### Chapter 2

### Electric Power Supply at Mt. Fuji Weather Station

### Tokyo Office, NPO Mount Fuji Research Station

### 1. Introduction

It was 1944, in the last stages of World War II, when the first electric wire was laid on Mt. Fuji as part of the Imperial Headquarters' plan to maintain the communication network between Mt. Fuji and Tokyo, Hachijo, and Nagatsuda. According to Taisaku Shizaki's book, Story of Mt. Fuji Weather Station (2002), in April 1944 the Imperial Headquarters decided to establish the wireless communication network to maintain a hotline in the event that Honshu Island would become a battlefield, with Mt Fuji Weather Station as the microwave relay base. Since the most difficult problem at the time was safe maintenance of power supply, the decision was made to use a diesel motor. However, the motor required considerable improvement before it could be used at high altitudes with low atmospheric pressure.

The Imperial Headquarters assessed the situation in July of that year and installed the electric wires in a 2-week rush job completed by 500 military personnel. Commercial electricity at the weather station was not used until after the war in January 1947, when a 150kg transformer was carried up the mountain by Hiroshi Shimura, reputedly the strongest goriki on Mt. Fuji, who could carry 4 soldiers at a time and had recently returned home. Even though the Mt. Fuji RADAR was established in 1964, the electricity supply was not renewed, creating problems for the engineers to maintain them. When new buildings for the Mt. Fuji Weather Station were built in October 1973, the first renovation of the electric wiring took place, including the installation of three 6-cm wires capable of transmitting 6600 V (the recommended level for RADAR at the time).

The wires were installed aerially, running from #1 electric pole at Gotemba at 1075 m a.s.l. to #73 pole at 1575 m a.s.l. and then underground to the weather station at Kengamine. Figure 2-1 shows the electric wiring system when we, the NPO Valid Utilization of Mt. Fuji Weather Station (NPO Mt. Fuji), rented the electric system in 2007 (red line).



Fig. 2-1: Electric Wire System at Mt. Fuji Weather Station

# **2.** Severe lightning at Mt. Fuji: Special considerations for electricity use

Most climbers are familiar with the intensity of thunder and lightning on mountains, and as an independent high peak, the strength of Mt. Fuji's lightning is well known. For example, on August 9, 2008, one climber was reported to be fatally struck by lightning between the 6th and 7th Stations of the Fujinomiya trail, with other climbers only a few meters unharmed.

During the construction of new station buildings in the summer of 1973, engineers were alarmed at the need to seek refuge as soon as they noticed lightning approach. Many years later, the chief engineer of Taisei Building Co., Shosuke Ito, recalled the fear caused by his hair standing on end when lightning approached, even when wearing a helmet. On Mt. Fuji, lightning can come not just from above, but also from the sides or even from below. The common consensus is that there has been a lack of sufficient lightning rods on the mountain. Therefore, the most realistic way for workers to protect themselves and their instruments when lightning is forecast has been to cut the commercial electricity and then generate electrical power from a generator; indeed, JMA engineers at the station have used this approach for more than 70 years.

# 3. NPO Mt. Fuji and the electric wiring system

When NPO Mt. Fuji first started renting the weather station, JMA was reluctant to rent out access to the electric wiring system and planned for meteorological measurements to continue at Mt. Fuji Weather Station as an AMeDAS station but using batteries. This would remove the need for commercial electricity as well as eliminate maintenance costs associated with a commercial system, given the very likely event of problems caused by severe weather. However, we insisted that without a direct electricity supply, the weather station would not be useful for our purposes, especially for atmospheric chemistry. Ultimately, we were able to rent the commercial system including the electric wires, provided that NPO Mt. Fuji would be responsible for all expenses related to the system. This naturally includes maintenance costs for repair of electric wires damaged by heavy snow or natural disasters.



Fig. 2-2: Checking the underground electric wire near 3585 m a.s.l. (taken July 2007 by the mountain crew)

Although we were fortunate enough to be able to rent the commercial system and begin our research observations, system maintenance became one of the most troublesome issues of NPO Mt. Fuji's logistics. Also, the rental period was limited to just 2 months in the summer because, without people on-site, the electricity cannot be switched on and off when lightning occurs and such a situation was not permitted by the creditor, JMA.

At the beginning of NPO logistics in 2007, we carefully inspected the wiring system, one third of which is aboveground, with the rest buried. Inspecting the underground section is very difficult, so we checked the mountain huts, which have periodic aboveground markers displaying information about adjacent sections of wiring. Aboveground wires can be checked more easily, but they are prone to damage from heavy snow or trees branches and require very careful inspection.

Fortunately, at this time, chief electrical engineer Tomohisa Okoda, who had just retired from JMA, joined NPO Mt. Fuji, allowing us to maintain the same expert in the same position when we started our logistics. Figure 2-2 shows the engineers of Kandenko Co., Ltd. checking the underground wires near 3585 m a.s.l.

Mr. Okoda had had an unfortunate experience the year before when almost 1 week of commercial electricity supply was lost. After this, the particularly fragile huts on Umanose and #64 pole were checked with special care (Fig. 2-2). Therefore, in 2007, the connection was successful with simultaneous switching at the summit and #1 pole. We felt a sense of accomplishment when, on July 9, 2007, we could announce to our members that we had successfully turned on the electricity. With this, we felt ready to start our summer research campaigns. Over the last 10 years, except for 2015 when the summer campaign was delayed 1 week because of an underground wire accident at the shrine (Table 2-1), we have been very lucky to have successful connections at the beginning of every campaign. We greatly appreciate that we have been able to work with the know-how acquired through relationships with individual members of JMA.

## **3.1 Damage to the electric poles by heavy snow** (2008)

In summer 2007, we were struck by a typhoon at the beginning of the research campaign. Frequent lightning strikes also meant we had to switch from using the commercial electricity supply to local generators as many as 54 times over the summer. However, when the campaign ended, we found that generally the results were unexpectedly good and the campaign was a logistical success. With the unexpected success of the 2007 summer research campaign and the acquisition of new research funds, our 2008 New Year's Day was more celebratory than ever before.



Fig. 2-3: Electric poles damaged by heavy snow in 2008

However, bad news came in February that the Echo Rangers had found on their patrol that 12 poles (#58-64 poles) had been damaged by heavy snow. We discussed repairs with JMA, but as they were no longer using the commercial electricity, they were no longer responsible for such repairs. As an NPO, we therefore needed to fund the repair bill of almost 5 million yen ourselves if we were to continue using the commercial electricity supply. Given that the forthcoming summer research campaign would be impossible without commercial electricity, after much deliberation and with much reluctance, NPO members allocated some of the valuable research funds toward repairing the poles, which are now listed as NPO assets. Fig. 2-3 shows the electric poles damaged by heavy snow in 2008.

## **3.2 Exchanging the inherited transformer for a new one at the NPO's expense**

Another unexpected misfortune with the commercial electricity was that we had to acquire a new transformer to replace the previous transformer that contained PCB, a chemical with high electric resistance and stability against water and chemicals but that was proven to be hazardous for human health in the Kanemi Oil PCB Poisoning incident in 1968. Although PCB was used in transformers from before 1972, its use was legally banned in 1975 and older products were then phased out, starting with domestic products and moving to industrial products. The year 2012 was the deadline for removing PCB-utilizing transformers. As JMA had stopped using the commercial electricity supply at the Mt. Fuji Weather Station, they accepted responsibility for removing the old transformer, but financial responsibility for acquiring a replacement PCB-less transformer for future use fell on us. Therefore, we acquired a new transformer for around 2 million yen, which is listed as another NPO asset.

#### 3.3 Sharing electricity

Sharing electricity for the public toilet built by the Ministry of Environment at the summit—the so-called 'Bio-Toilet'—started in 2007. In 2014, we also started sharing electricity with Oyama town in Shizuoka Prefecture from #72 electric pole.

### 4. A motion dynamo as an alternative power supply: NOx is an obstacle for atmospheric chemists

One of the most important jobs for mountain crews is to check instruments after lightning has occurred. This is fundamentally the same as when JMA maintained the station, although lightning forecasts are more accurate nowadays. To avoid lightning damage, the commercial

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electricity supply is cut whenever lightning is forecast, and a motion dynamo power supply is used. However, because this system is not completely free of NOx emissions, atmospheric data for  $O_3$ , NOx, and other atmospheric species cannot be recorded when the motion dynamo is operating. These dynamos cause problems for atmospheric chemists when lightning occurs very often because we cannot record continuous data. Further complicating matters, de-nitrifiers cannot be easily utilized at the summit of Mt. Fuji, where atmospheric pressure can be as low as 650 hPa and where there is wind circulation. Therefore, establishing a NOx-free alternative power supply has been a longtime goal (see Chapter 4.10). Table 2-1 shows major events concerning the power supply over the past 10 years.

Event	Year	Start Date	End Date	Affected
Damage to 12 electric poles caused by heavy snow	2008	May 16	July 3	
Cubicle switch damaged by lightning	2010	June 21	July 12	
Overhead wire cut at power transmission line #70 pole, presumably due to metal fatigue	2011	July 7		
12 hours of blackout at night caused by mice	2012	August 15 21:43	August 16 9:55	Fight against wild animals has started to protect the electric wire
Blackout caused by lightning at Gotemba	2013	August 11 15:35	August 11 20:55	
Underground wire found damaged, presumably caused by use of heavy machinery when building the campus at the shrine atop Mt. Fuji	2015	June 24	July 8	One week delay of summer campaign
Sand pile caused by snow melt was found under the overhead cable between #70-71 poles	2016	May 25	June 20	