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Inspection Report

Samsung SDI Co., Ltd.

Cheonan Plant

Location	: #508, Sungsung-dong, Cheonan-si, Chungcheongnam-do, Korea
Date	: July 1~2 , 2021
Inspected by	: Younghoon Joo, Seungkwan Ryu

SAMSUNG FIRE & MARINE INSURANCE

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Summary

Introduction

An inspection was conducted for two days on July 1~2, 2021 to develop underwriting information regarding the Cheonan Plant of Samsung SDI Co., Ltd.

The following staff members of the plant participated in the inspection process:

- Duckjoon Oh General Manager, Safety and Environment Group
- Donghyun Kim Senior Manager, Safety and Environment Group
- Seunghwan Sin Assistant Manager, Safety and Environment Group

General Description

The plant is located in Cheonan, which is approximately 100 km south of Seoul. The coordinates are 36˚50′41″N and 127˚06′53″E.

The brief history of the plant is as follows:

1996.	Completed Cheonan Plant
1998.10	Development of 42” and 50” wide PDP
1999.08	Changed company name to Samsung SDI
2000.07	Completed rechargeable cell factory construction
2001.07	Completed PDP P1 Line construction
2003.06	World’s first development of 260,000 full color AMOLED
2003.11	Completed PDP P2 Line construction
2004.11	Completed of PDP P3 Line construction
2005.11	World’s first development of highest energy density fuel cell
2006.10	World’s first mass production of AMOLED
2009.01	Established Samsung Mobile Display (SMD) (Joint Company with Samsung Electronics) AMOLED production line transferred to SMD
2009.08	The first BCM Certification in manufacturing industry in Korea
2014.06	Discontinued manufacturing of PDP panel
2015	Discontinued manufacturing of Copper-Indium-Gallium-diSelenide (Solar Panel)
2018	Completed M Line (Renamed to M2 Bldg. in 2019) construction for battery manufacturing
2018	Obtained ISO 45001 Certification

Samsung SDI and Samsung Electronics (SEC) within the Cheonan Plant were both established

in 1996. The two Samsung affiliates are located on the same site without boundaries and share the main entrance.

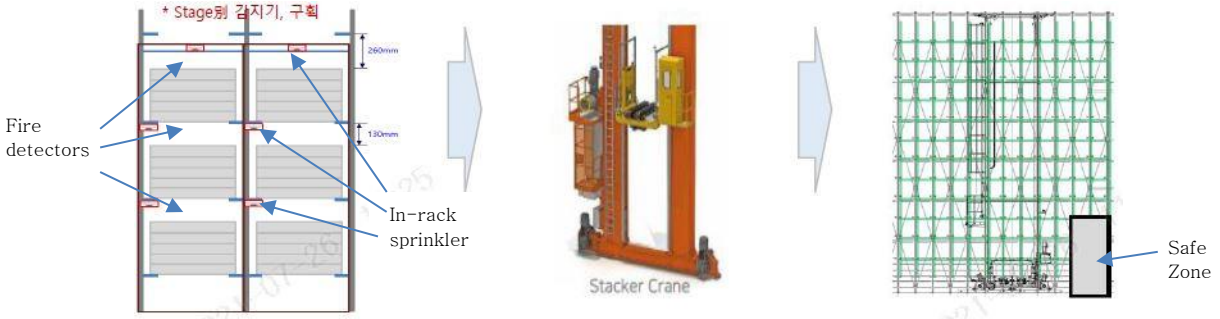
Some business divisions of Samsung SDI merged with Cheil Industries Inc. in July 2014. The two companies are integrated vertically from chemical materials supply chain to the final products. With the merger, the Samsung SDI Energy Solutions Division decided to discontinue the plasma display panel (PDP) production due to changing market needs for plasma TV. All of the equipment in the PDP production lines was dismantled at the end of 2014. Copper-Indium-Gallium-diSelenide (CIGS) solar panel lines were also discontinued in 2015 due to economic reasons. Currently SDI is focusing on manufacturing three types of lithium-ion battery at SDI Cheonan Site: cylindrical LIB, prismatic LIB, and PLI (Polymer pouch Lithium Ion Battery).

Mother Line was constructed in the M2 Bldg. in 2018 to increase manufacturing capacity for Lithium Ion Battery (hereafter LIB) by retrofitting the spaces in the building, previously used for Solar Panel Line and ESS Lab.

Special Risk Improvement for Battery aging process

The plant continuously makes efforts to improve the protection of the battery process. The following improvements for battery process were found in 2021.

- Wireless Fire Detection System and Automated Crane Removal for battery aging racks
The plant developed a special fire protection system for battery aging racks. Wireless smoke detectors are installed above every single tray in all tiers of battery rack storage for aging. In case of any smoke detector goes off, the automated stacker crane moves to that signaling fire detector location and automatically take the battery tray out of the rack. The stacker crane is programmed to automatically move to the battery tray of assumed fire and remove it out of the rack. It is subsequently carried into the safe zone that is a specially designed compartment made of fire resistant materials. CCTVs and infrared cameras are also installed and the operators in the control room are watching and able to control manually the movement of the stacker crane if needed. The investments for this system spent is 26.9 Billion KRW and this will be applied to other plants.



[Wireless fire detectors on every tray] [Automated stacker crane] [Safe Zone for burning battery tray]

Besides in-rack sprinklers of K=160 are installed in every level of tiers in battery aging storage.

Current Risk Status

The Samsung SDI Cheonan plant occupies 221,547 m^2 of land area and 422,382 m^2 of total floor area. There are 30 buildings and most constructions are of 2-hour rated fire resistance.

All PDP production and Copper-Indium-Gallium-diSelenide (CIGS) solar panel production were discontinued at SDI Cheonan, and all PDP production equipment was removed from process areas.

An AMOLED (Active Matrix Organic Light Emitting Diode) production line was installed on the 4th and 5th floors of M2 Building Area 2 in 2006. Ownership of the AMOLED process was separated from Samsung SDI on January 1st, 2009 and was ultimately transferred to SDC (Samsung Display Co, Ltd.). SDC has rented the west side of M2 Building and has been operating AMOLED manufacturing.

Battery production is composed of the following processes: raw material mixing, coating, compression cutting, assembly, and formation. Batteries are supplied to major electronics companies such as Samsung Electronics, for cellular phones, laptop computers, and mobile devices.

There are approximately 3,664 employees currently on duty. Production lines are operated 7 days per week, 3 shifts per day. Security is contracted with S-Tech, a professional security company.

Fire protection system is provided in accordance with Korean Fire Law. City water is supplied as the fire water source and both indoor and outdoor hydrants are provided across the complex. All areas of the site are protected by automatic fire protection, such as sprinkler systems, gaseous extinguising systems, and foam systems. All fire mains in Samsung SDI Cheonan are looped, so if fire pumps in one utility building fail to operate, other pumps can supply fire water to the whole area.

The nearest public fire brigade is Doojeong Public Fire Station, which is located 4 km from the plant. Access to the premises is considered fair. There is a fire truck on the site which is owned by SDC. Based on the contract, SDC will dispatch the fire truck to SDI in case of emergency.

Cheonan is not in the normal typoon paths. There is no body of water near the site and it is surrounded by paved public roads.

The plant obtained ISO 14001 and ISO 45001 cerification in 2015 and 2018, respectively. And the plante received “S Grade” on PSM (Process Safety Management) program in April 2014. Also, Samsung SDI established a Business Continuity Management System (BCMS) from September 2008 to August 2009, and obtained BS 25999 certification from BSI (British Standard Institute) on August 26, 2009. The scope of BCMS is the whole process of the battery business, including R&D, sales and marketing, manufacturing, purchasing, and customer satisfaction (HQ and domestic plants).

Loss History

There was a fire accident for last 5 years. The fire accident took place in August 2019 in a Charging-discharging room on the ground floor of M1 Building. It resulted in a loss about 2.2 billion KRW claimed, but not settled yet.

Cylindrical batteries under development failed during charging-discharging process and extinguished by water-based portable extinguishers in 10 minutes. Four charge/discharge stages were burned and other equipment in the room was damaged by corrosive smoke.

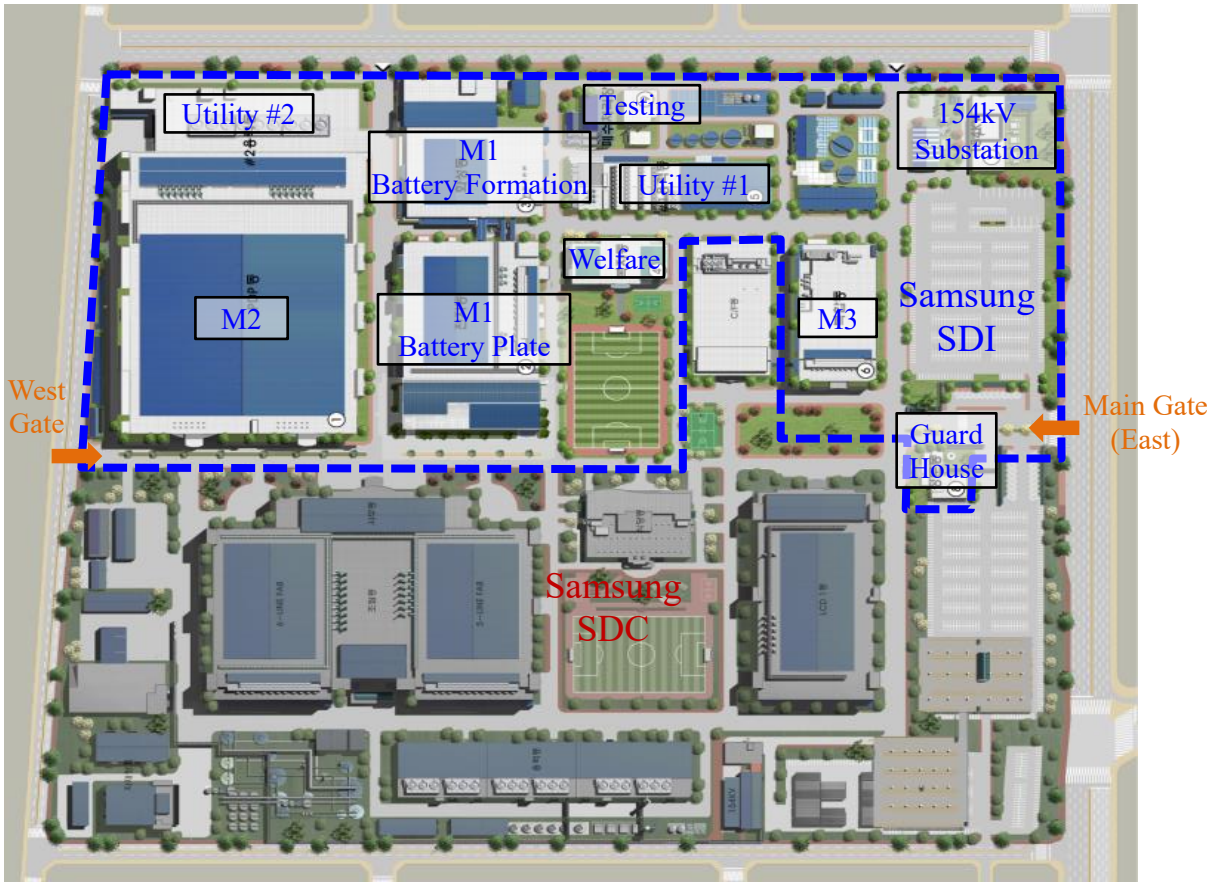
Construction

Site Layout

The plant is located in Cheonan, which is approximately 100 km south of Seoul. The coordinates are 36˚50´41˝N and 127˚06´53˝E.

Two Samsung affiliates are located at a single industrial site in Cheonan: Samsung SDI and Samsung Display (SDC) (refer to layout below). Both companies share an eastbound main entrance and there are no boundaries between the affiliates. The total site area is 501,851 m^2, where Samsung SDI occupies 221,547 m^2 of total land area and 422,382 m^2 of total floor area, respectively.

There are two main entrances, east and westbound to this site, but the east gate is mainly used and the west gate is temporarily open during commuting time. There are six lanes of public roads surrounding all sides of the site.



<Layout of Samsung SDI and SDC Cheonan >

General Construction

There are about 30 buildings in the site. The buildings are mostly seperated by at least 10 m. Most of the building construction is fire resistive, and all metal sandwich panel roofed structures are insulated with 50 to 75 mm-thick glass wool.

The main buildings are described in the following table.

#	Building & Usage	Area (m^2)	Floors	Constructions				
				Floor	Column	Beam	Wall	Roof
1	M2 & Utility #2 [1)]	274,380	B1/6F	Conc.	RC	RC	MT/SP	RC Slab
2	M1 Battery Plate	58,882	B1/5F	Conc.	RC	RC	MT/SP	RC Slab
3	M1 Battery Formation	18,659	3F	Conc.	RC	RC	MT/SP	RC Slab
4	M3	31,448	B1/5F	Conc.	RC	RC	ALP/SP	RC Slab
5	Utility #1	9,427	2F	Conc.	RC	RC	PC Conc.	RC Slab
6	154kV Substation	2,381	2F	Conc.	RC	RC	Conc.	RC Slab
7	Welfare center	11,752	B1/4F	Conc.	RC	RC	PC Conc.	RC Slab
8	Waste Transfer Station	1,550	B1/2F	Conc.	ST	ST	SP	SP
9	Flammable Storage	518	1F	Conc.	ST	ST	BR	SP
10	Guard House	1,644	1F	Conc.	RC	RC	Conc.	RC Slab
11	WWT #2	963	B1/3F	Conc.	ST	ST	MT	MT
12	Safety Test Room	408	1F	Conc.	ST	ST	MT	MT
13	WWT #1	1,517	2F	Conc.	ST	ST	MT	MT
14	GCS	1,186	2F	Conc	RC	RC	BR	SP

1) SDC occupied floor area (136,721 m^2) is included in M2 and Utility #2 Building

◆ **Legend**

RC: Reinforced Concrete *ST: Steel (fire resistive)* *MT: Metal* *PC: Precast Concrete*
SP: Sandwich Panel with glass wool *Conc.: Concrete* *ALP : Aluminum panel with glass wool*
WWT: Waste Water Treatment Facility

The M2 Building is composed of Area 1 and Area 2. Area 1 was completed in 2001 and Area 2 was completed in 2003. Area 1 and 2 are separated by double layer of 1-hour rated fire walls and fire doors. Between these two fire walls, there are staircase and no combustible. The third floor of Area 2 is shared by SDI and SDC, and the internal separation is done by 1-hour rated steel gypsum panel walls. There is a passageway between the M2 Building and the Utility Building #2 and it is equipped with fire detectors and sprinkler protection.

The battery plate manufacturing line of M1 Building is composed of Area 1 and Area 2. Area 1 completed its construction in 1998 and Area 2 was extended in 2003. The second floor of the M1 Battery Plate Building is connected to the M1 Battery Formation Building by an overhead bridge. This passageway is constructed of noncombustible structure and is protected by pre-action type sprinkler systems. There are several openings for transporting products via conveyors between the buildings, and those openings are protected with drencher systems.

The exterior walls of battery production buildings are covered with precast concrete and metal

sandwich panels insulated with 75 mm-thick glass wool. The battery production process is very sensitive to humidity, as the electrolyte salt ($LiPF_6$) decomposes to form hydrofluoric acid (HF) when exposed to moisture. The presence of HF in battery cells causes degradation, so the battery assembly lines are maintained as dry rooms. To maintain low humidity, urethane foam insulated sandwich panels were used for internal walls of the dry rooms in the M1 Battery Plate Building.

<Overhead bridge between M1 Battery Plate and Formation Bldg.>

Occupancy

Production

The Samsung SDI Cheonan Plant produces three types of lithium ion rechargeable batteries; cylindrical and prismatic type of Lithium Ion Battery (LIB) and Polymer Lithium Ion Battery (PLI).

Li-ion batteries use lithium, which is lightweight and has high levels of electric and chemical potential to retain battery voltage (~4V). Other raw materials of LIB module production lines are electrolyte (mixture of various chemicals), 1-Methyl-2-Pyrrolidone (NMP, solvent for cathode), and aluminum (cathode) and copper (anode) sheets.

The manufacturing process of the three types of battery - Cylindrical LIB, prismatic LIB and Polymer Lithium Ion Battery – is very similar.

<Brief Process Flow >

1) Mixing $LiCO_3$, binder, and solvent, etc.
2) Plate (copper for anode and aluminum for cathode)
   A-1. Anode: coating and drying
   A-2. Cathode: coating, drying, pressing, and laminating
   B. Cutting and Slitting
   C. Vacuum Drying
3) Assembly
   A. Stacking and winding plates in series (cathode + separator + anode)
   B. Injecting electrolyte
   C. Insert/Welding cathode and anode with lead wire
   D. X-ray scanning and Sealing
   E. Tubing and Pre-charging
4) Formation(Iterative Process)
   A. Battery Cell Check
   B. Cell Aging at ambient temperature.
   C. Check Internal Resistance / Open Circuit Voltage
   D. Cell Aging at a high temperature (43 ~ 60℃)
   E. Check Internal Resistance / Open Circuit Voltage
   F. Module grading by its capacity
5) Final Inspection

The production areas of the Plate Building are managed as Class 10,000 cleanroom.

■ **Common plate process**

Aluminum foils (for cathode) and copper foil (for anode) rolls are stored in the press roll room. The unwound metal foils are coated with slurry which is mixture of active material powder, graphite, binder and solvents.

Anode uses water as a solvent, and cathode uses a mixture containing NMP as a solvent. After the coating and drying process, pressing, laminating, and vacuum drying processes are followed to remove residual solvent.

The main ingredient of cathode solvent is 1-Methyl-2-Pyrrolidone (NMP). NMP has a flash point of 96℃ and its auto-ignition temperature is 270℃. Hence, all equipment in the coating process is grounded with metal plate and the slurry transport vessels are also grounded to avoid a fire or explosion by electrostatic discharge.

The coated foils with the slurry are cured by passing through the electric dryer operated at 100 to 120℃. Each dryer is equipped with thermostatic controls, temperature alarms and gas detectors. Organic vapor emissions from the curing dryer are extracted to RTOs through steel ductworks.

Then, cured plate foils are pressed by passing between a pair of rolls to achieve proper thickness and cut by slitting machines to narrow and widen widths. The finished foils are vacuum dried in the dry room.

■ Assembly process

Rechargeable lithium battery cells are made in a characteristic "swiss roll", a single long sandwich of positive electrode, negative electrode and separator rolled into a single spool. These rolls are stacked into a case and the electrolyte is injected between rolls.

In case of LIB, electrolyte is produced by dissolving lithium fluoride salts in a various solvent mixture. Dimethyl carbonate (DMC) is a main component of the electrolyte. DMC has a flash point of 18 ℃, and the electrolyte has a flash point of about 26~50 ℃ and auto-ignition temperature of about 90℃, depending on the mixture. Organic gas detectors and solvent leak detectors are provided around electrolyte service tanks.

There are three and one electrolyte supply rooms in the M1 Battery Plate Building and M2 Building, respectively. These rooms are fire compartmented by 1-hour rated walls. Electrolyte is supplied to the assembly room by nitrogen pressure. The supply pipes are made of double stainless steel. These rooms are protected by deluge sprinkler systems interlocked with flame detectors and smoke detectors.

There are three and two assembly rooms (dry rooms) in the M1 Battery Plate Building and M2 Building, respectively. The battery production process is very sensitive to humidity, as the electrolyte salt (LiPF6) decomposes to hydrofluoric acid (HF) when exposed to moisture. The presence of HF in battery cells causes degradation, so the battery assembly lines are maintained as dry rooms.

After the injection process, batteries are welded by laser and pre-charged in the charging station. The charged battery modules are then transferred to battery formation process.

■ Formation process

Li-ion and polymer batteries module require iterative charge/discharge process to prevent operation beyond safe operating range, and to balance cells to eliminate state of charge

mismatch, thereby significantly improving battery efficiency and increasing overall capacity. This process is conducted by repeatedly charging and discharging the batteries at ambient and high temperatures (45~60℃). The internal resistance and open circuit voltage of battery modules are checked in between the iterative steps to check the performance of modules. Battery modules are automatically loaded, charged and removed at rack type charging bays by stacker cranes.

M1 Building

The detailed occupancy of the M1 Battery Plate Building is shown below;

Floor	M1 Battery Plate Building	
	Area 1	Area 2
3F	Vacant	#3 Dry room Cylindrical LIB (4 lines)
2F	#1 Dry room Prismatic LIB (2 line)[1)]	#2 Dry room Cylindrical LIB (1 line)
1F	Common plate process	Common plate process
B1	Machinery/Electrical Room	Machinery/Electrical Room

Note 1) : Under construction for changing to Cylindrical LIB line

M1 Battery Plate Building is mostly protected by pre-action sprinklers, except mixing process where is protected by foam system. In M1 Formation Building, aging rooms are provided with ceiling level pre-action sprinklers plus in-rack sprinklers for aging racks. Charging-discharging rooms of M1 Formation Building are protected by total flooding inergen system and local gaseous suppression system for each charge station. Only Phase 4 charging-discharging room in M1 Formation was recently retrofitted with ceiling level pre-action sprinklers.

M2 Building

SDC has rented the west side, Area 2, of the M2 Building and has been manufacturing AMOLED. As AMOLED production area is covered by a separate insurance policy, details on AMOLED production lines are not included in this report.

The detailed occupancy of the M2 Building is shown below;

Floor	M2 Building	
	Area 2	Area 1
5F	AMOLED Line	Formation / Module Sample Shop[1)] / Mini-Cell[1)]
4F		Office & Lab. / Warehouse / Vacant
3F	SDC Offices	ABS*(1 line) : Dry Room /Formation PLI (6 line), NS line[2)] : Dry Room / Formation
2F	SDC	Common plate process
1F	SDC	
B1	Machinery/Electricity Room	Machinery/Electricity Room

SDC SDI

* ABS : Automotive Battery System

Note 1) : Module Sample Shop for EV(electrical vehicle) and Mini-Cell line for small-sized mobile devices was newly added on the 5th floor of M2. Both occupancies are protected by wet-type sprinklers, VESDA and addressable detectors.
2) NS line for small-sized wireless earset was newly added on the 3rd floor of M2.

The process in the M2 building is identical to the existing process, but enhanced protection level is provided against the risk. All areas of the M2 building are protected by sprinklers: pre-action system for Dry rooms and Charging rooms, wet system for the other areas in M2 building.

The Charging room, which is exposed to the fire risk, is protected by VESDA, total flooding gaseous extinguishing system, and additonal pre-action sprinkler system for back-up. Each charging station in the room is protected by local HFC agent gaseous extinguishing systems activated by cross-zone UV/IR detectors.

Rack storages in the aging rooms are proteced by wet sprinklers on the ceiling level and additionally in-rack sprinklers are provided every 3m vertically.

M3 Building

Samsung SDI uses the 1st, 2nd, 3rd and 4th floor of M3 Building as offices, R&D facilities and laboratories for rechargable battery production.

The forth and fifth levels of M3 Building was sold to SDC in 1999 and was eventually transferred to SDC in 2012. The total floor area of the 4th and 5th levels owned by SDC is 7,417 m^2.

Floor	Complex Building	User	Owner
5F	Vacant, IT room ($66m^2$)[1)]	SDC	SDC
4F	R&D rooms[1)], Offices[1)]	SDI[1)]	SDC
3F	R&D rooms, Offices and Warehouse	SDI	SDI
2F	R&D rooms, Offices and Supporting rooms	SDI	SDI
1F	Offices & Laboratories for battery production	SDI	SDI

Note 1) : According to the information provided by Samsung SDI, 4th floor is used for R&D rooms and offices by Samsung SDI. Only small area of 5th floor is used for IT room by SDC.

Flammable Materials

Electrolytes (mixture of dimethyl carbonate, ethyl chloride, etc.) and 1-Methyl-2-Pyrrolidone, commonly known as NMP, are the main flammables and combustible liquids used at SDI Cheonan. NMP is used as a solvent for cathode, and about 7,000 kg of NMP is used daily.

Electrolyte supply room NMP storage tank Flammables storage

NMP storage tanks are located in separate rooms, and are classified as explosion-proof areas in accordance with the local regulations. These tank rooms are equipped with explosion-proof electrical equipment, flame detectors and fixed foam extinguishing systems.

Drums of electrolyte are placed in electrolyte supply rooms, where electrolyte is supplied to the service tanks in the process area pneumatically. Pneumatic supply is actuated by the low and high level transmitters at the service tanks. Electrolyte supply rooms are also classified as explosion-proof areas in accordance with the local regulations.

Utilities

Electricity

Korea Electric Power Corporation (KEPCO) supplies power at 154 kV for SDI Cheonan Plant. Electricity is received from the Seocheonan substation at 154 kV via dual underground lines. The output voltage is then stepped down to 22.9 kV at 4 oil-filled main transformers, 2 of which were installed in 2011. The main transformers are located outdoors adjacent to the 154 kV Building, with concrete fire walls between the 4 transformers. Normally, 2 transformers are in service and other two are for stand-by.

Contract power is 160,000 kW and peak load reached to about 81,000 kW last year.

The electricity is stepped down once more at 20 local transformer rooms, and there are 5 oil-filled and 39 mold-type local transformers.

<Main transformers>

Emergency Power

The 154 kV Building holds 4 in-house diesel engine generators, each 3,200 MW rated, and the output voltage of these generators is 6,600 kV. The generators can provide emergency power to emergency lights, fire fighting equipments, and utilities in case of power outage. Also, Uninterrupted Power Supplies (UPS), 5,400 kW LIB, could supply power to critical process controls, exhaust systems and emergency shutdown systems for about 20 to 30 minutes in an emergency. The total flooding CO_2 suppression system is provided in the generator room.

Steam

The plant has 17 water-tube boilers located in Utility Buildings to provide process steam in order to supply heating to all plant areas. These boilers have total capacities of 105 ton/hr. The usual load of boilers is about 35~60%.

Compressed Air

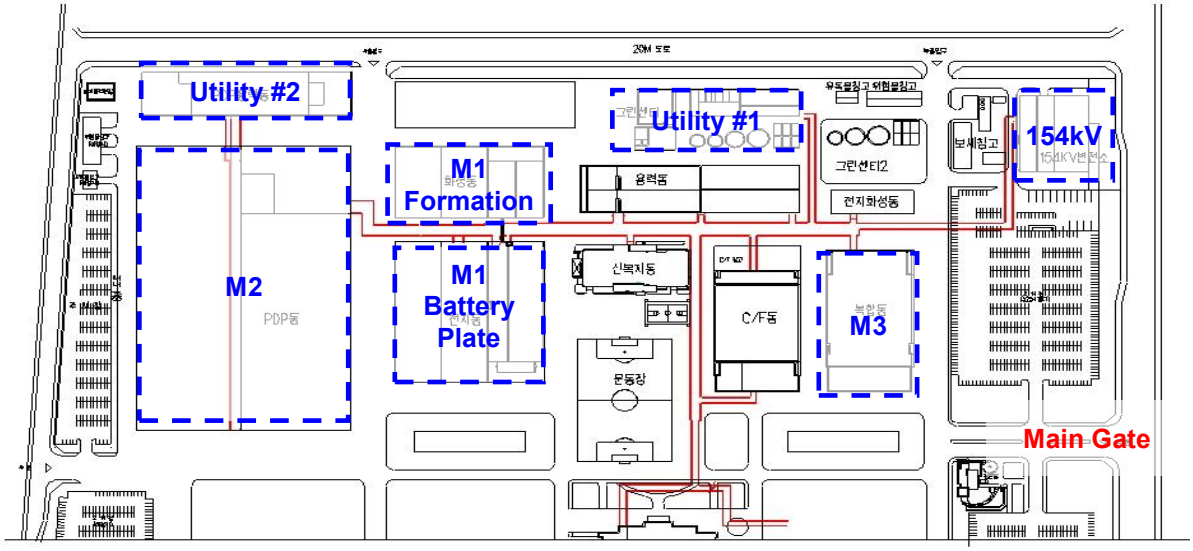
There are a total of 14 air compressors in both Utility Buildings #1 and #2 to supply process air and instrument air throughout the plant. Total capacity of these air compressors is 125,180 Nm^3/hr.

Chillers

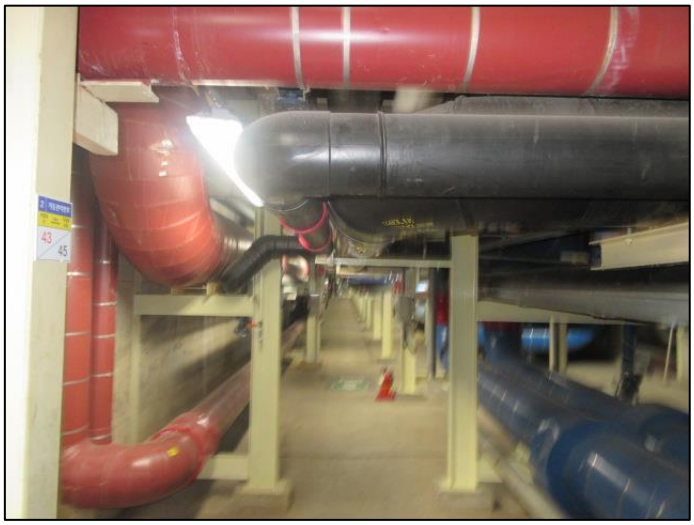
There are 25 adsorption type chillers to provide cooling water for condensers in Utility Buildings #1 and #2. Total capacity of chillers is 28,645 USRT.

Utility Tunnels

There are two separate utility tunnels in the plant. Electricity supply line is seperated from steam and water lines in the ground tunnel. Tunnel 1 runs from the 154 kV Building to the M2 Building, and Tunnel 2 connects Utility Building #1 to the end of the soccer field. Each tunnel is 4 m high and 6 m wide. The total area of the tunnels is 3,144 m^2 and pre-action sprinkler and deluge systems are provided for fire protection. The connections between the two tunnels and buildings have fire walls made of concrete and fire stopping.



<Layout of Ground Tunnels>



<Inside of Ground Tunnels>

Exhaust Air Treatment Facilities

The details of exhaust air treatment facilities are as below ;

Type	Qty	Capacity	Location
RTO	3	1,433 CMM	Rooftop of M1 Bldg.
Scrubber	7	6,300 CMM	Outdoor & Rooftop of M1, M2 Bldg.
Adsorption Tower	3	550 CMM	M1 Bldg., WWT
Scrubber + Adsorption Tower	4	1,900 CMM	Rooftop of M2 Bldg.
Total	17	10,183 CMM	

Protection

Fire Water Supply

There is a 1,500 m^3 raw water pond located beside the Wastewater Treatment Facility and it is divided into two 750 m^3 sections. Also, there are two underground tanks with a capacity of 1,700 m^3 and 1,750 m^3 each, both located in the basement of the Utility Building #2. In addition, there is an elevated water tank that holds 32 m^3 of water on top of the M3 Building.

Fire Pumps

The fire pumps are listed in the table below. The fire pumps are for indoor and outdoor hydrants, foam systems, water spray systems, and sprinklers.

Location	Pumps	Specifications			Quantity
		Power (HP)	Head (m)	Flow (LPM)	
Utility Building #1	Main(Motor)	75	98	1,600	2
	Jockey	10	98	100	2
	Spare(Engine)	130	98	3,000	1
Utility Building #2	Main(Motor)	100	98	2,840	2
	Jockey	15	98	190	2
	Spare(Engine)	130	98	5,681	1

All pumps will start automatically when the pressure switch of pressure tanks sends pressure drop signals directly to the fire pump control panel.

All fire mains in Samsung SDI Cheonan are looped. So if fire pumps in one utility building fail to operate, then other pumps can cover the whole area.

Automatic Fire Protection

Automatic fire protection is provided by sprinklers, gaseous suppression, fixed foam, and water spray systems. All systems are installed in accordance with Korean Fire Law.

Sprinkler Systems

Automatic sprinkler systems cover most of the area within the plant, with the exception of fairly small structures holding hazardous materials such as the LNG governor station, Flammables storage, Toxic storage, and Wastewater Treatment Facility. Sprinklers installed in the M2 Building are wet type and the ones installed within the cleanrooms are FM approved.

Other buildings, including M1 Battery Plate Building and aging rooms of M1 Battery

Fomation Building, are protected by pre-action sprinkler systems because the battery production process is vulnerable to accidental water discharge.

The Dry rooms (assembly lines and coating areas) of M1 Battery Plate Building were previously protected with total flooding gaseous suppression systems (inergen), but SDI is replacing inergen system with pre-action sprinkler systems to ensure reliability of fire protection systems. Currently, all Dry rooms have pre-action sprinklers installed.

#	Location	Protection	Lines
Dry room 1	2nd floor of M1 Battery Plate Bldg.	Pre-action sprinkler	Prismatic LIB (2 line)
Dry room 2		Pre-action sprinkler	Cylindrical LIB (1 lines)
Dry room 3	3rd floor of M1 Battery Plate Bldg.	Pre-action sprinkler	Cylindrical LIB (4 lines)
Dry room 4	3rd floor of M2 Bldg.	Pre-action sprinkler	ABS (1 line) PLI (6 lines)

Gaseous Protection Systems

Charging-discharging rooms in M1 Battery Formation Building is protected with total flooding inergen systems to avoid unexpected water damage. Only Phase 4 charging-discharging room in M1 Formation was recently retrofitted with ceiling level pre-action sprinklers. On the other hand, a pre-action sprinkler system is provided in all the charging-discharging rooms of M2 building. Also, local gaseous fire suppression system is provided in each stage of charging-discharging rooms in both M1 and M2 Formation.

The control rooms are protected by NAFS-III systems.

Automatic total flooding CO_2 systems are provided in the electrical rooms (including 154 kV Building) and WWT #2 rooms. The gaseous suppression systems are activated by cross-zone smoke and heat detectors, or by manual pull stations. When CO_2 systems activated, audible and visual alarms are triggered to warn the employees in the gas flooding area because of the danger of suffocation.

Foam System

Automatically operated foam systems are provided at the NMP storage tank rooms and mixing rooms within the M1 Battery Plate Building, where NMP is handled. The foam concentrate is 6% AFFF(Aqueous Film Forming Foam).

Water Deluge System

Water spray systems are provided for the flammable storage of electrolyte in the M1 Battery Plate Building.

Manual Fire Fighting

Fire Extinguishers and Hydrants

There are 582 indoor and 53 yard hydrants. Hose and nozzles are available in the vicinity of the hydrants. Also, there are 5,199 fire extinguishers throughout the plant. Supply, visibility, and access to these extinguishers is well maintained.

Water Spray System

The ambient temperature and high temperature aging rooms in the M1 Battery Formation Building and M2 Building are protected by manually activated in-rack water spray system in addition to the automatic sprinkler systems on the ceiling, which are activated by VESDA (Very Early Smoke Detection Apparatus) and smoke detectors.

Alarm System

Smoke detectors and heat detectors are adequately spaced throughout the site. The total number of fire detectors is 10,752.

Flame detectors are provided in NMP storage tank rooms, aging rooms, and charging-discharging areas of the M1 Battery Formation Building and M2 Building.

The air sampling-type detectors, VESDA (Very Early Smoke Detection Apparatus), are provided in the charging-discharging rooms and aging rooms of the M1 Battery Formation Building and M2 Building.

In the M2 Building, VESDA has been installed for both common plate process areas and Dry room areas.

<VESDA system in M Line>

Combustible gas analyzers are provided in the electrolyte supply rooms, and gas concentration levels are monitored at local control rooms.

Fire alarm signals from smoke and heat detection, manual stations, pump running, and reservoir water levels are transmitted to the Fire Command Center, located beside the Guard House.

Staff members in the Fire Command Center monitor the site 24/7. The Fire Command Center has a computerized graphic panel which provides an audible and visual indication of fire alarms as well as printed records. Emergency backup power is available for all alarm systems.

Fire Truck

There is a fire truck in the site which is owned by SDC. Based on the contract, SDC will dispatch the fire truck to SDI in case of emergency.

Loss Control Practices

Organization

The Safety and Environment group is responsible for general safety and environmental management. There are a total of 41 staff members in the team, which consists of 6 people for environment, 14 people for health, 3 people for global support and safety management and 18 people for fire prevention and protection.

The staff members are assigned to provide fire safety education and firefighting drills regularly for all employees. Accordingly, the emergency response network is well-organized.

Security

The Cheonan plant contracted with “S-Tech”, a security company providing 42 fully trained guards on site. Security regulations are strictly maintained 24 hours a day, 365 days a year. Hence, the guards participate in monthly training sessions and are fully equipped and trained for emergency response. An adequate number of CCTV cameras are equipped with night-lights, monitoring all site areas with video recording capabilities.

Access to the plant is permitted under the strict check-in clearance at the Guard House. All visitors’ information is systematically input and visitor passes are issued accordingly. All baggage is scanned and inspected thoroughly when both entering and exiting the complex.

Fire protection shutoff valves and fire pumps are inspected daily and tested quarterly. All fire detectors are tested yearly for possible malfunctions. Fire extinguishers are inspected by each department on a monthly basis. Thus, all records are written and kept on files.

There is a comprehensive ‘permit to work’ system to control maintenance activities on site. Work permission is issued for hazardous work such as a hot work. Handling and controlling of hot work is strictly managed by the Environment & Safety Team personnel.

The public fire brigade, Dujeong Fire Station, is located 4 km from the plant. The response time is approximately 5 minutes. Traffic in this area is considered normal.

Smoking is not allowed within the site.

Exposures

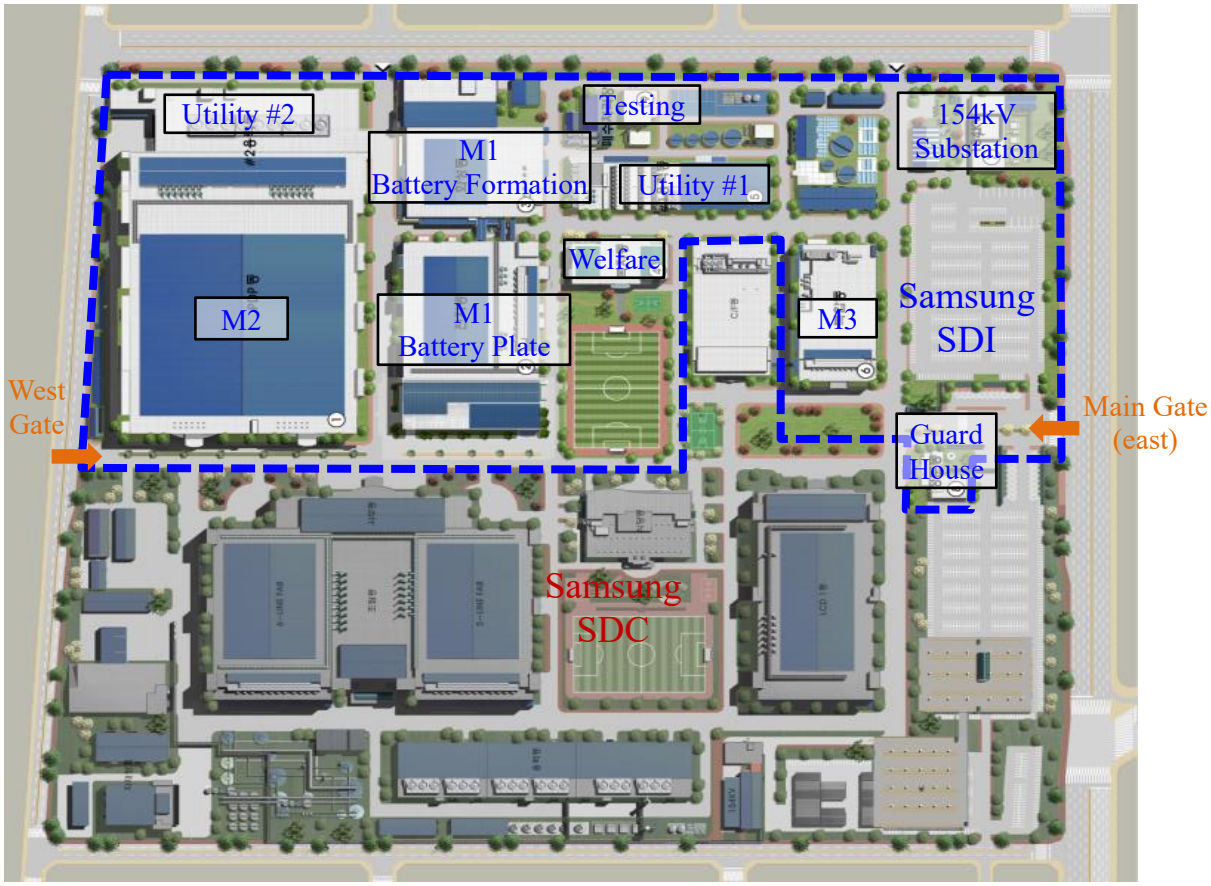
Fire and Explosion

In the adjacent site, Samsung Electronics operates PKG & Assembly line, Line 5. The distance between Line 5 and the M2 Building is more than 35 m.

The AMOLED production line is located in the M2 Building. This line is separated from areas occupied by SDI, by floors and more than 1 hour-rated construction.

The site is separated from the nearby businesses by 20 m wide roads on all four sides.

Thus, SDI has fire exposure from AMOLED production line located in 4th and 5th levels of M2 Building. Fire exposures from the surrounding sites are considered low due to adequate separation.

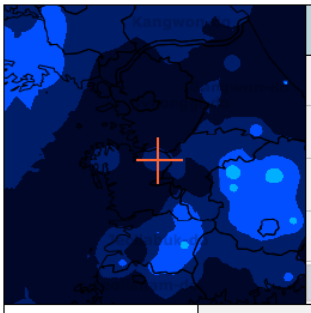


< Layout of industrial site >

Natural Hazards

Rainfall/flood

Tropical typhoons, which generally occur from June to September, have been the main natural perils in Korea. The typhoons may bring strong winds and heavy rainfall. The following map shows the maximum daily rainfall of the Korean peninsula for the last 50 years (1971-2020). The observed maximum daily rainfall on the site is 281 mm/day.



Rainfall	
Maximum Daily Rainfall : 281mm/day	
GRM	Zone 4
Swissre	--
Munich Re	--

Flood depth : 0.3~1.0m (Landslide, Slope failure caused by flood)

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
GRM	~150	150~200	200~250	250~300	300~

When site elevation is compared with the nearest river or reservoir elevation, the difference is 26 m, which means the site location is higher than the river elevation. The table below illustrates the elevation and flow accumulation of both the closest and the largest bodies of waters within 10km of the site.

Flood			Reference River		
Zone 1(Elev. 57.0)			River	Flow Acc.	River length
	CASE 1	CASE 2	Hwang He River	110,000,000	5,463km
ELev.(Diff)	31.0(+26.0)	12.0(+45.0)	Mekong River	74,000,000	4,180km
Distance	3.3km	8.3km	Han River	4,800,000	514km
Flow Acc.	3,617	40,471	Sumjin River	700,000	39km

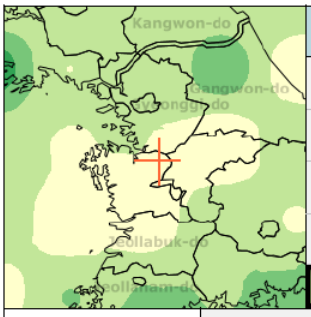
* CASE 1 : Most closed waters
CASE 2 : Most largest waters within 10km

* Elev. : Elevation / Acc. : Accumulation / Diff. : Difference

Considering both rainfall and elevation, the estimated flood risk is considered low.

Windspeed

The Korean Peninsula is affected by 2-3 typhoons annually. The figure below illustrates the observed maximum instantaneous wind speed map for the Korean peninsula for the last 50 years (1971-2020). The observed maximum instantaneous wind speed on the site is 26 m/s, classified as Grade 1.

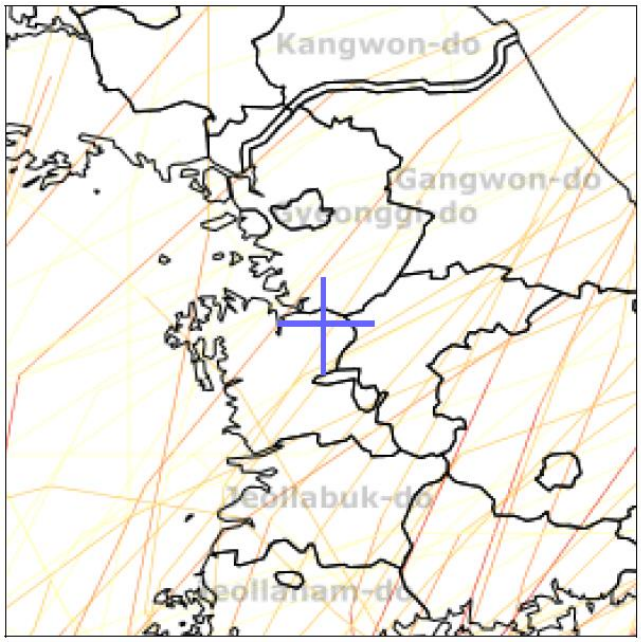


Wind Speed	
Maximum wind speed : 26m/s	
GRM	Zone 1
Swissre	Level 1
Munich Re	Zone 0

Minor or no damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over

	0	1	2	3	4	5	6
GRM(Zone)	--	~27	27~35	35~41	41~48	48~	--
Swiss Re(Level)	--	20~30	30~40	40~50	50~60	60~70	70~85
Munich Re(zone)	21~39	39~51	51~59	59~70	70~83	83~	--

The map below shows the routes and intensity of typhoons across the region for the last 50 years (1971-2020).



Storm	
	~ 27m/s
	27 ~ 35m/s
	35 ~ 41m/s
	41 ~ 48m/s
	48m/s ~

Volcano

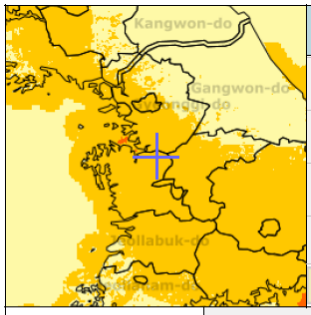
The occurrence of a volcano in the Korean peninsula is infrequent and of low intensity. The map below illustrates the recorded volcano in Korean Peninsula (Korea Meteorological Administration, USGS/U.S Geological Survey). There are very few volcanoes in Korea, and as a result, there is no exposure to this site.

Volcano	Indirect damage (Ash, GAS, Acid rain, etc.)
Distance : 341km	
Zone	Zone 1
Last Known Eruption	B.C. (Holocene)

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
GRM	40~	20~40	10~20	5~10	~5

Earthquake

The occurrence of an earthquake in the Korean peninsula is infrequent and of low intensity. A major earthquake has not been recorded around Korea since 1973 (Korea Meteorological Administration, USGS/U.S Geological Survey). According to the U.S Geological Survey, the peak ground acceleration is 1.4 m/s^2 (with a 10% chance of exceedance in 50 years).



Earthquake	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
Peak Ground Acceleration : 1.4㎡/s²	
GRM	Zone 2
Swissre	Moderate
Munich Re	Zone 2

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
MMI	V	VI	VII	VIII	IX
PGA	0.0~0.9	0.9~1.67	1.67~3.04	3.04~5.64	5.64~

Summary

South Korea lies in the temperate zone and experiences four seasons. Geographically, it is located in the middle latitudes of the Northern Hemisphere, on the east coast of the Eurasian Continent and adjacent to the Pacific Ocean. It shows complex climate characteristics which reveal both continental and oceanic features. South Korea has distinct monsoon winds, a rainy period locally called "Jangma", typhoons, and often heavy snowfalls in winter.

Based on the Samsung Fire & Marine Insurance Global Hazard Map (GHM) and the result of risk survey performed, the natural hazard risk grading is as follows:

Section	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Rainfall				√	
Flood	√				
Windspeed	√				
Volcano	√				
Earthquake		√			

* GHM Risk Grade Grade 1: very low, Grade 2: low, Grade 3: medium, Grade 4: high, Grade 5: very high

Loss History

There was a fire accident for last 5 years. The fire accident took place in August 2019 in a Charging-discharging room on the ground floor of M1 Building. It resulted in a loss about 2.2 billion KRW claimed, but not settled yet.

Cylindrical batteries failed during charge/discharge process and extinguished by water-based portable extinguishers in 10 minutes. The failed batteries were manufactured in the pilot line for test purpose, not for sale. The batteries under development were overcharged during charging and caused thermal runaway.

As a result of this accident, four charge/discharge stages and electric cables were burned and other equipment in the room was damaged by corrosive smoke. The smoke did not spread outside the room and the loss was limited within the room.

Reportedly, SDI has introduced new development line dedicated for test purpose and enhanced charge/discharge condition after the accident.

Attachment

MFL Evaluation

Maximum Foreseeable Loss (MFL) is the largest loss to result from an insured event, as calculated from an understanding of the overall hazard and associated business impact. This event assumes that active protection systems or safety devices are impaired, with the exception of specifically approved and tested MFL fire wall and door. The event can be related to fire, explosion, equipment failure, or other scenarios, with the exception of natural hazards.

1. Top Risk

The M1 Building is selected as the Top Risk, considering PD and BI.

2. MFL Calculation

1) PD MFL

According to the GLCC's MFL guideline, MFL values of the top risk and the total insurable values are as a following table.

(Unit: thousand KRW)

Assets	TIV in 2021 (Based on RCV)	MFL Value for M1 Bldg.	MFL Value for M2 Bldg.
Building	1,226,496,356	70,340,220	152,796,209
Structures	134,788,810	2,473,818	4,216,821
Machinery	1,370,796,931	542,563,040	606,208,146
Instrument	12,988,205	4,383,308	1,878,359
Mold	46,338,407	1,933,856	1,518,256
Vehicles	13,554,012	2,545,805	10,866,425
Tools & Fixtures	61,704,260	9,323,250	10,512,111
Inventory	150,161,864	49,222,004	100,939,860
Total	**3,016,828,845**	**682,785,300**	**888,936,189**

PD Top Risk : M2 Building

PD MFL is estimated to be **888,936,189 thousand KRW (29.5 % of TIV, based on RCV).**

2) BI MFL

BI Top Risk : M1 Building

Annual Gross Profit is 1,025,150,844 thousand KRW. The sales amount of M1 Building product is accounted for about 67% of total sales and recovery period will be 9 months. So, annual gross profit of the top risk, the estimated BI MFL is as follows.

BI MFL loss is estimated to **515,138,299 thousand KRW. (50.3 % of Gross Profit)**

3) Combined MFL

- M1 Building

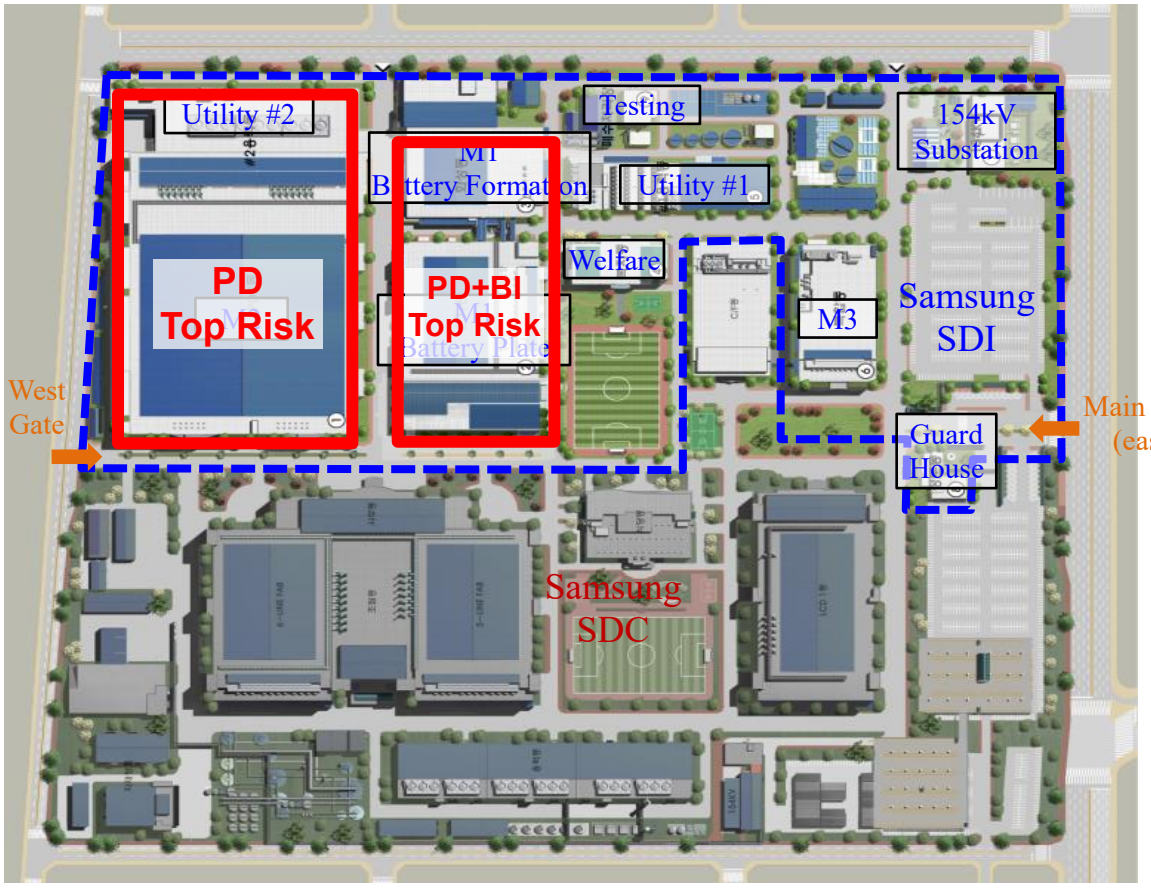
Combined MFL(Amount) = MFL_{PD} + MFL_{BI} = **1,197,923,599 thousand KRW**

Combined MFL(%) = (MFL_{PD} + MFL_{BI}) / ($TIV_{combined}$) = **29.6 %**

- M2 Building

Combined MFL(Amount) = MFL_{PD} + MFL_{BI} = **1,142,661,022 thousand KRW**

Combined MFL(%) = (MFL_{PD} + MFL_{BI}) / ($TIV_{combined}$) = **28.3 %**


Utility #2
PD
Top Risk
M1
Battery Formation
PD+BI
Top Risk
Testing
Utility #1
Welfare
154kV
Substation
M3
Samsung
SDI
West
Gate
Main Gate
(east)
Guard
House
Samsung
SDC

< Layout >