The Research Council of Norway (NFR)

NORSAR

NORSAR Scientific Report No. 2-96/97

Semiannual Technical Summary

1 October 1996 – 31 March 1997

Kjeller, May 1997

7.2 Initial plans for implementing IMS stations in Norway

Introduction

Annex 1 to the protocol to the Comprehensive Nuclear Test-Ban Treaty contains tables listing altogether 321 stations in the International Monitoring System (IMS) that will be installed to verify compliance with the treaty. Six of these stations are located on Norwegian territory. These stations are listed in Table 7.2.1 and shown in Fig. 7.2.1.

Work is now underway under the direction of PrepCom (Preparatory Commission for the Comprehensive Nuclear Test-Ban Treaty Organization) and its Provisional Technical Secretariat (PTS) in Vienna to establish the IMS. For example, technical specifications for the various sensor types of the IMS have been approved by PrepCom, and a budget for 1997 for site surveying and station upgrading/installation has been adopted. Discussions on the continuation of this installation program in 1998 have already started in PrepCom.

In our capacity of National Data Center for Norway, NORSAR will be technically responsible for the operation and maintenance of IMS stations on Norwegian territory. NORSAR is therefore prepared to cooperate with the PTS in the conduct of site surveys and IMS stations upgrading/installation, and this short paper presents our current thinking in terms of initial plans for implementation of the six IMS stations in Norway.

Initial plans for each of the six IMS stations in Norway

The NORSAR large-aperture seismic array

This IMS primary seismic station has recently undergone a comprehensive refurbishment program and basically meets the requirements for technical station specifications (with the exception that data are currently not authenticated) now adopted by the PrepCom (see PrepCom document CTBT/PC/II/1/Add.2). There is, however, still need for some future work, as detailed in the following:

- There is a need to further harden the field installations to secure long-term maintainability. This can partly be achieved through measures to make certain hardware components less vulnerable to external loading, like electrical interferences. The NORSAR array is located in an area that is exposed to frequent lightning strikes during the summer season (May-September).
- As mentioned above, the NORSAR array was recently refurbished. The version of AIM digitizers installed are, however, no longer produced by the manufacturer (Science Horizons). The implications of this in terms of long-term maintainability must be investigated.
- The NORSAR array has currently no on-site data buffering capability (with the exception of a buffer of a few hours' length between the digitizers and communication interface modules). Such a capability is essential in ensuring data continuity in cases of communications line dropouts as well as problems at the data receive end (national or international data center). It is therefore planned that such a capability will be installed.

- We intend to furnish the NORSAR array with a regional processing capability through the integration of the co-located NORESS regional array. The NORESS electronics equipment will need to be replaced before a full integration can take place.

The ARCESS seismic array

This array has been selected as an IMS primary seismic station. It was installed in 1987 and uses technology designed and developed by the Sandia National Laboratory in Albuquerque, New Mexico, USA, in the early 1980s.

Strictly speaking, the ARCESS array nominally satisfies the minimum IMS station requirements, again with the exception that there are currently no data authentication arrangements. With the exception of the seismometers, however, the array electronic components are the only ones of their kind in the world, and it will thus not be possible to maintain this array when the present supply of spares is exhausted. So there is a definite need to replace the array data acquisition system (mainly digitizers, clocks and "array controller") with standardized equipment that will be maintainable in the forseeable future. The current ARCESS system has no on-site data buffering, and for the same reasons as given above for the NORSAR array, we plan to install such a capability.

The Spitsbergen seismic array

The existing seismic array at Spitsbergen was selected as one of the 120 IMS auxiliary seismic stations. This array was built in 1992 and is located in a very challenging Arctic environment. For example, the supply of power to the field installation is through the use of windmills that charge a battery bank. After some considerable efforts in identifying the best windmill technology and optimum batteries for this environment, the power supply for the Spitsbergen field system has lately been very stable. There is, however, a need to strengthen this system by installing another windmill so that the station will operate even in case of failure of one of the windmills.

The data from the various sensor sites of the Spitsbergen array are transmitted in analog form via buried cables (of lengths up to 1 km) to digitizers located at the array center. This limits the dynamic range of the data, and there is a need to install digitizers as well as GPS clocks at each sensor location. There is also a need to provide more state-of-health information than is done today from this station.

The data from the Spitsbergen array digitizers are transmitted via one-way radio links to the array controller, which is located in Longyearbyen at a distance of approximately 18 km from the array site. There is a need for a two-way radio link to support the sending of commands (e.g., calibration commands) to the field equipment.

After completion of the modifications to the Spitsbergen array indicated above, we are confident that this array will fully satisfy the requirements adopted by PrepCom.

The Jan Mayen seismic station

Since 1962 the University of Bergen, Norway, has operated seismic stations on the small Norwegian island of Jan Mayen situated on the mid-Atlantic ridge. There is currently a broad-band

3-component station at Jan Mayen, and this station was selected as one of the IMS auxiliary stations. We have been in contact with the University of Bergen regarding the technical status of the existing station at Jan Mayen. The seismometer used today is of type Streckeisen STS-2, which is fully adequate for the IMS. It is our assessment, however, that the digitizer and on-site data-buffering equipment need to be replaced.

We are also discussing with the University of Bergen how to arrange communications for this station. The Jan Mayen island has a satellite system today that handles communications to and from mainland Norway. It is considered to be cost-effective and also optimal with respect to future maintenance to integrate the Jan Mayen seismic station communications with the existing communications infrastructure.

The infrasound station at Karasjok

This IMS station does not exist today and will be built at the location of the ARCESS primary seismic station. This co-location with the ARCESS array will be cost-efficient, as the communications infrastructure for the ARCESS seismic array can then also be used for the infrasound data.

The PrepCom has allocated funds for a site survey in 1997 for this infrasound station. It is our intention to closely cooperate with the PTS in the conduct of this site survey and possibly also involve Norwegian expertise outside NORSAR. The standard IMS infrasound stations are planned to be four-element arrays (triangle with a fourth element in the center) of aperture 1-3 km. The site survey will need to determine suitable locations of each of the sensors (micro-barographs) with its noise-reducing pipes or hoses, taking into account the effects of terrain, wind and local vegetation.

The radionuclide station at Spitsbergen

The geographical coordinates proposed for this yet-to-be-built IMS station are the same as those of the Spitsbergen auxiliary seismic station. In practice, we consider that an optimum location for this new station will be in Longyearbyen (a small settlement with about 1000 inhabitants), at a distance of 15 km from the seismic station. The radionuclide station could possibly be located in the vicinity of the location of the Spitsbergen array controller in Longyearbyen, and thus make use of the communications infrastructure already established for transmission of the seismic data.

Work is now underway in PrepCom to try to reach agreement on which 40 out of the 80 IMS radionuclide stations that will be capable of noble gas monitoring (in addition to the particulate monitoring) upon entry into force of the treaty. We thus anticipate a decision by PrepCom, hopefully in September this year, whether the Spitsbergen radionuclide station should be planned to have a noble gas detection capability in its initial configuration or not.

As we have no expertise of our own at NORSAR within the field of radionuclide monitoring, we are consulting with experts of the Norwegian Radiation Protection Authority (in Norwegian: Statens Strålevern) on matters related to this new station. Nevertheless, NORSAR will function as a coordinating agency in this regard, and will be the point of contact for the PTS in the future establishment and operation of this station.

Communications

PrepCom's Working Group B is currently working on a design of the future global communications infrastructure that will be established to support a) the transmission of data from the 321 IMS stations to the IDC, and b) the forwarding of data and products from the IDC to the State Signatories. This work will need to be concluded before it will be clear in detail how communications will be arranged for the Norwegian IMS stations. But irrespective of how this will be handled, NORSAR will need to receive data directly from these stations, in order to adequately carry out our tasks in operating and maintaining the six Norwegian IMS stations.

The NORSAR array requires one communication line from each of the 7 concentrated regions of instrumentation of the array (the so-called subarrays). Maintaining the current communications infrastructure with 7 domestic links to the Norwegian NDC and one international link to the IDC would be expected to reduce the overall cost for communications in the future IMS. In addition, the buffering at the NDC ensures high data availability and eases the system monitoring and maintenance functions performed by the NDC. The use of ten domestic VSAT links (7 for the NORSAR array, one for Karasjok, one for Jan Mayen and one for Spitsbergen) and one well-monitored high-speed international link may well prove to be the most reliable and cost-effective arrangement in the future for Norway's six IMS stations.

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Table 7.2.1. IMS stations located on Norwegian territory, and listed in the protocol to the Comprehensive Nuclear Test-Ban Treaty.

IMS Network	Station	Lattude	Longitude
Seismic primary	NORSAR array, NAO Hamar	60.8N	10.8E
Seismic primary	ARCESS array, ARAO Karasjok	69.5N	25.5E
Seismic auxiliary	Spitsbergen array, SPITS Spitsbergen	78.2N	16.4E
Seismic auxiliary	3-C station, JMI Jan Mayen	70.9N	8.7W
Infrasound	Karasjok	69.5N	25.5E
Radionuclide	Spitsbergen	78.2N	16.4E

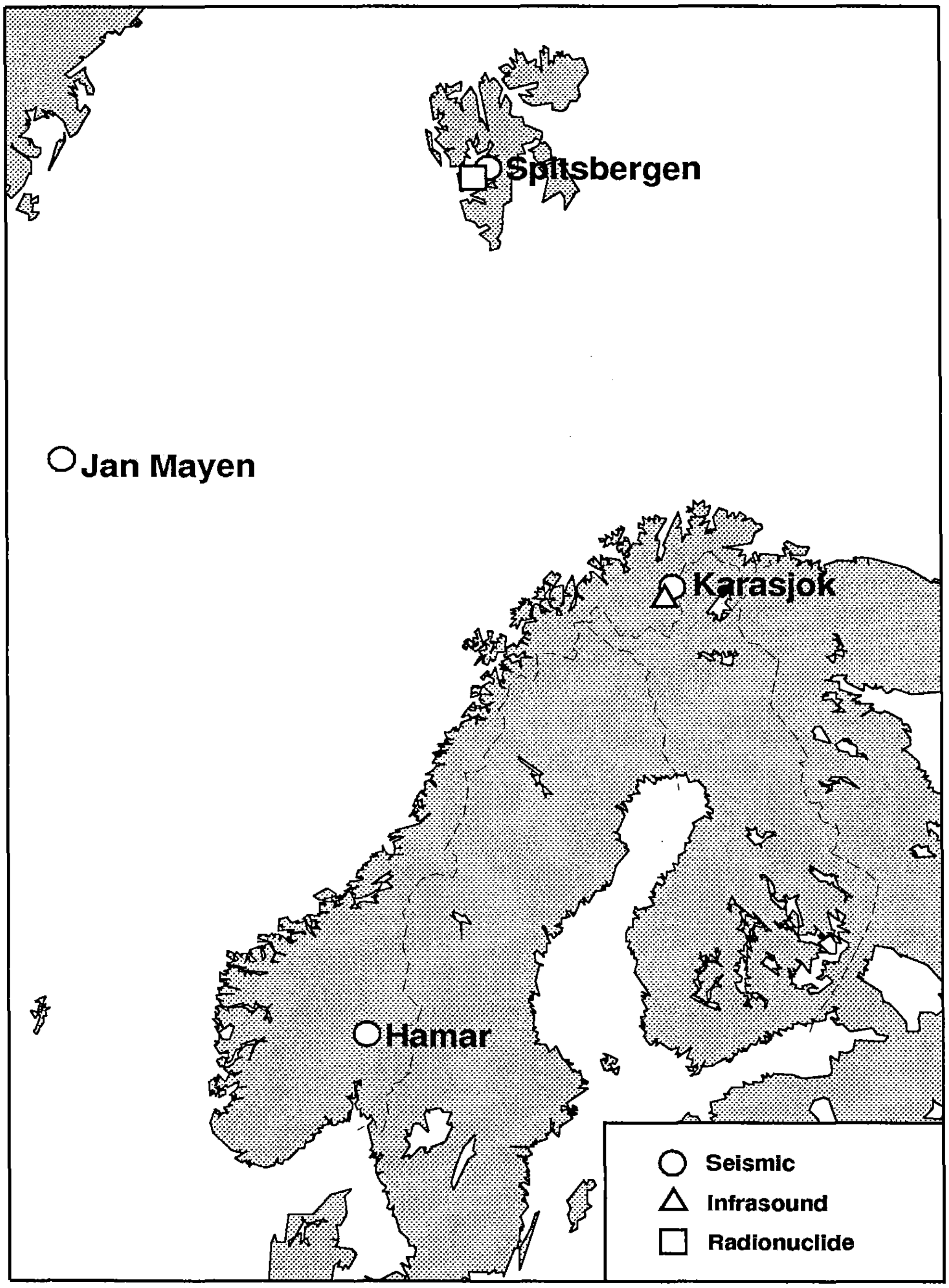

Fig. 7.2.1. The figure shows the six IMS stations located on Norwegian territory.