust the regulator arbitrarily because the pressure of the auxiliary container is set at the optimal condition of 1.7kg/cm2 (0.17MPa).
☞ It is designed to maintain stable spraying force even when cleaning an electric switchboard located at a position higher than 3m.
In the case of the air-hose and cleaning solution supply hose connected to the spray-gun, it was designed to be 10m long to prevent the compressor and the electric switchboard from sticking close together during cleaning.
Even if the length of the Air Hose is 100m, the injection pressure is the same, soitis desirable to connect only the length of the Air Hose without moving the Compressor forcibly.

C. Turn on the power to the compressor to fill the air pressure.

○ Use the input power by connecting the 220V/60Hz (Chinese, Southeast Asian 220V/50Hz) direct power (switchboard), and do not use it by connecting it to a power outlet for separation.
☞ The reason is that the power of the electrical equipment being used may be “Off” because the compressor uses high power over 100% of the instantaneous rated current.

☞ 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

◯ When cleaning the electric switchboard, keep a safe distance of 1m from the handle of the spray-gun.
☞ Thespray-gun is manufactured in a separate standard and has lengths of ①64cm and ②38cm.
☞ Spraying should be done in the horizontal direction, and it is effective to do it from topto bottom.

Minimum approach distance by voltage

Operating voltage(V)	Minimum approach distance (cm)	Remark
300V less than	No contact	※Safety rules It is a concept different from the approach limit distance in the table of Article 350 Line (Special High Voltage Live Operation).
300~750	30	
750~2000	45	
2000~15000	60	
15000~37000	90	
37000~88000	110	

F. Cleaning solution

Ⓞnly NWK-99(S) should be used as the cleaning agent.
Ⓐfter completing the work using the pressure tank, move the remaining cleaning agent to the original container to prevent infiltration or loss of external moisture, and immediately close the lid and store.
☞ order to move the remaining amount of detergent remaining in the pressure tank to the original container, remove the cleaning agent connection hose from the spray gun and connect it to the original container to move it quickly and without loss by air pressure.

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

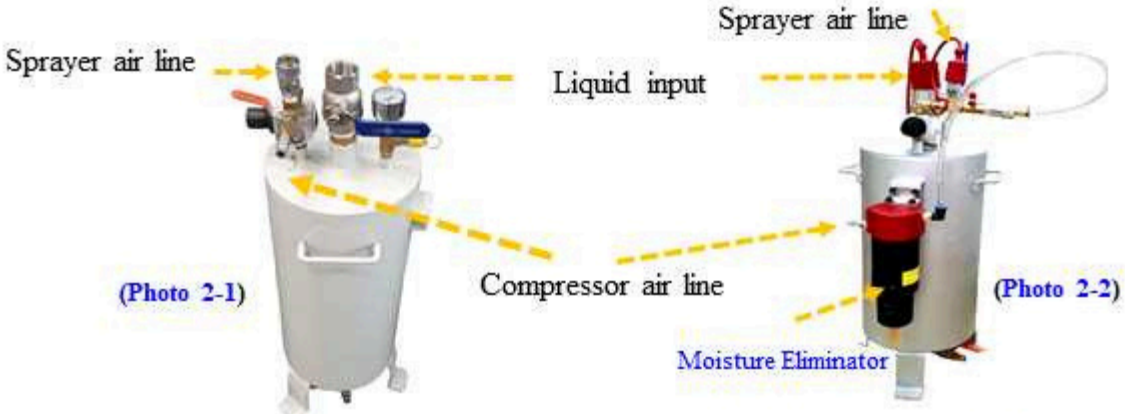
A. Auxiliary tool equipment composition1

1) Current status of dust cleaning related equipment and safety products

2) Compressor and Moisture Filter, Regulator **(Photo-1)**

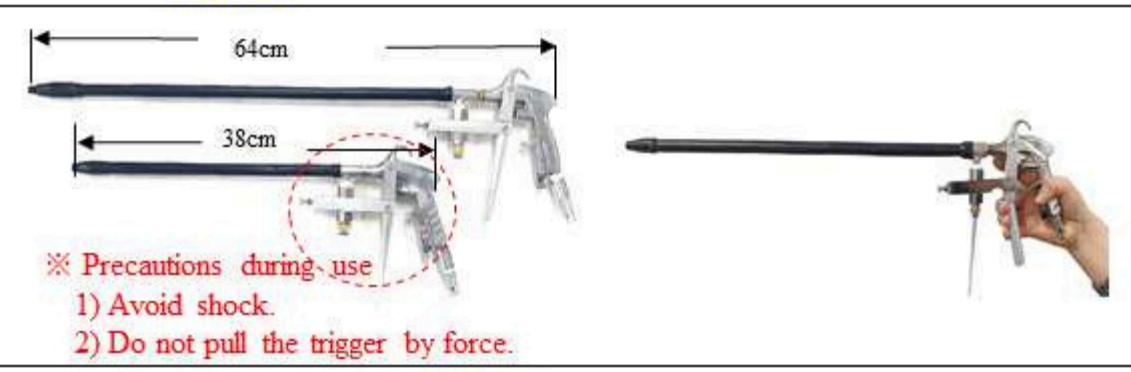
B. Equipment for work

1) Auxiliary tool & Moisture Filter assembly (**photo-2**)

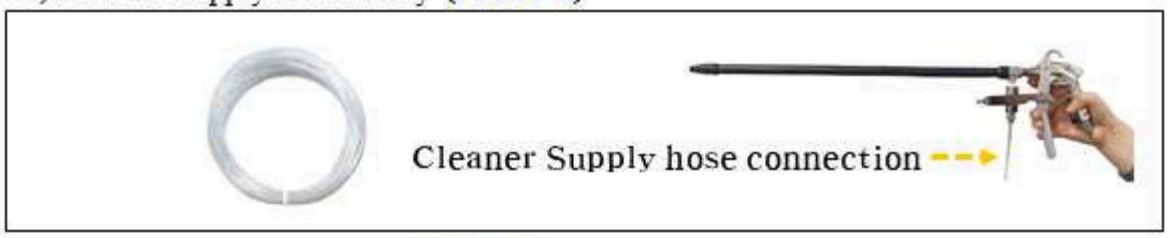


※ If Moisture Eliminator is mounted on the compressor as shown in **Photo-1**, install it as **Photo 2-1**.

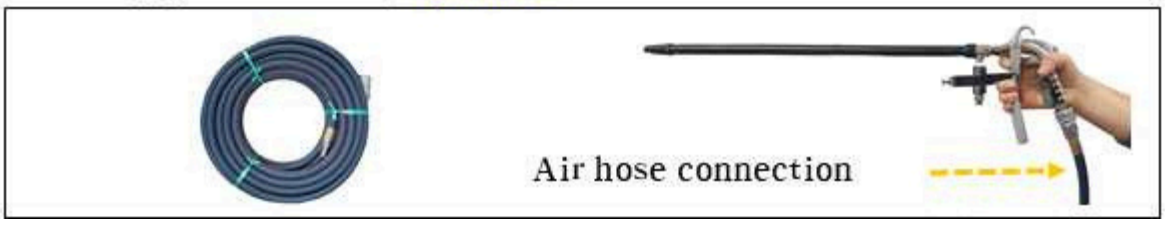
2) Sprayer (**Photo-3**)



3) Cleaner Supply Hose Ass'y (**Photo-4**)

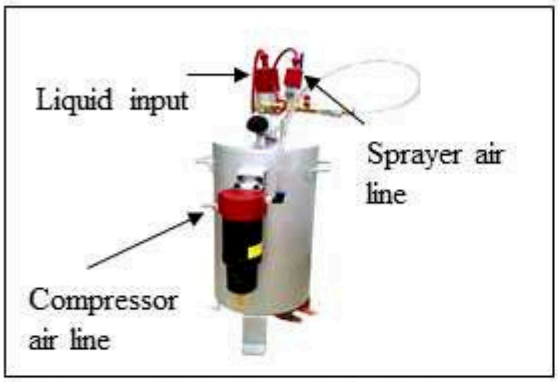


4) Air supply hose assembly (**photo-5**)



C. Assembly Process

1) Auxiliary tool

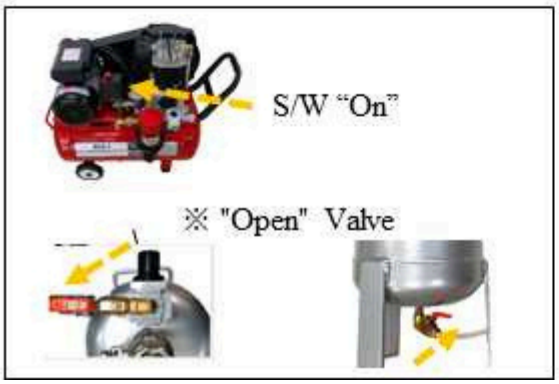


2) Cleaning solution injection

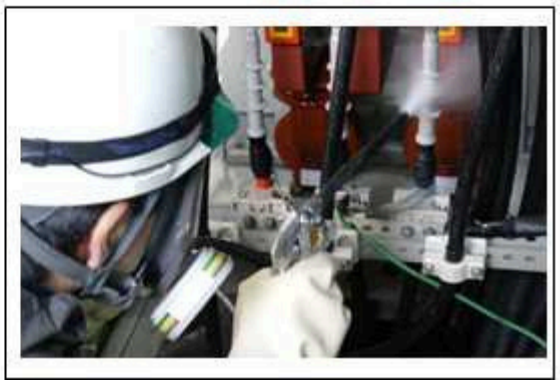
3) Connect Moisture Eliminator filter + Air + Cleaning liquid supply hose to Auxiliary tool

4) Spray gun + cleaning fluid supply hose + air hose connection

5) Compressor Power Connection



6) Cleaning operation



5. Preparation of Work and Checking of Environment

A. Preparation of Work

- The Site Superintendent (Site Manager) shall visibly check the environment of jobsite 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, andenter 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 and to prevent re-contamination of electrical equipment located under the object to be cleaned, an adsorbent cloth is installed on the floor.

6. Caution on Dust cleaning Works

○ The number of workers shall be organized into a group of 5 people, including a supervisor (1 person), a special high-pressure washing worker (1 person), and an auxiliary worker (3 people). ☞ In case of energized work, one team (3 persons) is required for safety. ○ For safety management, there shall be one high-pressure cleaning worker in one work area. ○ 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 foreign substances or items other than tools necessary for work on the floor. (※ Possession of mobile phones, etc. is prohibited) ○ In the workplace, a control sign should be installed at the entrance to prohibit the entry of outsiders. ○ Workers must follow safety rules when working, and must learn about safety accidents and safety-related training of operating equipment and various measures before starting work. ○ Workers must wear standard safety equipment. ○ Work equipment should not be placed close to the work object, and in particular, the compressor should be placed at a distance of at least 2m from the work object. ○ If an abnormality occurs during work, stop the work immediately, report it to the supervisor, and restart it after the cause is found. ○ Work must follow the instructions of the supervisor (site manager), and work other than the permitted work should not be carried out arbitrarily. ○ When a unit (PCB card, other parts, etc.) hernias during work, an identifiable mark or number tag should be attached to the unit to prevent the unit position from being changed during installation. ○ When moving the hernia unit, be careful not to damage it. ○ When it rains, do not dust cleaning the high-voltage equipment outdoors as much as possible. ○ Activities that are not related to cleaning work (eg, smoking, eating, etc.) are prohibited in the workplace. ○ Precautions during dust cleaning are as follows. ☞ Thoroughly remove dust as it may cause malfunction, damage to major parts, short circuit, or flashover. ☞ Remove the dust that has been stuck for a long time with a jig or manually after a regular maintenance period or after power is turned off.

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	C ycle
Power / Power Distribution Transformers	Transformer	Currentand voltagemeasurement	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	**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** 3 Year
		Discoloration, damage	6 months
Rotary machine	Stator and rotor	Vibration analysis	**1Cycle/Year**
		Visual and mechanical check **Clean**	1 time / year
	magnetwire	Electrical test	1 time / year
	Brush, current collector ring, co mmutator	Visual and mechanical check	
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 S yste m)		Visual inspection	Quarter
		Daily maintenance	6 Monthly

☞ 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. (※ In the context, “Clean” refers to dust cleaning.)

8. ESS Cleaning Cycle

A. ESS(Energy Storage System) Operational Management Standards

o On June 12, 2019, the Ministry of Commerce, Industry and Energy announced thatESS 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.

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

o In particular, each business site decided to strictly manage the operating environment such as the prohibition of additional charging after charging the battery andthe 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)

Division	Item / Cycle	Details	
		Before	**After**
Filling rate	Charge		No additional charge after full charge
Operating environment	Temperature	If dust accumulates in battery module and condensation management of the battery is generated and dried compartment will be performed repeatedly, fire may occur due within the manufacturer's to insulation breakdown at the recommended range. ground between the cell and the module enclosure.	the Temperature, humidity and dust
	Humidity		
	Dust		
Management system	Legal inspection c ycle	4 Year	**1 Year**