

Underwriting Survey Report

Property All Risks

May 2025

Gyeonggi Green Energy Co., Ltd.
(Fuel Cell Power Plant)

Table of Contents

Chapter 1 Introduction	1
Chapter 2 Summary	2
Chapter 3 Overview	3
3.1 Site Operations Summary	
3.2 Recent Changes / Plan	
3.3 Loss History	
3.4 Conclusion	
Chapter 4 Values & Loss Estimation	7
4.1 Sum Insured Value	
4.2 Probable Maximum Loss	
4.3 Loss Estimates Summary	
4.4 PML Scenario	
Chapter 5 Site Descriptions	10
5.1 Natural Hazard Exposures	
5.2 Geographic Conditions / Layout	
5.3 Buildings & Constructions	
5.4 Manufacturing Processes & Facilities	
5.5 Storage	
5.6 Utilities	
Chapter 6 Fire Protections	21
6.1 Fire Water Supply	
6.2 Water Based System	
6.3 Fire Detections / Alarms	
6.4 Special Extinguishing System	
6.5 Fire Extinguishers	
6.6 Fire Fighting Organization	
Chapter 7 Management Systems	25
7.1 Overall Organization	
7.2 LTSA (Long Term Service Agreement)	
7.3 Spare Parts	
7.4 Maintenance	
7.5 Safety	
7.6 Site Security	
Chapter 8 Appendices	27

Chapter 1

Introduction

Purpose of Visit	This report covers risk description & assessment about the fuel cell power plant called 'Gyeonggi Green Energy Co., Ltd.' located in Hwaseong-si, Gyeonggi-do, Korea. The report has also been prepared on behalf of the Hyundai Marine & Fire Insurance to give proper underwriting information regarding to insurance coverage and for estimating the Probable Maximum Loss (PML).
Account	Gyeonggi Green Energy Co., Ltd.
Site Address	#77, Barangongdan-ro 3-gil, Hyangnam-eup, Hwaseong-si, Gyeonggi-do, Korea
Class of Risk	Fuel cell power plant
Survey History	Survey Visit Date - 27 May 2025 Last Survey Date - 8 May 2023
Survey Attendees	<u>Risk Management Research Center, Hyundai HiLife Claims Services</u> Ryu, Kwanhee - Senior Risk Engineer
Site Contacts	Gyeonggi Green Energy Co., Ltd. Kwon, Hyuck Jin - Manager
Disclaimers	This report does not indicate that all possible hazards have been identified, or no other hazards exist. Hyundai HiLife Claims Service Co., Ltd. does not make any warranty concerning the contents of this report or disclaims, whatsoever, for any errors or omissions in the information given or the consequences of reliance thereon. Any advice contained herein is solely for the assisting the insured regarding loss control and safety.

Chapter 2 Summary

Gyeonggi Green Energy Co., Ltd.																		
Latitude		37.0803 N																
Longitude		126.9094 E																
<u>Property Values (M KRW)</u>		<u>Other Insurable Values (M KRW)</u>																
Building4,151 -		MB345,732 -																
Structure31,919 -																		
Machinery345,732 -																		
Fixture285 -																		
<hr/>		<u>Loss Estimates (PML, M KRW)</u>																
Property Total382,088 -		Property Damage114,600 -																
* RCV basis insurable amount estimated using cost trend method.		MB10,500 -																
<u>Natural Hazard Exposure</u>		<u>Main Hazard Features</u>																
Earthquake	Moderate	Site condition / Layout	Good															
River Flood	No Hazard	Building Construction	Good															
Flash Flood	No Hazard	Operational Hazard	Average															
Windstorm	Moderate	Operational Control	Average															
Hailstorm	Very Low	Protection	Average															
Subsidence & Collapse	Low	Management	Average															
Lightning	Low																	
<u>Allied Perils</u>		<u>Loss Record (within recent 5 years)</u>																
External F&E	Moderate	<table><tr><th>Date</th><th>Loss type</th><th>Loss (M KRW)</th></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table>		Date	Loss type	Loss (M KRW)												
Date	Loss type	Loss (M KRW)																
Vehicle/Vessel Impact	Moderate																	
Strikes / Riots	Low																	
Subsidence / Landslip	Low																	
Overall Risk Rating		Average																

Chapter 3 Overviews

3.1 Site Operations Summary

Gyeonggi fuel cell power generation corp. as a predecessor of Gyeonggi Green Energy Co., Ltd. was established in November 2011, and changed their name to Gyeonggi Green Energy Co., Ltd. (hereinafter refers as 'GGEY') in July 2012. GGEY is a special purpose company (SPC) established by project financing between Korea Hydro & Nuclear Power (KHNP) (62%), POSCO ENERGY (19%) and Samchully (19%).

The fuel cell power plant was constructed from November 2012 to December 2013 (14 months), and reportedly its total investment is about 330 million USD. They started the commercial operation on 20 December 2013.

They have total 21 molten carbonate fuel cells (MCFCs) facilities at the site and its total power generation capacity is 58.8MW (2.8MW x 21 units). GGEY is the largest fuel cell power plant in Korea. MCFCs are expected for high-efficiency power generation systems having 47% efficiency and it's up to 80% when including heat recovery efficiency. GGEY is also supplying the heating resource for District Heating (DH) service.

GGEY has operated their business stably since their commercial operation. The annual production capacity is total 440,000MWh electricity, 880,000 REC (Renewable Energy Certificate). The electricity generated is sold to Korea Power Exchange, and REC is sold to KHNP, POSCO ENERGY and Samchully. Also, the heat produced is sold to HUCES.

Currently, annual sales volume is reported to be about 60.8 billion KRW in 2024, and 10 regular staffs and 4 in-house subcontractors are working for the site.

3.2 Recent Changes / Current Operation

There have been no changes at the site in view of property but some significant changes for the plant operation along with the change of the LTSA (Long Term Service Agreement) with Korea Fuel Cell Co, Ltd. which was expired on 21 May 2025.

The remaining 3 units of stack modules (not replaced in 2023 from delay in delivery and each MCFC has two stack modules in it) were finally substituted in 2024. Also, new LTSA has issued with FCE (FuelCell Energy based on USA) for 7 years (May 2025 to May 2032), the licenser of MCFCs technology. And, 4 O&M personnel are staying at the site.

Currently, 15 units out of total 21 MCFCs are normally operated at present. As for the not operated 6 units, 3 of them are not certified with the national electrical safety inspection before operating, and another 2 is in trouble with the power generation efficiency down, and the other one is under maintenance.

Operating efficiency is reported to be about 44.2% on our survey. Also, normal operation will be expected from May 2026 after the completion of 11 units of HRU (Heat Recovery Unit) replacement. Also, 1,100 M KRW of investment is planned for the replacement of 11 HRUs reportedly.

3.3 Loss History

There has been no loss claims related to insurance program during the last 5 years.

3.4 Conclusion

The greatest potential loss at the site is unexpected fire or explosion accident during a fuel cell power generation. Fuel cell power generation is known as much as lower risk of fire and explosion than other power plants. Molten carbonate fuel cells (MCFCs) adopted in this plant use carbonate salts as an electrolyte and produce hydrogen from natural gas (NG). While the hydrogen reacts with oxygen in stack module, electricity and heat are generated.

In general, the fuel cell is hard to fire and explode by leakage of hydrogen gas because the exposed hydrogen isn't accumulated and flies off into the air. There are fuel pressure control valves, gas leak detectors, emergency shut-down (ESD) device and fire suppression system (nitrogen purging) in the fuel cell facility.

However, the inherent risk concerning using flammable gas could not be excluded because large volume of NG and hydrogen are used during power generation process. Hydrogen having low LEL of 4% and high UEL of 75% could be easily fired and exploded while it has stayed in the casing of stack module and auxiliary equipment.

Overall fire or explosion risk is considered to be low, but the fire and explosion event might be broken out by following factors.

- Open flames, sparks from welding or grinding
- Electrostatic sparks from poorly earthed
- Electrical sparks from motors, switches or relays

Additionally, there are two buildings in the site. The buildings are more than 100 meters away from each other. So, we consider that the fire spread exposure to main building and main substation is low. Also, the buildings are over 10 meters off from the fuel cell facilities, and they are of non-combustible structure such as reinforced concrete and steel framed structure.

All fuel cell units are operated as a batch type power generation process. The facilities' damage is expected to be not high because each fuel cell facility has various protection tools such as gas leak detectors and ESD system, and physical clearance between fuel cell units are adopted adequately. So, total loss of all fuel cell facilities is not considered to be high.

Fire protection facilities, portable fire extinguishers and hydrants are installed throughout the site. Also, there are automatic fire suppression facilities such as water spray for main step-up transformers and gaseous suppression system (HFC-125) for the main substation.

According to hot-work permit, all hot-work is reported to the safety manager and monitored by supervisor during hot work. After hot-work finished, finished status of work is also reported to the safety manager.

Smoking is approved only at the designated area. CCTV surveillance system and watchman service are operated in this site for 24 hours.

Considering the above all factors & occupational characteristic of the site, we consider that fire & explosion exposures are to be moderate.

Natural Hazards

In terms of natural hazard, the site is considered to be moderate risk zone in windstorm & earthquake. Site ground is 19 meters higher than sea level and there has been no loss record regarding flooding. And lightning protection system is equipped at the top of the fuel cell facility. Unexpected torrential rain and strong wind followed by typhoon can cause some damages to fuel cell and auxiliary facilities. But this site has been no loss record by typhoon and flood during the last five years.

Machinery Breakdown Exposure

There is no high pressure vessel or high speed rotating equipment at the site. But total 21 units of MCFCs are exposed to electrical hazards during operation. And also main transformers & water pumps for district heating service are exposed to MB hazards as well.

However, most utilities including above critical facilities are maintained by preventive and predictive maintenance program with skilled engineers. No loss has been reported since the completion of the site. Therefore, machinery breakdown risk is considered to be not severe.

Business Interruption Exposure

There are some outside factors which can leads to BI event like cut off of fuel (NG) or water supplying. However, it is assumed that the influence about BI is considered as slight because fuel or water supplying could be restored within a week, and the sales of District Heating (DH) business is under 5% of total sales amount.

Along with the renewal of the LTSA to new contractor, stack module is delivered from overseas, mainly from USA. Its lead time is reported to be about 12 months. And, main step-up transformers are expected to be delivered within 6 months from domestic market.

Surrounding & Liability Exposure

Surroundings of the site are roads and third party factories. The nearest building of third party is about 1m away from the site. Therefore, this exposure is considered to be severe.

Based on risk assessments result that comprises a broad categories of exposure to the risk and loss mitigation measures, this site is rated to be an **Average** level in its risk category.

Remark

Above overall rating is mainly concerned with those perils is relevant to property damage (excluding machinery breakdown) and business interruption. In this report, we provide our opinions as to the quality of the risk on a worldwide industry basis. The following definitions apply;

<i>Good</i>	<i>The very best current day practice in the class of industry</i>
<i>Above Average</i>	<i>Embodies some of the best practices in the class of industry</i>
<i>Average</i>	<i>Acceptable standards exhibited</i>
<i>Below Average</i>	<i>Some areas below the standard of current day practice</i>
<i>Fair</i>	<i>Embodies few or none of the standards expected of current day practice</i>

Chapter 4 Values & Loss Estimation

4.1 Sum Insured Value

(Unit : M KRW)

Insured	Section	Asset	Insured Value	Remark
Gyeonggi Green Energy Co., Ltd.	PAR (Property All Risks)	Building	4,151 -	
		Structure	31,919 -	
		Machinery	345,732 -	
		Fixture	285 -	
		PAR Total	382,088 -	
	MB (Machinery Breakdown)		345,732 -	

※ Above values are based upon the insured amount on the existing package insurance policy (2024.06.28 ~ 2025.06.28).

4.2 Probable Maximum Loss

We understand the probable maximum loss, i.e. the maximum loss that might be expected, at a cautious estimate, to occur as a result of a single loss event, taking into consideration all the circumstances of the risk. Individual property damage rate, fire-fighting facilities/fire protection measures or other management features have to be left unconsidered for a PML assessment. This assumption does not include additional indirect losses like debris removal cost, and we do not take inflation factor into PML consideration.

4.3 Loss Estimates Summary

Coverage	Scenario	Loss Estimates (M KRW)	% TSI
Property Damage	Fire & explosion	114,600 -	30%
Machinery Breakdown	Physical explosion and/or electric failure	10,500 -	3% of MB

4.4 PML Scenario

4.4.1 PML for Property Damage

Fire/explosion case would be the most severe loss event in respect of Property Damage except the catastrophic disaster such as earthquake. This assumption does not include additional indirect losses like firefighting expense and debris removal cost. Loss assumption herein is based on insured value, and we do not take inflation factor into PML consideration.

The site is considered to be single large risk, and most of property values are concentrated on the MCFC facilities for power generation. Also, the MCFCs are installed in two blocks of A and B (15 units in the B, and 6 units in the A) at the site, and we assume the top risk area as following (Refer to the 8.1 layout).



Pic. Top Risk on the satellite Image

PML for property damage may be broken out by a fire accident of the MCFC facility in the middle of operation. Fire could be occurred by NG explosion at the reformer due to poor ignition. It could be damaged to neighboring MCFC facilities considering layout and fire spreading.

Separation between MCFC facilities is 5~15m, and most of the facilities are metal structures, so the MCFCs and adjacent BOPs (Balance Of Plant) will be damaged partially. We assume that total 7 MCFC units and related BOPs are damaged by fire event, and it is up to 30% of property value of GGEY.

Consequently, PML loss assumption is estimated to be about 114,600M KRW for property damage (about 30% of the T.S.I.).

4.4.2 PML for Machinery Breakdown

Among the machinery, the most valuable one is considered to be one of MCFC facilities (total 21 MCFC units). And the PML for machinery breakdown is likely to arise at the stack module of a MCFC unit caused by electrical problems. Also, each MCFC unit has two stack modules of 1.4MW each.

Physical explosion and/or electric failure are expected under PML situation, and we assume that full breakdown of the one of stack modules at the unit, and partial damage to the other stack module plus surrounding BOPs could be possible. Also the module is delivered from USA according to the change of LTSA contractor (US based FCE), and its lead time will be over 12 months.

Consequently, PML for machinery breakdown is estimated to be about 10,500M KRW (about 3% of the MB values).

4.4.3 PML for Business Interruption

There are some outside factors which can leads to BI event like cut off of fuel (NG) or water supplying. However, it is assumed that the influence about BI is considered as slight because fuel or water supplying could be restored within a week, and the sales of District Heating (DH) business is under 5% of total sales amount.

Also, LLI (Long Lead Item) is considered to be MCFC facility, and its lead time is expected over 12 months. In case of main step-up transformers, they are delivered within 6 months. Therefore, we assume that the maximum recovery time in the event of the loss of MCFC facilities will be over 12 months.

Chapter 5 Site Description

5.1 Natural Hazard Exposures

5.1.1 Meteorological Data

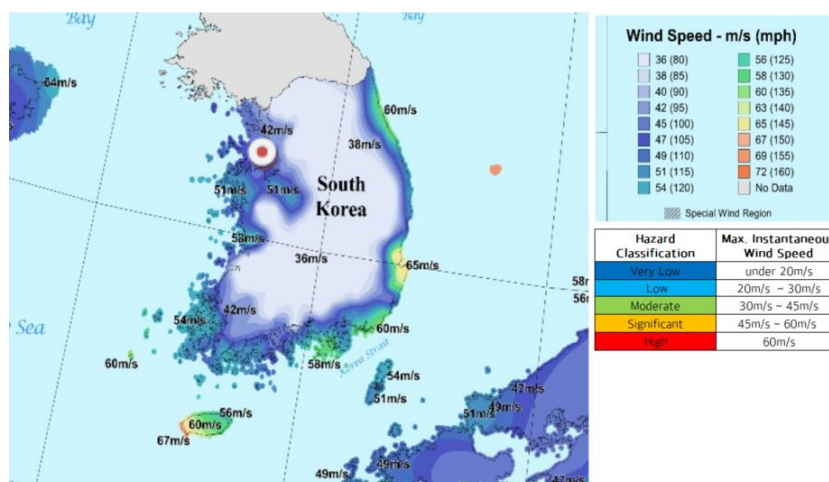
Temperature Max.	39.3 °C	Temperature Min	-18.6 °C
Precipitation (24 hours) Max	333.2 mm	Precipitation (1 hour) Max	92.5 mm
Snow Fall Max.	32.3 cm	Great Gust	30.5 m/s
Annual Precipitation (total)	1,320.3 mm		

Above meteorological data is based on Statistical Data of Korea Meteorological Administration - Focused on Suwon (1995 ~ 2024), the nearest observation post. There can be geological differences between the site and meteorology observation post.

5.1.2 Windstorm / Typhoon

Korea is located in an area prone to tropical cyclones and is subject to typhoons. On average, typhoons hit Korea three times a year, mostly between July and September. Typhoons usually bring torrential rain and strong winds. According to the Korea Meteorological Administration, the peak wind gust at the site since the first observation is 30.5m/s and it is classified as a Moderate (30-45m/s) windstorm risk zone.

During the risk survey, it was not informed whether the wind-resistant design was applied to the buildings & structures or not, but the overall structure of the buildings & structures are rigid with low story. Also there has been no loss related to this hazards for recent five years. Therefore this exposure is considered moderate.



Pic. Basic Wind Speed, a 100-year mean recurrence interval
(Refer to FM Global Data Sheets)

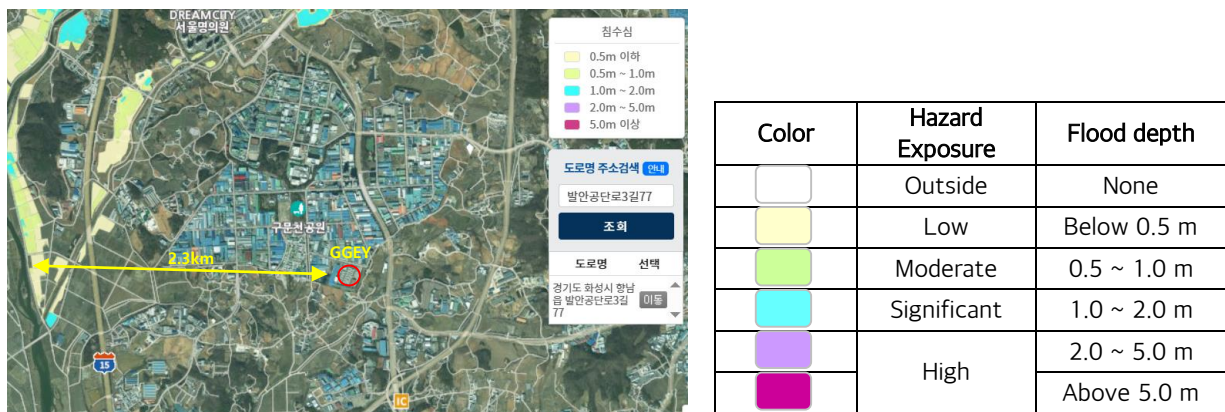
5.1.3 Flood

River Flood

This area is classified as no hazardous zone according to National flood hazard map. The site is located in an industrial area developed on hillock area. Local river runs to west about 2.3km distant from the site but drainage system is properly developed along the site boundary including the fuel cell units, and no flooding loss has been reported for the site since the completion of the site.

Flash Flood

The site is classified as no hazardous flash flood hazard area. No loss has been reported related to this exposure and drainage system condition is considered adequate as a developed industrial area.



Pic. National flood hazard Map

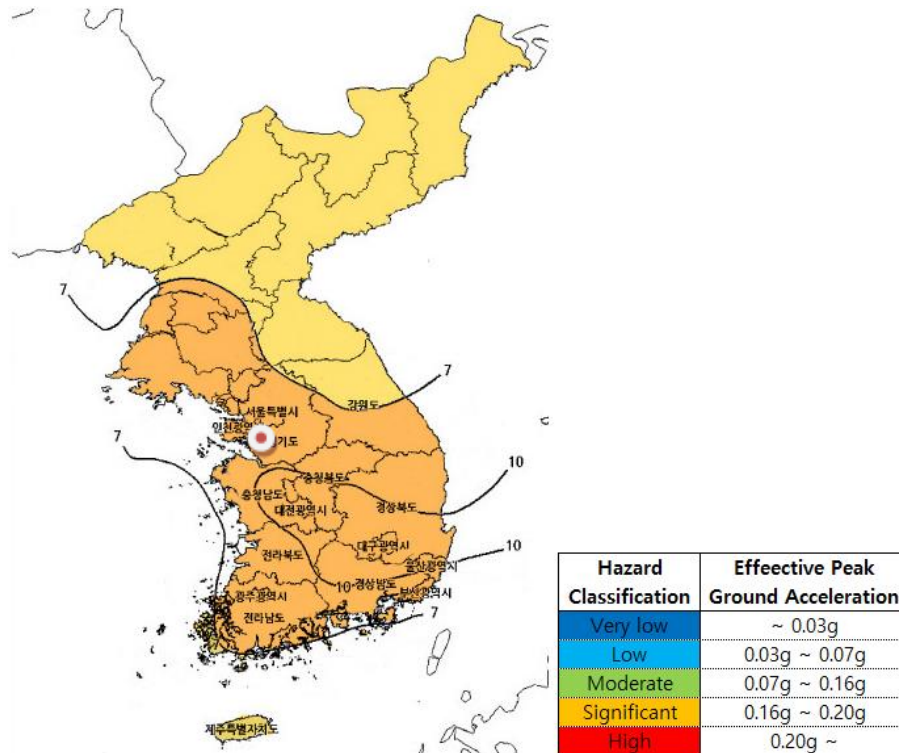
5.1.4 Earthquake

The Korea National Emergency Management Agency (NEMA) issued the seismic hazard map considering the seismic zone factor based on the 500-year return period. According to this map, Effective Peak ground Acceleration (EPA) of this area is 0.07~0.10g for the return period 500 years. And it is classified as Moderate earthquake risk zone.

Annual average number of earthquakes was about 50 times in Korea during the last five years. Most earthquake intensity is smaller than 3 or 4 magnitudes.

During the risk survey, it was not informed whether the earthquake-resistant design was applied to the buildings but the main equipment (MCFC) was designed to withstand earthquake, which is a magnitude 6.5 on the Richter scale. And the site has no loss record related to this hazards for recent five years.

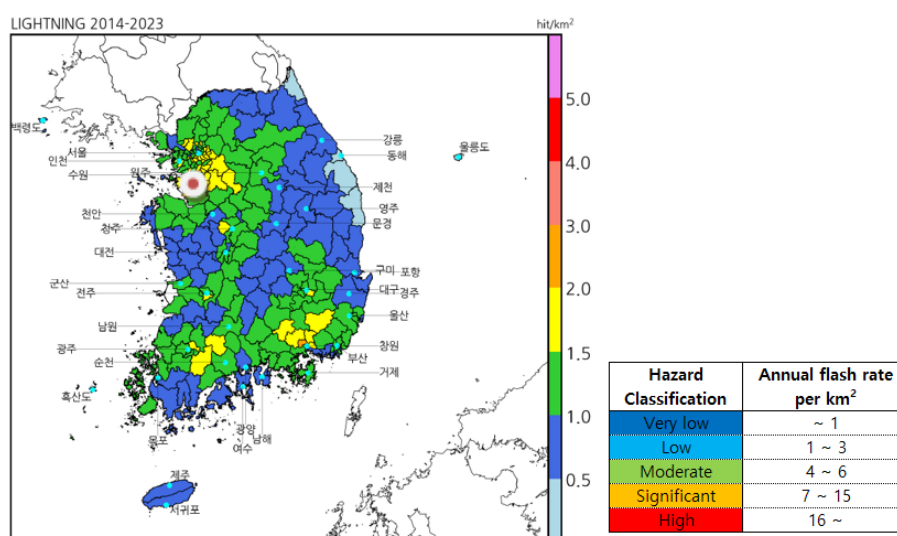
Therefore, we consider this exposure is not severe.



Pic. Seismic hazard map based on 500-year return period (%g)

5.1.5 Lightning

Korea Meteorological Administration examines the annual average of lightning strikes per unit area (grid). And each grid size is based on 5 km x 5 km. According to this data for recent 10 years (2014 to 2023), annual flash rate/km² in this site is reported less than a strike and it is classified as Low lightning risk zone.



Pic. The map of lightning hazard based on the annual average of lightning strikes during 10 years (2014 ~2023)

Lightning protection systems, which are prepared on the top of the fuel cell facilities, cover the whole area. A fuel cell facility has two lightning rods at the top of the equipment. However momentary power failure could be occurred by lightning.

The site area is not reported as high-frequency lightning zone. And no loss is reported related to this exposure for recent five years. Therefore, we consider this exposure is considered to be not severe.

5.1.6 Subsidence and Collapse

The site is located within industrial complex area which is developed on a little sloped farm land area. And the soil condition of the site is considered stable. No symptoms of subsidence and collapse have been observed since the site construction. We consider that site is exposed to low risk level of subsidence and collapse.

5.2 Geographic Conditions / Layout

The site is located within local Industrial Complex in Hwaseong-si, Korea which is approximately 45 kilometers away from Seoul to south, Longitude 126.9094E, Latitude 37.0803N. Rectangular shaped site occupies 20,405. square meters of ground area. Access roads, 20m width of main road to 6m one of branch to the site, are developed around the site area so that accessibility to the site is considered good.



Pic. Satellite image of the site

There is no basement area or underground property in the site, and drainage system is considered to be adequate and well maintained in premise. During the survey, no symptoms of subsidence or collapse were observed. Also, there is no cutting slope or construction area around the site.

Main entrance gate is on the north side of the site and security fences are provided on the site boundary as well. Neighboring occupancies are mostly other factories over the road as an industrial area. And the nearest third party is 1m apart from the site to west so that fire spread potential is expected.

5.3 Buildings & Constructions

GGEY has two buildings of the main building and the main substation (See Appendix A. Layout). The main building is made of steel frame structure with sandwich panel wall and roof. Also, the building is mainly divided into utility room and office, and a block wall is prepared between the office & utility room. In case of the main substation, it is of reinforced concrete structure with block wall & slab roof.



Main building (bldg. No.1)



Main substation (bldg. No. 2)



MCFC facilities



Front view of the site

Fire proofing is supplied to the steel structural component of the building but details of fire rating was not informed. Also, core insulation of the panel wall & roof is reported to be fire retardant EPS materials.

Clearance between the main building and MCFCs area is about 15 meters, so that we consider that the fire spread potential between two areas is low. Details of buildings refer '8.1 Layout', '8.2 Building list' in this report.

5.4 Manufacturing Processes & Facilities

5.4.1 Molten Carbonate Fuel Cells Generation Introduction

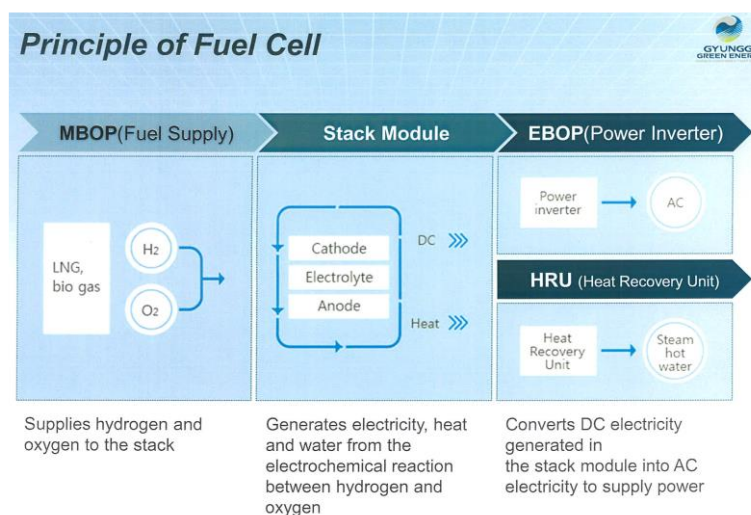
Molten carbonate fuel cells (MCFCs) are one of the types of fuel cells. MCFCs are expected for high-efficiency power generation systems (having 47% efficiency) using hydrocarbon fuels, such as natural gas (NG) and coal gas. This power plant has total 21 MCFCs facilities using NG for fuel and its total power generation capacity is 58.8MW (2.8MW x 21 units). Also, they are supplying heating resource for district heating.

Types of Fuel Cells				
	Low Temperature		High Temperature	
Fuel Cell Type	Polymer Electrolyte Membrane (PEM)	Phosphoric Acid (PAFC)	Molten Carbonate (MCFC)	Solid Oxide (SOFC)
Efficiency	35%	42%	47%	55%
Applications	<ul style="list-style-type: none"> • Backup power • Portable power • Distributed generation • Transportation 	<ul style="list-style-type: none"> • Building Application 	<ul style="list-style-type: none"> • Electric utility • Distributed generation 	<ul style="list-style-type: none"> • Auxiliary power • Distributed generation (R&D Stage)

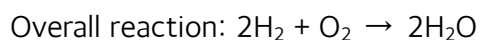
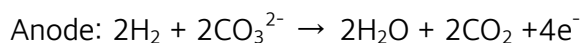
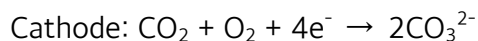
Source : Comparison of Fuel Cell Technologies, DOE

MCFCs use carbonate salts of alkali metals as electrolyte and its operating temperature is high at 650°C. At the cathode, oxygen and carbon dioxide are converted to carbonate ions, which then through the electrolyte to the anode and react with hydrogen to produce carbon and water (steam). In this process, DC electricity is generated by electrode reactions and hot water is produced by heat reactions.

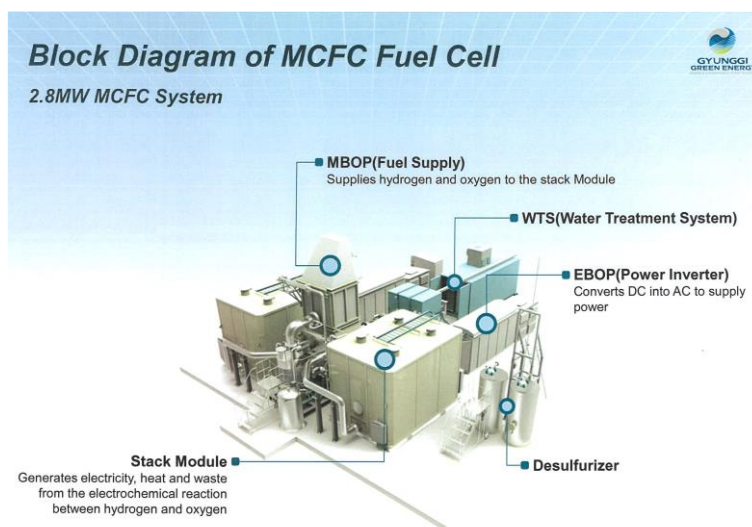
The principle of MCFCs process is as follow.



The electrode reactions for MCFCs are as follows.



The model number of MCFC is 'DFC3000' type designed by domestic company, POSCO ICT, and constructed by POSCO ENERGY. The block diagram of MCFCs is as follow.



5.4.2 Process Flow & Description

There are total 21 MCFCs facilities which generate 2.8MW each in the yard. The MCFC facility consists of two stack modules which have 1.4MW capacity individually. (1.4MW x 2 stack module x 21 MCFCs = 58.8MW)

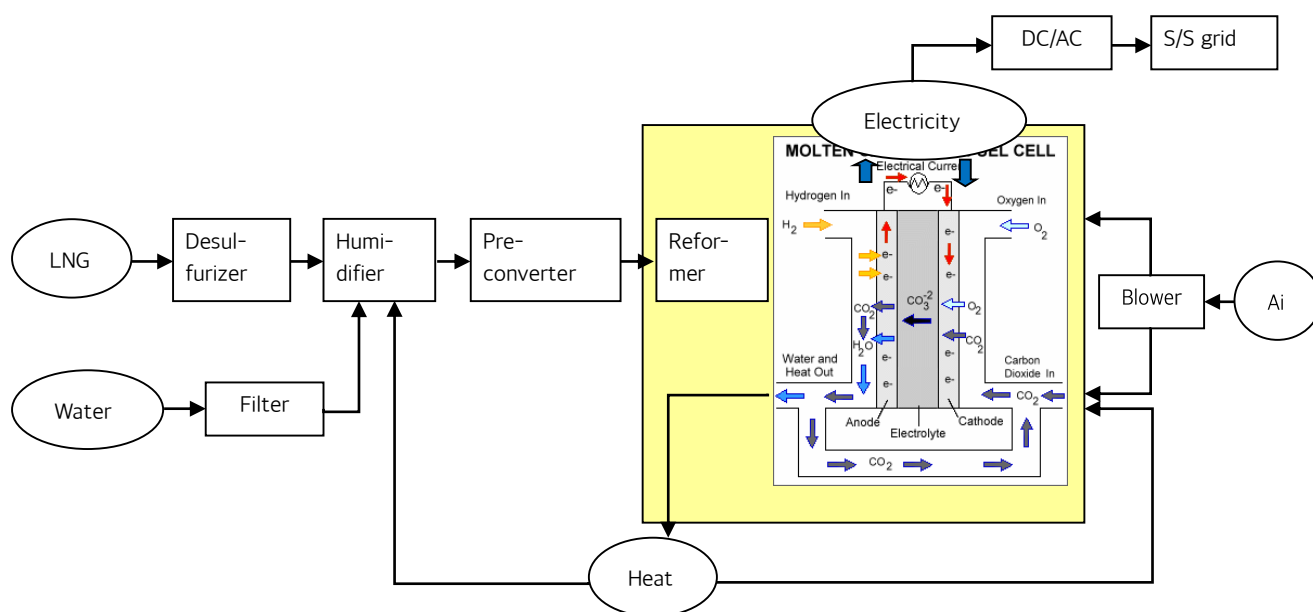
Under the LTSA agreement, GGEY replaced the MCFC facilities on a five-year cycle. 18 MCFCs were replaced with the same specifications as the existing facility in 2019. And the auxiliary facilities were replaced in May 2020. However, the remaining three units have not been replaced, so the operation is currently suspended and future replacements are being discussed.

LNG, the raw material for power generation, is supplied through the pipeline from Samchully, a gas supplier. Hydrogen is created in the stack module through a reforming process which produces hydrogen from the reforming reaction between the hydrocarbon fuel - LNG - and water.

The hydrogen gas is then separated into electrons and cations, and the electrons flow through an external circuit to provide the power to the fuel cell load, and then return to be consumed in the cathode electrochemical reaction.

The electron flow through the external circuit produces the desired power (DC current). An inverter is used to convert the DC output to AC.

The hot steam used for the fuel cell reaction is produced through a heater and a humidifier, and a generated heat of the fuel cell reaction is used for the reaction as a heat source of endothermic reaction.



Pic. Brief process diagram of MCFC

5.4.3 Process Hazards & Safety Measures

Due to the highly corrosive nature of the electrolyte, various countermeasures are required. MCFC facility has a desulfurizer in each unit to protect stack module for lifetime, and pressure safety valves are equipped to the desulfurizer as well. Rupture disk is also installed at top of the humidifier.



PSVs at the top of desulfurizer



Flame detectors

EMO (Emergency Machine Off) switch is provided to each MCFC unit, and lightning rods are also prepared as well. Around LNG supplying pipe, desulfurizer, reformer and stack modules are designated as explosion proof zone, and flame detectors are provided as well.



Lightning rod at the top of MCFC unit



EMO switch

Fuel gas is controlled by remote control valve (MOV) and gas leakage detectors are equipped around the fuel cell facility. When a gas leakage is detected, shutoff valve of fuel supplying pipe is activated and hydrogen gas is immediately discharged into the atmosphere, and nitrogen purge is carried out at the same time.

5.4.4 District Heating Equipment

Heat recovery unit is installed in each fuel cell unit and D.H (District Heating) pumps circulate the heated water in the closed distribution line. For district heating service, there are total 18 D.H pumps at the utility room and are operated alternately.

- D.H return pump: 30kW x 3 x 3sets
- D.H supply pump: 30kW x 3 x 3sets

Heat distribution pipeline consists of supply and return line and is buried underground. Total length of the pipeline is about 800m x 2lines and the average diameter of pipe is about 300Φ. The pipelines are owned by HUCESS, so HUCESS performs inspection and maintenance. Heat is supplied to Hyangnam area of Hwaseong City.

5.5 Storage

There are no flammable materials in use or storage other than LNG at the site. LNG is used for fuel of MCFCs facilities. NG is supplied to each MCFC facility in about 362 standard cubic feet per minute. LNG is supplied through the pipeline from an external gas company.

The area around the LNG supply pipe is designated as an explosion-proof area, and the gas leak alarm system is monitored 24 hours in main building. Also, automatic shutdown valves are installed and they are activated by gas leak detectors.

5.6 Utilities

Utilities are maintained by the dedicated in-house subcontractor (Yeongjin). Total 3 members reside for utility maintenance and repair works. All utilities are checked and maintained by PM (Preventive Maintenance) schedule periodically.

5.6.1 Electric Power

The generated power (DC) from fuel cell is transferred to AC by inverter and stepped up to 13.8kV by fuel cell unit transformer. And, the 13.8kV is stepped up to 154kV by two 50/65MVA main transformers and transmitted to 154kV grid of KEPCO (Korea Electric Power Corporation) by buried underground cables along the road. And, there are two station service transformers to be supported 13.8kV electric power from the on-site.

Main transformers are oil type and installed at the outside of main substation, and stations TRs are mold type ones. The list of substation is as follow;

Place	Equipment	Capacity	Qt'y	Voltage
Yard (Main Substation)	Step-up Transformer	50/65MVA	2	154kV / 13.8kV
Main Substation (No. 2)	Station service Transformer	400kVA	1	13.8kV / 380V / 220V
Electric room (No. 1)	Station service Transformer	1,000kVA	1	13.8kV / 380V / 220V



Main TRs & Switch gear



Sub TR for in-house use

Main substation building is of reinforced concrete structure. There are fire walls between two main transformers. The transformers are in gravel based dike, and protected by water spray system with line type detectors.

All transformers are regularly checked and tested by external experts, named Korea Electricity Safety Corporation (KESCO) about insulation analysis such as insulation-resistance test, insulated oil test, dissolved gas analysis and partial discharge test.

Emergency Power

There is no emergency generator in the site. But there is one 22.9kV power line for an emergency from KEPCO, and uninterruptible power supply (UPS) is installed inside of fuel cell facility. There are no boilers, compressors and chillers on the site.

5.5.4 Water Supply

Water is supplied from the city main via underground pipeline. This is directed to the 200tons water tank in the utility room. The water level is maintained by ball-top valves which are actuated open mechanically when the level goes down to the designated level. For water supply, there are total 12 water pumps (4kW x 4 x 3sets) at the water treatment room. The water pumps are operated alternately.

Chapter 6 Fire Protections

Design and installation of fire protection system is based on Korean Fire Standards. Periodical inspections and maintenances of fire protection systems are done by maintenance team and contractors in charge. General management condition of fire protection system is considered adequate.

6.1 Fire Water Supply

Fire water and fire pump system is divided into yard hydrant & water spray system and indoor hydrant system. Fire water is supplied from city water main to the site, and their fire mains are branch type and not linked each other. Fire water is stored in common water tank which has 200 tons capacity in the utility room.

Fire pumps composed of two electrical motor pumps are operated by a pressure drop of pressure tank automatically. Especially, a diesel engine driven fire pump is equipped for stand-by pump of yard hydrant system on an electric power failure.

Specification of fire pumps and fire tanks are as follow.

Location	Fire Water	Fire Pump Specification	Usage
Utility room (1F)	200 tons (common)	Main: 60HP x 70M x 2,000LPM (Motor) St.by: 82HP x 70M x 2,000LPM (Engine) Jockey: 5HP x 70M x 60LPM (Motor)	Yard Hydrant & Water Spray
Office room (1F)	7.8 tons (exclusive)	Main: 15HP x 50M x 390LPM (Motor) Jockey: 3HP x 50M x 60LPM (Motor)	Indoor Hydrant



Fire pumps

6.2 Water Based System

Hydrants system

Indoor hydrants (4 sets) are installed in main building, and yard hydrants (8 sets) are installed around the site. At the site, PIVs are installed to know the opening and closing of the fire extinguishing water pipe line buried underground. During the survey, there are no obstacles in front of the hydrants and overall maintenance condition is considered to be good.



Yard hydrant



PIV (Post Indicator Valve)

Water spray system

Main step-up transformers are protected by water spray system (40 heads) and fire wall is installed among the transformers. This water spray system is operated by line type fire detectors.



Water spray system for main TR

6.3 Fire Detections / Alarms

Smoke and heat detectors are provided in the buildings and line type detectors are installed around the main transformers. P-1 type fire alarm panel is situated at the DCS room where are continuously manned.

Especially, gas detectors and flame detectors are installed at the fuel cell facilities. When a gas leakage is detected, the shutoff valve of the piping is activated in order to prevent explosion and the hydrogen gas is immediately discharged into the atmosphere, and nitrogen purge is carried out at the same time.



Fire control panel & Gas leak alarm

6.4 Special Extinguishing System

Gaseous Suppression System

Total flooding type gaseous suppression system (HFC-125) is provided with the main substation. The volume of the gas cylinder is 28 bottles x 75kg. It is actuated by fire detection and also, nitrogen injection system is installed for the accident of fuel cell facility. The capacity of the nitrogen gas tank is 30tons.



Gas cylinders



N2 tank storage

6.5 Fire Extinguishers

Also, the portable fire extinguishers (90 units) are provided throughout the site area. Walking distance to every single fire extinguisher is less than 20 meters which are required by the government regulations.

6.6 Fire Fighting Organization

Volunteer fire brigade from employees is organized and firefighting education/drills are held regularly. The nearest public fire brigade is located about 7.5 kilo-meters away from the site.

Chapter 7 Management Systems

7.1 Overall Organization

GGEY consists of 3 teams and 10 employees (Management: 4 staffs, safety & QC: 2 staffs, and technical team: 4 staffs). They have an average of more than 10 years of experience in the same field.

8 members of them are related to monitoring for fuel cell units and operating only auxiliary utilities such as hot water pumps. Fuel cell generation system is remotely monitored and controlled by FCE (FuelCell Energy, Inc.) in the headquarter of US.

There are two contractors; Yeongjin maintenance (Yeongjin), and fuel cell facility maintenance (FCE). Reportedly, four personnel stay at the site on our survey, but it will be decreased to be two in the near future.

7.2 LTSA (Long Term Service Agreement)

There is a long term service agreement for fuel cell facility with FCE. LTSA includes planned maintenance service and remote control & operation service for the main equipment (MCFCs).

GGEY has renewed its long-term service agreement (LSTA) with FCE this year, especially in May. 2025. The term of the LTSA contract is 7 years (2025.5.22 ~ 2032.5.21).

7.3 Spare Parts

Spare parts are maintained based on design demands of manufacturer. GGEY has maintained a satisfactory stock on consumable spares and critical spares for most major equipment. The critical equipment of key machines such as air heaters, EDI units, UPS batteries, WTS HMI batteries, pre-converter, and etc. are supplied under the LTSA schedule.

7.4 Maintenance

Maintenance program has been developed and established. The LTSA with FCE covers maintenance service of fuel cell facility. GGEY conducts preventive and predictive maintenance works based on TBM (Time Based Maintenance) procedures.

The capacity warranty is contracted as 90% of generating capacity. If it could not meet 90% of capacity, the stack module is changed.

The time based maintenance schedule is as follow.

Cycle	Target List	Cycle	Target List
1 M	Total plant condition inspection	24 M	RO membranes replacement
6 M	Activated carbon filter replacement (F1.2) RO pre-filter replacement FAB pre-filter replacement FAB debris filter replacement PCU vent filter replacement Anti-scalent supplement/replacement FAB motor greases replacement	36 M	EDI unit replacement UPS1-1/1-2 battery replacement WTS HMI battery replacement RO membrane replacement (F3.2) EDI unit replacement (E4.1) Pressure relief valve replacement Nitrogen charging De-sulfurizer media replacement (depending on the GC analysis)
12 M	Activated carbon filter medium replacement EDI conductivity sensor replacement Nitrogen charging	60 M	WTS multimedia filter (F1.1) media Pre-converter / deoxidizer Catalyst replacement Skid1 PLC battery Stack module replacement (depending on the operating time) Nitrogen charging
18 M	Air heater inspection & part replacement Transformer vent filter replacement FAB final filter replacement Air heater replacement Smoke detectors replacement UV/IR flame detectors replacement Nitrogen charging De-sulfurizer media replacement (depending on the GC analysis)		

7.5 Safety

When all works such as work in enclosed space, welding work is conducted in boundary of site, work permit sheet should be obligatorily issued by safety team and the sheet must be posted at working area. Duration of work permit is limited by day basis. Safety education is provided before work to contractors.

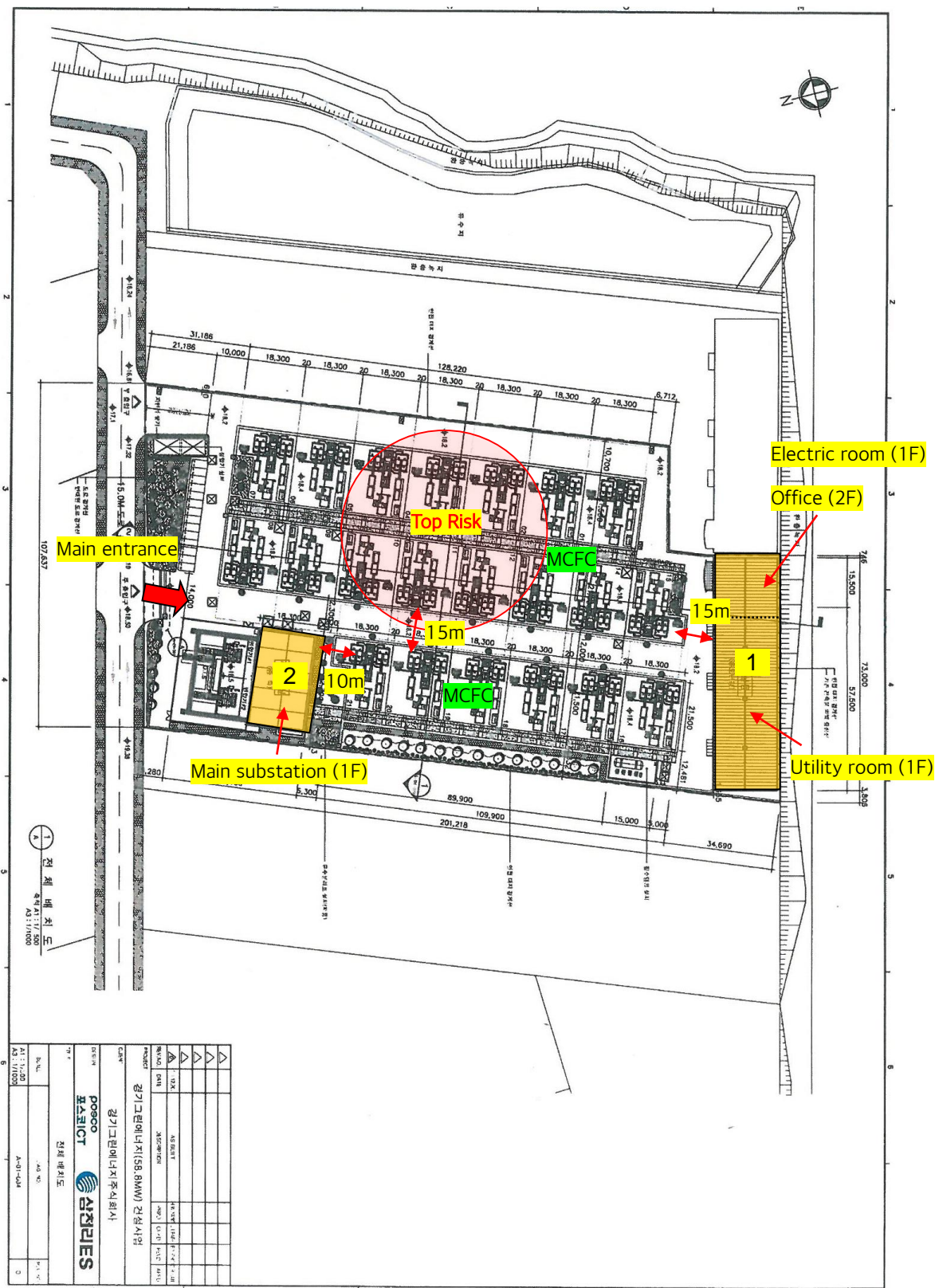
Smoking prohibition is enforced in whole area of the plant including the entire building and outdoor facilities. A formal emergency response plan has been prepared and documented. There is an emergency response team which includes members for fire-fighting, rescuing and supporting.

7.6 Site Security

For security, there is a guardhouse at the entrance manned by security personnel 24 hours a day, and all visitors and vehicles should be confirmed at the entrance. Steel fences are provided around the plant, and regular patrols are provided. And many surveillance cameras are installed throughout the site, and those are monitored. Outside facilities are well arranged and cleared up. Inside of the buildings are also well arranged and clean.

Chapter 8 Appendices

8.1 Layout



8.2 Building list

No	Building	Floor	Total Floor Area (㎡)	Structures (Column / Wall / Roof)
1	Main building	1F/2F	1,821.00	STL / SP / SPOST
2	Main substation	1F	654.19	RC / RC / RC
Total			2,475.19	
* Abbreviation STL : Steel Framed Structure STOST : Sandwich Panel On Steel Truss CSOST : Color Sheet On Steel Truss BL : Block SP : Sandwich Panel CS : Color Sheet RC : Reinforced Concrete Structure				