Laser Safety in Ny-Ålesund: Aircraft Avoidance System (AAS)

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Abstract

This poster explains the reason for NMA to make an aircraft safety system that differs from the aircraft safety system used for other SGSLR sites. It also shows a system overview and describes the subsystems that the AAS consists of.

1. Background

The NMA Earth Observatory is located at Brandal outside of Ny-Ålesund on Svalbard. Because of the sensitivity of the VLBI antennas at the observatory, Norwegian law states that the whole city of Ny-Ålesund is to have radio silence on the frequency band from 2GHz to 32 GHz [1]. This excludes a radar to be used for SLR aircraft safety in Ny-Ålesund.

Also, the area surrounding the observatory is a bird sanctuary. Therefore, NMA personnel is supposed to work remotely from the city as much as possible instead of working at the observatory.

Because of this, NMA has had to find other means to avoid firing the SLR laser at aircraft flying through the area.

The goal has been to create a system that meets the requirements of the Norwegian Civil Aviation Authorities, NASA, NMA and the Governor of Svalbard.

2. System Overview

The AAS consists of three different barriers which work in different ways and provide redundancy to the system. The barriers are shown in figure 1:

Barrier A: A danger area including the whole operation area of the laser (10 to 90 deg elevation) from altitudes 0 to 66 000 ft.

Barrier B: A manual switch system.

Barrier C: An automatic, ADS-B based switch system.

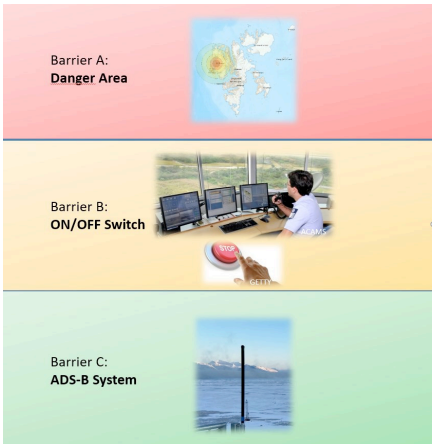

Figure 1: AAS Barrier Overview

3. Subsystems/Barriers

Barrier A is a danger area published by the Norwegian Aviation Authority, barrier B is a manual switch system and barrier C is an automated system. Barrier B and C are both based on hardware and software which are both designed to be fail-safe.

3.1 Barrier A

The first barrier of the AAS is a danger area that will be published by the Norwegian Civil Aviation Authority. Planes may still fly into this area, but it will be at their own risk. Figure 2 is a draft showing how the danger area will be built up of layers. The layers are made to match the 10-degree minimum ranging elevation of the SGSLR so that the whole operation area of the laser is covered by a published danger area all the way from 0 to 66 000 ft altitude, which means all altitudes of the controlled airspace. The map of Svalbard in figure 3 is also a draft showing the same layers as figure 2.

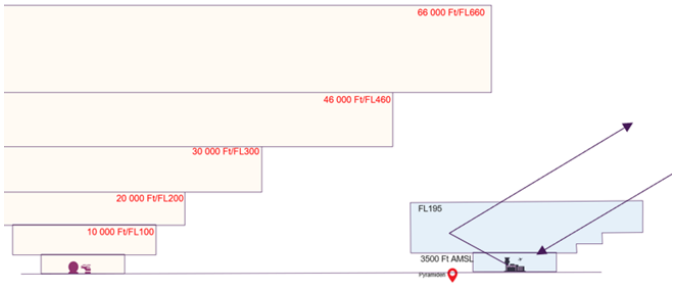

Figure 2: Danger area side view. Source: Norwegian Civil Aviation Authority

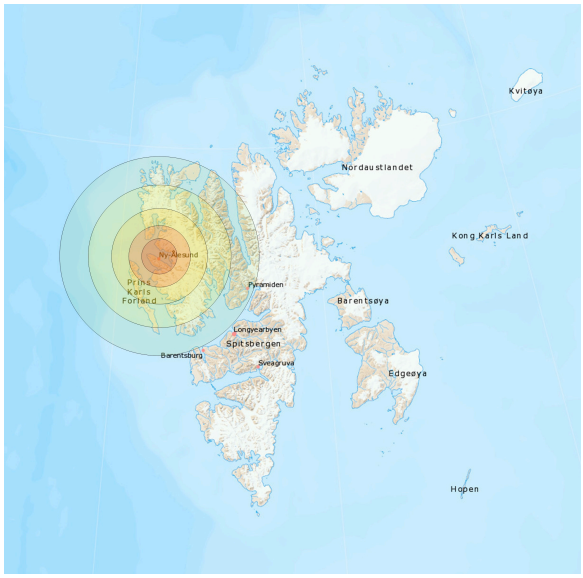

Figure 3: Map showing the danger area. Source: NMA and NPI

3.2 Barrier B

Barrier B is a switch system consisting of two separate, remote switches. One switch is in the Svalbard Airport Tower in Longyearbyen. This switch is based on the existing switch system developed by the European Incoherent SCATter (EISCAT) in Longyearbyen. The airport tower personnel have been using this system for a long time to inhibit the EISCAT radar each time an aircraft passes over Gruve 7 (Mine 7) outside of Longyearbyen which is where the EISCAT radar is located.

The other remote switch is a portable on/off switch for the NMA staff in Ny-Ålesund. This switch has been developed by NMA. This switch is designed to be connected to the local NMA network with an ethernet cable. It can be used during remote operations of the SLR from the NMA office at Rabben near the airport in Ny-Ålesund or during local operations at Brandal.

A schematic drawing of the switch system is shown in figure 4.

A main unit is located at the SLR site. This unit communicates with the two remote switches via UDP and TCP. Both switches need to have a connection with the main

unit for the SLR laser to be able to operate. In addition, a watchdog ensures that the SGSLR receives a block signal if the AAS software fails.

The main unit sends a continuous 5-volt signal to the NASA SGSLR Laser Safety Subsystem (LSS) to indicate that the laser is ok to fire. If the output voltage from the main unit drops to 0 volts, this indicates that the LSS must block the laser.

The switch controller also receives a signal back from the LSS. This signal indicates whether laser energy is exiting the SLR system or not. This signal is especially important for the Svalbard Airport Tower in Longyearbyen. According to the procedures the tower needs this confirmation before letting any air traffic into the danger area.

All switching is being logged to an NMA server.

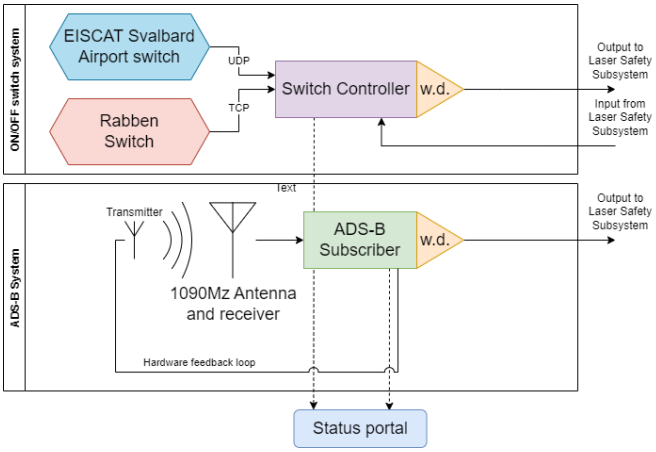

Figure 4: System overview

3.1 Barrier C

Barrier C is an automatic system that uses a passive antenna to receive aircraft identification and position data. Figure 5 shows the range of the receiver from the NMA main office in Hønefoss.

A Raspberry PI (single board computer) receives data from the ADS-B receiver and uses NMA-developed software written in Python to determine if the laser needs to be blocked.

If the elevation of an aircraft seen from the SLR site exceeds 10 degrees, or if an aircraft suddenly stops broadcasting its position while moving towards the SLR, the ADS-B subsystem will automatically set its output voltage to the LSS to 0. The LSS then blocks the laser.

During a normal day, very few aircraft pass through the area. It is therefore hard to know whether we don't see any traffic because an ADS-B component like the antenna or a cable has been damaged or if it's because there is no traffic at the moment. To periodically check the system, a 1090 MHz transmitter sends an ADS-B signal to the ADS-B system to test that all hardware and software is working. To do this legally, an

application must be sent to the Norwegian Civil Aviation Authorities and the Norwegian Communications Authority. NMA will then be given an official ICAO 24-bit address for a test transmitter in Ny-Ålesund.

Just like for the switch system, a watchdog ensures that the SGSLR receives a block signal if the AAS software fails.

As for the switch system, a 5-volt signal to the LSS indicates that the laser is ok to fire, and 0 volts indicates that the laser must be blocked.

Figure 5: ADS-B coverage from the NMA office in Hønefoss.

References

[1] Regulation on general permits for the use of frequencies (Fribruksforskriften) https://lovdata.no/dokument/SF/forskrift/2012-01-19-77.