

## THE REVIVAL OF ONAHAMA SMELTER & REFINERY FROM THE DISASTER BY THE GREAT EAST JAPAN EARTHQUAKE

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### Abstract

The earthquake with seismic intensity six trembled Iwaki City, Fukushima Prefecture, Japan on March 11 2011 and a subsequent tsunami attacked the coast on which Onahama Smelter & Refinery was located. The earthquake damaged many facilities and liquefied the ground. The tsunami flooded one third of the plant area. Furthermore, the repair work had to be suspended by the accident happened at Fukushima Daiichi Nuclear Power Station. The repair work was re-started in April and progressed smoothly. The operation was restarted on June 30 and the revival of Onahama Smelter & Refinery from the disaster by the Great East Japan Earthquake was completed. Radioactivity measurements have been programmed in detail and applied all over the materials covering from raw materials to products in order to supply safe and relief products to customers. The radioactive contamination to the products has not been detected at all.

### Introduction

Onahama Smelter & Refinery was founded in 1963 as the first Cooperation Copper Smelter & Refinery in Japan. Until now, each of the facilities has been strengthened year by year and 60,000Mt/M copper concentrate was treated and 25,000 Mt/M electrolytic copper was produced. Furthermore 15,000 Mt/M combustible waste materials such as shedder residue from used automobile, electrical home appliances and vending machines were treated by substitution of fossil fuel used at two reverberatory furnaces. Table I shows capacity of each of plants. The Great East Japan Earthquake with seismic intensity nine as seismic centers located at the northeastern offing was occurred at 14:46 on March 11 2011. The earthquake with seismic intensity six and a subsequent tsunami attacked Onahama Smelter & Refinery. The revival was full of difficulty by addition to the big damage by rumors caused by an accident in Fukushima Daiichi Nuclear Power Station afterwards. In spite of these difficulties, the operation was restarted on June 30 after every single person engaged in the revival had devoted efforts for 3.5 months.

The following items will be described in the present paper:

- 1) Damage received by the Great East Japan Earthquake and revival plan,
- 2) Current operation after the revival.

Table I. Capacity of Each of Plants

Smelter	60,000Mt/month Copper Concentrate Mitsubishi S Furnace, 2-Reverberatory Furnaces, 5-P.S. Converters, 3-Anode Furnaces
Refinery	25,000Mt/month Electrolytic Copper Starting Sheet Tank House No.1&No.2 Tank Houses (12,000mT/Month) No.3 Tank House (13,000mT/month)
Acid Plant	55,400Mt/month (98% $H_2SO_4$ ) No1 & No3 Acid Plants (Single contact converters)
Gypsum Plant	28,000Mt/month
Fine Casting Plant	8,000Mt/month, Billets&Cakes

### Damage received by the Great East Japan Earthquake and revival plan

Electricity, drinking water, plant water, seawater stopped promptly after the earthquake occurrence. After the urgent stop measures were executed in the trembling caused by an intense earthquake, all workers evacuated to neighboring ground. Fortunately there was not environmental and work related accident at all with the help of appropriate urgent correspondence and the evacuation procedure drilled regularly twice a year. The damage of each of plants is listed in Table II and photos of miserable damaged facilities are demonstrated in Figure 1.

The repair work was limited without the restoration of the lifelines which were supplied by Tohoku Electric Power, Fukushima prefecture and Iwaki city. It took 74 days though all lifelines recovered because the lifelines were damaged all over the Tohoku district. On the other hand, almost all facilities in Onahama Smelter & Refinery were also damaged. Therefore, it was judged that each of facilities was restarted one by one.

The revival plan was summarized as follows.

1. Repairs of the utility such as pits and plumbing of plant water and sea water were taken priority. Especially, an outlet port of discharge was completely collapsed by the tsunami and had to be remodeled to earthquake-resistant structure before sea water was supplied. Figure 2 shows photos of outlet port of discharge drainage.
2. The fine casting plant was restarted prior to other plants. Because the operation could be possible without supply of sea water and by treated purchased electrolytic copper which was delivered by Mitsubishi Materials Corporation. First of all, it was necessary to satisfy customer needs to the maximum as much as possible.
3. Mitsubishi S furnace, one reverberatory furnace, three PS converters and two anode furnaces which were necessary for partial operation, shall be restored first at the smelter section.
4. Starting sheet tank house and No.2 commercial tank house which were with a little damage comparing with No.1 & No.3 commercial tank houses shall be restored first at the refinery section. Figure 3 shows photos of No.3 tank house.
5. No.3 acid plant which was less damaged than No.1 acid plant shall be restored.

Table II. Damage of Each of Plants

<p><b>Smelter</b>                  S furnace, reverberatory furnaces, PS converters and anode furnaces stopped with full melt. The ceiling and the sidewall bricks of the reverberatory furnaces dropped more than 20,000 pieces.</p>
<p><b>Refinery</b>                  More than 140,000 sheets of anodes and cathods dropped into cells and inside lining of more than 80% cells was injured.</p>
<p><b>Acid Plant &amp; Gypsum Plant</b>                  Converters, drying towers and absorption towers stopped with SO<sub>2</sub> gas. Many cracks and breakings were observed in towers, plumbing and gas duct .</p>
<p><b>Utilites</b>                  Sea water pit was breaking. Many pipes of drinking water, plant water and sea water cracked. Outlet port of discharge drainage was collapsed. Numberless cave-ins and cracks were observed in all roads .</p>

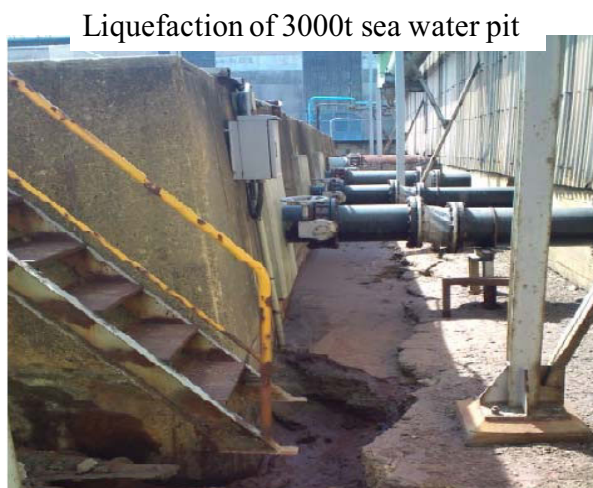
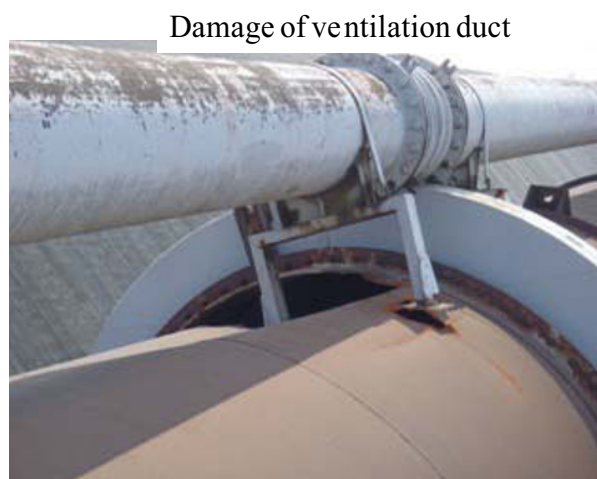


Figure 1 Photos of damaged facilities



Figure 2 Photos of outlet port of discharge drainage

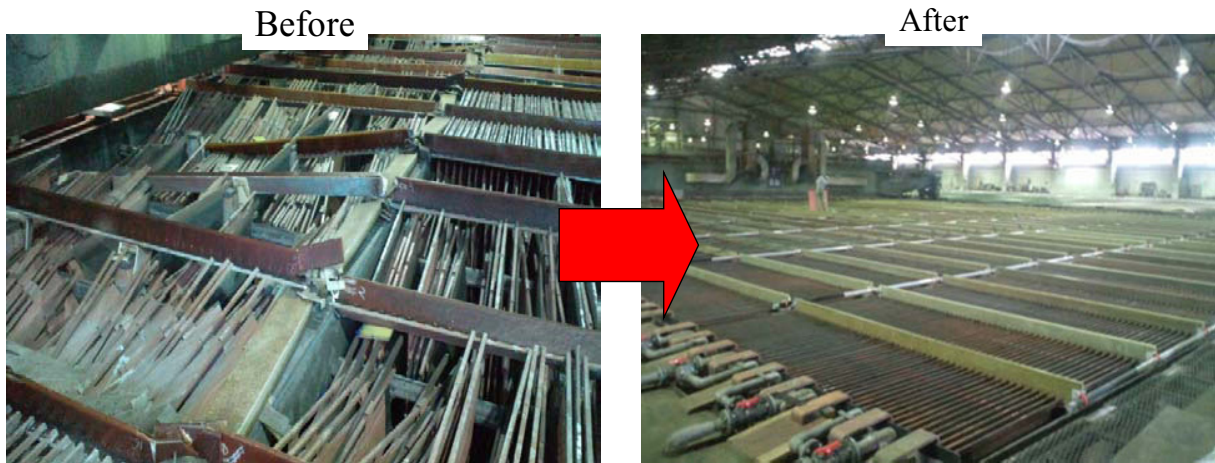


Figure 3 Photos of No.3 tank house

Table III. Process of Revival

Mar. 11	Hit by the Great East Japan Earthquake
Mar. 23	Received electricity from Tohoku Electric Power
Mar. 28	Restrated supply of drinking water by Iwaki city
Apr. 11,12	Hit by the aftershocks of intensity 6 twice
Apr.22	Restrated supply of plant water by Iwaki city
May. 16	Restarted fine casting plant
May. 24	Restarted supply of sea water by Fukushima prefecture
Jun. 29	Restarted refining operation at No2 tank house
Jun. 30	Restarted smelting operation at 65% of capacity
Jul. 2	Increased smelting operation to 90% of capacity
Aug. 23	Returned to smelting operation at full capacity
Aug. 31	Returned to refining operation at full capacity

410 employees, 350 contractors in plants and 12 staffs who were dispatched from Mitsubishi Materials Corporation as a parent company, were engaged in revival. Furthermore, the total number of contractors which were temporarily called for repair work from the all over Japan reached to more than 36,000 man-days.

The process of revival was shown in Table III. Partial operation at 65% of the capacity was restarted on June 30 and full operation was realized on 30 August when the original revival plane was moved up more than one month before. As a result, the revival of Onahama Smelter & Refinery from the disaster by the Great East Japan Earthquake was completed.

### **Current operation after the revival**

Onahama Smelter & Refinery was located at the position of 53km south-southwest from Fukushima Daiichi Nuclear Power Station and the location has been out of a refuge area. However there was concern of the radioactive contamination to products after the operation was restarted. New system for radiation control has been introduced to cope with inquiry about safety from customers and secured safety of products.

Main correspondence to radioactive contamination carrying out was shown as follows.

1. As of raw materials, all recyclable materials such as shredder residue have been checked over loading trucks utilizing radiation detector. Only recyclable materials less than the standard value had been received. As radiation of fly ash generated from incinerators was higher than the standard value, treatment of fly ash has been suspended since accident of Fukushima Daiichi Nuclear Power Station.
2. As of products, radiation dose of products was measured by the third party. Fortunately, radiation dose of products such as electrolytic copper, sulfuric acid, gypsum, copper sulfate, crude nickel sulfate was lower than detection limit.
3. Radiation dose of discharge water from waste water treatment plant and off gas from stack was measured once a month. The value always showed lower than detection limit. Space dose of radioactivity was measured once a month and the result was posted in order to let the employees feel relieved.

By such severe management, the radioactive contamination to products has not been found at all and the measured value has been reported to customers if requested.

Figure 4 shows amount of treated copper concentrate and produced electrolytic copper after revival. It was forced that the treatment of copper concentrate sometimes decreased or stopped by blackout or water supply troubles caused by the frequent aftershock, however damage of facilities in plants was not occurred at all by an effect of the earthquake-resistant remodeling. The supply of lifelines was recovered month by month, and improved further. Consequently the production also increased and the treatment of copper concentrates has achieved a new record of 68,425 metric-tons in August 2012. On the other hand, the collection of combustible waste materials such as shredder residue had decreased sharply after the operation was restarted as shown in Figure 5. It consisted of two reasons.

- 1) The earthquake disaster passed throughout East Japan and many scrap factories which generated shredder residue were driven into the shutdown.
- 2) Many people had to buy used cars immediately because many cars were carried away by the tsunami. As a result, a disposal car decreased sharply and the raw materials of the shredder dust also decreased sharply.



However, the collected amount of shredder residue gradually recovered and returned to the amount before the earthquake disaster since April 2012.

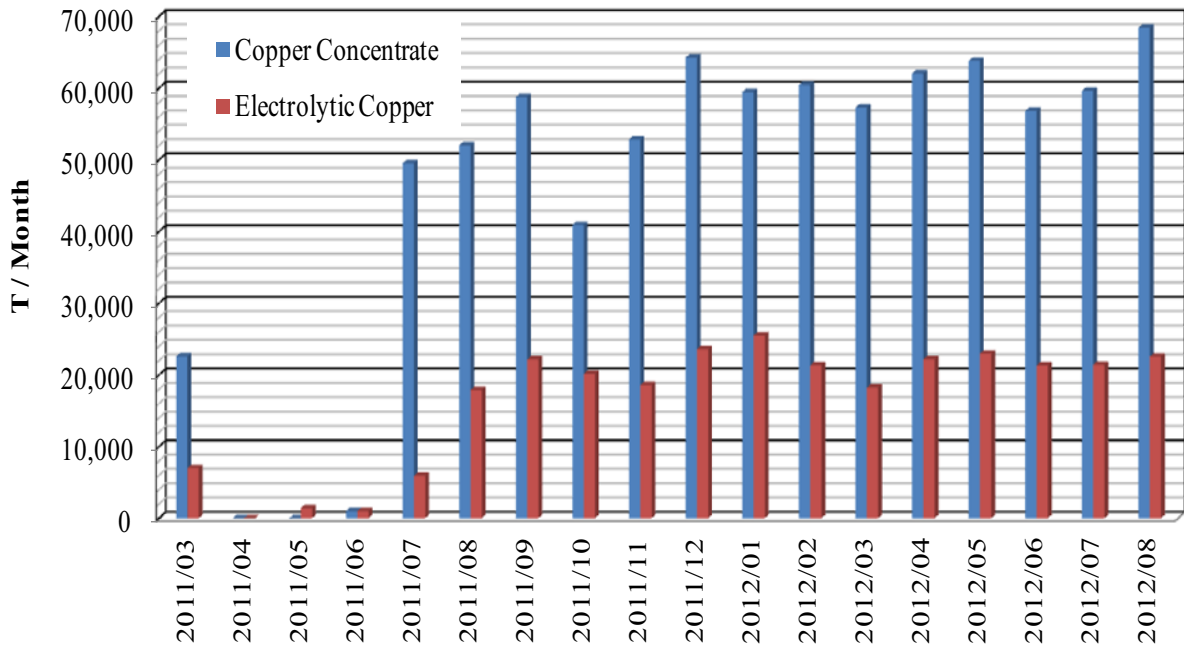


Figure 4 Amount of treated copper concentrate and produced electrolytic copper after revival.

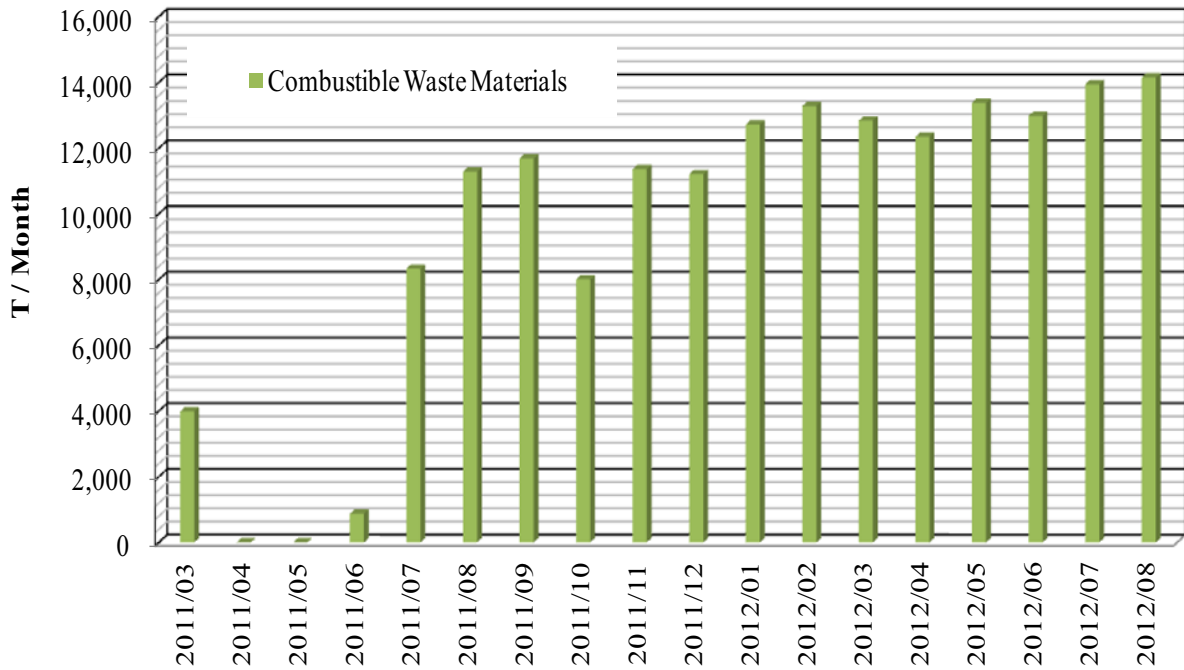


Figure 5 Amount of treated combustible waste materials after revival.

## Conclusions

1. The earthquake disaster was an unhappy event for Onahama Smelter & Refinery. However, the employees grew up vigorously and gained a lot of irreplaceable experience through revival process. It was possible that restart of operation was made largely early as a result of desperate effort of all people.
2. There has never been radioactive contamination to products after the nuclear accident because new system for severe radiation control has been conducted rigidly.
3. The operation after the revival is favorable as a result of improvement of the facilities including earthquake-resistant remodeling together. The new record of amount of treated copper concentrates was established in August 2012 and collection of combustible waste materials also turned upward.

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