ENGLISH TRANSLATION FOR REFERENCE PURPOSE ONLY
This notice is an English translation of the original Japanese text of the timely disclosure statement dated July 6, 2023, issued by Daio Paper Corporation, and is for reference purposes only. In the event of any discrepancy between the original Japanese text and this English translation, the Japanese text shall prevail.

July 6, 2023

To whom it may concern:

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Measures Addressing Aftermath of Boiler Breakage at Our Subsidiary Iwaki Daio Paper Corporation (3rd Report)

Regarding the accident that damaged a boiler at our consolidated subsidiary, Iwaki Daio Paper Corporation (hereinafter "Iwaki Daio") based in the Minamidai district of Iwaki City, Fukushima Prefecture, on September 6, 2022, we sincerely apologize to residents in the neighborhood, customers, related companies, relevant authorities, and many other parties concerned for any anxiety and inconvenience caused.

Following the accident, Daio Paper and Iwaki Daio set up an "Accident Investigation Committee," which included external intellectuals, on November 1, 2022, to investigate the causes of the accident and work out measures for preventing a recurrence.

We have so far held six committee meetings, and as a result, come up with an accident investigation report describing the determination of its causes and means of fending off any recurrence. Details are shown in an attached paper. The following is a summary of the report.

(Attachment) Report on Investigation of Explosion Accident Involving In-house Power Generation Equipment at Iwaki Daio Paper Corporation

The Daio Group will thoroughly execute measures to prevent such an accident in the future and give top priority to safety in factory operations. Additionally, we will continue our efforts to reduce environmental impact through the effective utilization of renewable energy.

1. Overview of Accident

At around 6:49 a.m. on September 6, 2022, a boiler exploded at Iwaki Daio's in-house power generation equipment in Iwaki City, Fukushima Prefecture, causing a Group company employee to suffer a burn and scattering some sand, ash, refractory materials, etc. outside the relevant factory.

<Status of damage>

▪ Personal damage: One Group company employee who was working around the relevant equipment suffered a burn.
* The affected person has returned to work after receiving treatment in hospital for about 40 days.

▪ Damage to neighborhood: Some sand, ash, refractory materials, etc. were scattered on a municipal road in the north of the relevant factory (there was no human or vehicle traffic then).

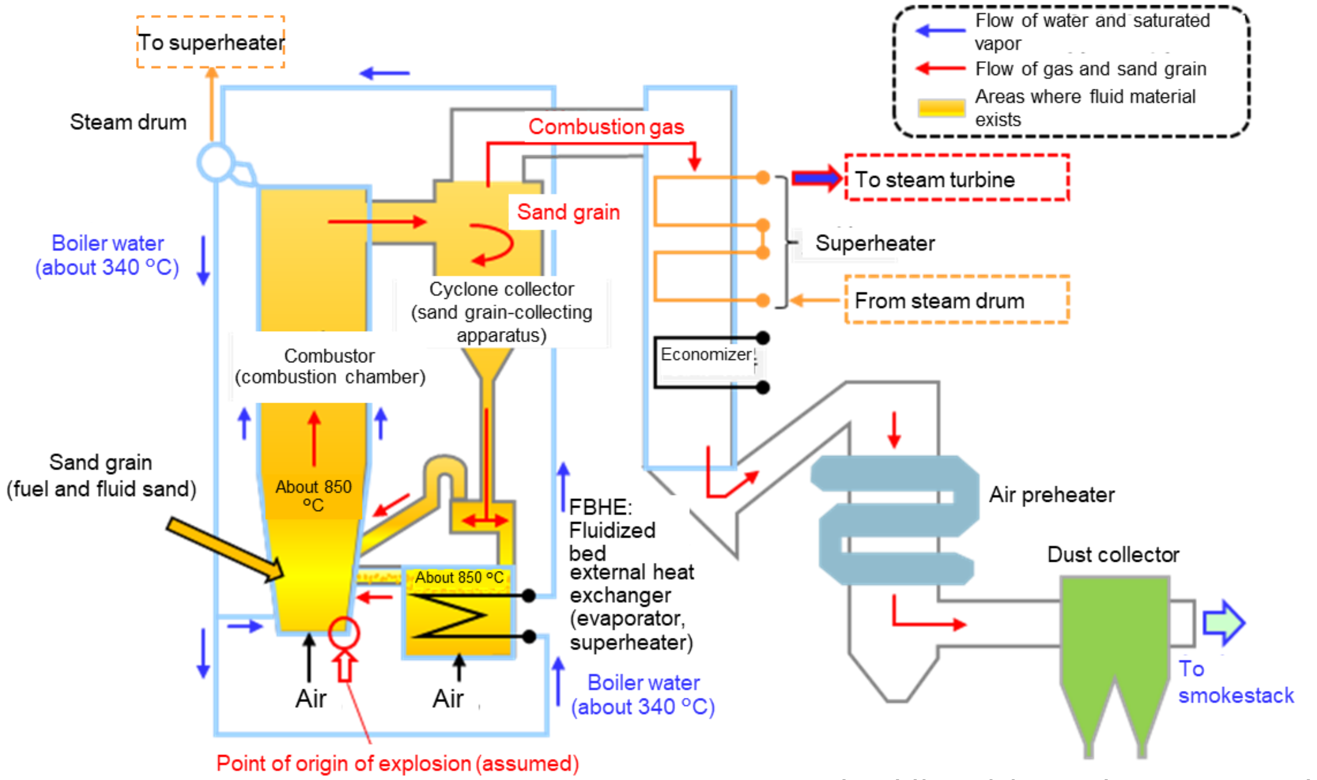
▪ Damage to equipment: Total loss of boiler combustion chamber (combustor) and heat exchanger adjunct to the boiler, other parts also partially damaged and deformed.

2. Overview of Affected Equipment

Boiler portion of in-house electricity generation equipment that powers newsprint and paperboard production machines

1) Electric output: 33,333 kilowatts
2) Boiler type: Circulating fluidized bed (CFB*) boiler
3) Fuel: Woodchips, RPF, tire chips, waste inside premises
4) Start of operation: October 2008
5) Manufacturer: Mitsubishi Heavy Industries Ltd. (currently Mitsubishi Heavy Industries Power IDS Co., Ltd.)

<Schematic View of Boiler>



Source: Material provided by Mitsubishi Heavy Industries Power IDS Co., Ltd.

3. Causes of Accident

Possible causes of the boiler explosion include an explosion of unburnt gas, dust explosion, and steam explosion. As a result of investigation into operating data and on-site visual probes, we have assumed that the accident was caused by a steam explosion stemming from instant contact of massive water with fluid sand that has a large heat capacity.

* The accident investigation report attached defines “steam explosion” as “rapid explosion-like gasification (volume expansion) of water that came into contact with high-temperature sand.”

1) Place of occurrence

We confirmed one water tube fracture inside the combustion chamber, which appears to be the point of origin of the explosion accident.

2) Process of steam explosion

A massive amount of saturated water leaked from the water tube fracture, rapidly gasifying upon contact with a large volume of high-temperature fluid sand in the combustion chamber and causing cubic expansion, eventually resulting in a steam explosion.

3) Causes of steam explosion (causes of water tube fracture)

(1) A number of presumed causes were identified after investigating what triggered the steam explosion from the viewpoints of design, installation work, operation and maintenance checkup.

(2) As the portion of tube fracture that initiated the explosion has been seized by investigative authorities, we are requesting probes from various perspectives, including dimensional inspection, metallographic observation, and hardness testing.

Under the circumstances, we have not yet been able to narrow down the presumed causes, as details of the initially fractured portion are yet to be made known.

(3) Accordingly, we will endeavor to take measures addressing all presumed causes on the way to restoring the relevant equipment.

When the outcome of official investigations by the authorities concerned is made available in the future, we will call another meeting of the Accident Investigation Committee as necessary to identify causes and discuss necessary additional measures to be taken.

4. Measures to Prevent Recurrence

As described in the accident investigation report, we will consider restoring the boiler equipment after implementing recurrence-preventing measures for a number of presumed causes.

1) Measures addressing water tube leakage

- Eliminate seal fin for triangular space* (which results in disappearance of triangular space)
  * Very narrow space between the sealing material, which ensures combustor airtightness, and the water tube; it is too narrow to allow inspection.
- Restrict scale buildup on the inside of water tubes (avoiding the risk of creep damage)
- Prevent decline in pH level of boiler water (avoiding the risk of tube corrosion by hydrogen)
- Prevent the risk of heat load rising on water tubes as a result of refractory removal (avoiding corrosion by hydrogen, creep damage, rupture risk)

2) Measures to reduce the risk of steam explosion occurring even when water leaks

Besides the measures described in item 1), we requested the boiler manufacturer to take additional safety steps. As a result, some design specifications have been changed as follows.

- Eliminate triangular space to prevent massive water from abruptly coming into contact with fluid material with high heat content

3) Measures to prevent the scope of breakage from expanding further

- Render water piping structure on peripheral walls of external heat exchanger (water tubes + refractory structure) into a non-pressure structure (casing/iron plate + refractory structure)
- No installation of evaporator inside the external heat exchanger

5. Impact of Boiler Breakage on Earnings Performance

As a result of the power shortage caused by the boiler breakage, energy costs increased due to the use of heavy fuel oil and the increased use of purchased electricity. Both the higher energy costs and a loss caused by scrapped boiler equipment were already factored into the consolidated financial statements for the year ended March 2023. Energy costs are expected to continue rising due to the power shortage, and have already been incorporated into our consolidated earnings performance forecast for the year to March 2024. Meanwhile, we expect to receive a machinery insurance payout following the explosion accident, but at this moment, it is impossible to estimate both the period of insurance receipt and the payout amount. Therefore, the insurance factor is not included in the above earnings projection.

We will let you know any possible effect on our earnings performance as soon as it becomes clear.

In light of the accident, we reaffirm that safety is the utmost priority in factory operations, and we are fully committed to doing everything in our power to regain trust.

END

Attachment

Iwaki Daio Paper Corporation

Report on Investigation of Explosion Accident Involving In-house Power Generation Equipment

* The details are subject to change depending on the results of future

1. Overview of Accident. Status of Damage, etc.

At around 6:49 a.m. on September 6, 2022, a boiler of power generation equipment exploded during usual operations, bringing the equipment to an emergency stop. (Immediately before the event, we did not confirm any phenomena that would allow us to detect any leakage, such as a rise in abmodality, or deviation, between the amount of water supplied and that of evaporation.)

○ Status of damage

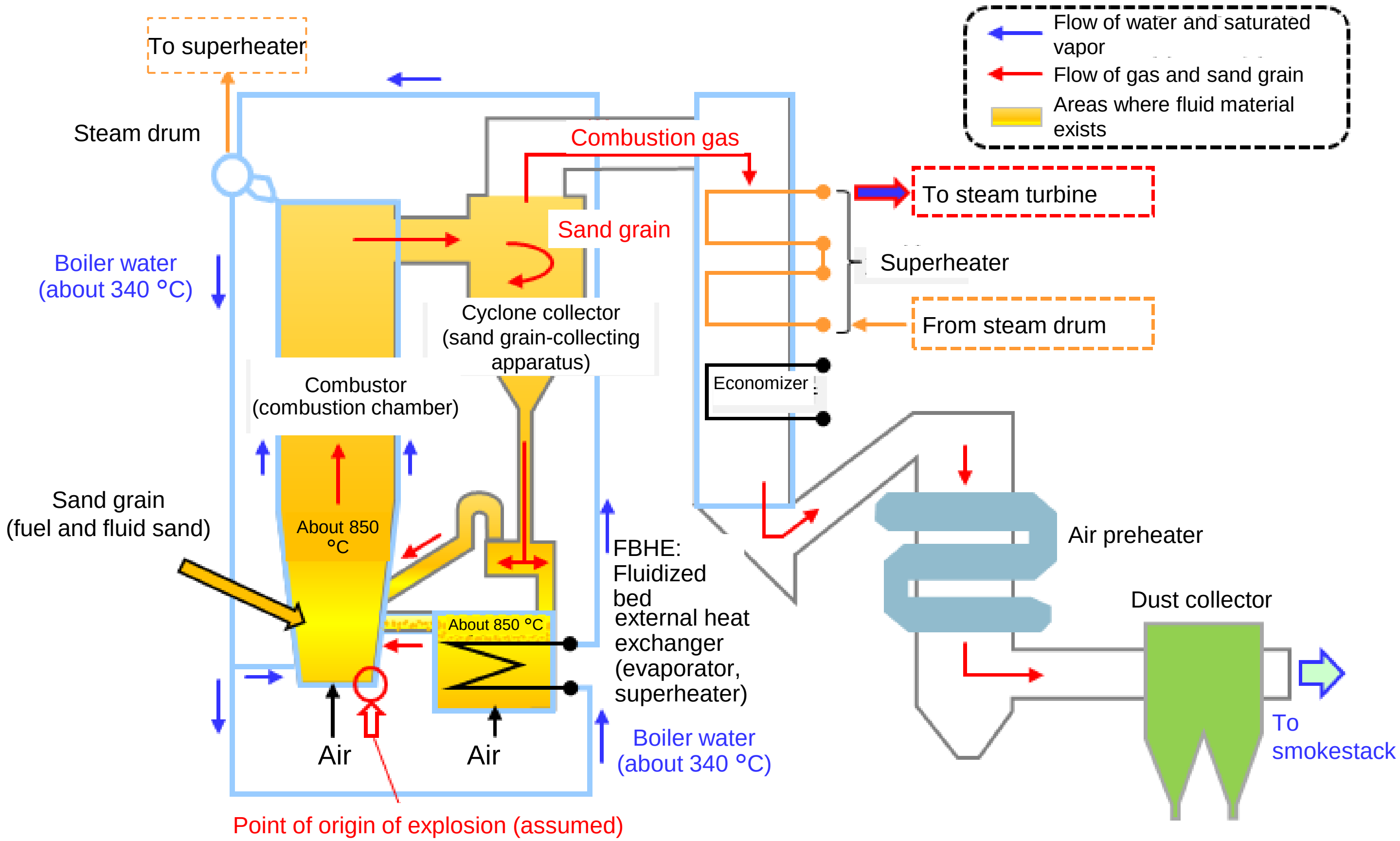
- Personal damage: One Group company employee who was working around the relevant equipment suffered a burn.
- Damage to neighborhood: Some sand, ash, refractory materials, etc. were scattered on a municipal road in the north of the relevant factory (there was no human or vehicle traffic then).
- Damage to equipment: Total loss of boiler combustion chamber (combustor) and heat exchanger adjunct to the boiler, other parts also partially damaged and deformed

○ Overview of power generation equipment

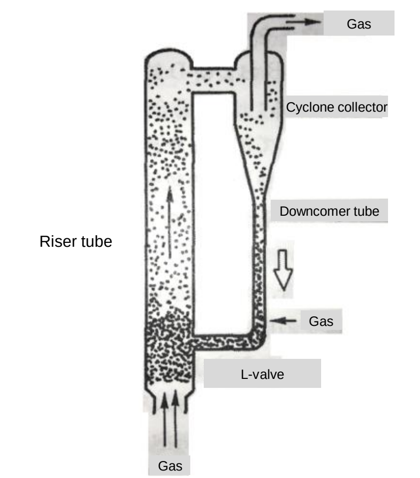
- Electric output: 33,333 kW
- Boiler type: Circulating fluidized bed (CFB)
- Specifications: Evaporation amount 170 t/h, steam pressure 15.8 MPa, steam temperature 548 ° C (maximum)
- Fuel: Woodchips, RPF, tire chips, waste inside premises
- Start of operation: October 2008
- Total hours of operation: 107,758 hrs
- Total No. of operation stops: 68
- Manufacturer: Mitsubishi Heavy Industries Ltd. (currently Mitsubishi Heavy Industries Power IDS Co., Ltd.)

* The details are subject to change depending on the results of future investigations.

<Schematic View of Boiler>



Source: Material provided by Mitsubishi Heavy Industries Power IDS Co., Ltd.



Difference of sand grain density inside the combustor

Source: Fluidized Powder Bed Handbook, Association of Powder Process Industry and Engineering

[Characteristics of circulating fluidized bed (CFB) boiler]

- Grain (mainly fluid sand) is used as a heat exchange medium to improve combustibleness and heat exchange efficiency
- The boiler has a structure in which the above grain is separated/gathered by cyclone (collecting apparatus) and then recycled into the combustor again.
  (As shown in the right chart, grain density is thick in the lower part of the combustor and thin in the upper part.)
- Fuel is put into the lower part where grain density is thick to ensure combustibleness.

* The details are subject to change depending on the results of future investigations.

2. Track Record and Membership of Accident Investigation Committee

2-1 Track Record of Meetings

Following the explosion, we inaugurated an Accident Investigation Committee, exploring its causes and discussing measures to prevent a recurrence.

We have so far held six committee meetings. As a result, we have come up with findings of presumed causes and measures addressing such causes.

		2022 September	October	November	December	2023 January	February	March	April	May	June
		★ 9/6 Accident occurs	○ 11/1 1st meeting of Accident Investigation Committee	○ 11/29 Natural Disaster WG	○ 12/2 2nd	○ 1/16 3rd	○ 2/15 4th	○ 3/13 5th		○ 5/11 6th	○ 6/5 Natural Disaster WG
On-site probe	Authorities	○ 10/19 to 10/21 1st on-site investigation	○ 10/27 2nd	○ 11/30 3rd	○ 12/26, 27 4th	○ 1/11 5th; ○ 1/27 Confiscation (on-site probe completed)					
On-site probe	Iwaki Daio & MPW-IDS	○ 9/6 to 9/7 1st investigation	○ Escorted to local police; ○ 10/28 3D measurements	On-site probes (*as needed) (Probe into initially fractured portion)		○ 1/27 Sample tube transport (similar portions)					
In-house investigation MPW-IDS				○ 11/18 3D data sorted out	3D data Analysis (deformation model presumed)	○ 1/18 Causes presumed (desktop examination basis)	○ 1/30 Sample tube accepted	○ 3/6 Sample tube analysis completed (fracture causes presumed)		○ Sample tube Extra analysis completed 4/26: MPW-IDS 4/26: Iwaki Daio	
Horizontal deployment	Iwaki Daio	○ After accident information shared within Daio Paper Group (no boiler of same type in use)									
Horizontal deployment	MPW-IDS	○ Orally explained to other companies as needed on same boiler type after accident		○ 11/24 Incident report issued						○ Incident report issued	○ Horizontal deployment explained regarding delivery of same-type of boiler to other companies

2. Track Record and Membership of Accident Investigation Committee

2-2 Membership

- Accident Investigation Committee members were nominated to shed light on its causes from a fair and objective perspective and recommend measures for preventing a recurrence. It consisted of eight in-company members (including Daio Paper Group officials) and four external members (three from the manufacturer and one university professor). According to themes necessary, experts from the manufacturer participated in committee meetings.
- As an adviser, the Electric Power Safety Division, Kanto Tohoku Industrial Safety and Inspection Department, Ministry of Economy, Trade and Industry, also participated in the meetings.

Chairman

Daio Paper Corporation	Mishima Mill, Production Division	Acting Manager

Member (operation control)

Iwaki Daio Paper Corporation	General Manager
Iwaki Daio Paper Corporation	General Manager, Power Department

Member from Daio Engineering Co., Ltd. (boiler construction, maintenance)

Iwaki boiler construction project	General Manager
Iwaki Security Dept., Security HQ	General Manager
Iwaki Security Dept., Security HQ (Chief BT Expert)	Section Chief
Power Security Dept., Security HQ (Mishima Mill)	General Manager

Member from Daio Paper Corporation

Energy Planning Dept., Production HQ	General Manager

Secretariat

Daio Engineering Co., Ltd.	
Iwaki boiler construction project	General Manager Section Chief

Member from Mitsubishi Heavy Industries Power IDS Co., Ltd. (boiler manufacturer)

Solutions G, Service Promotion Dept. (probe into causes)	Group Leader
Service Business Div. (response to police)	Deputy Director, Service Business Div.
Service Business Div. (general)	Senior PM
Other experts concerned depending on themes	

External member

Faculty of Engineering, Yokohama National University	Professor

External adviser

Tohoku Branch, Kanto Tohoku Industrial Safety and Inspection Department, Ministry of Economy, Trade and Industry
Electric Power Safety Division

3. Presumption of Accident Causes

3-1 Conclusion

- Possible causes of the boiler explosion include an explosion of unburnt gas, dust explosion, and steam explosion. As a result of investigations into operating data and visual on-site probes, we assume that the accident was caused by a **steam explosion** stemming from the instant contact of **massive water** with fluid sand that has a high heat capacity.

- A number of presumed causes were identified after investigating what triggered the steam explosion from the viewpoints of design, installation work, operation and maintenance checkup.
  Meanwhile, no reduction was observed in the tube's inner wall thickness of the fractured portion, allowing us to conclude that leakage was different, at least from the previous explosion accident case.

- As the portion of tube fracture that initiated the explosion has been seized by investigative authorities, we are requesting probes from various perspectives, including dimensional inspection, metallographic observation, and hardness testing. Under the circumstances, we have not yet been able to narrow down the presumed causes, as details of the initially fractured portion are yet to be made known.

- As for measures to fend off a recurrence, the Accident Investigation Committee discussed them, including means of preventing a boiler explosion even in the event of a tube fracture occurring for reasons other than the presumed rupture. The move was given a high rating as a step toward accident prevention.

- When the outcome of official investigations into the initial fracture by the authorities concerned is made available in the future, we are set to call another meeting of the Accident Investigation Committee as necessary to identify causes and discuss necessary additional measures to be taken.

- Regarding the next project (restoration of the damaged No. 4 boiler at Iwaki Daio), we expect to apply accident prevention measures for a number of presumed causes.

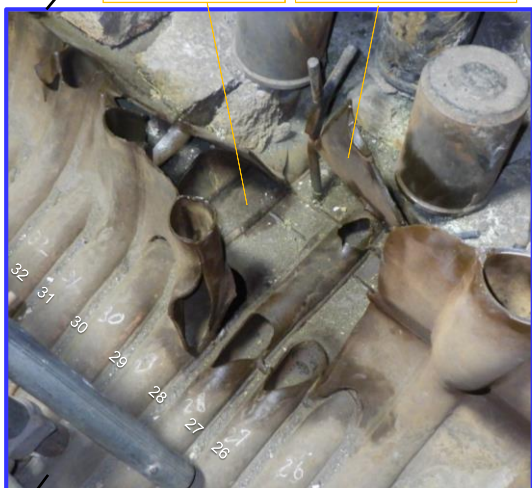
* The accident investigation report attached defines **"steam explosion" as "rapid explosion-like gasification (volume expansion) of water that came into contact with high-temperature sand."**

* The details are subject to change depending on the results of future investigations.

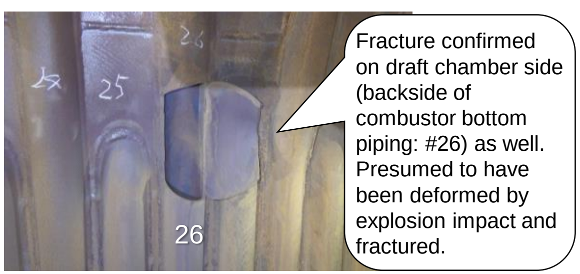
3-2 Understanding Present Situation

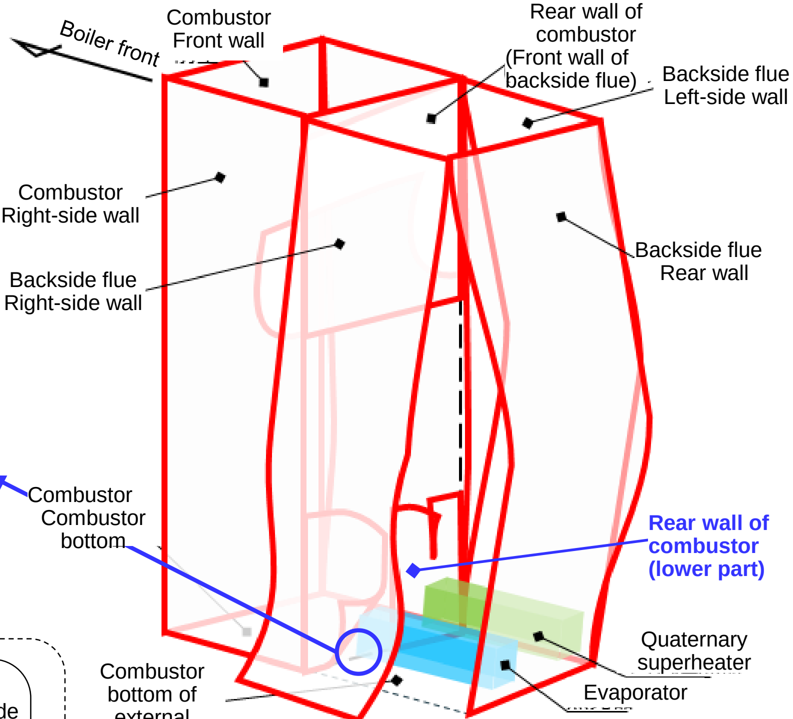
1) Status of boiler breakage

- We have found the lower part of the combustor's rear wall to have greatly deformed and fractured toward the external heat exchanger side (the boiler's back side), showing signs of enormous power having worked in that direction, with deformation near the bottom of the combustor most remarkable.
- While there are a majority of tube fractures forced by the explosion, we have presumed the furnace bottom tube #30 (the 30th pipe from left), which shows a fracture caused by internal pressure, was the initially fractured portion.

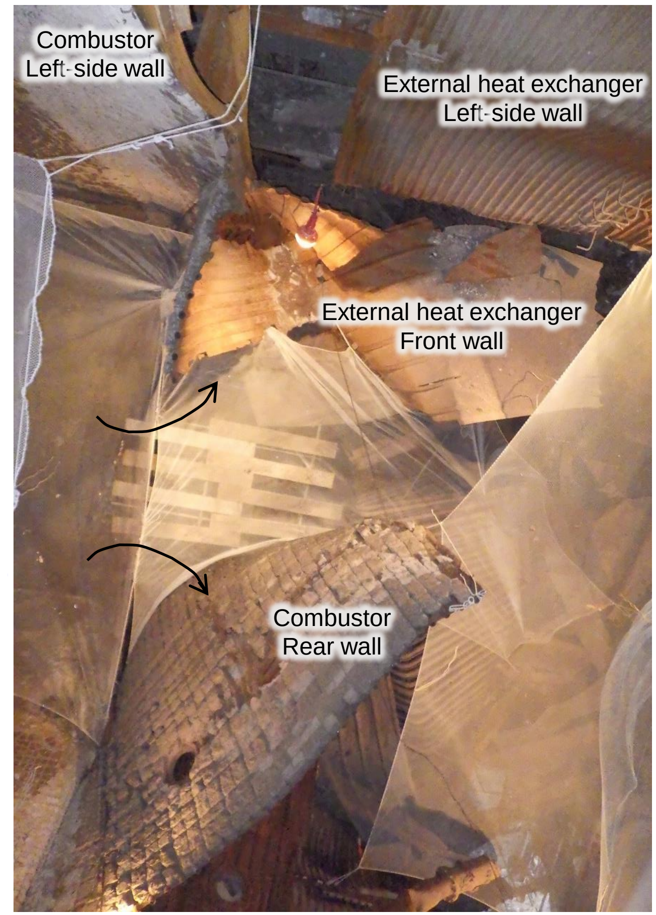


Status of combustor bottom piping (presumed point of origin)





Schematic view of boiler deformation status



* The details are subject to change depending on the results of future investigations.

2) Characteristics of initially fractured portion (presumed)

- #30 fractured portion is open, along the welded portion of the seal fin, in the axial/peripheral direction.
- According to visual observation, there was no cut in the inner wall thickness of the fractured portion, which shows signs of breakage caused by brittleness.
- Scaling was confirmed on the inside of tubes, but it is not known if it occurred before the blast.
- #30 fractured portion is within the triangular space where neither sand nor gas reaches, usually due to the seal fin that blocks them.

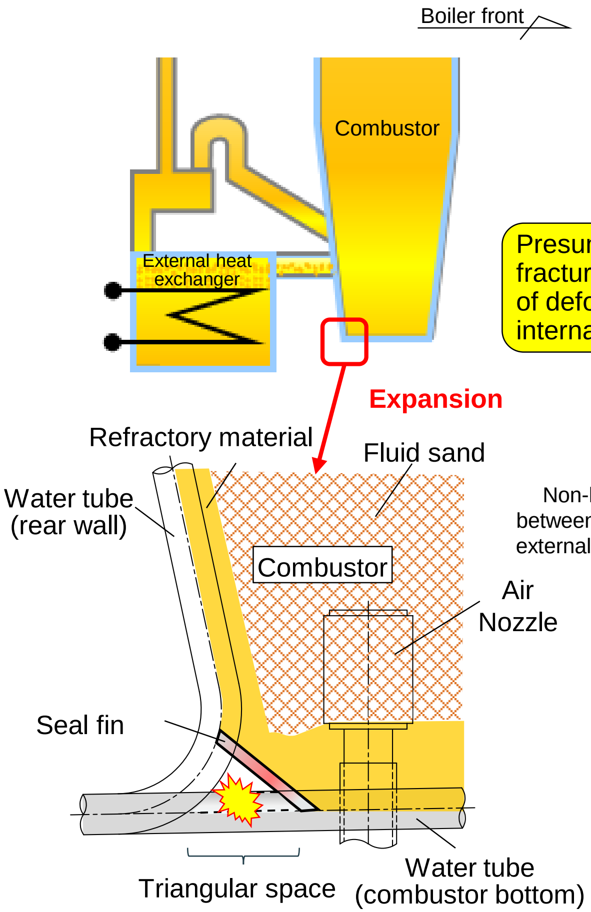
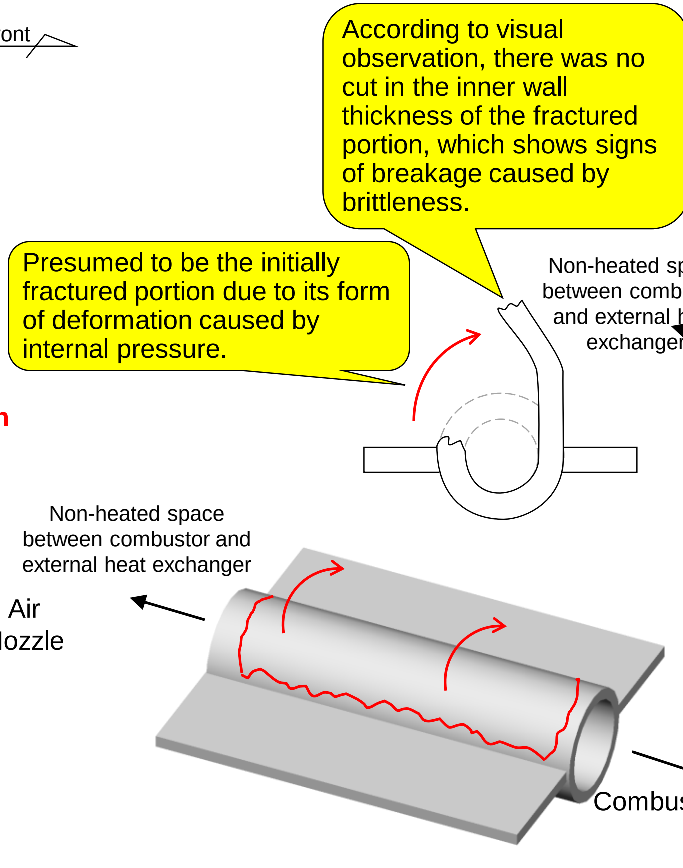
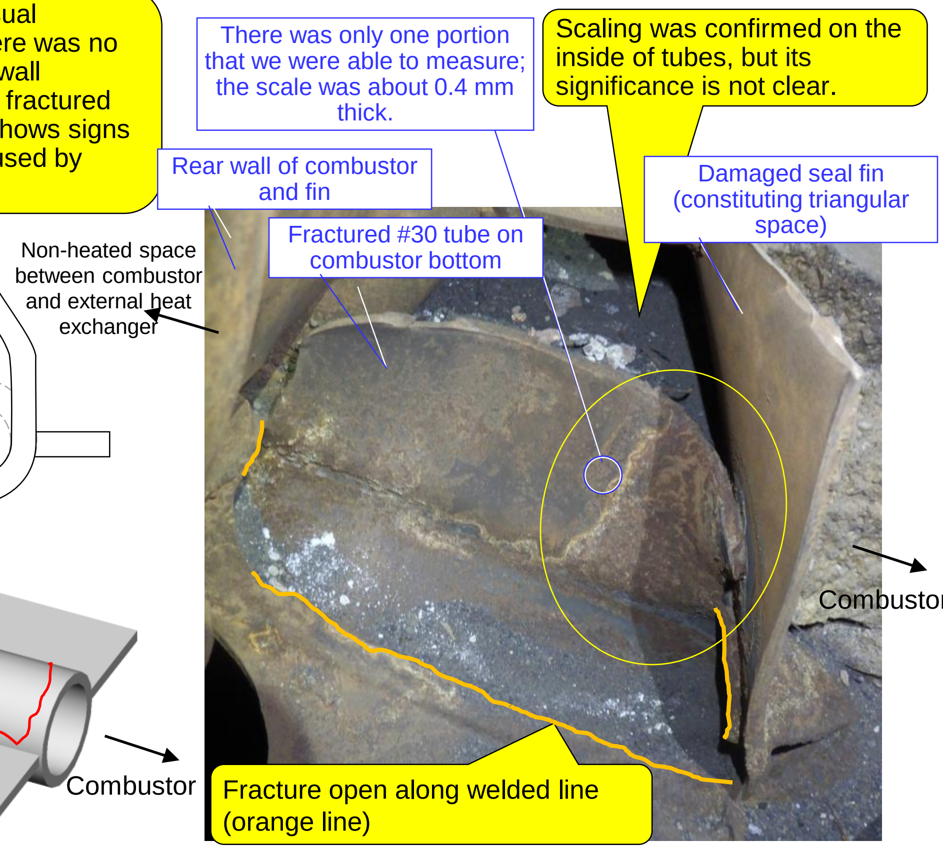


Chart of fractured portion



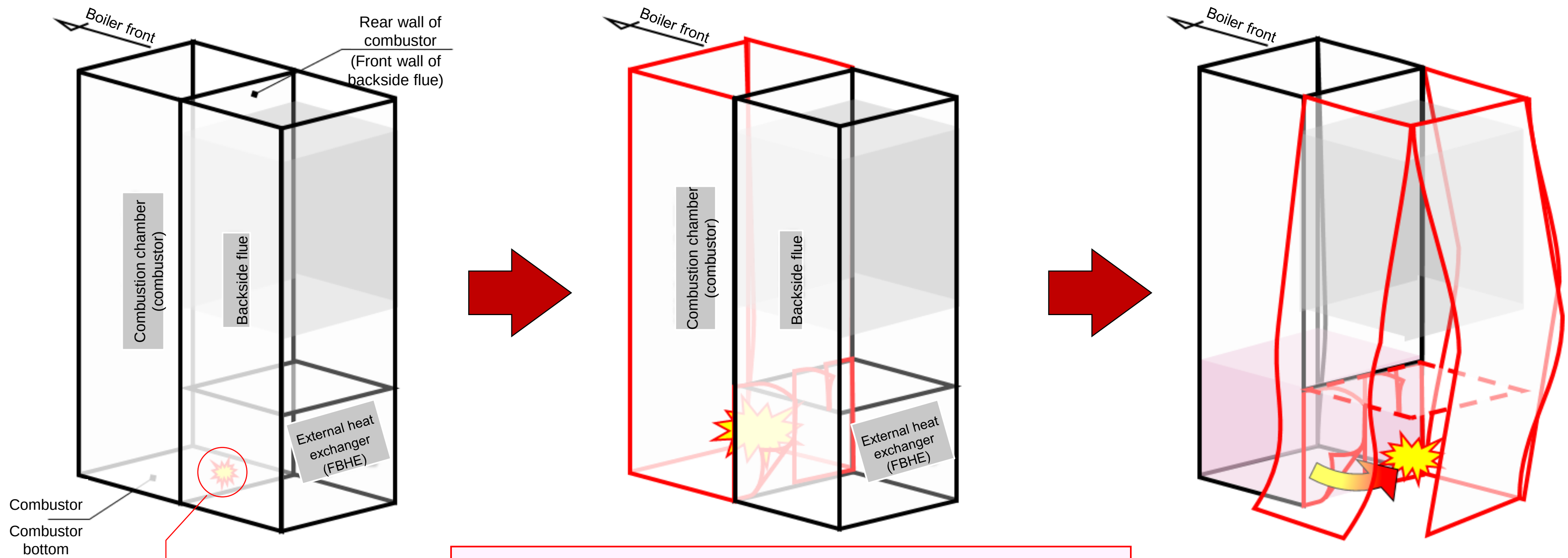
Illustrated fracture of #30 tube on combustor bottom



Status of fracture of #30 tube on combustor bottom

* The details are subject to change depending on the results of future investigations.

3-3 Flow of Accident Occurrence (Presumed)



Causes of leakage

- **Water** leaked due to tube fracture
  - △ Corrosion by hydrogen
  - △ Creep damaged
  - △ Crack (fatigue)
  - ✕ Reduced thickness for abrasion

Causes of combustor breakage (Leakage is the cause that led to steam explosion)

- Instantly contact with fluid sand which has a high heat capacity (lots of fluid sand on combustor bottom)
  - → **Steam explosion** (inside combustor) → Combustor broken
- △ Massive water instantly leaked in sealed triangular space without refractory

Causes of further breakage

- **Steam explosion** (inside external heat exchanger)
- ↓ External heat exchanger broken
- ↓ Complete loss

* The details are subject to change depending on the results of future investigations.

3-4 Causes of Leakage

Causes have not been identified as detailed analysis has yet to be made regarding the initially fractured portion (#30), but we have derived a number of presumed causes as a result of investigations from the perspectives of design, installation work, operation and maintenance checkup.

We believe it possible to narrow down causes by investigating the initially fractured portion, which has been confiscated by the authorities, from various perspectives, including dimensional inspection, metallographic observation, and hardness testing conducted by the Accident Investigation Committee.

1) Design

- There was no problem with the tube in the leakage area, for which we had selected the right dimensions and material quality that fitted the designed temperature and pressure.
  (*Interpretation of the technical standards concerned is based on their revised version of 2005.)

Article 5 (omitted)...The material must have safe chemical ingredients and mechanical strength against chemical and physical effects on the material at the maximum temperature used.

➡We have confirmed that material selection is based on "Interpretation of Technical Standards for Electrical Installations" (hereinafter "ITSEI") (Appendix 1, Article 2, Chapter 2).

Article 6 (omitted)...The structure of a pressure-resistant portion must ensure safety against maximum stress arising in the highest pressure or highest temperature used...(omitted)

➡Design confirmed as being in line with its respective standards, as follows.

- **Strength calculation : Executed based on ITSEI (Article 3, Chapter 2)**
- **Tolerable stress of material used in strength calculation: ITSEI (Appendix 1, Article 4, Chapter 2) applied**
- **Water pressure test on pressure-resistant portion : Executed on the level 1.5 times the maximum pressure used, based on ITSEI (Article 5, Chapter 2)**

<*Discussions on design continued on next page>

* The details are subject to change depending on the results of future

3-4 Causes of Leakage

1) Design (continued)

- The boiler manufacturer (Mitsubishi Heavy Industries Power IDS Co., Ltd.) began to use a seal fin for the triangular space in 1994 with a view to improving the sealing performance of the relevant portion. Adoption of this structure resulted in a structure with a "triangular space" surrounded by welded lines that was too narrow to allow inspection. (In usual operations, the relevant portion is covered by refractory and requires no inspection.)

- The Accident Investigation Committee conducted a desktop examination based on the hypothesis that the portion concerned was subjected to stress (thermal stress) caused by expansion and contraction at the time of boiler startup/stoppage, and to stress stemming from boiler vibrations, generating fatigue crack growth and forcing evaporator piping (water tube) to fracture. But the panel failed to find out the possibility of high stress being generated.

- For the same reason, the committee inspected similar tubes (#52, #54) and conducted non-destructive tests on the whole range of similar places. As a result, the committee was unable to confirm any tendency of damage as it was concerned about.

3-4 Causes of Leakage

2) Installation work

- The combustor bottom is divided into three parts, namely the boiler portion, and the left and right parts. Each part is made at a factory and assembled into a complete structure by on-site manual welding.
  On-site welding is performed between #28 and #29, a portion close to #30, and between #53 and #54. In order to avoid direct on-site welding of pressure-resistant parts as much as possible, the equipment is structured to allow on-site welding of each fin installed at a factory beforehand.

- During its on-site investigation, Iwaki Daio analyzed the welded portion of similar tubes (#52, #54) because the fracture appeared to have originated from the boundary part of the combustor bottom piping, combustor bottom fins, and seal fin, that had been welded in on-site work.
  As a result, insufficient welding and blow holes were observed in the welds between fins and tubes welded at the factory and between fins and tubes welded on-site, but no abnormalities in strength were confirmed by the hardness and tensile strength test results. (The minimum tube thickness calculated using a breakdown point resulting from the tests was 2.13 mm, showing no thinning in the inner wall thickness of the combustor bottom piping (about 4 mm thick), thus confirming that it is currently strong enough).

> Article 6 (omitted)...The structure of a pressure-resistant portion must ensure safety against maximum stress arising in the highest pressure or highest temperature used...(omitted)

* The fractured portion is a pressure-resistant part as described by the Ministerial Ordinance that is the basis of ITSEI, and accordingly, soundness of the “pressure-resistant part” to which fins were welded is required.
Therefore, such soundness can be ensured by the fact that the relevant pressure-resistant part has passed the water pressure test based on Article 6 of the Ministerial Ordinance (Article 5, Chapter 2, ITSEI).
(Article 74, Chapter 10, does not apply to the welded parts between tubes and fins, which are exempted from self-imposed inspection of welded parts.)

➡ **It was confirmed that the water pressure test had been performed at the level of 1.5 times the maximum pressure used, based on ITSEI (Article 5, Chapter 2).**

* The details are subject to change depending on the results of future investigations.

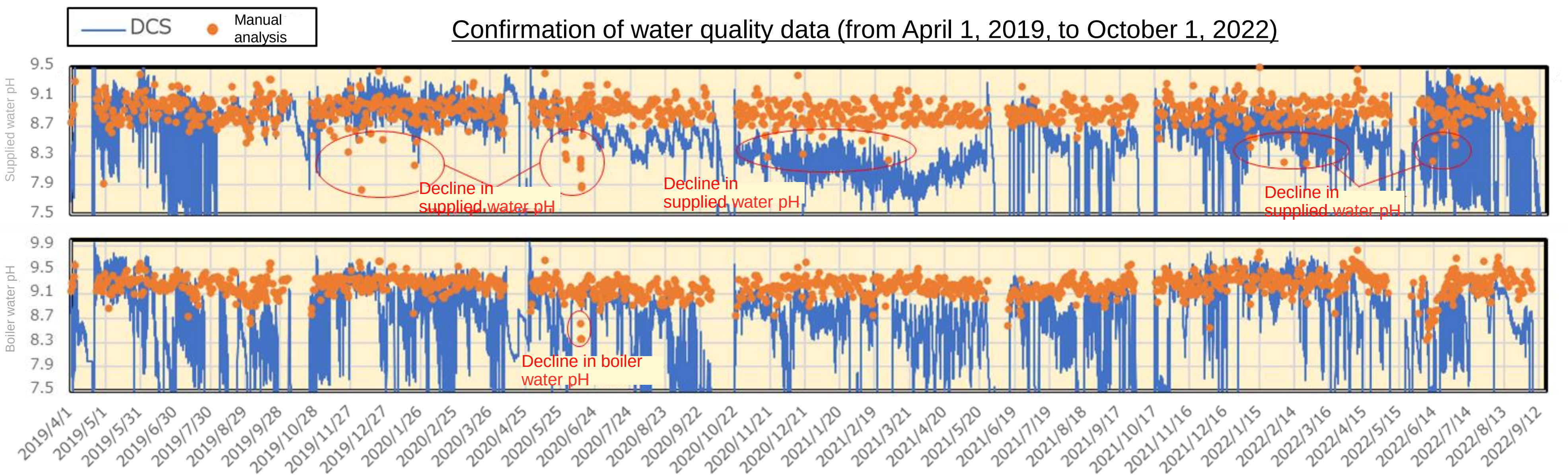
3-4 Causes of Leakage

3) Operation

- Water quality used to be managed in accordance with the standards of JIS B 8223. The pH levels of water newly supplied to the boiler and existing boiler water were below the standard of 8.5, as shown in the graphs below.
  The effects of hydrogen corrosion due to deterioration of water quality have been studied on similar parts, and the characteristics of such corrosion have not been confirmed.

- Iwaki Daio routinely conducted manual in-house analysis of pH and conductivity levels once a day as a water quality management practice.
  Readings from a continuous water quality monitoring instrument were used as a reference because they fluctuated widely. Calibration of instruments is performed by an outsourced service provider once every two months.

Confirmation of water quality data (from April 1, 2019, to October 1, 2022)



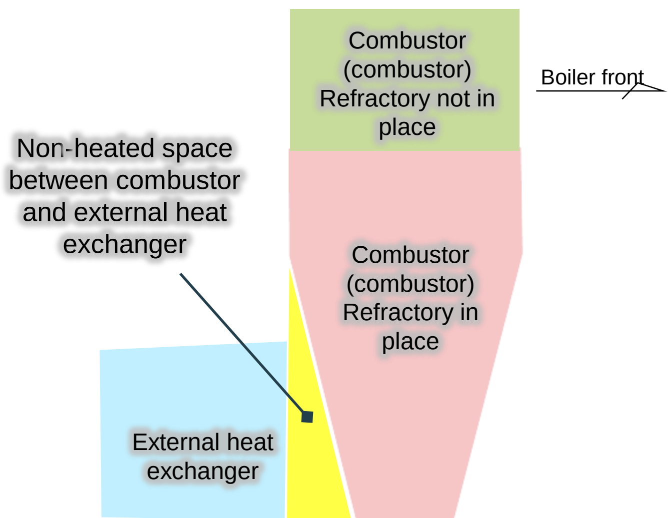
* The details are subject to change depending on the results of future investigations.

3-4 Causes of Leakage

4) Maintenance checkup

- Status of maintenance checkup so far of combustor water tubes and refractory materials
  - ▸ Periodic repairs have been carried out in approximately six-month cycles since April 2009, the year after the boiler went into operation.
    The six-month cycle is an arbitrary cycle set by Iwaki Daio according to the operational status.
  - ▸ Details of maintenance checkup during periodic maintenance work are shown in the table below.
  - ▸ There was no problem as the inspection was conducted in accordance with the interpretation of the periodic self-inspection and the Guidelines for Periodic Inspections of Thermal Power Stations (Thermal and Nuclear Power Engineering Society).
  - ▸ The last inspection before the explosion was conducted in May 2022, four months before the accident. Its results were as follows.

Water tubes: Inspected water tubes in the upper part of the combustor, not covered by refractory.
Water tubes in areas prone to abrasion were protected with sprayed film, otherwise the tubes were uncovered.
Sprayed film had its thickness measured, and any film with reduced thickness was replaced.
As for uncovered tubes, their exterior appearance was visually inspected and their thickness measured. There was no reduction in their thickness less than the controlled thickness.
Refractory: Uplift displacement and peeling were observed on some of the front and rear walls of the combustor. Partial repair was performed.
* Maintenance checkups on combustor water tubes and refractory material were outsourced to service providers other than Iwaki Daio and the boiler manufacturer.



Schematic lateral view of boiler

Classification	Combustion chamber (combustor)	Non-heated space between combustor and external heat exchanger
Water tube	• Sprayed film measurement and re-spraying of water tubes not covered with refractory (right above refractory and at corners) • Thickness measurement of water tubes not covered by refractory and without sprayed film	• Visual inspection only
Refractory material	• When non-compliance was found as a result of visual and hammering inspections of the refractory lining, replacement work was performed.	• Refractory lining not in place

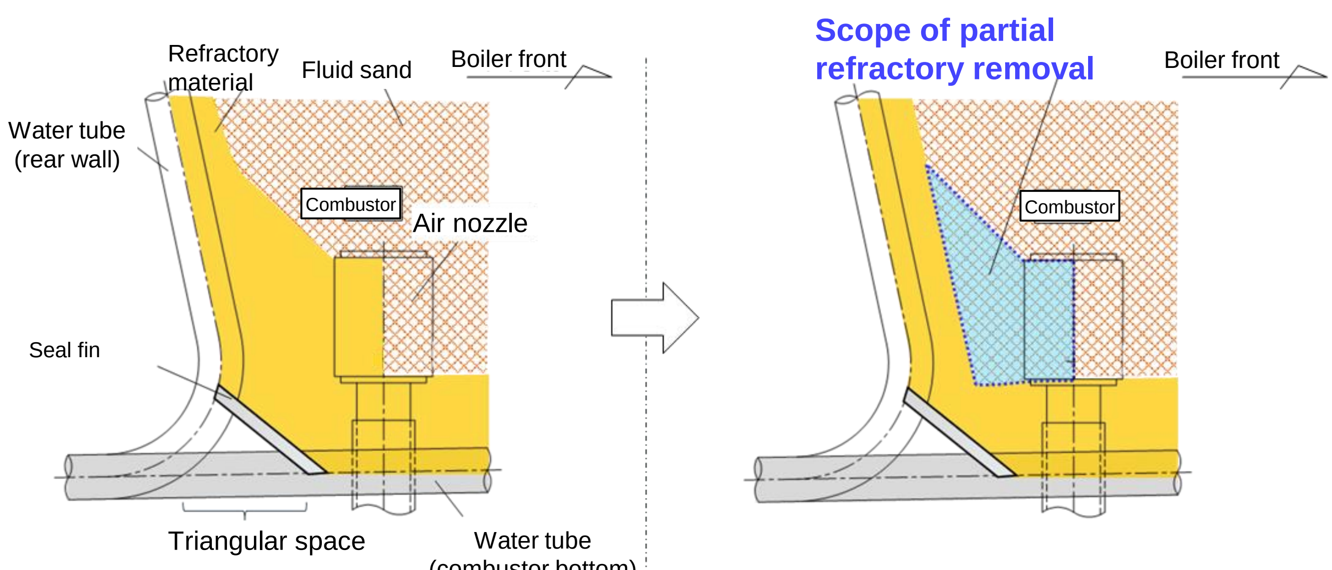
Maintenance and inspection status at time of periodic maintenance

* The details are subject to change depending on the results of future investigations.

3-4 Causes of Leakage

4) Maintenance checkup (continued)

- The structure was designed to require removal of the refractory material when replacing the air nozzles where the refractory material was installed. At its own discretion, Iwaki Daio had removed part of the refractory material in the area covering the nozzle.
- The triangular space was not described in the relevant chart, and Iwaki Daio did not know its presence. The company did not check with the manufacturer when changing the original specifications.
- We evaluated the impact of water tubes exposed by falling out of the refractory material around the triangular space.
  Even when heat input becomes excessive (exposed to high temperature inside the combustor), a simple increase in heat input alone is not enough to raise the temperature to a level where creep damage occurs, leaving the possibility of boiler breakage low.
- As the scale buildup in the combustor bottom tubes becomes thicker, the metal temperature rises as heat transfer is impaired, increasing the possibility of creep damage. It is not certain that there was any significance in our measurement this time.



(1) Original form

(2) With refractory removed

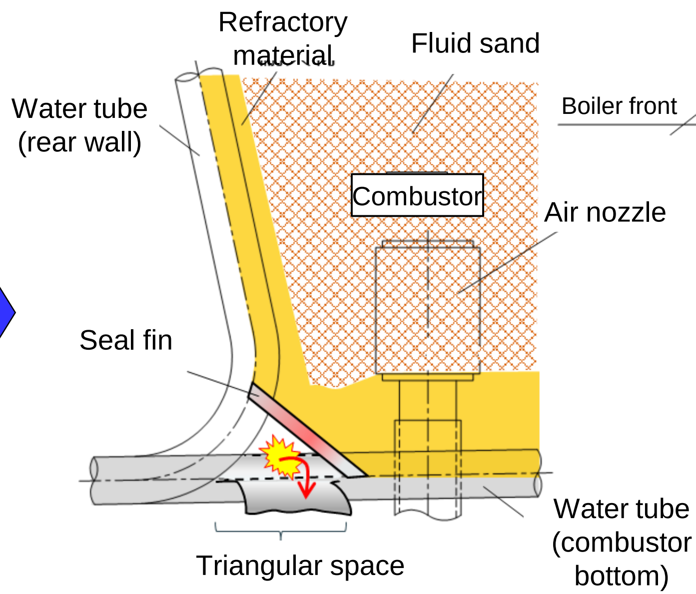
* The details are subject to change depending on the results of future investigations.

3-5 Causes of combustor breakage (why leakage resulted in steam explosion)

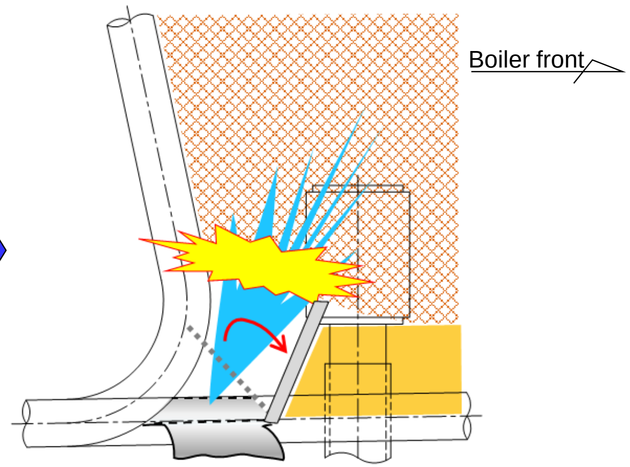
• Since details of the fractured portion of #30 have not yet been analyzed, it is not yet known why the fracture occurred. However, based on the results of the visual inspection and other factors, the following possibility was considered likely: A fracture developed in the #30 tube, causing a large opening in the triangular space to occur instantaneously, causing **a massive amount of water to leak out**, destroying the seal fin, abruptly bringing the water into contact with fluid material containing a large amount of heat, triggering **a steam explosion**, and destroying the boiler.

A situation has arisen in which the following phenomena may occur independently or in combination to **cause water leakage**.

- Corrosion by hydrogen
- Creep damaged
- Crack (fatigue)



Conditions for water leakage to cause an abrupt fracture are present, causing it to occur within the "triangular space" (the large opening resulted in massive **water leakage**)

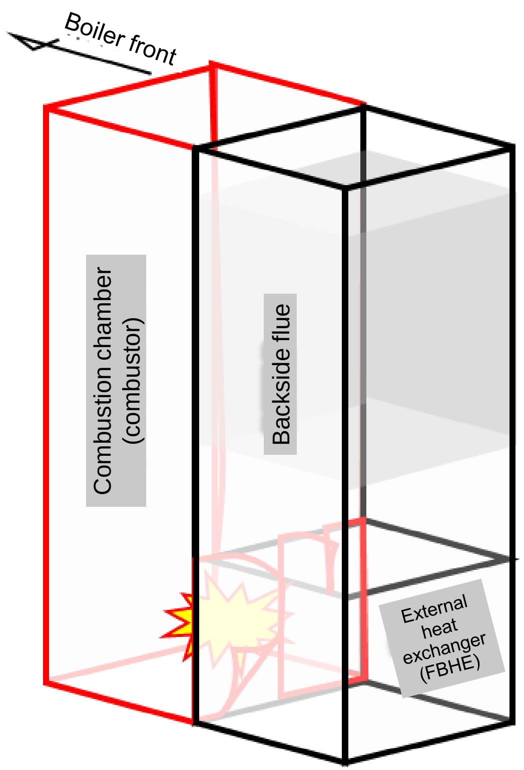


As **massive water leakage** destroyed the seal fin and came into contact with fluid sand containing high heat, **a steam explosion occurred** on the combustor side, fracturing its rear wall.

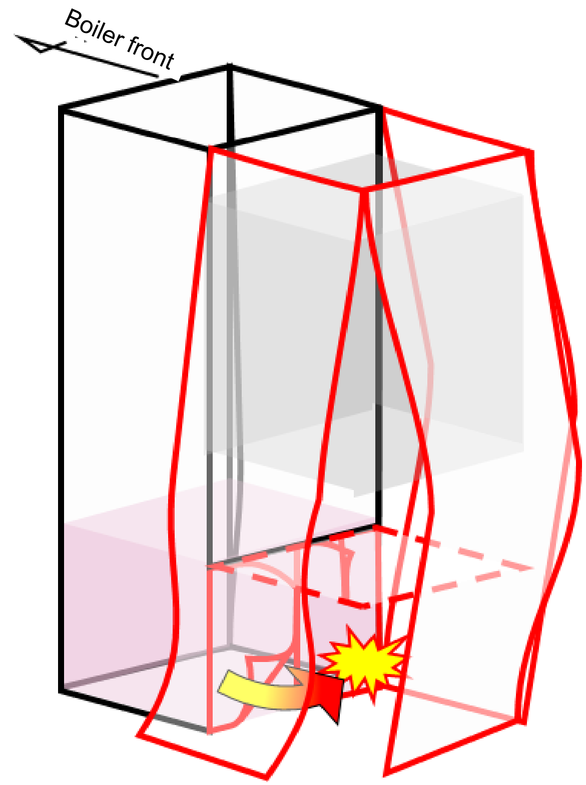
* The details are subject to change depending on the results of future investigations.

3-6 Causes of Further Breakage

- It is highly probable that **the steam explosion on the combustor side triggered** the fracture of the water tube in the external heat exchanger, causing **a large amount of water** to come into contact with the fluid sand in the external heat exchanger, resulting in **a steam explosion** and further expansion of the damage.



Steam explosion on combustor side fractures water tubes of external heat exchanger, causing **secondary water leakage**



Secondary wave of leaked water comes into contact with fluid sand inside the external heat exchanger, **causing steam explosion** there **(further expanding breakage)**.

* The details are subject to change depending on the results of future

4. Comparison with Other Similar (Same Capacity) CFB Boilers [Pointed Out at Previous WG Meeting]

- Abnormal numerical values were not confirmed in terms of basic boiler information (hours of use, number of starts/stops, fuel, etc.)
- Refractory breakage was not confirmed among similar CFB boilers.
- The base value of boiler water pH at the Iwaki Daio No. 4 boiler tended to be lower than that of similar CFB boilers.

* The details are subject to change depending on the results of future

5. Summary of Presumed Accident Causes and Measures to Prevent Recurrence

- Possible causes of the boiler explosion include an explosion of unburnt gas, dust explosion, and steam explosion. As a result of investigations of operating data and on-site visual probes, we assumed that the accident was caused by a **steam explosion** resulting from the instant contact of **massive water** with fluid sand that has a high heat capacity.

- Although the detailed conditions of the initially fractured portion have not yet been clarified, and we have not yet narrowed down the factors behind the accident, we would like to apply the following measures to presumed causes derived from various investigations.

1) Measures addressing water tube leakage

◎ Eliminate the seal fin for the triangular space (which results in disappearance of the triangular space)
◎ Restrict scale buildup on the inside of water tubes (eliminating the risk of creep damage)
◎ Prevent decline in pH level of boiler water (eliminating the risk of tube corrosion by hydrogen)
◎ Eliminate the risk of heat buildup on water tubes due to refractory removal
(corrosion by hydrogen, creep damage, avoidance of crack risk)

2) Measures to reduce the risk of steam explosion occurring even when water leaks

◎ Eliminate the triangular space to prevent massive water from abruptly coming into contact with fluid material with high heat content

3) Measures to prevent the scope of breakage from expanding further

◎ Render water piping structure on peripheral walls of external heat exchanger (water tubes + refractory structure) to a non-pressure structure (casing/iron plate + refractory structure)
◎ No evaporator installation inside the external heat exchanger

* 2) and 3) are measures Iwaki Daio requested the boiler manufacturer to take before restoring the boiler.
* Explanations were given by the boiler manufacturer regarding horizontal deployment to other projects.

* The details are subject to change depending on the results of future investigations.