Report on the Investigation of the Nagoya Works Coke Fire Accident and Power-Receiving and Distributing Equipment

April 7, 2015

Nippon Steel & Sumitomo Metal Corporation

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(Coke Accident Response Committee)

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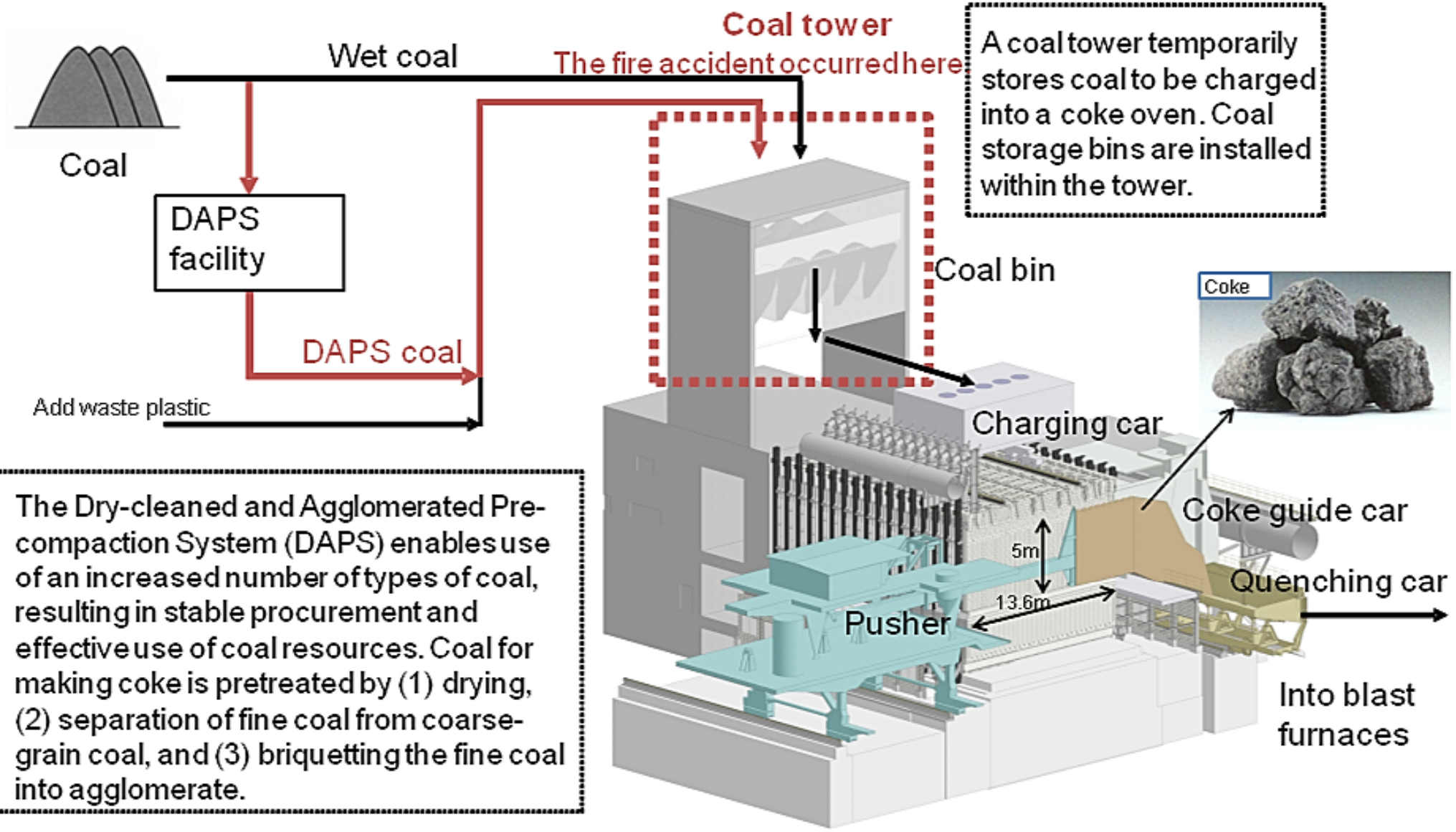
1. Outline

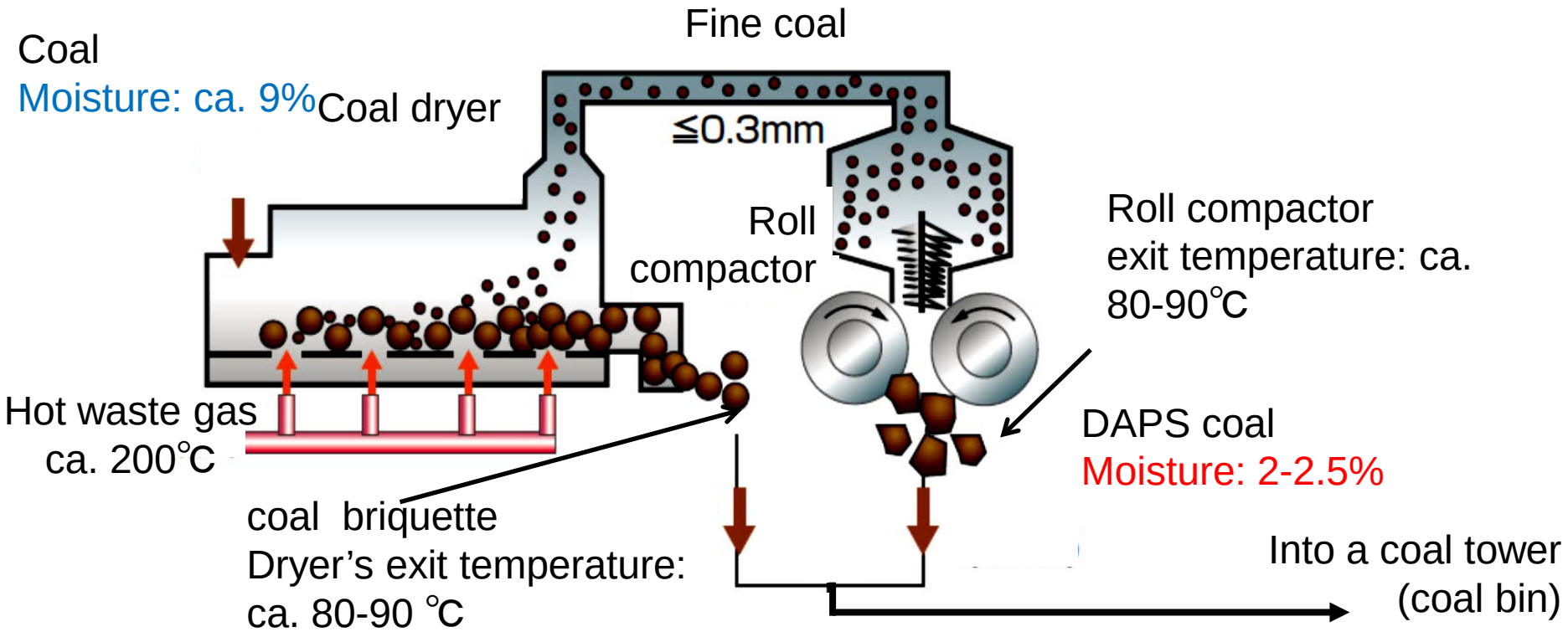
1-(1). Outline of Nagoya Works' Coke Plant



1-(2) Outline of DAPS Facility

Dry-cleaned and Agglomerated Precompaction System

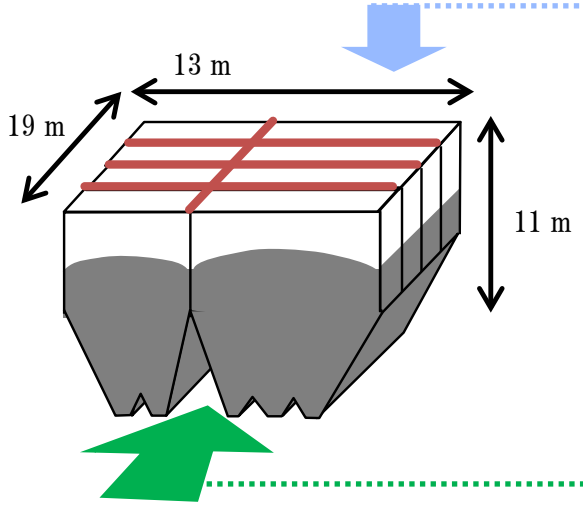
1) Coal is dried in a coal dryer by blowing in hot waste gas (ca. 200℃) from the bottom.
2) Separation of fine coal from coarse-grain coal.
3) Briquetting the fine coal into agglomerate by a roll compactor.

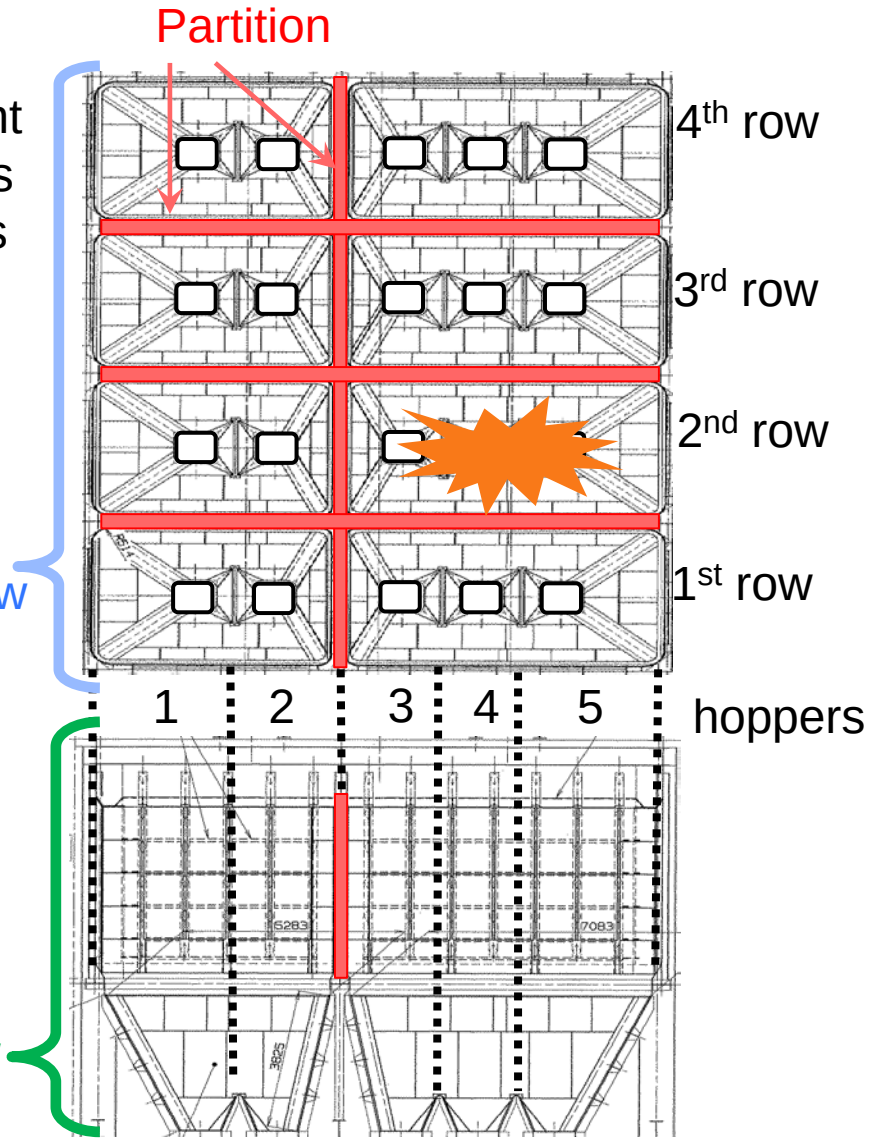


1-(3) Structure of Coal Bin in a Coal Tower

Coal bin

- The coal bin temporarily stores coal to be charged into a coke oven. (When the accident occurred, approx. 100 tons of DAPS coal was stored in the 2nd row of the bin. About 21 tons are discharged per batch.)
- The coal bin is partitioned by walls into rows and hoppers.
- The accident is presumed to have originated in the 3rd, 4th, and 5th hoppers on the 2nd row.





1-(4) Outline of Nagoya Works Coke Fire Accident

Where	No. 1 Coke Oven's Coal Tower of the Coke Plant of Nagoya Works
When	12:35pm, Wednesday, September 3, 2014

Outline

10:30	Detected a rise in the CO level within the coal tower
about 10:45	The workers arrived at site and confirmed smoke was generated from the coal bin of the coal tower. (High CO level within the tower prevented direct spraying of water.)
11:15	Began to discharge coal from the coal bin
about 11:18	Public firefighters arrived at site
about 12:10	Coal was discharged (five times)
12:35	The fire accident occurred within the coal tower

2. Presumed Direct Cause of the Accident

2-(1) It is presumed that the fire accident occurred in the following sequence.

1) DAPS coal was stored for a certain period

2) Hot coal mixed in the bin promoted spontaneous heating

Note: Both or either (1) or (2) might have happened.

3) Flammable gas was generated

4) Coal was discharged and the belt conveyor was ignited

5) The fire accident occurred

2-(1) How the Fire Accident Occurred-1

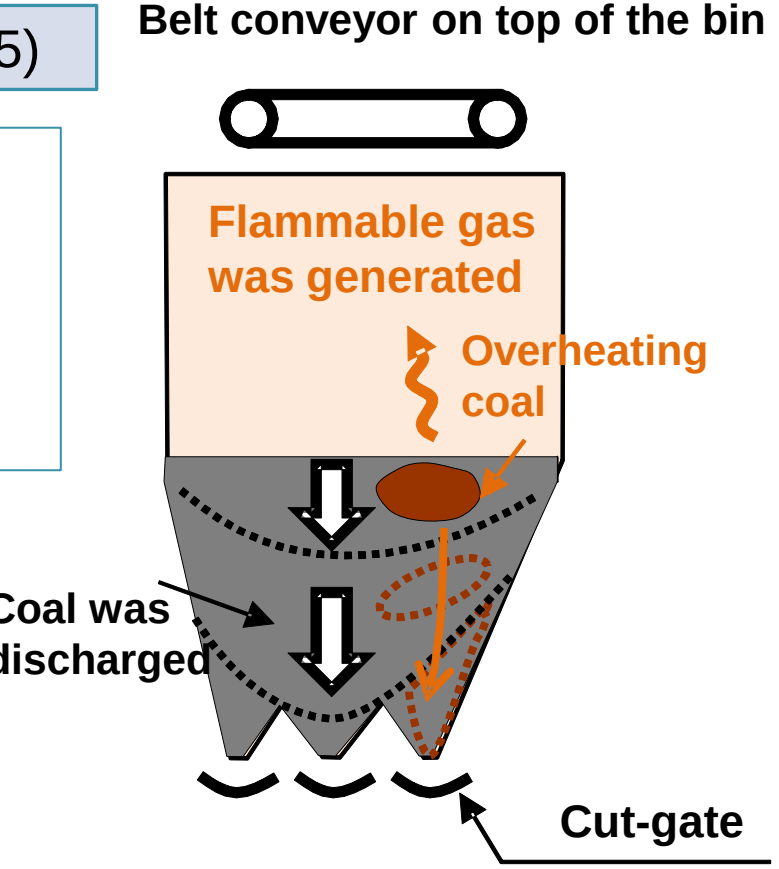
It is presumed that the fire accident occurred in the following sequence.

(1) Before coal was discharged (before 11:15)

1) DAPS coal was last transported from the DAPS facility on Aug. 30 and was stored in the coal bin for about 4 days. The coal became oxidized and its temperature rose spontaneously.

2) Hot coal, mixed in the bin, promoted spontaneous heating partially.

3) Spontaneous heating of coal generated CO and other flammable gas.



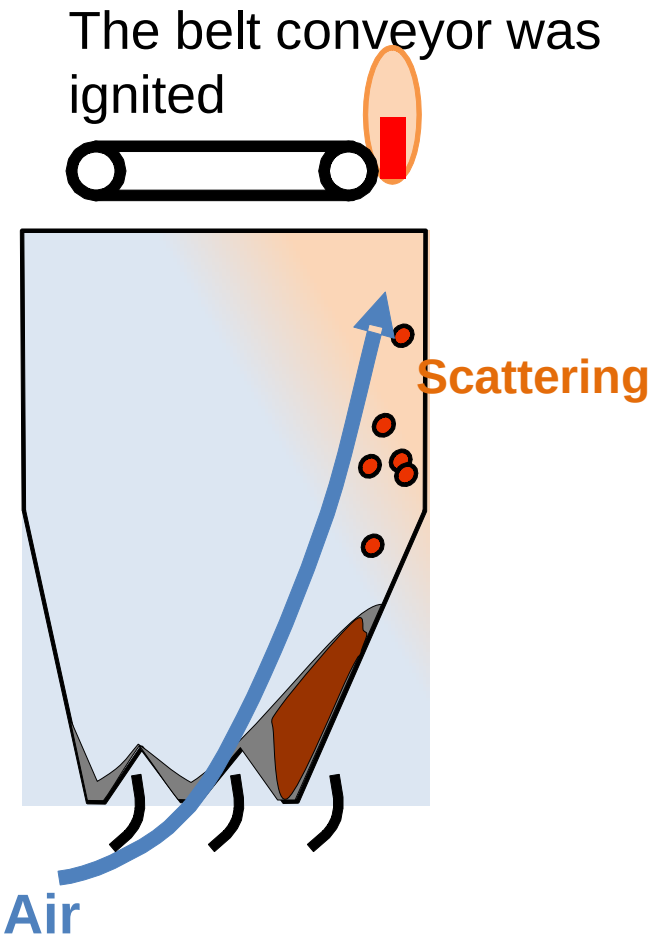
Note: Both or either 1) or 2) might have happened.

2-(1) How the Fire Accident Occurred-2

(2) The belt conveyor was ignited (at about 12:10)

4) High-level CO in the coal tower prevented direct spraying of water. Coal was then remotely discharged in five times.
After the last discharge, overheating coal unintentionally remained in the coal bin. The residual overheating coal and gas were blown up by the air, which was rapidly flowing in from the bottom of the bin*, resulting in igniting the belt conveyor.

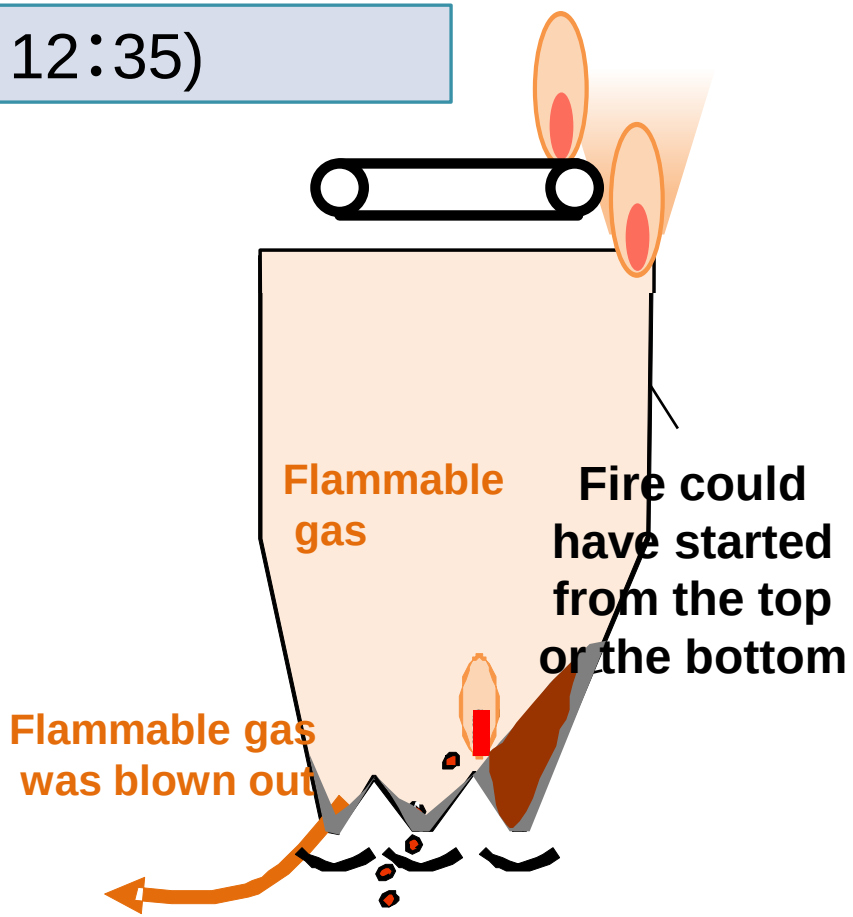
* Subsequently, the cut gate was shut down and stopped the entry of air.



2-(1) How the Fire Accident Occurred-3

(3) The fire accident occurred (at 12：35)

5) The residual overheating coal continued to generate flammable gas mainly consisting of CO, and the fire could have started from the ignited belt conveyor on the top or the overheating coal within the bin.



2-(2) Presumed Direct Factors

It is presumed that the following factors have directly caused the accident.

- Spontaneous heating of DAPS coal (possibly occurring from storage of DAPS coal for a certain period and mixture of hot coal into the coal bin)

- Direct spraying of water into the coal tower was not conducted and the coal in the coal bin was discharged. (Unintentionally, overheating coal remained in the coal bin.)

2-(3) Presumed Indirect Factors

It is presumed that the following administrative and other indirect factors were on the background of the accident.

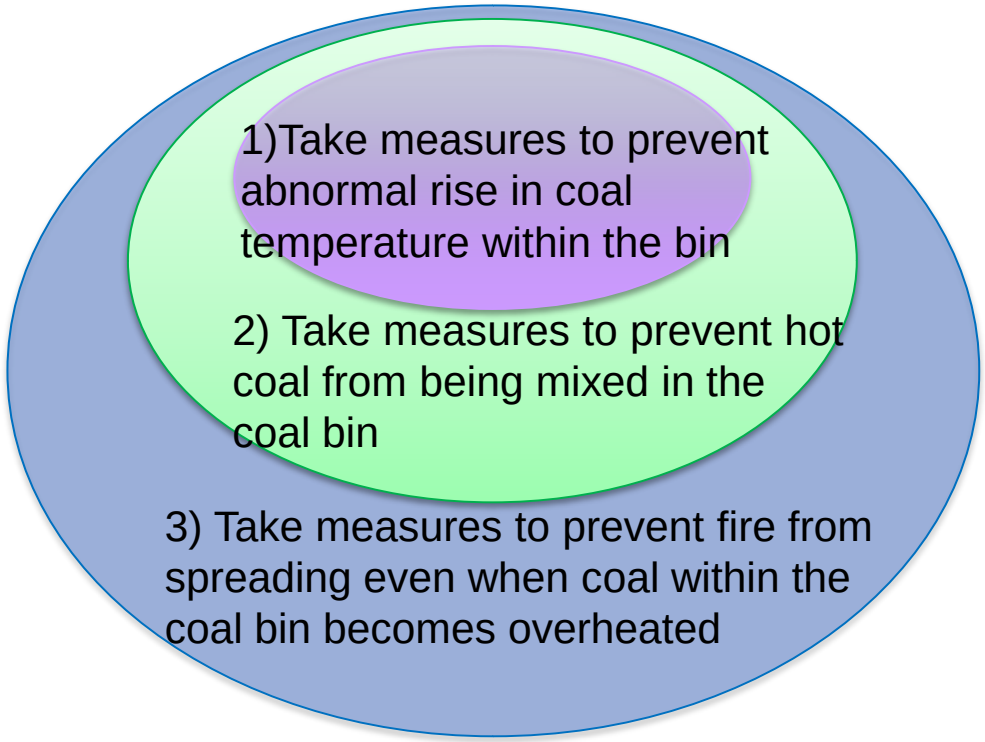
- Provisional measures for handling coal storage were not fully recognized by all of the relevant employees.
- A measure to prevent hot coal from being mixed in was not fully implemented.
- There could have been a problem in initial response when smoke was generated.
- Risk assessment of residual coal in a coal bin was not fully practiced by the relevant employees.

3. Measures to Prevent Recurrence

3-(1) Main Measures Against Presumed Direct Causes

【Triple Actions】

"Triple Actions" will be implemented to prevent recurrence of the causes of the accident and address all conceivable factors related to similar past incidents.

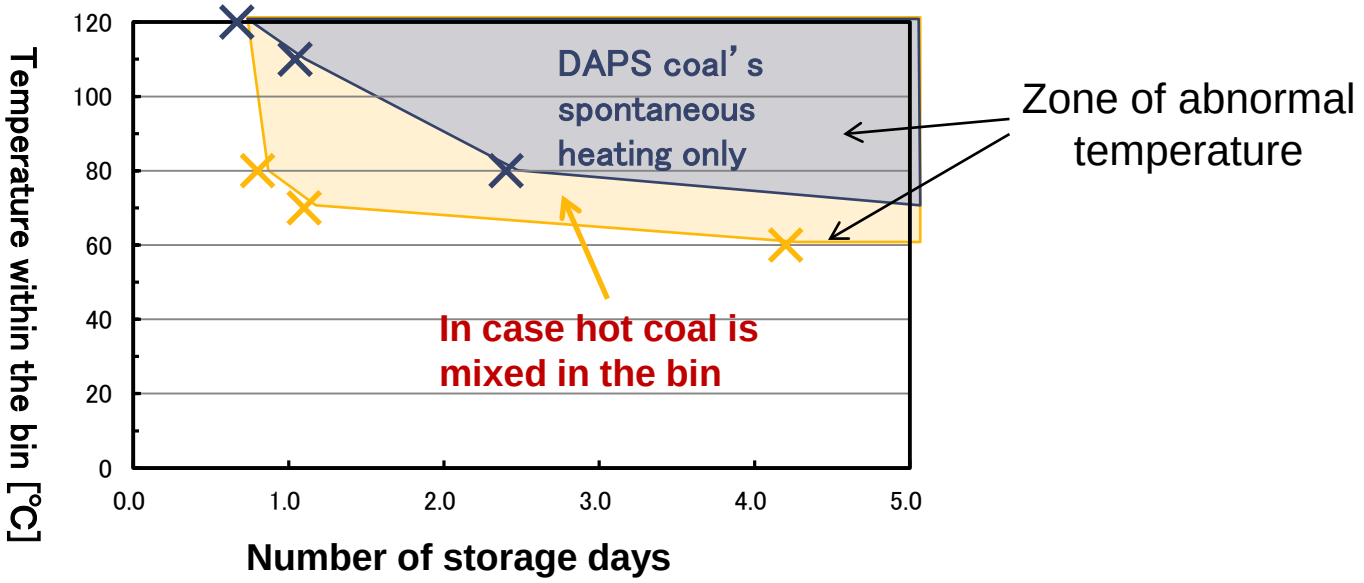


3-(1) Main Measures Against Presumed Direct Causes

1)Take measures to prevent abnormal rise in coal temperature within the bin

【Action】Revise the handling standard

- Keep the coal temperature within the bin equal to or less than 60℃. The DAPS coal is all discharged within three days at maximum.
- Any coal with a temperature exceeding 60℃ is entirely discharged immediately (within one day).



3-(1) Main Measures Against Presumed Direct Causes

2) Take measures to prevent hot coal from being mixed in the coal bin

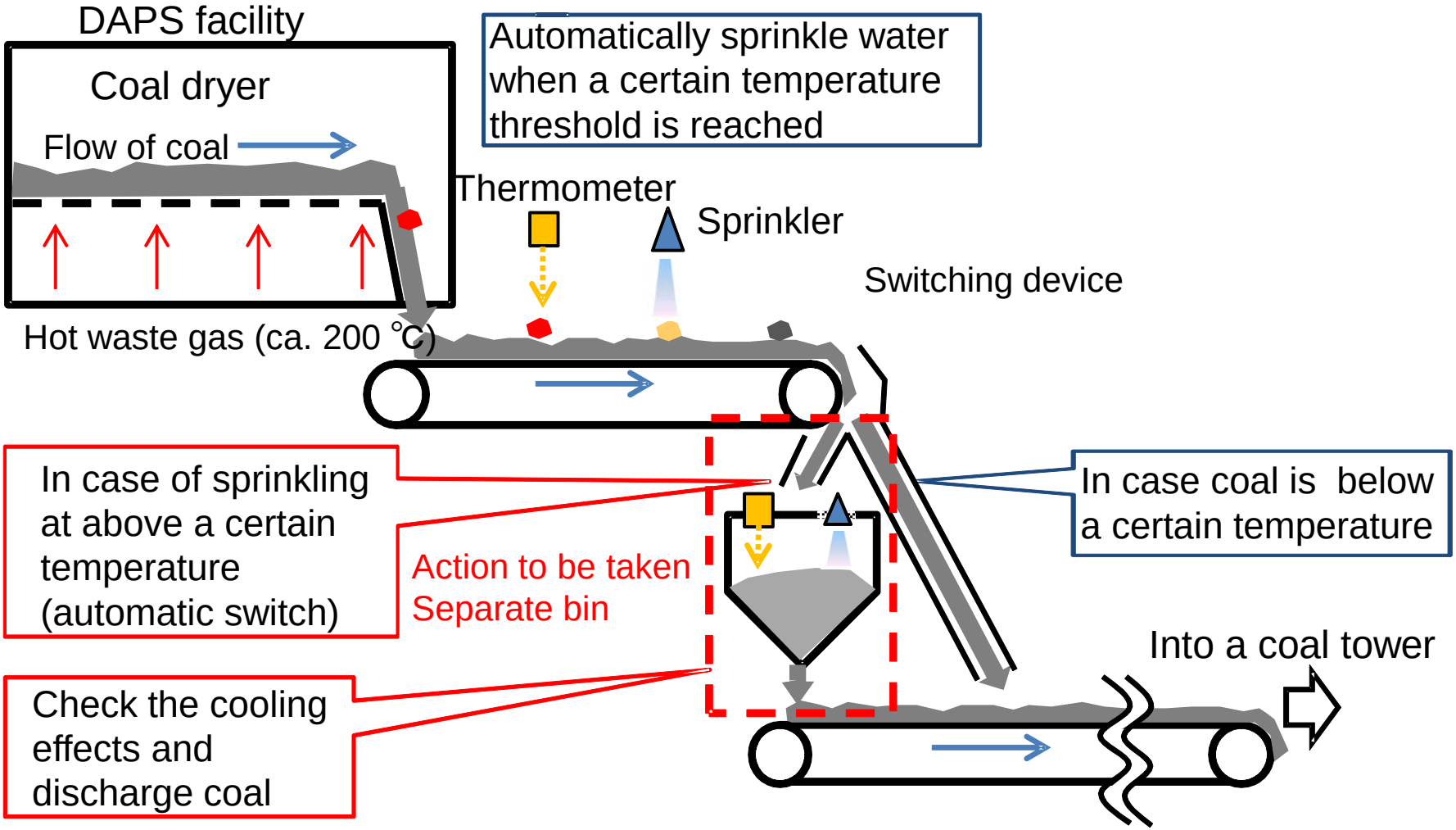
【Action】Improve the function of coal temperature control

- Coal hotter than a certain level is cooled by the (existing) automatic watering equipment and separately stored in a newly installed separate bin.

- A dust collector is installed near the belt conveyor to improve reliability of the thermal sensor.

3-(1) Main Measures Against Presumed Direct Causes

2) Take measures to prevent hot coal from being mixed in the coal bin



3-(1) Main Measures Against Presumed Direct Causes

3) Take measures to prevent fire from spreading even when coal within the coal bin becomes overheated

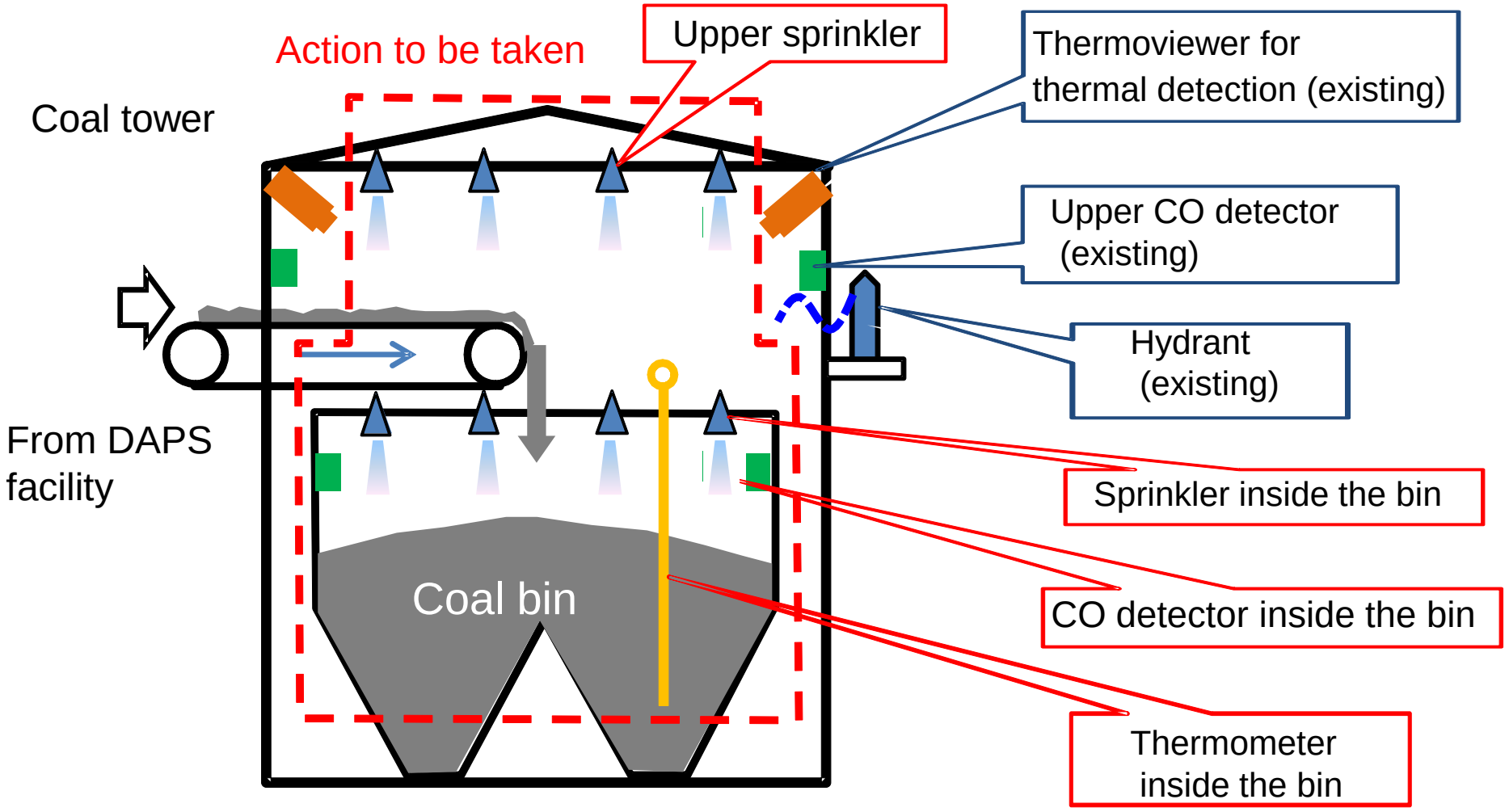
【Action】Implement fire preventive measures

- Implement measures for early detection of a spontaneous rise in the temperature of coal within a coal bin (by installing CO detectors and thermometers in the coal bin)

- Implement an early-action measure to prevent fire from spreading by early detection (by installing a remote-control sprinkler system within the bin and on the ceiling of the coal tower, equivalent to 600mm of rainfall per hour)

3-(1) Main Measures Against Presumed Direct Causes

3) Take measures to prevent fire from spreading even when coal within the coal bin becomes overheated



3-(2) Major Initiatives Regarding Indirect Factors

【 Initiatives taken by the company】

1) Invest in management resources (equipment and human resources) of steelworks

2) Enhance the head office organization and promote accident-preventive activities

- Plant Safety Div. (Nov. 2014); Monozukuri Planning Dept. (Nov. 2014); Coke Planning Div. (Apr. 2015)
- Plant Safety Committee and Standardization Committee to be formed
- Evaluation and assessment by third-party institutions (Japan Society for Safety Engineering, JIC Quality Assurance)

3) Enhance development of human resources (raise “genbaryoku,” or on-site capability)

- Planned development of capability of executives to deal with risks, and of those in charge of accident-preventive activities, by improved systematic programs

4) Raise safety-awareness so that we do not forget lessons from the accidents

- Implement consistent activities for enlightenment and dialogues on the accidents (for all employees)

3-(2) Major Initiatives Regarding Indirect Factors

【Initiatives taken at Nagoya Works】

1) Enhance accident-preventive management

・Strengthen organization and promote information sharing (i.e., more effective meetings, creating a position in charge of accident-preventive activities)

・Strengthen initial responsive capabilities (i.e., better training, clarifying procedures when smoke is generated)

・Improve risk-assessment activities (i.e., to extract risks out of past incidents)

2) Standardize and enhance management

・ Organizing standard documents on accident-preventive activities, including management of the DAPS facility

3) Improve education on accident-preventive activities and not to forget lessons from the accidents

・Education focused on standard documents, setting of an accident drill day, and making an information room with exhibits and materials

II. Investigation on Power-Receiving and Distributing Equipment

(Investigation Committee for Power-Receiving and Distributing Equipment)

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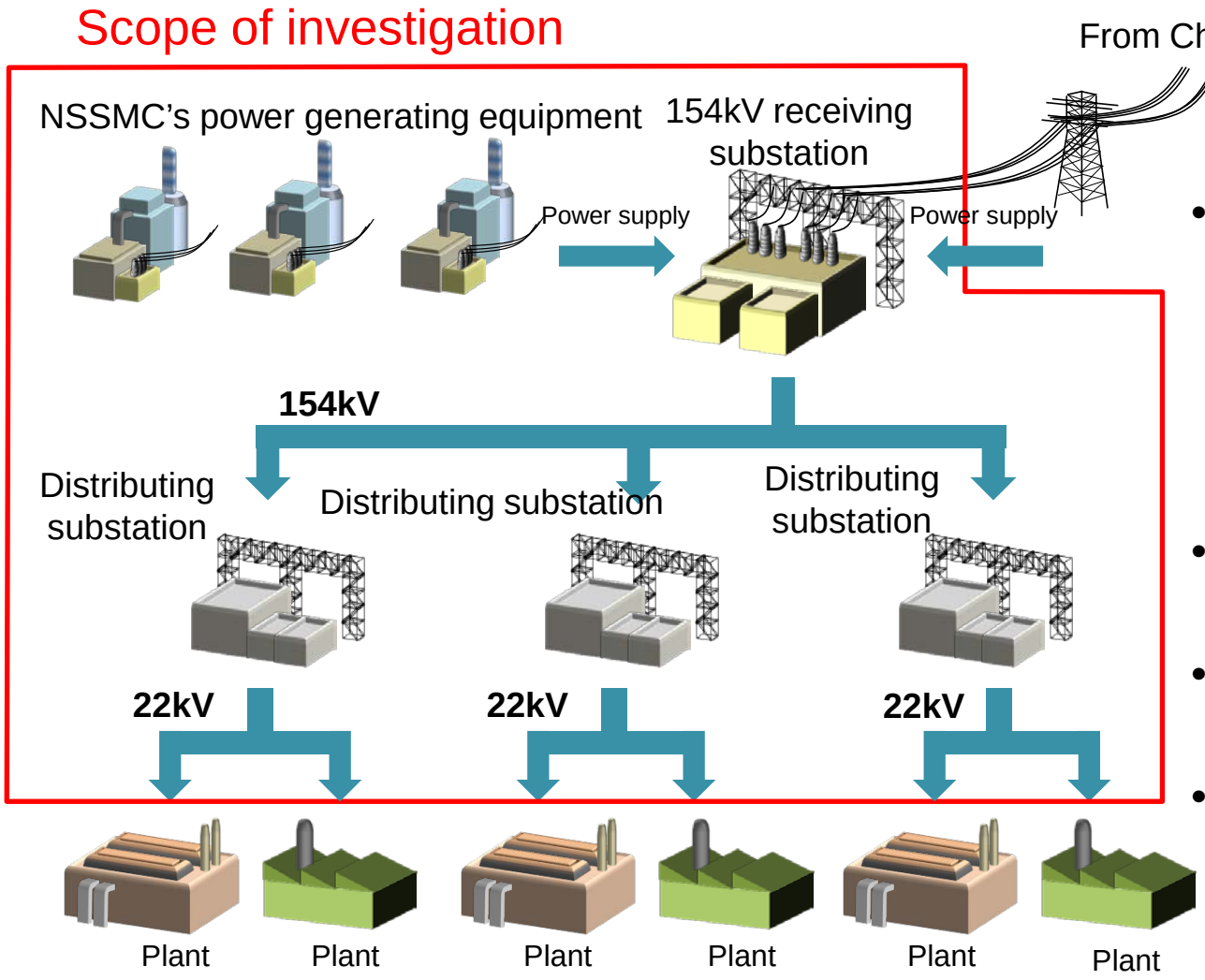
1. Purpose of Investigation

Consider an overhaul and new measures for improvement of all of the Nagoya Works' entire power supply related devices, including those which caused four power failure accidents.

In addition, study how to increase reliability of overall facility arrangements, incorporating a longer-term perspective.

2. Scope of Investigation

Check status of special high-voltage power supply devices in Nagoya Works (154kV-22kV)



- NSSMC's power generating equipment (5) (Total power output: about 550,000kW)
- Breakers (about 150)
- Transformers (about 60)
- Electric cables (Total length: about 140km)

3. Eight Key Points for Investigation and Review

Overhaul of power-related equipment and peripheral equipment and review of them for improvement, focusing on eight key points from operational and facility aspects.

Procedures and operation

(1) Check status of inspection, maintenance and diagnosis

(2) Check status of measures to switch source in the power supply network

(3) Check status of measures to prevent recurrence of past power supply system troubles

(4) Check status of conducting of drills on handling accidents

Systems and equipment

(5) Review power supply's design concept and operational status

(6) Review power supply's protection system

(7) Check design of system to prevent power failures in the entire steelworks

(8) Check equipment soundness (equipment replacement record)

4-(1) Investigation Results

A. It was confirmed that in general, inspection and maintenance of equipment was adequately performed. (Completed in Nov. 2014)
B. Some areas in need of review and improvement were identified and we are now implementing new measures.

＜Procedures and operation＞

Check points	Details	Results	Revision, improvement
(1) Inspection, maintenance and diagnosis	Check implementation status of all targeted equipment and the standard documents (13)	○	☆ Add items to the standard documents (6) [By Mar. 2016 (completed 5 items)]
(2) Operation of power supply system	Check the standard documents and process documents on power operation (ca. 270), and implementation status after the 2014 accidents	△	★ Partially review work flow (1) [Done by Nov. 2014] ☆ Improve the standard documents (11) [Done by Jan. 2015]
(3) Prevention of recurrence	Check implementation status for prevention of recurrence of troubles (27) in the past 10 years	○	–
(4) Drill on handling accidents	Check implementation status of drills on handling accidents and operational standard documents for handling of accidents (11)	○	☆ Improve drills (added 7 assumed cases) [Done by Mar. 2015]

○ Good; △ Need improvement; ★ Need to take measures; ☆ Improve for more reliability

4-(2) Investigation Results

＜Systems and equipment＞

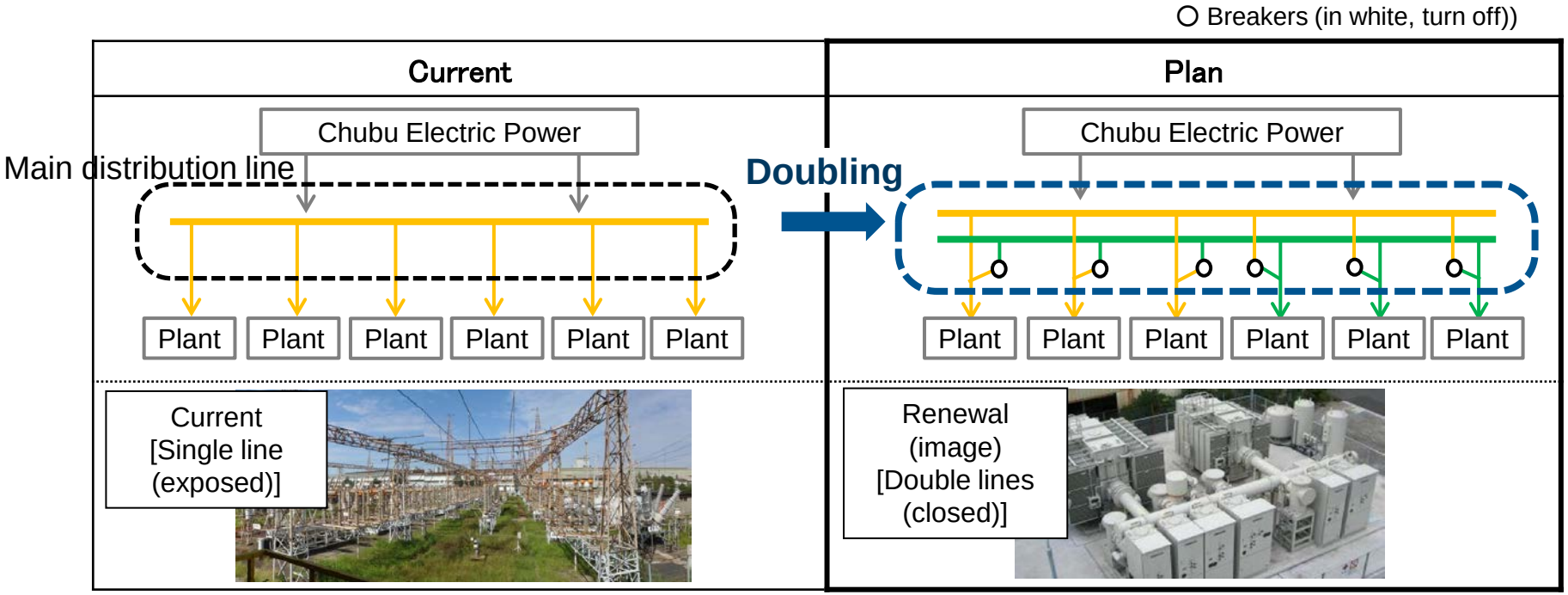
Check points	Details	Results	Revision, improvement
(5) Design concept and operation	Check design concept, operation and improvement records (16) of power supply systems (26) including those under abnormal circumstances	○	–
(6) Protection system	Check settings of protection equipment (ca. 700) and appropriateness of the entire system	△	★ Improve ground fault protection system • No. 4 generator [Done by Oct. 2014] • No. 3 generator [By Sep. 2015]
(7)Prevention of power failures in the entire steelworks	Check design of System Stabilizing Controllers (SSC) for prevention of power failures in the entire steelworks	△	★ Revise programs for defective parts of SSC [By Jun. 2015] ☆ Improve SSC functions and monitoring equipment [By Jun. 2015]
(8) Equipment soundness	Check replacement status and plans for all targeted equipment, and related standard documents (16)	○	☆ Add items to the standard documents (5) [By Mar. 2016 (2 items completed)]

○ Good; △ Need improvement; ★ Need to take measures; ☆ Improve for more reliability

5. Future Initiatives

We will make action plans to improve the Nagoya Works power system, including doubling of main distribution lines (receiving substations) and additional installation of transformers (NSSMC's power generating equipment), with the aim of improving the operation and reliability of power source-related equipment, in addition to continual thorough execution of checking and maintenance.

[Example]　Doubling of main distribution lines (receiving substations)



III. Briefings to Local Residents

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Briefings to Local Residents

1. The briefings for this report will be held for representatives from all community associations and neighborhood associations in Tokai City and part of Chita City.

- Assume participation of one or two persons from each association, totaling about 150 participants.
- The first briefing is scheduled to be open to the media.

◆ Briefing schedule

1) Tokai City Shoko Center	6:30pm, Wednesday, April 8, 2015 《Open to the media》
2) Tokai City Bunka Center	6:30pm, Thursday, April 9, 2015
3) Tokai City Shiawase Mura	6:30pm, Friday, April 10, 2015
4) Chita City Seishonen Kaikan	6:30pm, Tuesday, April 14, 2015

2. The briefing documents will be widely circulated to people in the local communities through their representatives who participate in the briefings.

Details of Related Committees

Power Failure Accident Response Committee

[Held on Sep. 16, 25, Oct. 16, 27 (four times in total)]

- Established: Jun. 22, 2014
- Members
  - Chair: Shinji Fujino, NSSMC's Managing Director and Member of the Board
  - Outside experts: 4 in total
    Akihiko Yokoyama: Professor; The University of Tokyo Graduate School
    Three engineers from the heavy industry
  - Other members from NSSMC: 13 in total
    From Head Office and Nagoya Works

Coke Accident Response Committee

[Held on Oct. 11, 23, Nov. 24, Dec. 17, 26, 2014, Feb. 8, 28, Mar. 14, 2015 (eight times in total)]

- Established: Sep. 4, 2014
- Members
  - Chair: Isao Mochida, Professor Emeritus, Kyushu University
  - Outside experts: 3 in total
    Ritsu Dobashi, Professor, The University of Tokyo Graduate School
    Takayuki Takarada, Professor, Gunma University, Graduate School of Engineering, Division
    Hisao Makino, Director, Central Research Institute of Electric Power Industry
  - Other members from NSSMC: 3 in total (from Nov. 2014 after change in members; only 2 members up to the end of Oct.)

Investigation Committee for Power-Receiving and Distributing Equipment

[Held on Sep. 16, 25, Oct. 16, 27, Dec. 17, 2014, Jan. 30, Feb. 26, 2015 (seven times in total)]

- Established: Aug. 11, 2014
- Members
  Chair: Kazuyuki Orita, Head of Plant Engineering & Facility Management Center and Executive Officer, NSSMC
  Outside experts: 4 in total (the same as left)
  Other members from NSSMC: 18 in total.
  From Head Office, Nagoya Works, and other steelworks

*Given the wide scope of investigation targets, internal experts (i.e., licensed electrical engineers) conducted preliminary investigation and discussion (twelve times since late Aug. 2014) and the results were used as a base for discussion at the committee.

Contact Information

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