Norwegian
Meteorological
Institute

METreport

No. 21/2015
ISSN 2387-4201
Observation

Andøya weather radar, damaged radome

Damaged radome due to lightning

Kjetil Stiansen, Laila F. Sidselrud

Norwegian
Meteorological
Institute

METreport

Title Andøya weather radar, damaged radome	Date 2015-11-03
Section [Section]	Report no. No. 21/2015
Author(s) Kjetil Stiansen, Laila F. Sidselrud	Classification ● Free ○ Restricted
Client(s) [Client(s)]	Client's reference [Client's reference]

Abstract

The weather radar located at Andøya, in the northern part of Norway, has during the last few years been exposed to several lightning strikes. Some of the earlier lightning strikes caused damage to electronics, but nothing that could not be repaired.

This report will focus on the last strikes that occurred in the end of January and in the beginning of February 2015.

Keywords
Weather radar, Radome, Lightning, Damage

Vegard Kristiansen

Disiplinary signature

Cecilie Stenersen

Responsible signature

Abstract

The weather radar located at Andøya, in the northern part of Norway, has during the last few years been exposed to several lightning strikes. Some of the earlier lightning strikes caused damage to electronics, but nothing that could not be repaired.

This report will focus on the last strikes that occurred in the end of January and in the beginning of February 2015.

Table of contents

Meteorologisk institutt
Meteorological Institute
Org.no 971274042
post@met.no

Oslo
P.O. Box 43 Blindern
0313 Oslo, Norway
T. +47 22 96 30 00

Bergen
Allégaten 70
5007 Bergen, Norway
T. +47 55 23 66 00

Tromsø
P.O. Box 6314, Langnes
9293 Tromsø, Norway
T. +47 77 62 13 00

www.met.no

1 Damaged radome at Andøya weather radar

Andøya weather radar has been unavailable for long periods during the winter 2014-2015 due to lightning strikes. The last registered strike, 8th of February, did serious damage to three of the radome panels. The structural integrity of the radome was severely impaired. Due to the weakened structural integrity, the radome did not withstand the strong winds in the consecutive days. This report summarizes MET Norway's experiences with the last strikes and infrastructural challenges that MET Norway is facing at this radar site

1.1

Description of the radar site and radar equipment

Andøya weather radar, wmo number 01018, is located on a mountain top named Trolltind, in Andøy municipality. Position: 69,24139° N, 16,00297° E.

Figure 1The radar from a helicopter point of view. The mast seen to the right is the local weather station.

Andøya is an island in the northern part of Norway. The weather on this island can be quite harsh. The radar is exposed to a costal climate and strong winds. During the autumn and winter season, the winds tend to be extra strong.

The radar is reachable by foot from a road at the bottom of the mountain, or by helicopter. It is about a one hour walk in steep terrain from the road to the radar.

Andøya weather radar was commissioned in 2007. The radar was delivered by German Selex System Integration. The radar is a type Gematronik Meteor 500 C with a peak power of around 250 kW

Power supply and communication are delivered by local companies. To ensure reliable power to the radar systems, a UPS was installed during the summer 2014

The mast seen on the first picture is an automatic Weather Station (AWS). Communication and power supply are delivered from the radar.

1.2 The incidents

In the period from December 2014 to February 2015 the radar was exposed to several lightning strikes.

Continental thunderstorms usually appear during summertime. In arctic coastal climate this is different. Thunderstorms appear most frequently over sea during wintertime. This is due to the temperature difference between relatively warm sea, and the cold arctic air, giving conditions for growth of cumulonimbus clouds.

The first strike was at the 3rd of December 2014. This strike knocked out almost all network related components, but did not make any damage to infrastructure or tower. Fortunately the radar system had one extra Ethernet port that was not in use. The port is located on the A3 PMC 661J which is a module on A2 MVME 2700-1251. This port was not intended to be used for communication purposes, but after reconfiguration of that circuit board, we were able to get the radar back online.

At the 27th of January 2015 a new lightning strike led, apparently, to another communication breakdown. After inspection the 16th of February, the radar turned out to be in such a condition that fault finding was impossible. The radar did not boot up, possibly due to a malfunctioning RCP (Radar Control Processor) board and/ or other faulty parts.

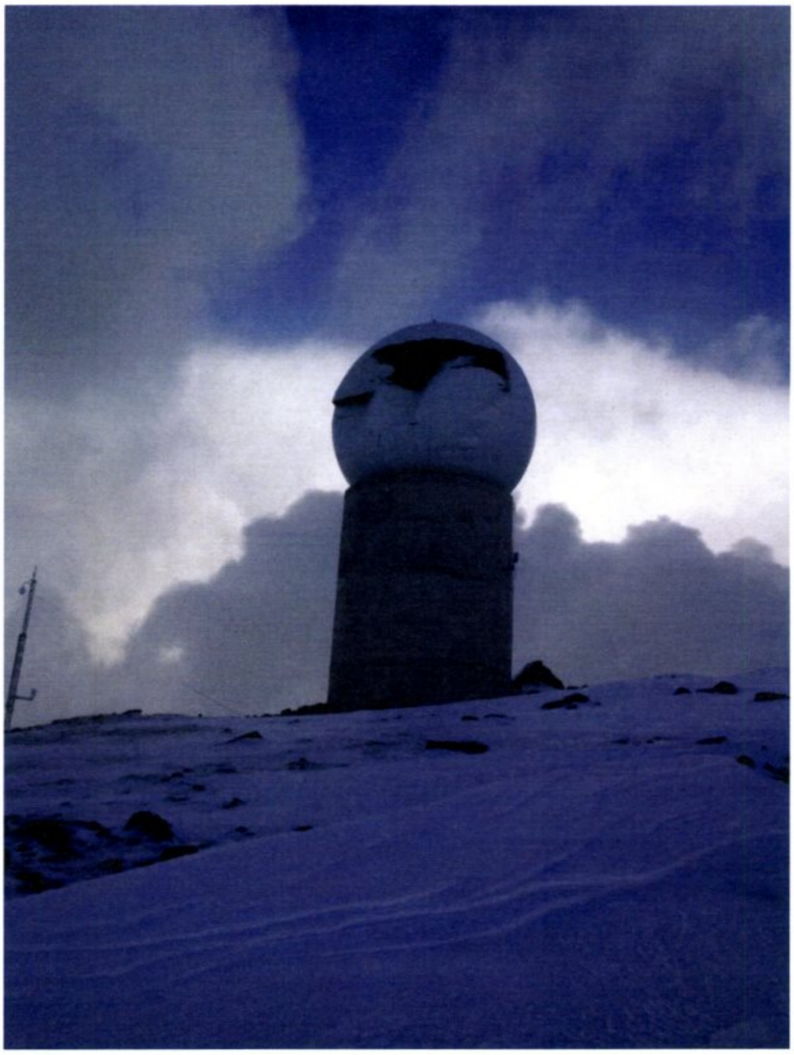
Radar parts that were verified to be broken, and those suspected to be broken, were dismantled and sent to the radar supplier for repair or replacement. Fuses to the radar were flipped into off position.

At the 8th of March the radar was hit by a third strike. MET Norway received the photo shown in figure 2 at Monday the 9th of March. The picture was taken by a local person who was out skiing.

As shown on the photo, three of the radome panels were severely damaged. The structural integrity of the entire radome was weakened considerably.

There was no way that the radome would withstand the strong winds that were announced in the forecast for the next days.

The local police were notified the same day MET Norway was aware of the situation. There was a risk that people could be hit by flying debris. Owners of the houses at the bottom of Trolltind who were in the forecasted wind direction, were made aware of the danger. Luckily no people were hit by flying radome parts and no other damages are reported.



Figur 2 The first picture that MET Norway received. The picture was taken by a local person who was on a ski tour

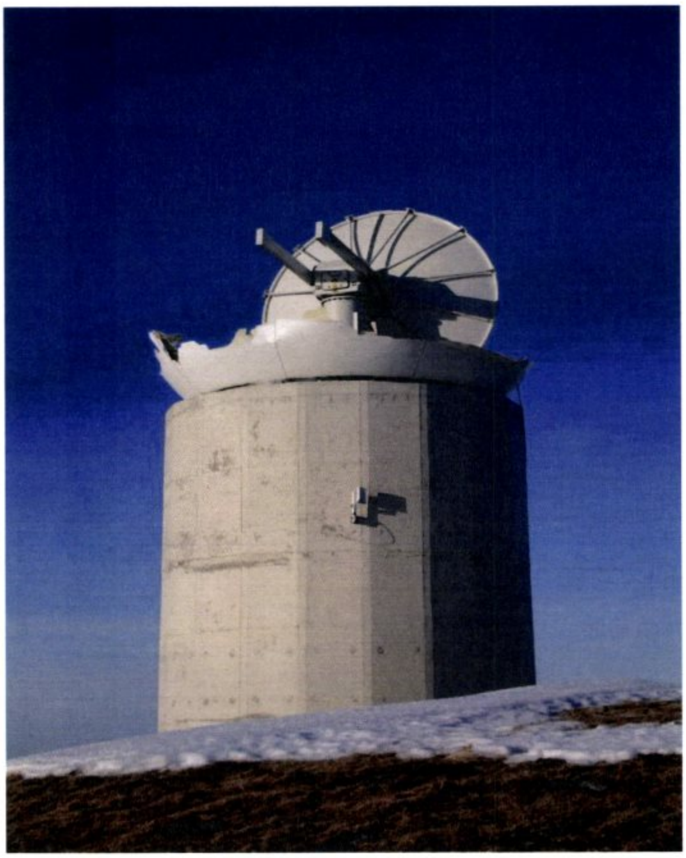


Figure 3 What was left of the radome after lightning and strong winds

The 12th of March the police was informed by locals that the majority of the radome was blown off the radar. Picture number 3 shows what was left of the radome. The picture is taken the 16th of March when MET Norway representatives were on site for inspection and securing the antenna.

1.3 Mitigation of damage and inspection

At Monday the 9th March there was a short window of time with acceptable weather. Our local contact was able to visit the radar. The main task for this visit was to seal as much as possible to prevent water intrusion.

MET Norway representatives were able to reach the radar site on Monday the 16th of March. Main purpose for the visit was to secure the antenna in a 90 degrees angle and cover all cabinets containing radar electronics with plastic to prevent water from entering. When the radar antenna is secured in a 90 degrees angle, the antenna can Withstand wind speeds up to 120km/h.

Figure 4 Antenna secured in 90 degrees angle

Inspection of the radar showed that no additional fuses where tripped. Additional fuses in this context, means that no other fuses were tripped than they who were manually switched off the 16th of January.

No overvoltage protection / surge protections were tripped.

Communication to site was also functioning.

It seems that the lightning has followed the surface of the radome and tower.

The antenna with pedestal and waveguide showed only negligible damage. The only visible "damage" to the antenna was some scratched paint and a cut/ notch in the waveguide

Figure 5 shows minor damage to the waveguide

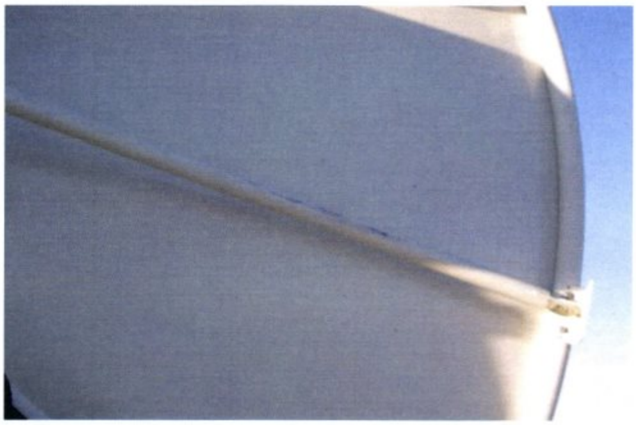


Figure 6 Scratch marks on the antenna

The radar might have been saved from more extensive damage to electronics because fuses were already manually switched off, and many circuit boards were removed for check and /or repair due to the previous lightning. The orientation of the antenna was away from the hole in the radome. Only the counterweights were facing towards the hole in the radome. That might have saved the antenna from more damage.

A later inspection showed that the waveguide was broken near the antenna feed.

Meteorologisk institutt
Meteorological Institute
Org.no 971274042
post@met.no

Oslo
P.O. Box 43 Blindern
0313 Oslo, Norway
T. +47 22 96 30 00

Bergen
Allégaten 70
5007 Bergen, Norway
T. +47 55 23 66 00

Tromsø
P.O. Box 6314, Langnes
9293 Tromsø, Norway
T. +47 77 62 13 00

www.met.no

1.4 Grounding challenges

The ground around the radar consists of porous rocks. This kind of rocks has high electric conductivity and makes the values for the transition resistance from grounding rod to ground higher than desired values. The norm values for this transfer resistance are set to max 10 ohm. (We found this value in an Norwegian book on lightning protection; Lynvernhåndboka published by Elforlaget).

For radar Andøya the transfer resistance are in the range 500 to 800 ohms. However, the values are within the range of what that can be expected with such soil conditions.

In 2014 MET Norway wanted to improve the lightning protection of radar Andøya. For assistance with this work, MET Norway cooperated with a lightning protection company named Braadland Automasjon .

The grounding/ equipotential bonding was improved according to their report. The report also pointed on incorrectly performed overvoltage protection.

Issues addressed in the report were corrected in August 2014 by an electrical company.

With equipotential bonding between all electronic cabinets and grounding rods laid out as shown in the picture, the grounding was concluded to be as good as possible in relation to the rocky soil conditions at the radar site.

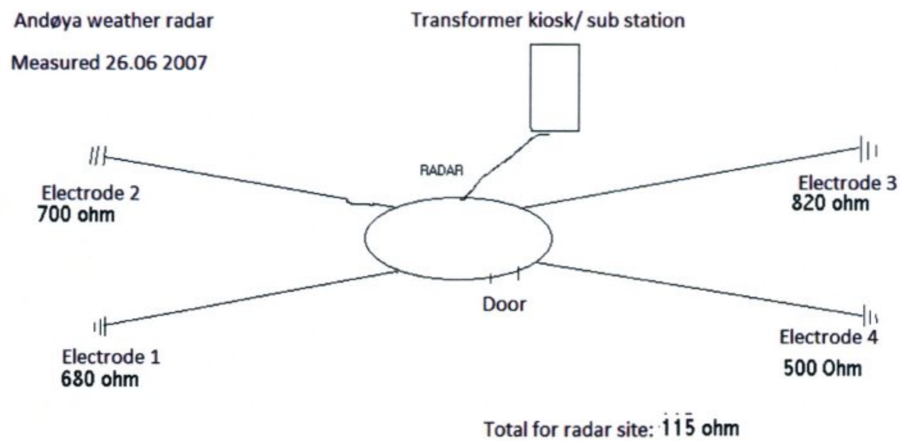


Figure 7 Overview of the grounding rods and their values. Figure from Braadland Automasjon

1.5 Why the lightning did damage to the radome

MET Norway's theory about why the radome did not withstand the last lightning strike is following:

The plausible reason to the damage is that (salty sea) water was contained in the radome panel joints. In heavy weather, sea water in sprayed over the entire island. The water forms a low- ohmic impedance to the lightning transient, probably in the same range as the lightning down conductors, or even lower, because of the large surface. The transient nature of the lightning causes the currents to tend to travel on conductor surfaces, the so called skin effect.

Lightning currents are in the range of kA (kilo Amperes) and contains several hundred mega joules of energy. Such huge amounts of energy makes the water contained in the panel joints to evaporate instantaneous. The sudden evaporation makes an explosion like effect on the radome panels, and the panels are delaminated and torn apart.

Figure 8 Delaminated radome panel due to fast evaporating water induced by lightning.

Our theory is supported by the lightning protection company, Braadland Automasjon.

1.6 Final work

The new radome were lifted 26.june 2015. During tests of the system it turned out that some electronics and one flexguide was defective. This parts were replaces, and Andøya weather radar were back into operation 18.th of August.

MET Norway has, in cooperation with Braadland Automasjon, further improved the lightning protection on radar Andøya.

The solution selected, is a solution with four lightning rods in 1,5 metres height above the surface of the radome. Each rod will be tied to its own down conductor mounted on the outside of the radar tower.
Each down conductor will be tied to the common grounding system for the whole site.

The rods ability to withstand wind and icing are about the same as the radome ability.

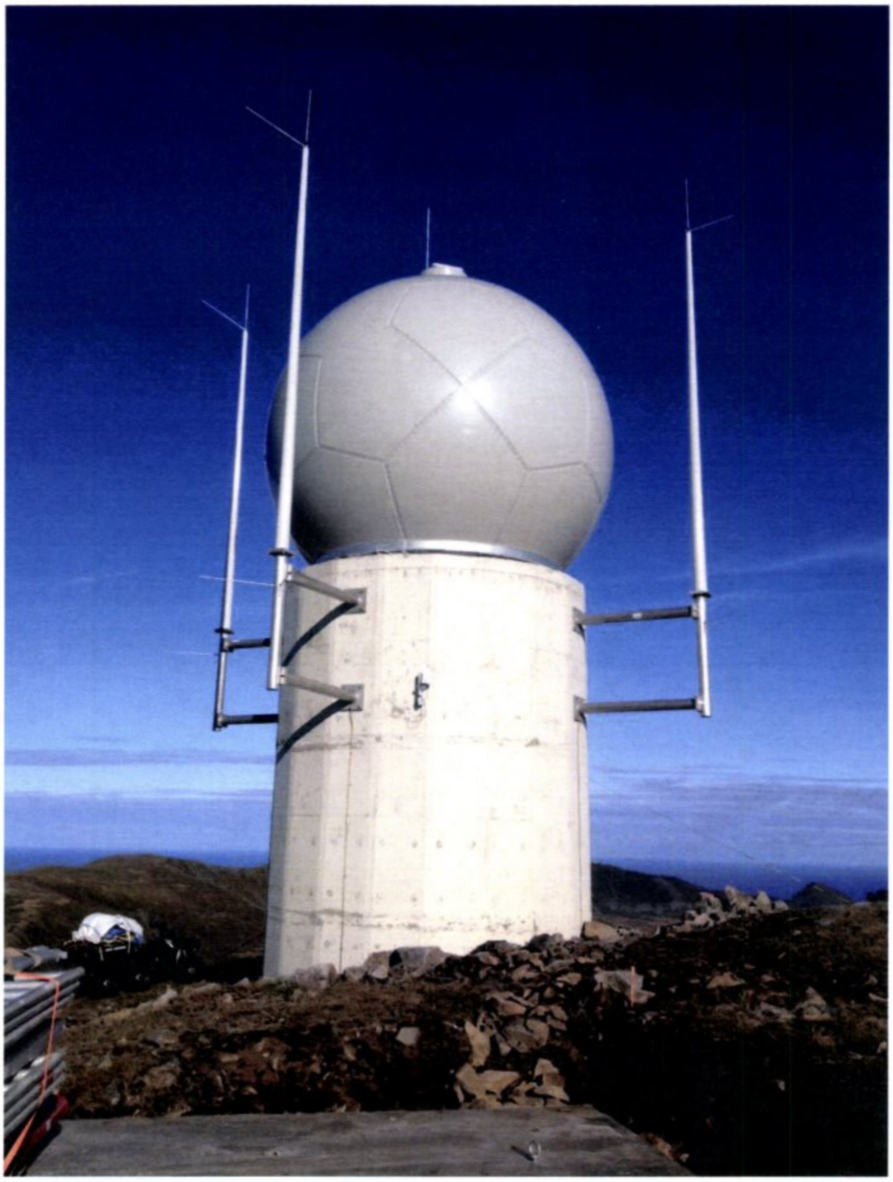


Figure 10.Picture of Andøya weather radar with the new lightning protection equipment.