Summary of the "Report on the Review Meeting for Fire Prevention Measures and Approach to Firefighting Operations after the Warehouse Fire in Miyoshi Town, Saitama Prefecture" (Part One)

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Introduction

A warehouse fire incident which occurred in Miyoshi Town, Saitama Prefecture, on February 16 (Thu.), 2017 took an extended period of about 12 days until full containment, due to the fire spreading inside the large-scale warehouse. After this serious incident, the FDMA in a joint effort with MLIT organized a "Review Meeting for Fire Prevention Measures and Approach to Firefighting Operations after the Warehouse Fire in Miyoshi Town, Saitama Prefecture" consisting of respected individuals, to discuss the fire prevention measures and the approach to firefighting operations to be taken from now on, and examined measures that would prevent the spread of fire as well as efficient firefighting activities so as to prevent a similar disaster in a large-scale warehouse in the future.

In this paper, I intend to summarize the "Report on the Review Meeting for Fire Prevention Measures and Approach to Firefighting Operations after the Warehouse Fire in Miyoshi Town, Saitama Prefecture" created on June 2017.

It should be noted that the opinion portion of this paper reflects my own personal view.

Summary of the "Report on the Review Meeting for Fire Prevention Measures and Approach to Firefighting Operations after the Warehouse Fire in Miyoshi Town, Saitama Prefecture"

Outline of the warehouse fire in Miyoshi Town, Saitama Prefecture		
Date and time	Outbreak	February 16 (Thu.), 2017 (time is under investigation)
	Recognition	February 16 (Thu.), 2017 at 09:14
	Fire suppression	February 22 (Wed.), 2017 at 09:30
	Full containment	February 28 (Tue.), 2017 at 17:00
Use		Number 1 (Article 14) of the Attachment to the Order for Enforcement of the Fire Services Act (Warehouse)
Structure		Reinforced concrete structure, partially steel construction
Number of stories		Three stories above ground
Building area		26,977.99 m^2
Gross floor area		71,891.59 m^2
Origin of fire		Scrap material room at the northwest corner of the 1st floor of the warehouse
Cause of fire		Under investigation
Burnt floor area		About 45,000 m^2 (under investigation)
Number of injuries		2 (1 severely injured, 1 mildly injured)

Warehouse external view

Chapter 1 Details of the Fire

1. Outline of the building in question

This building is one of the large-scale distribution warehouses that are recently increasing in number, and has a width of about 240 m and a depth of about 109 m, with a gross floor area of about 72,000 m^2. The internal space of the building is mainly used for the storing and sorting of products with little wall volume, and the height to the ceiling is also high, which as a whole creates a large space structure. The circumference of the building has a structure with a


Conditions inside the scrap material room

small number of exits to the outside other than the loading docks which are used for the loading and unloading of products.

In the building, many conveyors have been installed to convey the products. To connect vertically, there are conveyors which link the 1st and 2nd floor, and the 2nd and 3rd floor. For horizontal transfer, there are also conveyors specific for each floor. There are many employees working in the building for receiving, sorting and shipping the products, and at the time of the fire, there were 421 employees inside the building.

2. Outline of the fire and the initial response at the business site

The origin of the fire was the scrap material room at the northwest corner of the 1st floor of the warehouse. The scrap material room is the place where the used cardboard is collected from many places around the warehouse and accumulated on conveyors. At the upper opening of the room (2nd floor), the end part of the conveyor is installed, allowing the collected cardboard to be thrown down to the 1st floor through the opening and accumulated.

At about 09:00 on February 16 (Thu.) on the day of fire, an employee of a partner company working in the scrap material room discovered flames at the southeast corner of the room. At about 09:07, the regional alarm of the automatic fire alarm system sounded. Although the person who discovered the fire and other employees tried to extinguish the fire using fire extinguishers, the fire was not contained because the burning was too strong.

At 09:14, an employee who was involved in the initial fire extinguishing attempt called the 119 emergency number using a mobile phone.

After the automatic fire alarm system sounded, an employee went to the Disaster Prevention Center and confirmed the location of the automatic fire alarm system detector which had been activated on the disaster display board and saw smoke through the camera monitor, but failed to call the 119 emergency number. Because the burning was so strong, two employees extended the hoses from nearby external fire hydrants (2 units) individually and opened the valves, but did not push the button to start the pump, failing to attain the required pressure and volume of water.

At 09:21, the public firefighters arrived and took over the firefighting. Although at this stage, the scrap material room was full of flames, the force of the fire was quickly suppressed, and the fire did not spread to other areas of the 1st floor.

On the other hand, an employee working on the 2nd floor sensed a burning odor at about 09:08, and soon discovered flames coming from the opening above the scrap material room (2nd floor). It is estimated that the used cardboard on the 1st floor burnt rapidly and the strong flames rushed to the 2nd floor through the opening above the scrap material room.

The flames moving to the 2nd floor from the scrap material room on the 1st floor is considered to have burnt the inflammable materials near the opening above the scrap material room (2nd floor) and then spread horizontally on the 2nd floor. Although a fire shutter was installed near the opening above the scrap material room (2nd floor), the shutter was found to have closure difficulties caused by its contact with the conveyor. Likewise, there were many closure disabilities of fire shutters and closure difficulties caused by contact with conveyors, etc. found on the 2nd and 3rd floors, which are estimated to have provided routes for the fire to expand in the early stages.

Note that all 421 people who were inside the building were able to evacuate outside through such means as the use of wireless equipment and the collaboration of evacuation guidance teams on each floor.

Chapter 2 Operation Results of Fire Shutters

1. Results of the fire shutters closing motion

The resultant closing performance of the fire shutters is as follows based on a visual check during the on-site investigation after the fire. Of all the fire shutters on the 2nd and 3rd floors which were burnt (total of 133 locations), 61 failed to operate, 23 had difficulties caused by conveyors or others, and 4 were unknown due to their collapse, which means that about 60% of the fire shutters were found to have failed under normal conditions.

(1) Closure status of the 2nd floor

The wiring for the detectors that are interlocked with the fire shutters are divided into series 1 and series 2.

The closure status of the fire shutters on the 2nd floor was found to have exhibited the following incidents.

- For series 1, all the fire shutters that were to configure fire-proof compartments including the room containing the origin of the fire did operate but failed to form compartments due to closure difficulties caused by conveyors or other objects and, in other fire-proof compartments, many fire shutters did not operate.

- For series 2, many fire shutters had closure difficulties due to conveyors or other objects, and many shutters in the southeast part did not operate.

(2) Closure status on the 3rd floor

The closure status of the fire shutters on the 3rd floor was found to have exhibited the following incidents.

- For series 1, many fire shutters did not operate.
- For the southeast part of series 2, many fire shutters did not operate.

(3) Items pointed out during the inspection

During the firefighting equipment inspection (November 2016), the fire shutters were also inspected, and 22 locations were identified as having fire shutter closure difficulties due to obstacles on the 2nd and 3rd floors. The exact problems identified were anti-drop acrylic boards and anti-drop nets installed at the crossing points of the fire shutters and conveyors and were identified at 20 locations and 2 locations respectively.

It should be noted, however, that these closure difficulties were identified at the locations of the conveyor portions above the acrylic boards and nets, and the identified problems are not considered to be the direct cause.

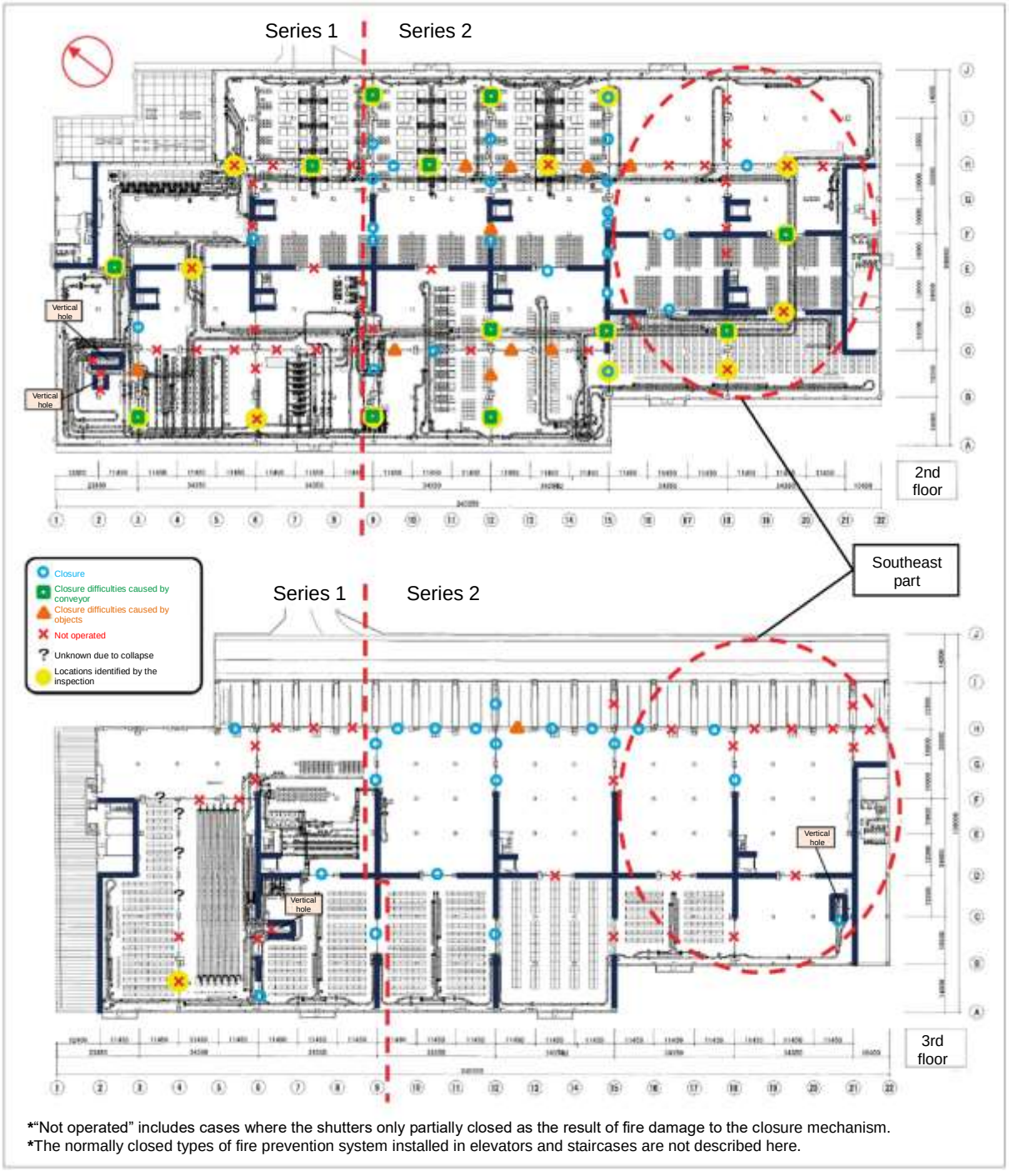
2. Operation status of the automatic fire alarm system

The wiring for the building's automatic fire alarm system is divided to series 1 and series 2.

The recording paper printed by the receiver shows the time when the thermal detector in each alarm district issued the alarm, the time when the smoke detector for the fire shutters operated, and the time when the fire shutters operated. According to the records of the security company who received the alarm, the time recorded by the receiver is considered to be later than the actual time by 7 minutes, and the time notations in this section all show 7 minutes later than the actual time.

The fire was recognized at 09:14 when the thermal detector in the alarm district of the scrap material room situated at the northwest corner of the 1st floor detected the fire.

With regards to series 1 of the 2nd floor, multiple thermal detectors detected the fire at 09:15 when the fire spread. For series 2, the start signals for the shutters and the thermal detectors operated.

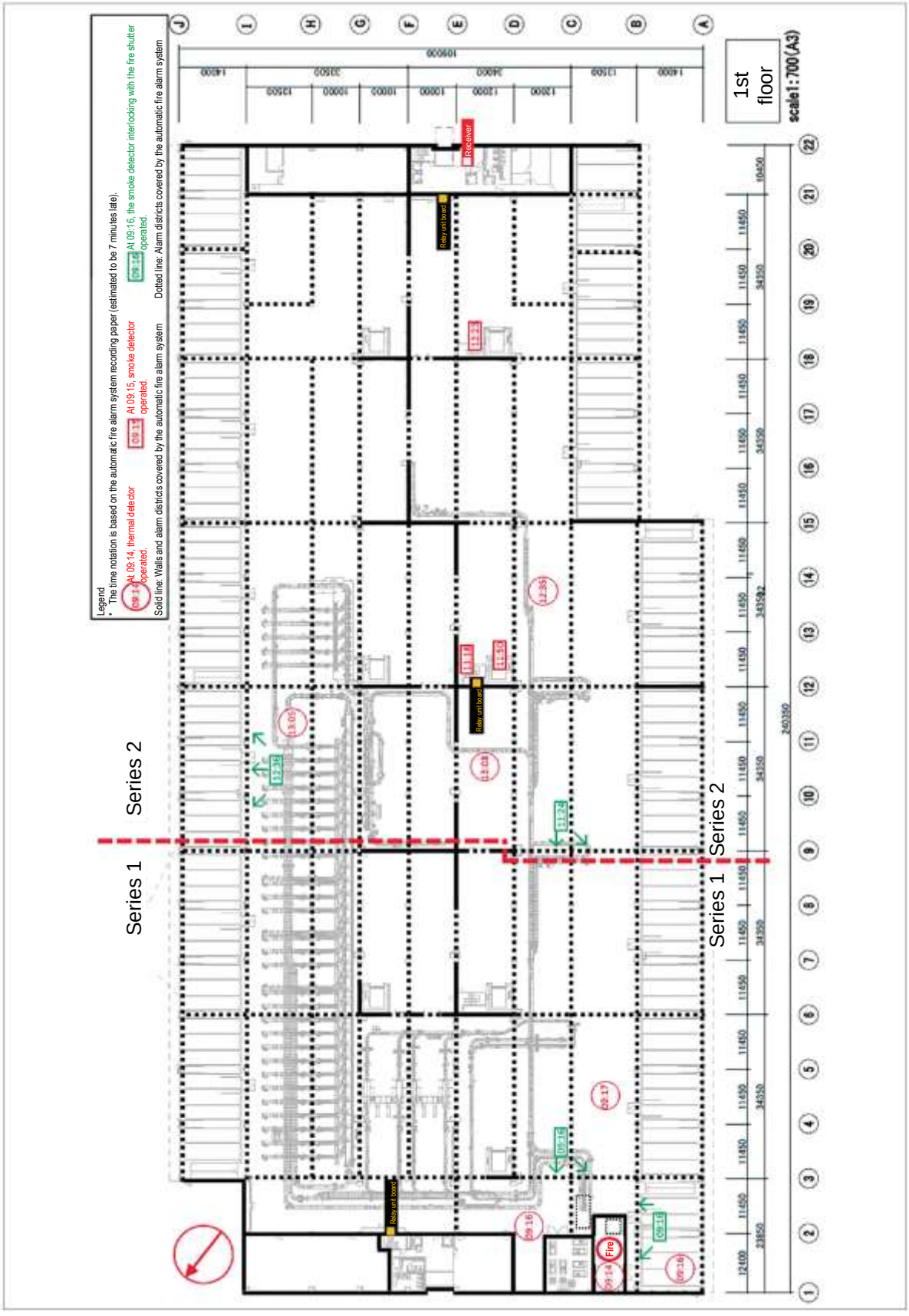


*"Not operated" includes cases where the shutters only partially closed as the result of fire damage to the closure mechanism.
*The normally closed types of fire prevention system installed in elevators and staircases are not described here.

For series 1, the transmission line developed a failure at 09:17, and then the functionality of the transmission line became unstable and was lost at 09:21, causing the inability to transmit signals from the detectors to the fire shutter relay devices, thereafter disabling the fire shutters.

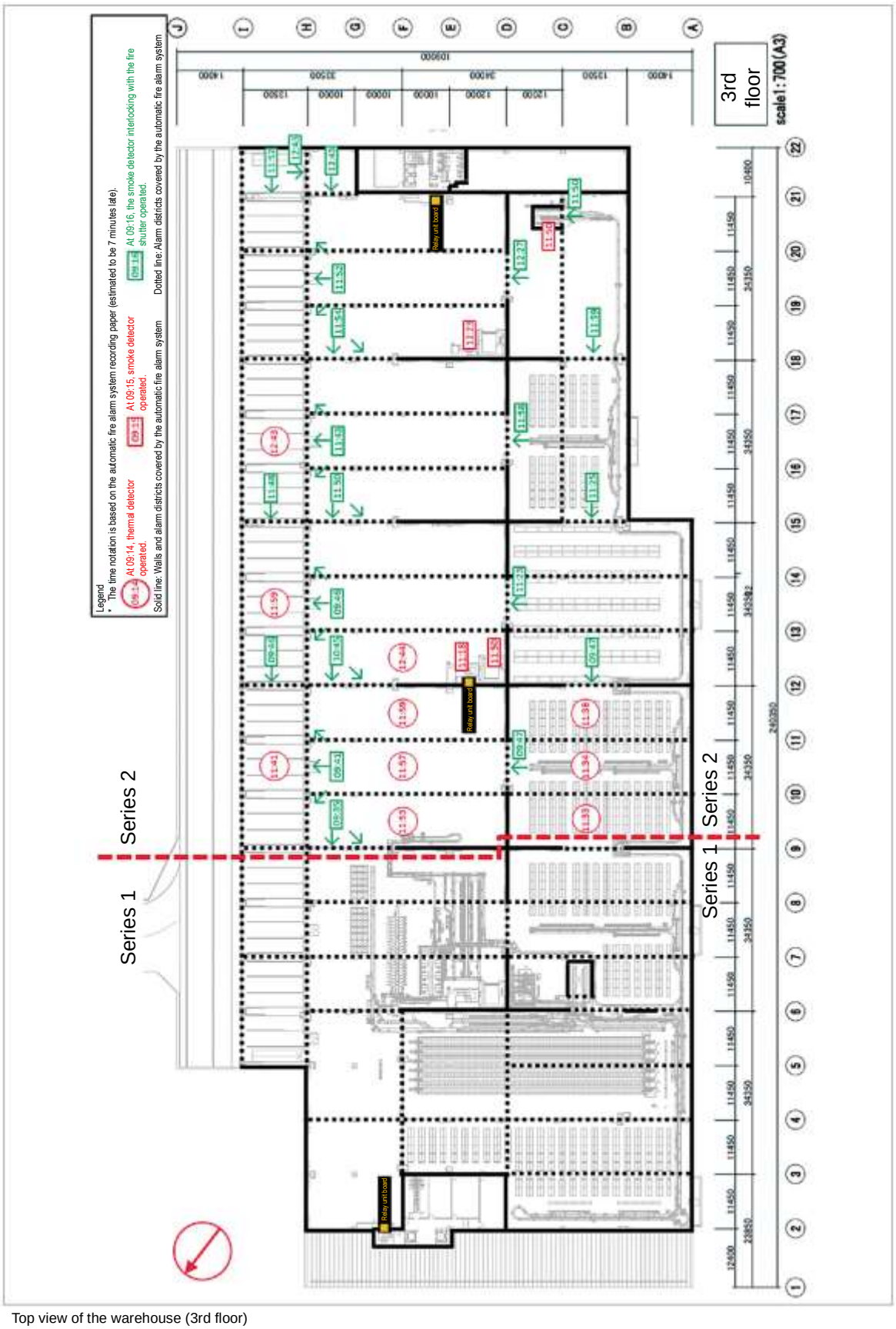
In this building, 4 units of analog type detectors (all installed at vertical hole portions), and the analog detectors installed at the upper location of the scrap material room (2nd floor) are considered to have impacted the failure of series 1.

Also, within the receiver, the blowing of the fuse which formed part of the wiring for the fire shutters was time-stamped at 11:23.

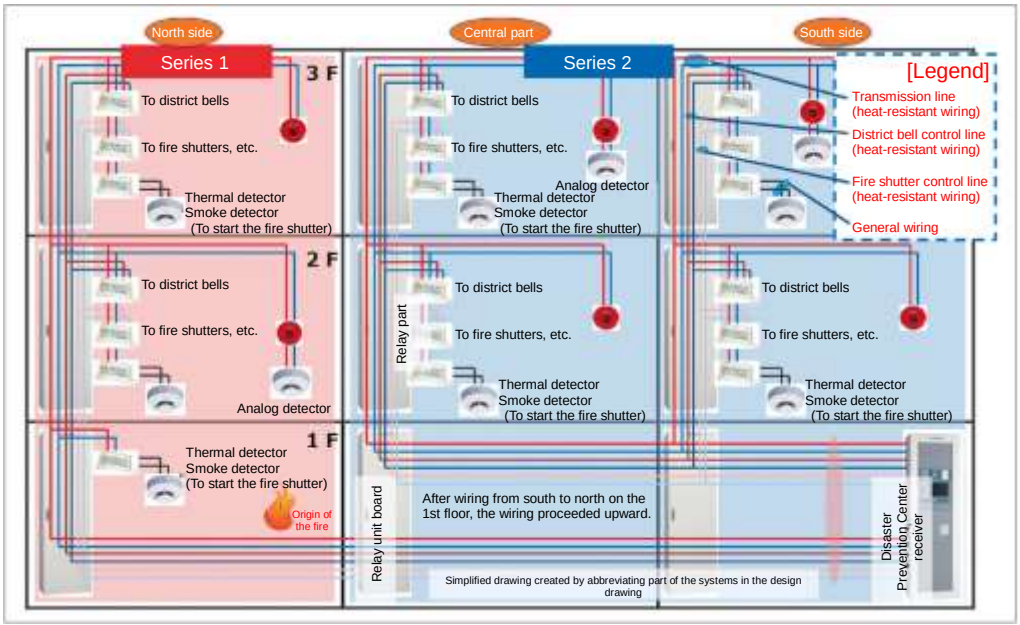


Top view of the warehouse (1st floor)

Top view of the warehouse (2nd floor)



Top view of the warehouse (3rd floor)



Wiring of receivers

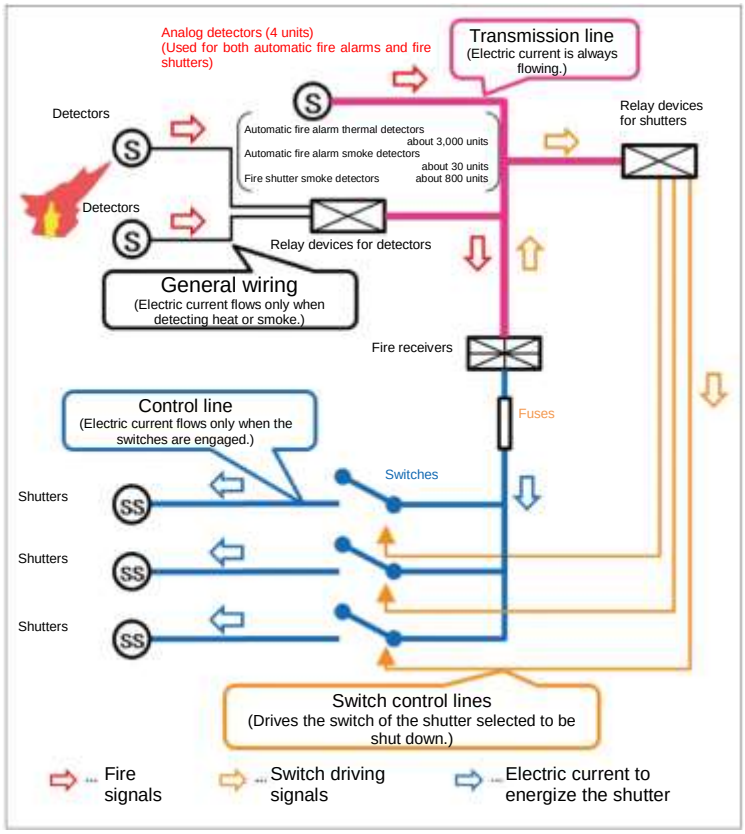
3. Wiring status of detectors, etc. interlocking with fire shutters

(1) Wiring of automatic fire alarm systems

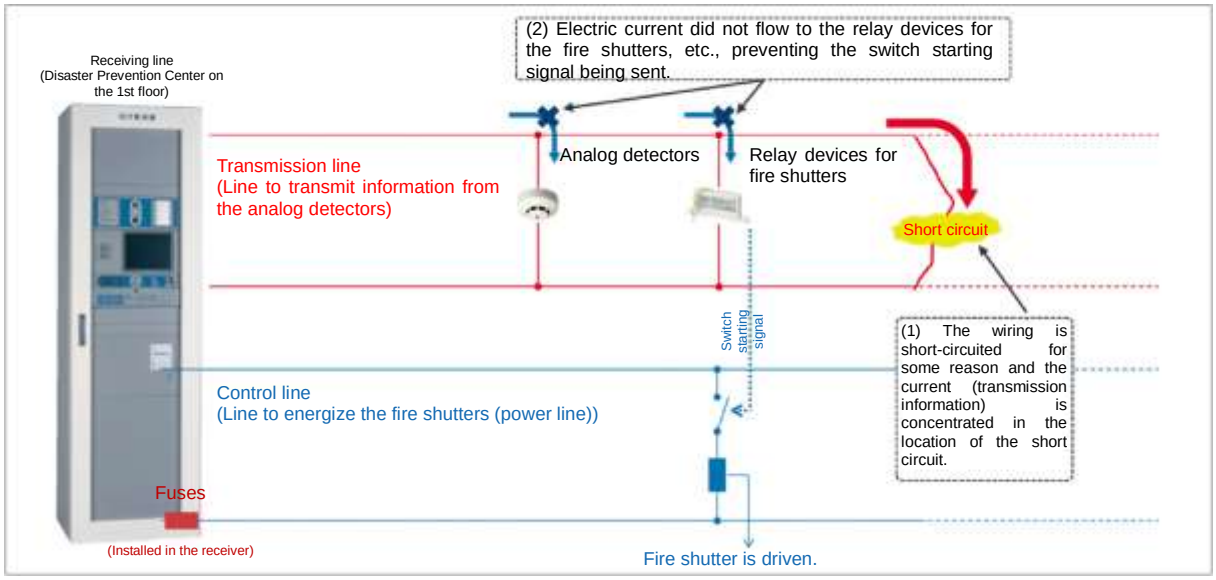
The wiring is divided into “series 1” for the north side where the fire broke out, and “series 2” for the central and south sides, and this wiring system is common to all floors (the wiring system is not separated for each floor).

While there are about 3,000 thermal detectors and about 30 smoke detectors installed for the automatic fire alarm system along with about 800 smoke detectors for the fire shutters, all of these detectors cause electric current to flow when heat or smoke is detected. Current also flows to a relay device in such event as a short circuit. For this reason, the wiring is done using general wiring with no heat-resistant capability. On the other hand, in the fire-proof compartments of the floor-penetrating parts in parts of the conveyors, 4 analog type detectors are installed, which transmit information on the percentage of smoke as necessary. Since these detectors are always driving the current, they are wired using transmission cable integrating the fire receivers, the relay devices for the detectors and the relay devices for the fire shutters. For this reason, when a failure such as a short circuit occurs at a given location, the information of all connected detectors cannot be transmitted at all.

For the transmission of information, the information from the analog type detectors, for example, is designed to be sent to the fire receiver which issues an instruction to a relay device for a fire shutter, which in turn sends the information to each fire shutter.



Outline of wiring (line diagram)



Outline of wiring (multi connection diagram)

Also, in consideration of a short circuit caused by a wiring mistake in the electrical installation, fuses are installed in the receiver side of the control line which supplies current to start the fire shutter not to damage the receivers.

(2) Malfunction of fire shutters in series 1

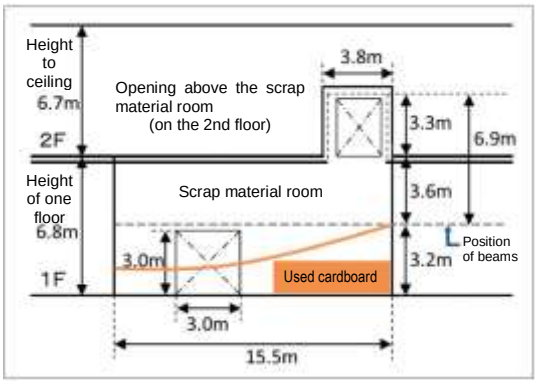
Regarding the cause of many fire shutters in series 1 not functioning, it is considered that the wiring used for transmitting information from the detectors (including the analog detectors connected to the transmission lines) was for some reason short-circuited in the fire, losing the entire functionality of the series as a consequence, which prevented the signals from the detectors being sent to the relay devices for the fire shutters.

The scrap material room is structured so as to allow the used cardboard transported on conveyors from each area of the entire warehouse to be thrown down into the scrap material room through the opening above the scrap material room (2nd floor) and be accumulated in the room.

According to the statement of the person who discovered the fire, the used cardboard had accumulated to a height of about half the height of the scrap material room on that day.

The fire in the room is considered to have flared up due to the intake air supplied from the forklift exit (the exit point for used cardboard) which caused much of the unfolded cardboard in the room to burn severely, with high temperature flames and heat bursting out from the opening above the scrap material room (2nd floor).

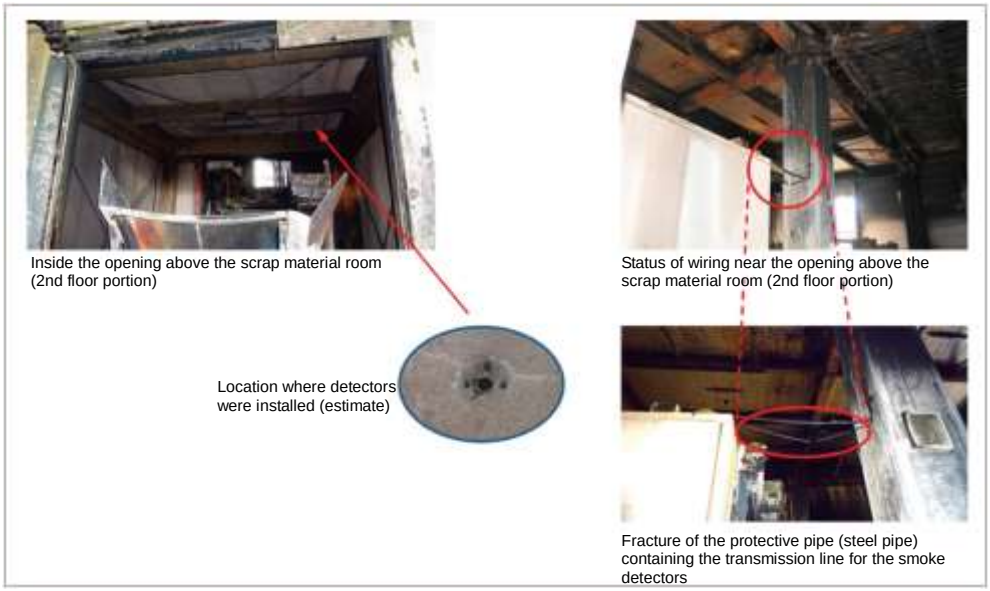
As a result, a reinforced concrete pillar on the 2nd floor near the opening was severely heated and showed explosive fractures.



Status of piled-up used cardboard in the scrap material room

Near the opening above the scrap material room (2nd floor)

Opening in the ceiling of the scrap material room on the 1st floor



Opening above the scrap material room

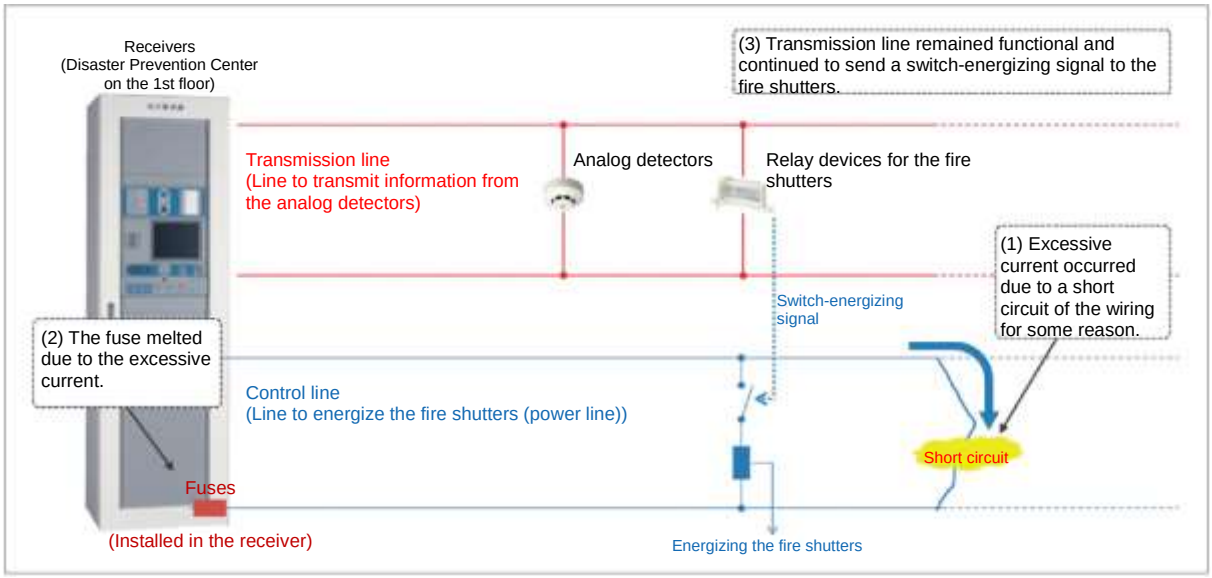
While the smoke detectors at the opening above the scrap material room (2nd floor) issued a fire signal (smoke density being equivalent to 10%/m), a starting signal for the fire shutters (equivalent to a smoke density of 17%/m) was not issued.

The smoke detector was configured to issue an alarm to the Disaster Prevention Center at a smoke density of 5%/m, and to sound the district bell at a smoke density of 10%/m.

It was confirmed that the detectors installed in the ceiling above the scrap material room had fallen off, and the protective pipe (steel pipe) containing the transmission line for the smoke detectors was fractured.

(3) Malfunction of fire shutters in series 2

Regarding the cause of many fire shutters in the southeast part in series 2 not functioning, it is considered that the control line to power the energizing shutters was for some reason short-circuited in the fire, blowing the fuse installed to protect the receivers in the event of some failure such as an electrical fire, causing the loss of functionality of the entire control line as a result.



Outline of wiring (multi connection diagram)

4. Results of heat resistance tests for detectors and wires

For the wiring in the compartments where analog detectors were installed, the following items were to be investigated using experiments.

(1) What conditions create the risk of a short circuit?

(2) What measures are effective to prevent a short circuit?

For an outline and more detailed results of these experiments, readers are requested to read the experiment report. However, as a result of reproducing the wiring (heat-resistant wires) at the warehouse, and experiments using heating detectors and part of the wiring as well as experiments using a refractory furnace, the following became known.

- No short circuits were found to occur when conducting wires come into contact when those wires are protected by heat-resistant coating, external coating or a steel pipe.
- It is possible that a short circuit could happen when a conducting wire comes into contact with another conducting wire or with a steel object when such wires are protected by heat-resistant coating and exterior coating but such coating has been melted by heat.

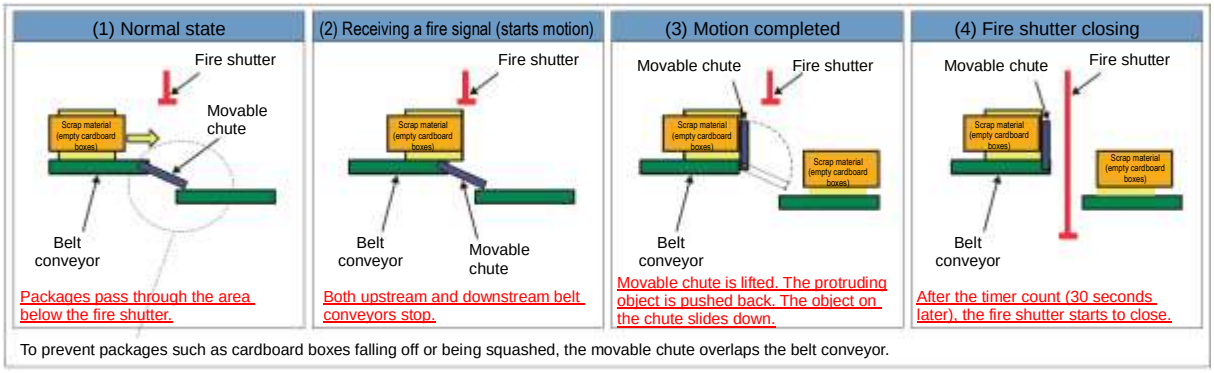
5. Closure difficulties of fire shutters

(1) Compartments created by fire shutters and intersecting conveyors

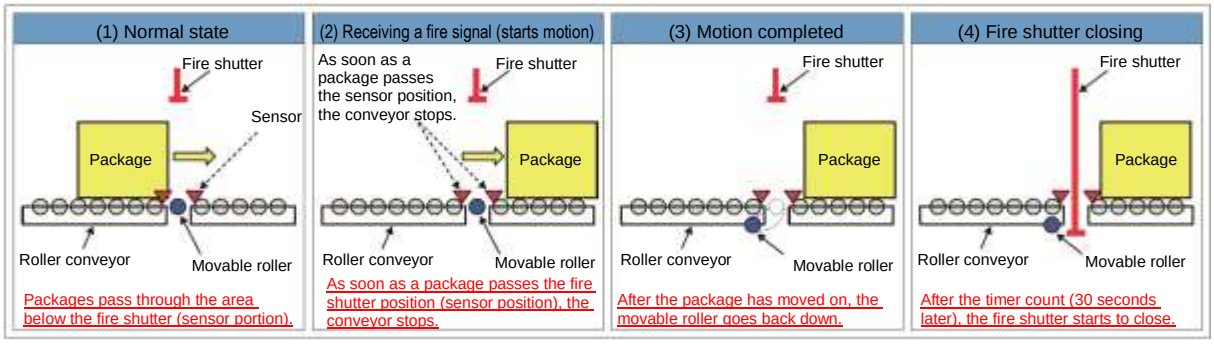
There are belt conveyors for carrying scrap material and roller conveyors for carrying products installed in the warehouse, some of which are installed to intersect at locations where the fire shutters would come down (crossing the fire-proof compartments).

The outline of the belt conveyors is as follows.

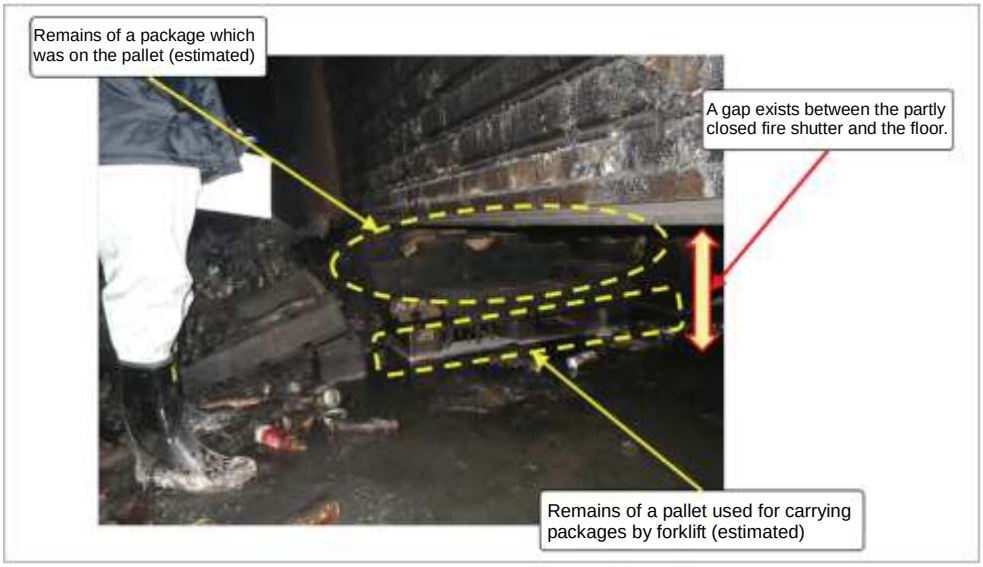
- They are used solely for “scrap material” such as empty cardboard boxes and cardboard offcuts.
- They are mainly installed in high positions. (3.0 m maximum and 1.5 m at the locations where workers would throw down the scrap material)
- If there is a gap between the conveyors, it is possible that any scrap material falling off the conveyors during transportation could cause closure difficulties for the fire shutters.
- The movable chutes which prevent the scrap material falling off are designed to overlap the downstream belt conveyor (the chutes are free to move upward), hence the movable chutes have a way to flip upward to get out of the way of the fire shutter.
- Since they use commercial power and do not have any backup power, they do not work during a power outage.
- They use general wiring and have no heat resistance.



Outline of the belt conveyor



Outline of the roller conveyor



Remaining items at a location where a fire shutter was to come down

- The exterior box that houses the control board installed for each belt conveyor is neither non-burnable nor flame-resistant.

  In addition, the outline of the roller conveyors is as follows.

- The conveyors carry boxes and containers which store products to be shipped out.
- They are mainly installed in lower positions.
- The packages are designed to flow on the conveyors with a certain distance between them and are controlled to take evasive action according to the status of sensors installed at each end of the conveyor.
- In consideration of the gaps between the roller conveyors and the size of the packages, a package should not fall through any gap, but a “movable roller” is installed to make the transportation more stable.
- The movable roller is normally energized, with the roller in the up position (the condition that could present closure difficulties). When the movable roller is not energized (or during a power outage), the movable roller is at the retracted position allowing the shutter to come down.
- Since they use commercial power and do not have any backup power, they do not work during a power outage.
- They use general wiring and have no heat resistance.
- The exterior box that houses the control board installed for each belt conveyor is neither non-burnable nor flame-resistant.
- Since the movable rollers are supported by air cylinders, the roller will fall back down if the air supply tube is burnt out.

During the on-site survey, the “movable chutes” installed at the junctions of the conveyors were found to malfunction, and there were multiple incidents where they presented closure difficulties. On the other hand, there were no incidents of the roller conveyors causing closure difficulties.

Regarding the cause of the conveyors causing closure difficulties, it is considered that any of the following incidents could have happened to prevent the movable portions such as the “movable chutes” from working correctly.

- They could not receive the fire signal correctly.
- The power to energize the movable portion was lost due to the power outage.
- The movable portion was designed, when it did not work, to remain in the condition which would prevent the fire shutter closing.

(2) Remaining items at a location where a fire shutter was to come down

At a location where one of the fire shutters was to have come down, the on-site survey found the remains of some items considered to be packages stored at that time. It is considered that these packages and some other items stored in the warehouse left at this location where the fire shutter was to come down provided one of the causes of the closure difficulties.

(To be continued in the next issue)