

FFI RAPPORT

DEVELOPMENT OF A CHEMICAL, ATOMIC AND TOXIC COMPOUND SURVEILLANCE SYSTEM - CATSS

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THESAURUS REFERENCE: 8) ABSTRACT A demonstrator of an automatic surveillance system for chemical, radiological and toxic compounds, called CATSS, has been developed at FFI. The system contains several commercially available detectors integrated into CATSS. CATSS has been tested in a wind tunnel to check if the air reaches the detectors. The system has also been tested outdoors at summer temperatures to check the power consumption. Software for read-out of alarms from the detectors has been developed. CATSS is intended to be integrated into the central Command Control and Information (C2I) System in the Norwegian Defence.				
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DEVELOPMENT OF A CHEMICAL, ATOMIC AND TOXIC COMPOUND SURVEILLANCE SYSTEM - CATSS

1 INTRODUCTION

The need for an integrated system that could detect and warn against chemical, radiological and toxic compounds arose during the deployment of Norwegian forces in Kosovo. The troops were stationed close to old worn-down industrial complexes with a high possibility of industrial accidents with associated leaks of chemical substances (1). It was also felt important to have a system that could respond to possible attacks with chemical and radiological agents in addition to industrial compounds. Systems available on the market (e.g. NBCerberus from Smiths Detection)(2) are large and not easy deployable. It was therefore decided to build a demonstrator to learn what parameters that are important when building or buying such a system. It was equally important to learn how such systems should be implemented into the Norwegian armed forces and connected into an overall Command Control and Information (C2I) system. This report describes the development and initial testing of a demonstrator for a Chemical, Atomic and Toxic Compound Surveillance System (CATSS).

2 REQUIREMENTS

The requirements for an automatic detection and surveillance system were a remote point detector that could be stationed around a permanent camp, e.g. in Kosovo, and also a system that could be deployed with our troops in a more war-like scenario. It should respond to the most relevant chemical warfare agents and industrial chemicals in addition to radiological agents. The system should be transportable and easily deployable with car or helicopter. It should be module based and have a battery capacity for minimum 12 hours in a war-like scenario and 6-7 days in peacetime operations.

The system should be able to automatically transmit an NBC-4 message to higher commands and also to estimate the danger area through an integrated software system (Figure 2.1). This will include, if possible, the integration of the prediction programs produced earlier at FFI, and should be able to estimate the danger area after a release of chemical warfare agents (CWA) (Figure 2.2) or toxic industrial chemicals (TIC). The software should be compatible with the C2I system under development within the Norwegian forces. The messages should be transmitted to higher commands using available means. This could be radio or cable depending on the current set-up (VHF radio is shown in Figure 2.1 as an example).

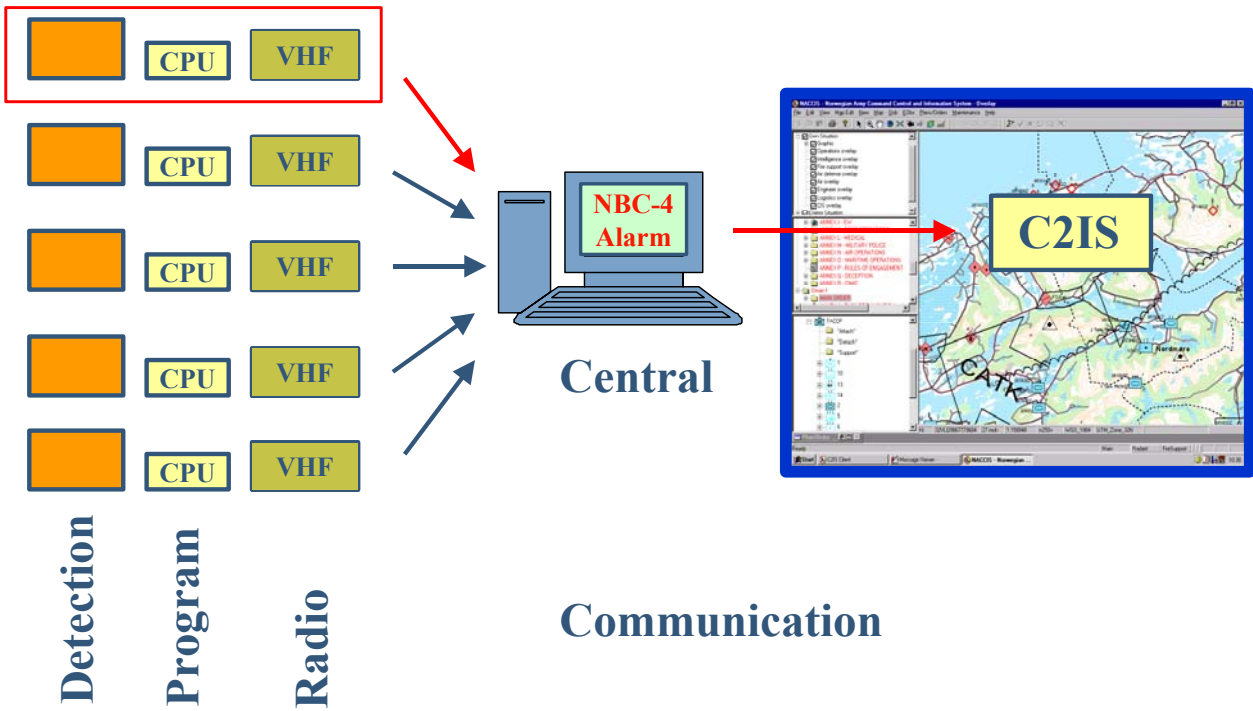


Figure 2.1 Schematic presentation of the CATSS line of communication

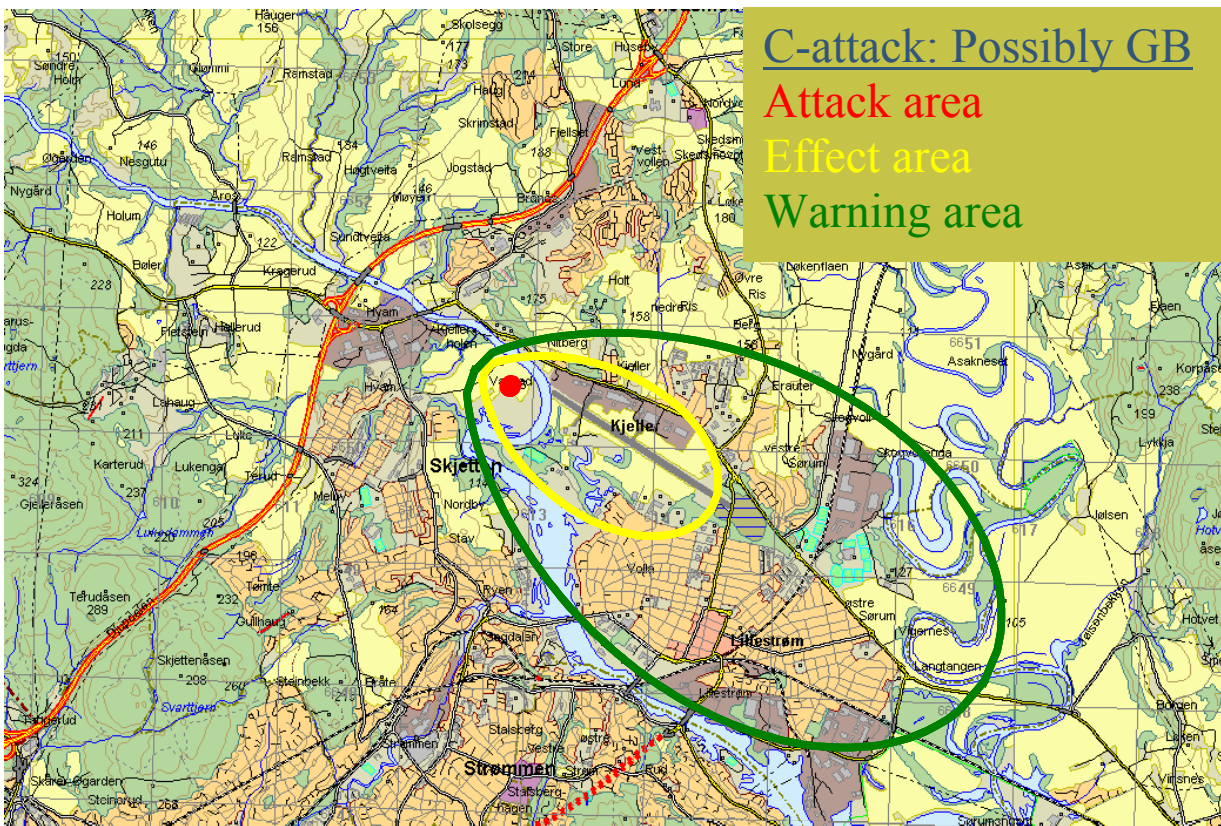


Figure 2.2 Schematic presentation of a plume of sarin (GB) from a chemical attack on Kjeller airfield as described by CATSS

3 SYSTEM DESCRIPTION

3.1 Hardware development

The work so far has been concentrated on developing a demonstrator that could teach us how to use such a detection system, and how to implement the information into the defence C2I system. The individual detectors in the demonstrator were therefore selected based on what is in use in the Norwegian forces today. In a future system, the detectors have to be selected based on detection performance, size and power consumption. The detectors used in the CATSS demonstrator were a GID-3 Chemical Warfare Agent detector from Smiths Detection (UK), an Automess from Automation und Messtechnik GMBH (Germany) for radioactive substances and a Multiwarn II from Dräger (Germany) for industrial gasses. In addition, the CATSS has an Acutime 2000 global positioning system (GPS) from Trimble (CA, USA) an ultrasonic wind sensor from Gill Instruments (UK) and a sensor for temperature and humidity (model MTO 5670.0) from G. Lufft- und Regeltechnik GMBH (Germany). The different detectors in the demonstrator are shown in Figure 3.1.



Figure 3.1 The content of the CATSS demonstrator

Car batteries (lead accumulators) have so far been used as power supply for CATSS. The advantages are that they are rechargeable and will work (with reduced lifetime) at low

temperatures during wintertime. The disadvantage is that the batteries are big and heavy. Three separate 12 V batteries have been used so far. Two 12 V batteries have been coupled together to deliver 24 V for the GID-3 detector, while one 12 V battery has been used for the rest of the system. The size of one of the batteries in use so far is 35 cm x 17 cm x 19 cm and it is quite heavy (23.2 kg). It will be necessary to choose detectors with lower power consumption in a further version of CATSS if the system is supposed to run on batteries. Another option is to run the system from a fuel operated power generator.

The GPS used in the demonstrator has no internal compass. The CATSS box has therefore to be placed in the correct geographical direction by means of a handheld compass. A GPS with an internal compass should be used in the next version of CATSS.

3.2 Software development

A computer system using the software LabWindows from National Instruments (TX, USA) is used in the prototype CATSS to read signals from all the detectors and to present the information on to the computer. A LittleBoard 700 computer board (Ampro, CA, USA) is placed in each detector box with connection through a cable to the home computer. In the future version of CATSS, the cable could be replaced by radio. Another programming language, running on a smaller and less power consuming platform, will probably also be used in the final version of CATSS. At least, this is important if the future CATSS will be running on batteries.

The screen view from the CATSS central, using the software called CATSS Alerter, is shown in Figure 3.2. This software, developed at FFI, has been used during the first evaluation of CATSS using one detector station only. An extended version of the central software will have to be made in order to handle several detector stations.

The CATSS Alerter has several features. One of three red boxes (industrials, CWA and radiation) appears in the upper left corner when one of the detectors in the CATSS box gives an alarm. The boxes will stay on the screen until clicked on by the user to ensure that the alarm is observed. Below the alarms, the individual readings from all the detectors are shown. In the upper middle part are several lamps showing the status (on/off) of the different sensors. It is also possible to turn sensors on and off by a mouse click. In the upper right corner are alarms and hazard levels from the different detectors in real time.

The bottom half of the screen contains a text window that could show the Error log, Sensor log or Communication log, selectable from a combo box. It is also possible to show the generated NBC-4 message on the screen by clicking on the NBC-4 message box.

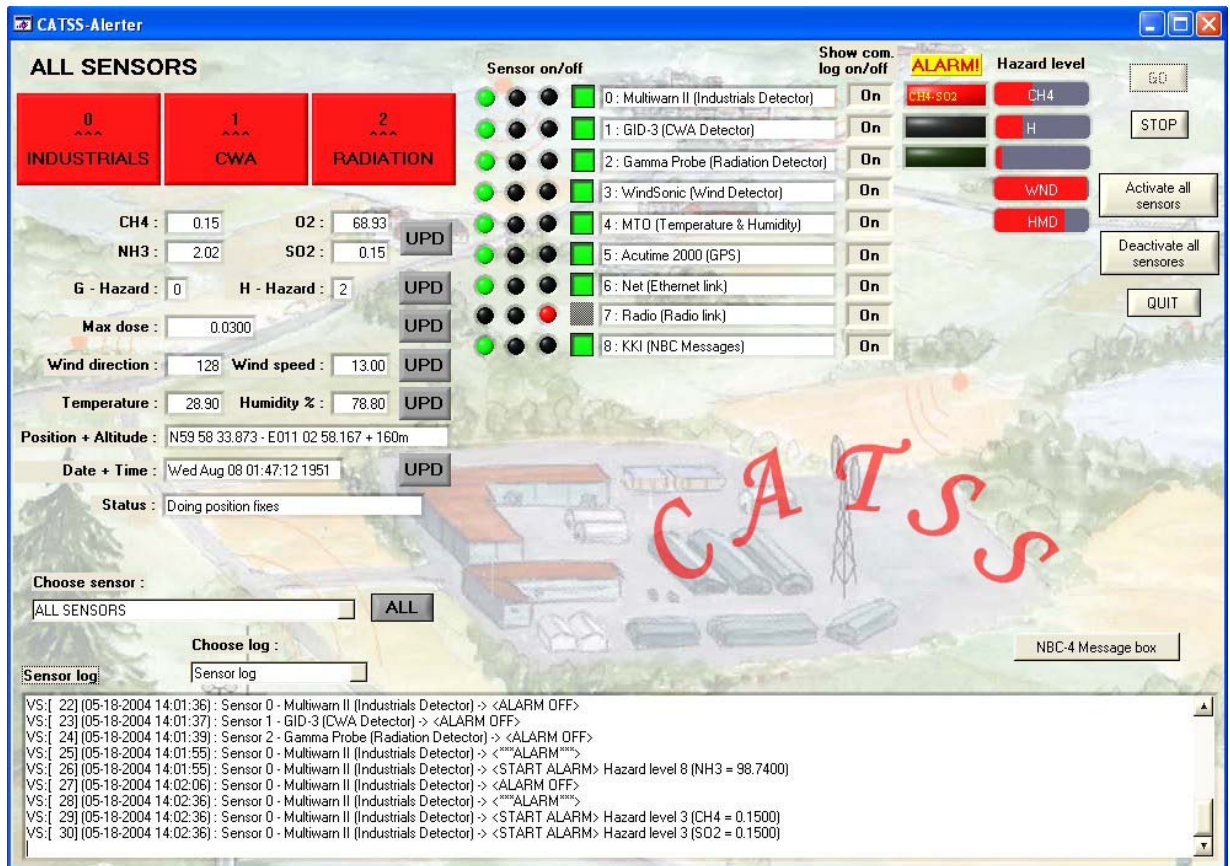


Figure 3.2 Output screen from the CATSS demonstrator

The next software version will run in a client-server mode, where the client version will be simplified and used in each detector box. No screen output will be necessary in this version of the client software. A more developed version will be used in the server, which would be used to read out data and control the CATSS detectors.

4 PRELIMINARY TESTING

4.1 Introduction

So far, the CATSS demonstrator has been tested outdoors during different temperatures to gain experience with the system. It has also been through testing in a wind tunnel in order to assure that the airflow reaches the detectors.

4.2 Test in wind tunnel

The CATSS demonstrator was tested in a wind tunnel to see if the airflow reached the detectors or was reflected by the main body of the system. Several modifications to the system were also tested in order to see any differences in the airflow. The wind tunnel set up at Forsvarsbygg (Norwegian Defence Construction Service) at Akershus Festning to test the

Norwegian Defence Colpro system was used for this purpose. Pictures from some of the experiments are shown in Figure 4.1.



a)



b)



c)



d)

Figure 4.1 Test of CATSS in a wind tunnel

The test in the wind tunnel showed that when using the plain CATSS detector box, most of the airflow reached the floor of the box where the detector inlets are located. Spoilers were placed on the box to see if more of the airflow could be diverted into the detector opening. As we can see from Figure 4.1 b), c) and d), a spoiler at the bottom of the detector floor could be advantageous to direct the airflow to the detectors. In order to prevent rain and snow from entering the detector opening, some “spoilers” might also be placed in the air opening as seen on the picture in Figure 4.1 c).

As a first modification, the height of the detector opening has been reduced to restrict rain and snow from entering into the compartment. A new test in the wind tunnel has to be carried out to see if this modification hinders the airflow from reaching the detectors. A picture of the modified CATSS detector box is shown in Figure 4.2.



Figure 4.2 Modified CATSS detector box

4.3 Testing outdoors

The CATSS was tested outdoors at different temperatures to gain experience with the system and to observe problems that might not occur in the laboratory. The CATSS wind and temperature detectors (Figure 4.3) were compared with readings at the Norwegian Institute for Air Research (NILU) close to the premises of FFI (Figure 4.4). This comparison showed reasonably good correlation between these readings. The wind speed was somewhat higher at NILU, but the reason for this might be that the sensors were placed higher in the terrain at NILU, where the wind speed is probably higher than at FFI.

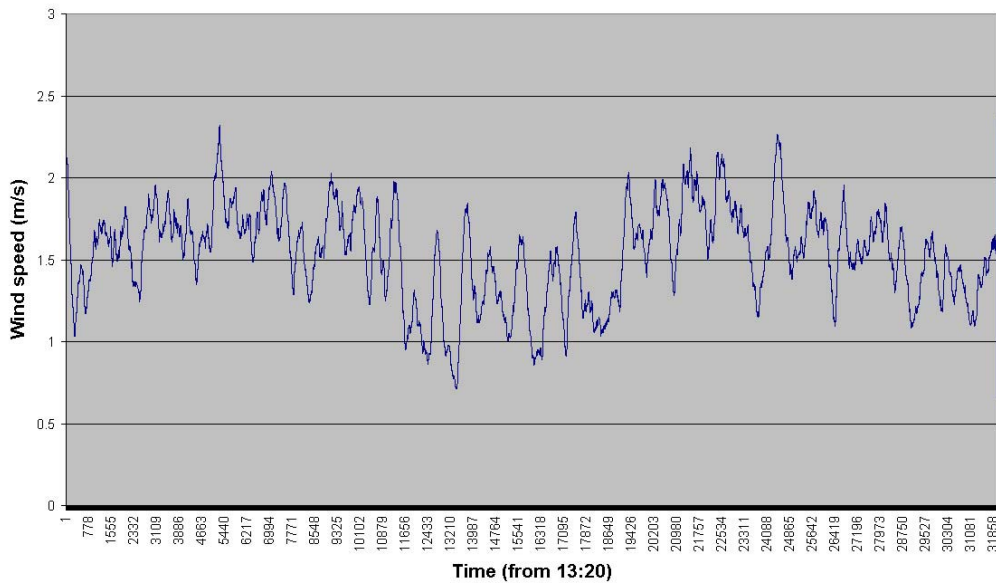


Figure 4.3 Wind speed measured with the CATSS sensor

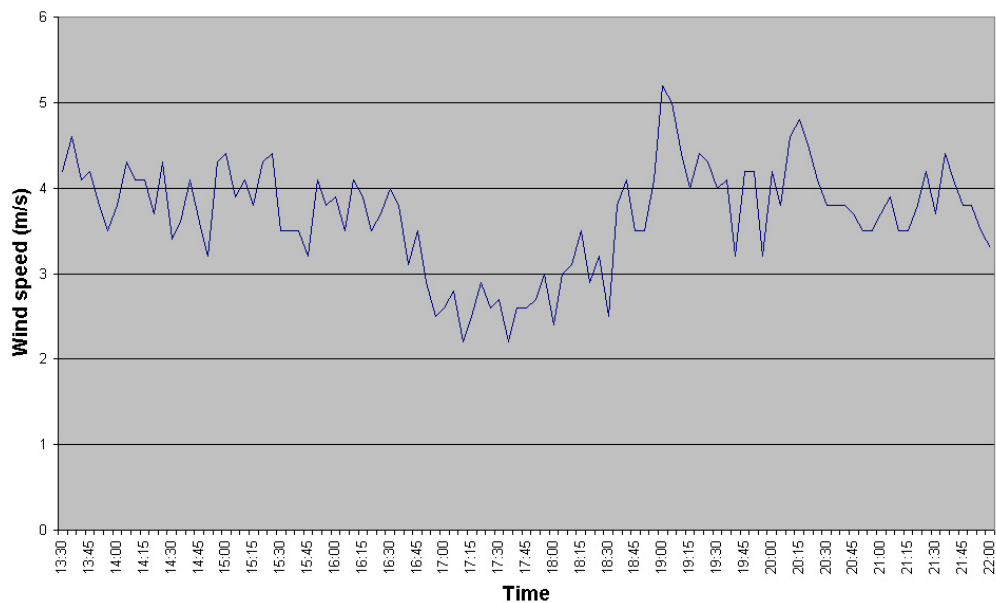


Figure 4.4 Wind speed measured at NILU

The power consumption was also evaluated. After the batteries were fully recharged, the system was run for some hours and the power consumption was logged. The results from these experiments show that the GID-3 draws a current of 1.6 A during start-up. After start-up, the power consumption fluctuates between 1.6 A and 0.3 A (Figure 4.5). The fluctuations are not even, probably because the temperature changed from 9 °C down to 7 °C and up again to 13 °C during the test period (Figure 4.6). The batteries used have a capacity of 88 Ah. If a mean power consumption of 1 A is assumed, the 24 V battery will last for approximately 88 hours (2.5 days) at a temperature around 10 °C.

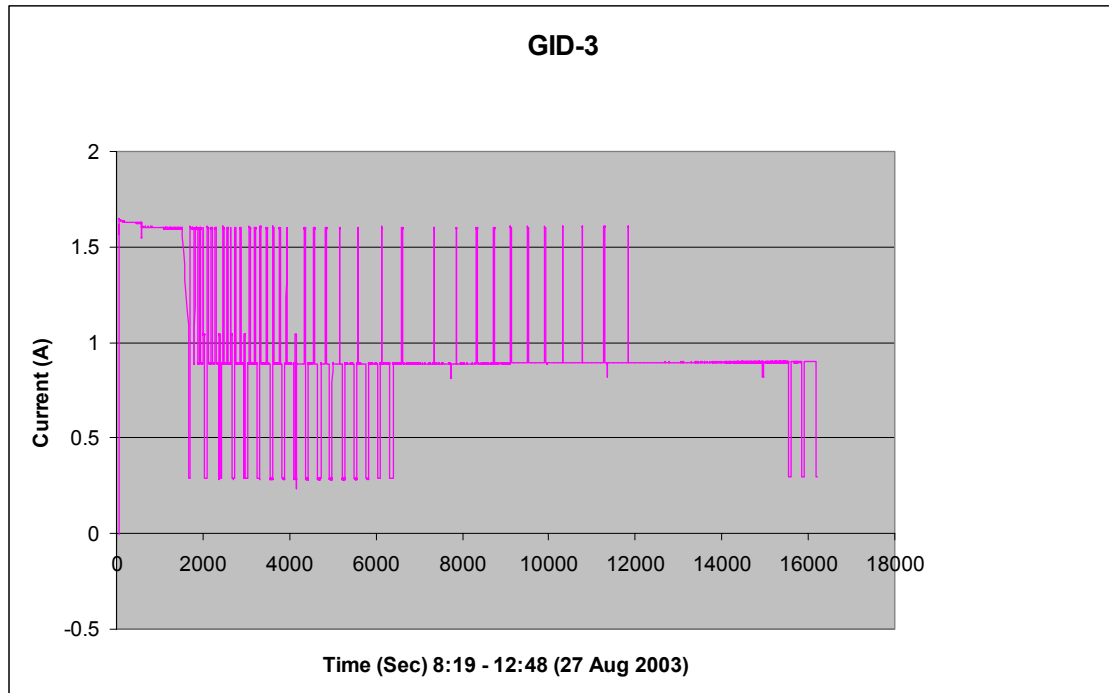


Figure 4.5 GID-3 power consumption

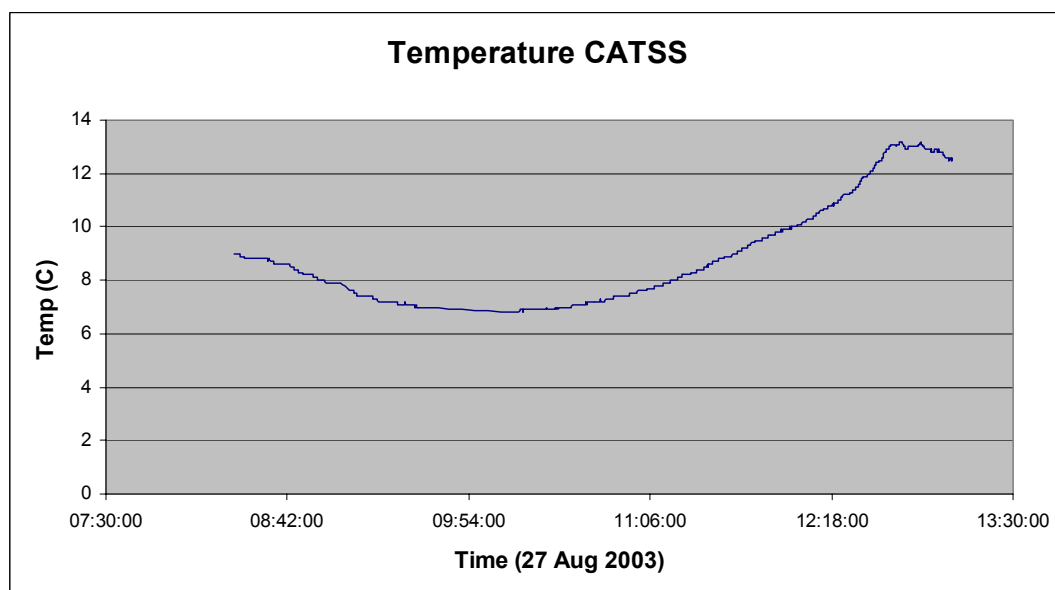


Figure 4.6 Outdoor temperature during the battery test

The power consumption for the 12 V system was also tested. This was done without the computer connected to the battery. The detectors coupled to the battery drew a current of 0.2 A during this test. Using this figure, the 12 V battery will last for approximately 440 hours (18 days) without the internal computer being connected. The current computer draws approximately 550 mA. With this power consumption included, the 12 V battery will last for approximately 115 hours (4.8 days). It is important to remember that the effects from the batteries will decrease during periods with lower temperatures.

5 COMMAND CONTROL AND INFORMATION SYSTEM

A possible connection of CATSS to the Norwegian Defence Command Control and Information (C2I) system is shown in Figure 5.1. Each CATSS detector, in for instance a battalion, might be connected to one computer serving as a relay station by use of radio links or cable. The information is thereafter sent to the headquarter where an NBC specialist is located. The NBC specialist will evaluate the information coming from the CATSS together with other available information regarding a possible release of NBC-agents or industrial chemicals. The NBC specialist will also have available NBC prediction programmes, e.g. the programmes made at FFI by J H Blanch (3), to be able to take remedial actions. The evaluated information will be sent out on the defence C2I network currently under development. Work is going on to make the prediction programmes available as overlays on the map used by the C2I system.

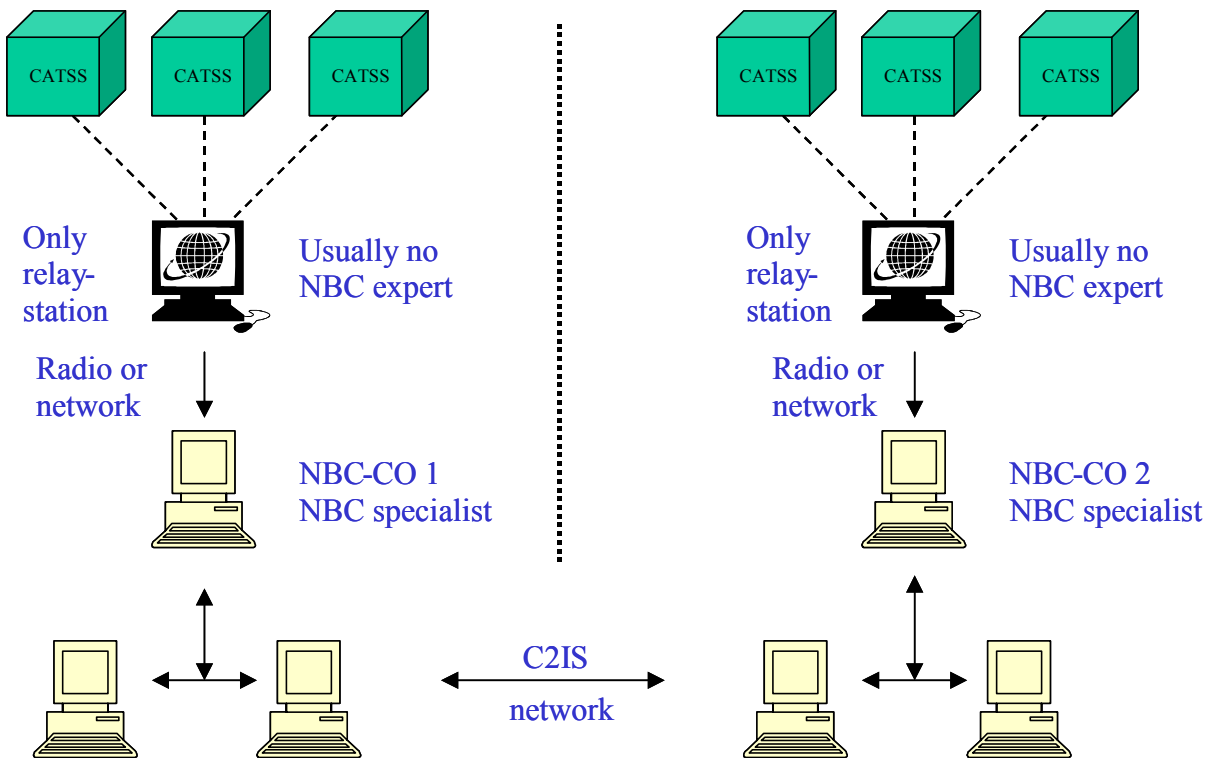


Figure 5.1 Connection of CATSS to the Command Control and Information System

6 FURTHER WORK

A reference group along with three working groups with participants from the military users have been set up. This group will look at different aspects of the deployment of CATSS within the military structure. One working group will describe a user interface (man-machine interface) and will also define alarm levels for the different CATSS detectors. Another group will define how CATSS could be used operationally. What will be the desired output from CATSS, and where (at which level) will the system be located. It has been foreseen that CATSS will at first be deployed at a static base (air base, international forces base, etc). The third working group will look at how CATSS can be interfaced with the C2I system in the Defence forces, which protocols that are necessary to follow (cable and radio) and selection of radio-system for CATSS. The working groups will report periodically to the reference group and to FFI.

7 CONCLUSIONS

The first demonstrator of a Chemical, Atomic and Toxic compound Surveillance System (CATSS) has been developed. The demonstrator will have to be tested in the field under different climatic conditions to reveal any problems or shortcomings that has not been seen during testing at FFI. The reference group and its working groups will clarify how CATSS could be used in a real situation. Important questions to be solved are: how would the user interface look like, and how could the system be interfaced with the Defence C2I system?

If CATSS are to be deployed at locations where there is no electricity available, the power consumption of the different detectors and data systems in CATSS will have to be reduced. Systems with low power consumption will have to be selected.

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