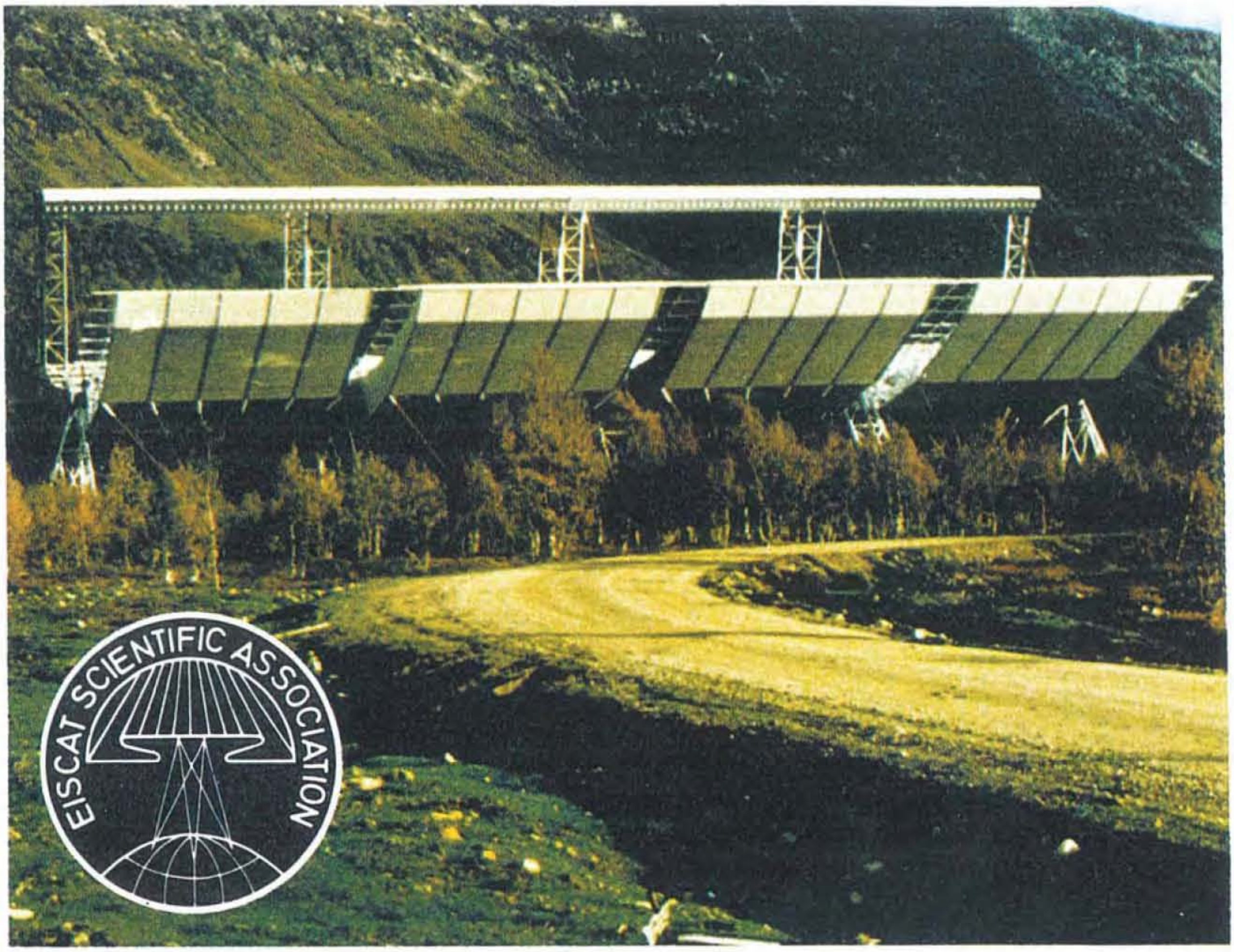
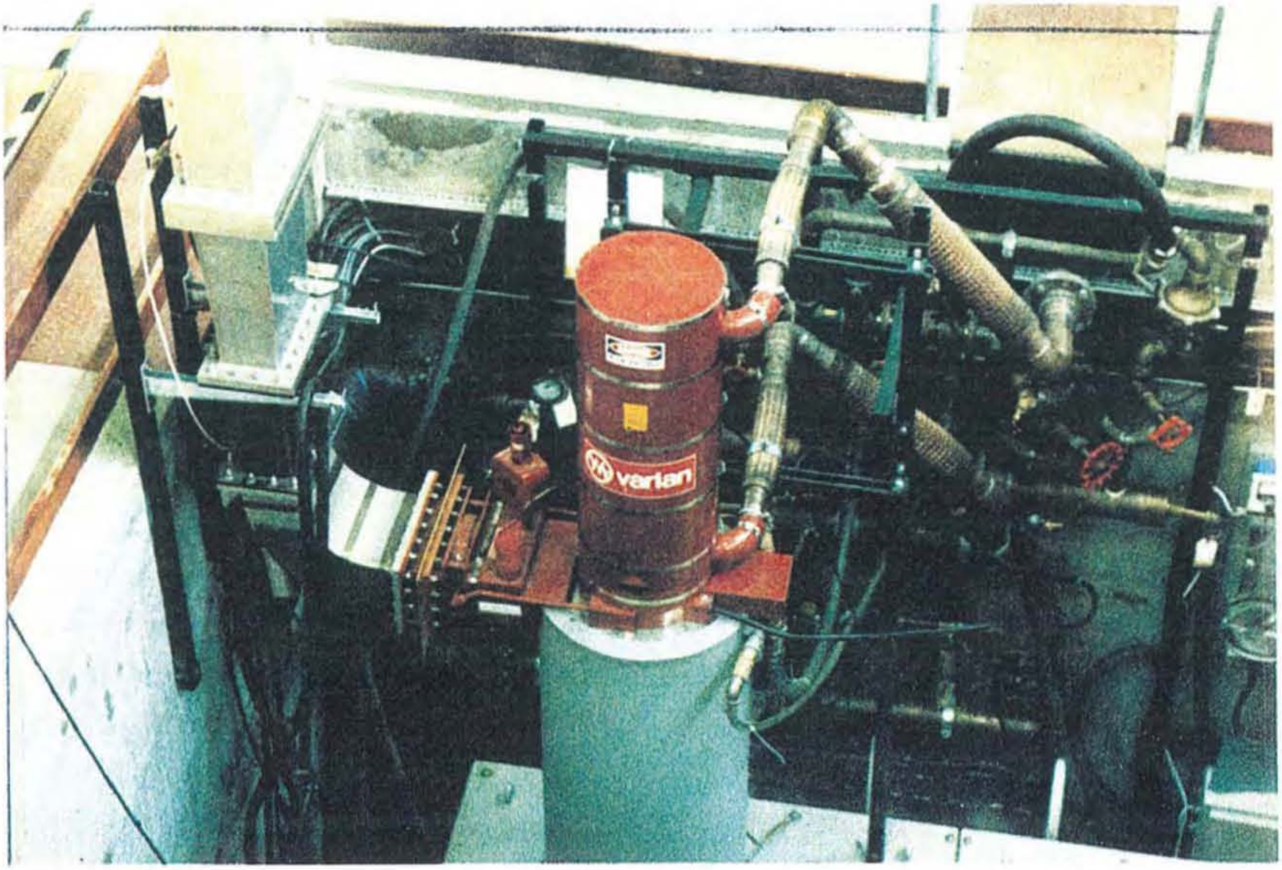


EISCAT

EUROPEAN INCOHERENT SCATTER SCIENTIFIC ASSOCIATION

ANNUAL REPORT 1980

S-98127 KIRUNA, SWEDEN, PHONE (0980) 18740



UHF Transmitter at Tromsø

CONTENTS

INTRODUCTION

The previous annual report dealt primarily with progress in acquiring the full equipment for EISCAT and expressed confidence that the transmitter — the major stumbling block in the instrumentation — would be delivered in time for the first observational results to become available during 1980. Once more our expectations have been frustrated by the slow progress in completing the UHF transmitter, and no radar observations have yet been possible.

There has indeed been some progress during the year. The recommendations of the klystron investigating committee, set up by EISCAT and referred to in last year's report, were largely implemented by the tube manufacturer. As a result, a working klystron was delivered to the transmitter manufacturer and installed. The UHF transmitter passed the preliminary in-plant acceptance tests — with some reservations — during June and July. The transmitter was shipped to Tromsø and has been installed there, but has not yet been able to transmit successfully for reasons explained later in this report.

The final acceptance tests of the VHF antenna have been completed, and only minor corrective work remains. In accepting the antenna a modest relaxation of one of the specifications of the antenna was agreed between EISCAT and the manufacturing consortium. High power testing, of course, will only be possible when the VHF transmitter is available.

The development of the basic data taking and data analysis programs proceeded during the year, but here again they cannot be put to the final test until the equipment is complete. Nevertheless, the software system has been tested as extensively as possible, for example in the reception of incoherent scatter signals from the French station at St. Santin, the reception of echoes from the moon, the search for natural electromagnetic emissions from auroral precipitating particles, and the observation of interplanetary and ionospheric scintillations.

In the meantime, the expectations of the scientific community regarding the degree of data analysis to be carried out on a routine basis have been rising, and have reached a level where it is clear that the EISCAT computers will not be adequate for the task. Serious considerations have therefore been given to the possibility of transferring several of the data analysis tasks to a large outside data centre.

The organization has continued to be overwhelmed with proposals for scientific work without being able to respond because of the delays in acquiring a working transmitter. We were unable to co-operate in the first ionospheric heating experiments at Tromsø; neither could we participate in the Energy Budget Campaign which started during December.

In spite of the grave disappointments, however, there has been visible progress toward an operating transmitter during this year, which was not the case last year. I therefore sincerely hope that I am better justified than in the previous annual reports in expressing confidence that EISCAT will be operating successfully during the coming year.

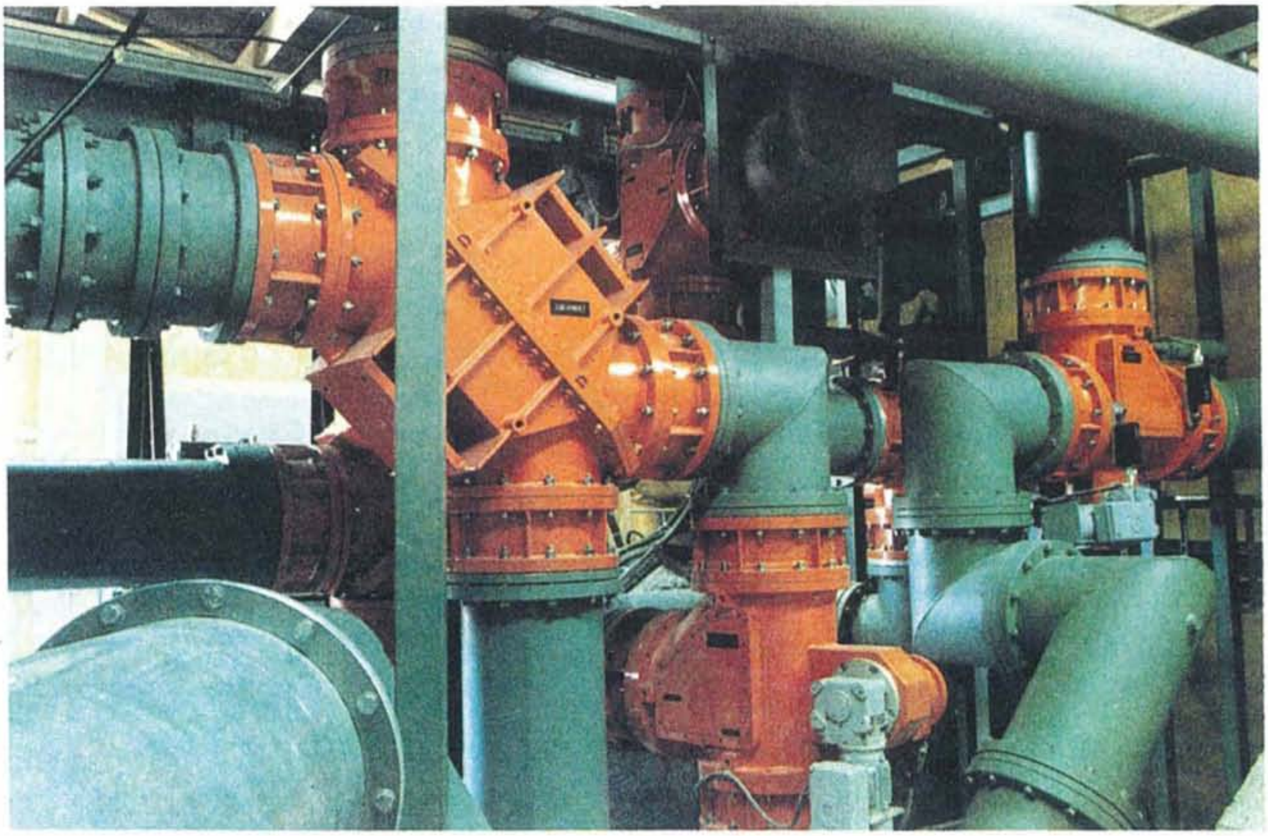
T. Hagfors
Director

ANTENNAS

During 1980 the UHF antennas have been operating at regular intervals, as part of a series of observing programs to be described later in the report. Apart from several minor failures which have been repaired as they occurred, these antennas have worked well. We expect that their reliability will increase with the steady regular use they will see when EISCAT is in full operation.

The VHF antenna was tested in a preliminary way at the end of 1979. The bulk of the radio frequency tests were, however, conducted during the spring of 1980 and will be described here. Some of the preliminary measurements were repeated, but although some of the results were slightly different from those given in last year's report there were no substantial changes.

The reflected power at the transmitter end of the feeder lines was measured again with the beam in the broadside position, and in addition similar measurements were made with the beams offset to



VHF Switchyard

VHF Antenna at Tromsø with Aurora

$\Theta = 21.3°$ and $\Theta = 25.2°$. According to the specifications, reflected power within the transmit band of 224 ± 1.25 MHz must correspond to a Voltage Standing Wave Ratio (VSWR) of less than 1.4 since a higher value would seriously reduce the available transmitter output power. The results are shown in Table I. Mode 1 refers to a switchyard position where the antenna works as a single antenna for both vertical and horizontal polarization which are fed independently. Mode 2 refers to split beam operation with circular polarization. (See Annual Report 1979).

Table I: Reflections of feeder line input

Pointing angle	Mode 1				Mode 2			
	Horizontal		Vertical		Sections 12		Sections 34	
	dB Loss	VSWR	dB Loss	VSWR	dB Loss	VSWR	dB Loss	VSWR
$\Theta = 0°$	24	1.13	26	1.11	26	1.11	26	1.11
$\Theta = 21.3°$	26	1.11	30	1.07	27	1.09	35	1.04
$\Theta = 25.2°$	26	1.11	16	1.38	19	1.25	21	1.20

The VSWRs can be seen to be well below the specification with the exception of that for vertical polarization at the extreme pointing angle of 25.2°.

The impedance of individual dipoles in the array was also measured as a function of frequency, for several different beam directions. It was then discovered that reflections of the individual dipoles were unacceptably large at extreme steering angles for the vertical polarization. At 25.2°, the extreme pointing angle, the reflection at the transmitter would be too large, the dissipation in parts of the feeder system too high and the overall efficiency too low. After urgent consultations with the Associates it was agreed to accept the angle $\Theta = 21.3°$ as the maximum angle. The scientific consequences did not appear to be too great. The reason for this antenna behaviour, which was not detected in any of the models tested, appears to stem from the presence of a surface wave on the beam-forming rods. We hope that future studies of the feed may show some way of correcting the problem.

The gain was measured on axis (i.e. $\Theta = 0°$) and at the extreme pointing angle of 21.3°. An example of a scan through Cassiopeia A with the offset beam is shown in the illustration opposite. The results of the gain measurements are given in Table II. The guaranteed aperture on access was 2900 m^2 so the results are satisfactory. The loss of gain when the antenna is phase steered is approximately as expected from the obliquity factor and from spillover and loss of reflector illumination at either end. Apart from a slight asymmetry in the polar diagrams of the antenna and apart from the unknown power handling capability it appears that the antenna works according to expectations.

Table II: Gain measurements against radio sources

Mode	Offset	Efficiency	Aperture
Vertical	0°	60%	2900 m^2
Vertical	21.3°	47%	2250 m^2
Horizontal	0°	69%	3300 m^2
Horizontal	21.3°	51%	2450 m^2

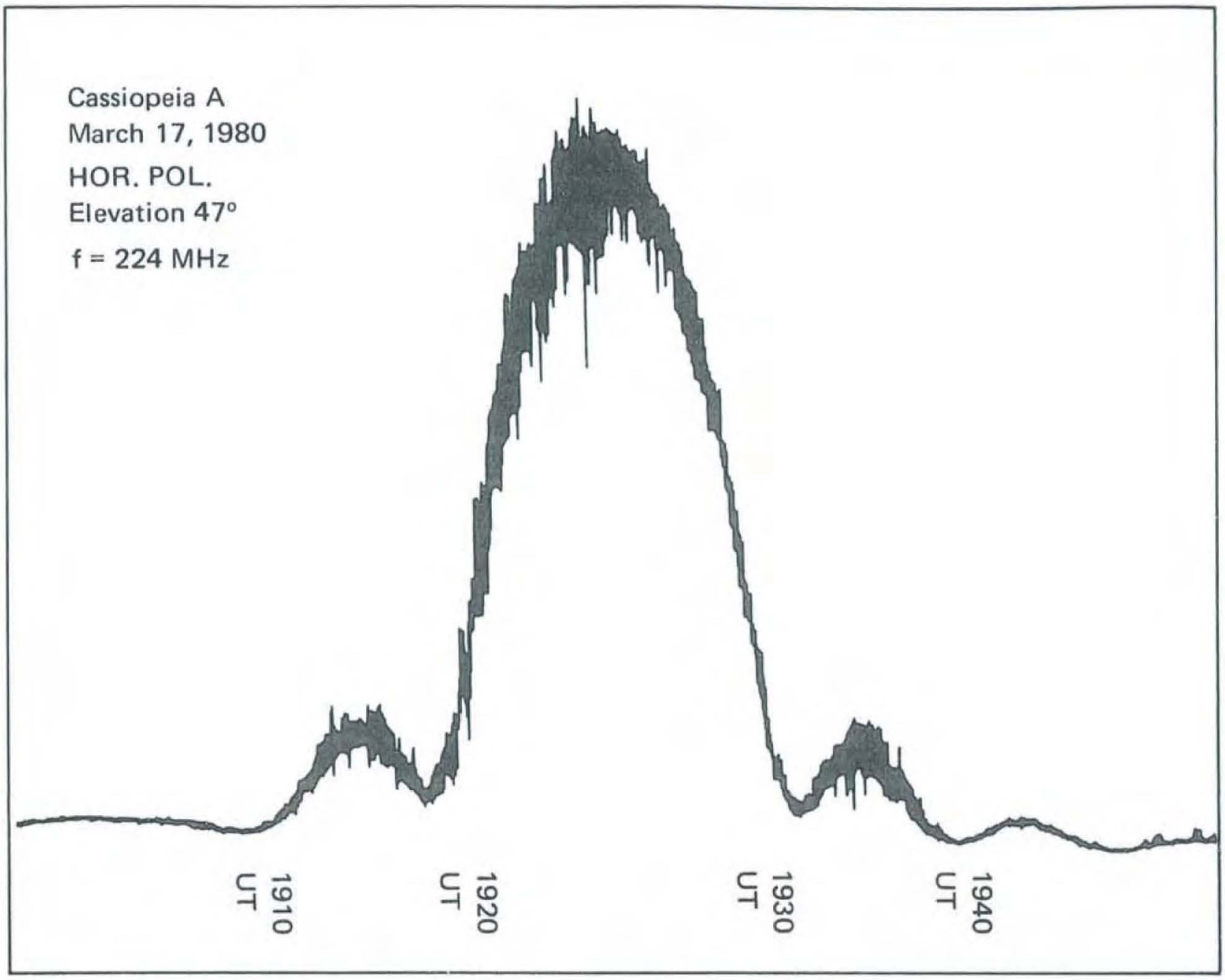
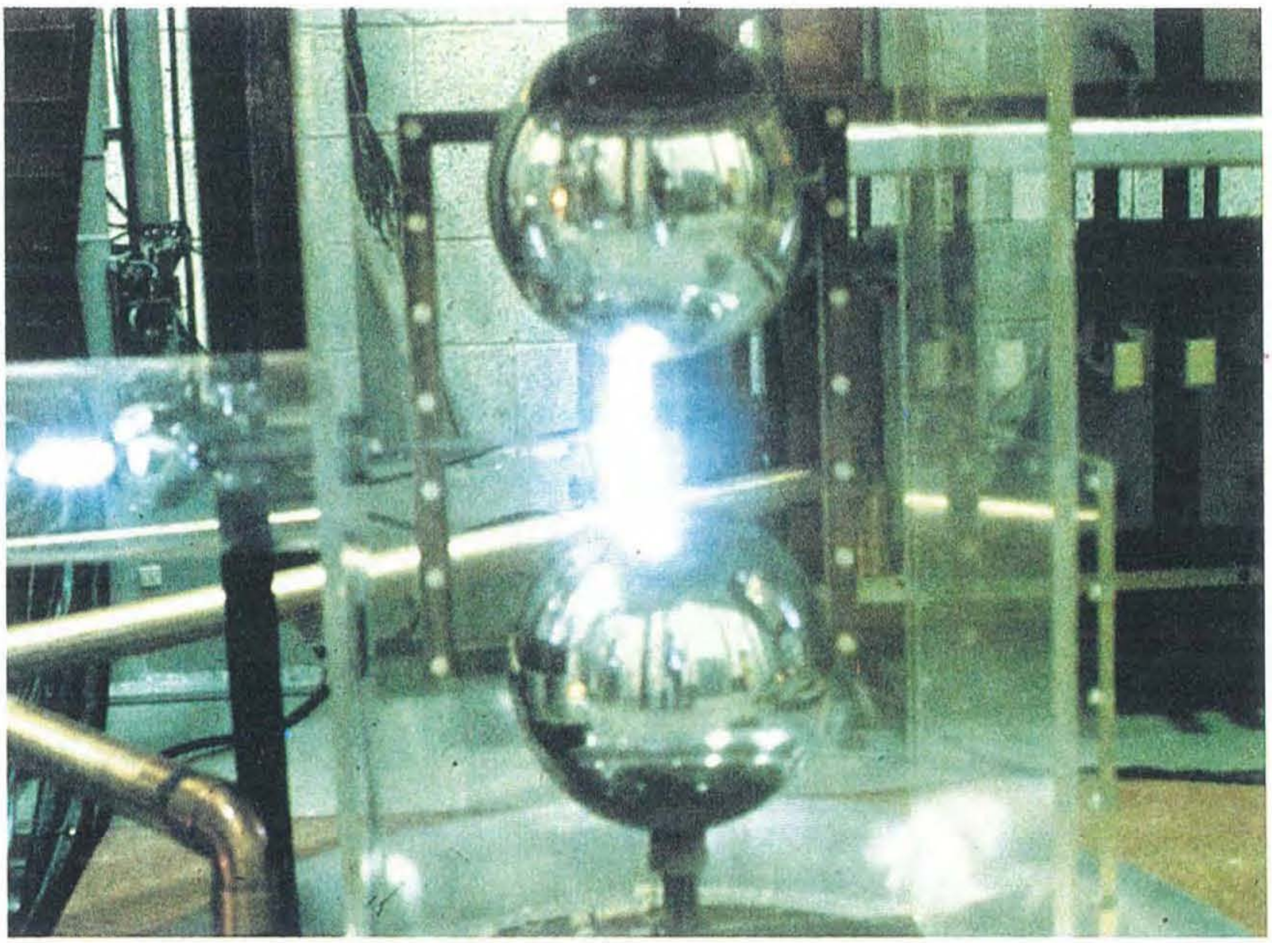


Figure 1: Transit of Cassiopeia A with the VHF antenna phase-steered to 21.3° azimuth i.e. n = 17. The record shows rapid ionospheric scintillations.

TRANSMITTERS

The design modifications proposed by the EISCAT klystron committee were implemented by Varian. The first modified tube was delivered to Aydin during March and was promptly installed and tested. The modified klystron appeared to work extremely well and the work needed to bring the transmitter up to full power was started.

There were again several set-backs: the mechanical switch which decides whether the power goes into the dummy waterload or into the antenna arced under high power, the dummy load itself arced and the duplexer gas tubes ignited erratically.



Crowbar of UHF Transmitter in action

Nevertheless, during June it was decided to go ahead with the acceptance tests in the manufacturer's plant without the switch, waterload and duplexer. These tests showed that the basic transmitter works well and that most of the complex modulation schemes which were planned for EISCAT can be implemented. In spite of the fact that some parts had been shown not to work, it was decided to ship the transmitter to Tromsø for installation.

This decision was made after both subcontractors involved had promised to continue the corrective work in Tromsø, bearing in mind that several modes of operation will be possible even without the defective parts.

The transmitter arrived in Tromsø at the end of August and was installed mechanically within a few weeks. There was some transportation damage due to inadequate packing, but this damage was corrected relatively easily and quickly.

The remainder of 1980 saw an amazing series of unexpected mishaps which prevented the operation of the transmitter. Pipes in the cooling system were damaged by freezing, causing such large leaks that all the coolant was lost; some of the coolant contaminated the insulating oil which had to be replaced; diesel fuel was mixed with the insulating oil when replacement took place. When, finally, in December everything was ready for high voltage turn-on the voltage control on the high voltage regulator did not function and had to be returned to the manufacturer for repair. By mid-December the Aydin installation team left Tromsø intending to return in January to complete the installation and checkout.

Meanwhile the VHF transmitter is being assembled in the manufacturer's plant in Palo Alto. All three VHF tubes have been delivered by Varian after acceptance tests in Varian's plant. It is expected that the in-plant acceptance tests of the VHF transmitter may take place during the early summer of 1981.

RECEIVERS

The cooled parametric amplifiers are — on the whole — performing well. The frequency of the mains power supply has been changed and this has resulted in a considerable improvement in the performance of the cryogenic system. As a result, at Sodankylä it has been possible to run the paramps for over five months without a break, providing a low system noise ($\sim$ 40K) in both channels. At Kiruna, one channel has proved equally reliable but in the other channel it has been necessary to use a spare up-converter with an inferior noise performance while the original up-converter has been in the USA for repairs.These repairs have taken far longer than anticipated.

In Tromsø it is planned to install the paramp in the antenna after the duplexer has been installed, and so the paramps have only been operating in the laboratory, but their performance appears to be satisfactory.

Meanwhile there has been a dramatic improvement in the state-of-the-art performance of GaAsFET preamplifiers, which can now provide cheap, low-noise amplification at higher ambient temperatures than necessary for the paramps. GaAsFET preamplifiers have already been used at Kiruna for observations at 1296 MHz and it has therefore been decided to buy GaAsFET preamplifiers as a standby in case there is trouble with the paramps.

The rest of the receiving system, between the paramps and the Analogue-Digital Converters (ADCs), has been subjected to a thorough and extensive series of tests carried out at Sodankylä. The overall conclusion was that the receivers would perform adequately provided certain modifications were made:-

i) the isolation between the two local oscillators (at 1053.5 and 813.5 MHz) at the 1st mixer is inadequate, and as they are derived from a single source, they can combine to give a strong coherent component in the final signal. PIN-diode switches with at least 60 dB isolation are to be introduced;

ii) the signal reflected from the 2nd mixer to the channel divider contains frequencies which can create spurious signals in the other channels. Isolation amplifiers will be introduced between the dividers and the 2nd mixer;

iii) the filters at the 2nd IF of 30 MHz do not adequately reject signals outside the pass-band. The most serious stray signal is the 90 MHz signal from the local oscillator. This can reach the quadrature detectors and beat coherently with the 3rd harmonic of the 30 MHz reference signal to produce a strong DC output which corrupts the final signal. It seems that the problem is in the filter switch. For two channels in each receiver, a 50 MHz low-pass filter will be inserted, and for the other channels the filter switch will be removed and a single filter hard-wired into the receiver;

iv) the filters in the DC amplifiers — especially the 500 kHz, 1 MHz and 2 MHz filters — are unsatisfactory. They do not have a flat frequency response and the phase-linearity is inadequate for Barker-coded signals. Moreover, there is often a large voltage offset in the output of the amplifiers. An improved DC-amplifier with improved filters and automatic offset correction has been tested at Sodankylä and will be introduced into the receivers.

When these modifications are completed it is expected that the receivers will form a totally reliable part of the EISCAT system.

CORRELATORS

The correlators are the heart of the EISCAT data-handling system. For example, in studies of the ion-line spectrum 8-bit samples of the in-phase and quadrature outputs of the DC amplifiers will be taken by the ADCs at a rate of 100 kHz or more. These samples will be stored in a buffer memory which holds a maximum of 4k 16-bit words. The data are then read from the buffer memory by the correlator itself in order to determine autocorrelation functions (ACFs) for each height being studied. The ACFs are stored in a result memory where they can be averaged over a suitable period before being transferred to magnetic tape. At the same time the buffer memory is refilled with new data. The timing of the whole operation is governed by the radar controller.

At the beginning of the year, prototypes of the radar controller, buffer memory, correlator and result memory had been completed. In March 1980 for the first time the system was operated as a whole, and with test input data it produced the correct ACFs as output.

While production of the four main units was being completed, further tests showed that although each part of the prototype operated successfully at a clock-frequency of 5 MHz, the combination was not always reliable at that speed, and could only be used with full confidence at 3.75 MHz. This speed was certainly adequate for all observations at the remote sites, but might limit the monostatic observations where up to 100 different heights would be processed simultaneously.

The problem was identified in the grounding circuits which were not adequate to carry the currents generated in certain states. By the end of the year the problem had been solved by a suitable reinforcement of the grounding circuits and it was anticipated that all the correlators, together with the buffer memories and result memories, would be delivered to all sites early in 1981.

Meanwhile, with the help of Terrance Ho of the Max-Planck Society, a suite of correlator programs has been developed to handle all the observations planned in the early years of full operation. These include power profiles derived from a single pulse transmission, ACFs at many heights from both single-pulse and multi-pulse transmissions, and cross-correlation functions.

COMPUTERS AND CONTROL

During 1980 the computing staff completed the prototype versions of the two languages that will be used in running EISCAT experiments, viz. TARLAN and EROS.

TARLAN (Transmitter-and-Receiver Language) is a simple language which defines the operation of the transmitter and the receivers. A TARLAN compiler generates the appropriate instructions to the radar controller which, in turn, issues command-pulses to different devices at times determined with microsecond precision.

Each instruction consists of 2 16-bit words, one defining the appropriate command and the other the corresponding dwell-time.

One bit in the instruction chooses either the transmitter or the receiver. If the transmitter is chosen, then a single word can switch the high voltage on-or-off, can determine the frequency to be transmitted, can switch the rf pulse on-or-off and can change the phase of the signal.

If the receiver is chosen, each channel can be switched on-or-off, the noise calibration signal can be added and the matched filters can be introduced for Barker coding. This word also instructs the ADC and correlator to start or end the computation of ACFs.

EROS (EISCAT Real-time Operating System) is the language used to control the antennas, the polarizers, and the receivers and to load the appropriate programs into the correlator. Over 70 different instructions can now be carried out via EROS and these include:-

i) instructions to point the three UHF antennas to a common scattering volume. A reference site is first defined and the scattering volume can then be defined either as a latitude, longitude and height or as an azimuth, elevation and range from the reference site. Special instructions have also been included to carry out small changes in any of the parameters defining the scattering volume. In all cases the known antenna pointing corrections are automatically applied;

ii) instructions to set the polarizer. By defining the two phase delays incorporated in each polarizer it is possible to receive any mode of linear or elliptical polarization;

iii) instructions to set the receiver. In this way the local oscillator frequencies can be chosen to determine the frequency observed in each channel; the attenuation in each channel can be set separately and the bandwidth of each filter chosen;

iv) instructions to the radar controller and correlator. Standard or special programs can be loaded into the data-handling system, the registers of the correlator can be set to given values and the DMA (Direct Memory Access) dumping of data from the correlator can be controlled;

v) instructions to the tape units. Tapes can be mounted, the status of the tape can be printed and the tape instructed to start recording;

vi) test programs. The status of the antennas, receivers, correlator and current tape can be printed; the clocks can be compared and the communication between sites tested.

In practice TARLAN and EROS have proved to be very simple and flexible languages for controlling EISCAT experiments. Several passive experiments have already been carried out successfully using these languages and the UHF common programs have been prepared in the form of TARLAN and EROS instructions.

These common programs have been "run" at the remote stations to test the software, the antenna, the polariser and the receiver but a full test will only be possible when the correlators are installed and the transmitter operating.

DATA REDUCTION

Latest estimates suggest that the EISCAT Common Programmes will generate about 50 tapes of raw data per year. These will consist of ACFs for different heights and different times, each integrated for a period of 10 secs. It is likely that the Special Programmes will also generate about 50 tapes of raw data per year.

It is intended that the initial data reduction of the common programme data will be carried out at EISCAT Headquarters.

The first stage will carry out a further integration of the raw data for a period of 2-3 minutes. During this stage we also hope to identify and remove obvious cases of clutter e.g. echoes from aircraft, satellites, the moon etc.

The data will then be reduced to provide physical parameters. A suite of programs has been developed to make a least-squares fit of theoretical ACFs to the observed data, after correcting for the frequency response of the receiving system and the noise background. In this way the electron density, electron and ion temperatures, ion composition and plasma velocity will be determined as a routine over the full height range covered, while the ion-neutral collision frequency will be measured in the lower E region.

It is intended that copies of these physical parameters will be sent to each of the six Associates, while the raw data will be maintained in a secure archive and copies sent on request to individual experimenters.

In the autumn of 1980, a small committee was set up to consider the best way in which EISCAT data could be reduced and distributed. It recommended* that while the reduction of the common programme data to give physical parameters should be carried out at EISCAT, the Headquarters did not have at present suitable equipment, or sufficient staff, to distribute copies of the reduced data and to provide raw data to individual experimenters on request. It was suggested that these tasks would be handled more efficiently by a major computing centre with the appropriate equipment.

Consequently, the Director initiated discussions with a number of computing centres, identifying those tasks which might be transferred.

Task A: to receive the tapes of reduced common programme data from EISCAT and distribute copies to each Associate; to store

*Review and Assessment of the EISCAT Data Handling Capabilities. *Bertrand de la Porte and Kristen Schlegel.*

and maintain these data in a secure archive; to compile an index and a microfiche survey of the data, and distribute these to the Associates and to EISCAT.

Task B: to receive the tapes of raw data from EISCAT, including those from the special programmes; to store and maintain these data in a secure archive; to compile and distribute an index of the tape contents; and to respond to requests for raw data.

Task C: to analyse raw data on behalf of experimenters using routines provided by EISCAT.

It is also hoped that a major computing centre would be able to compute additional parameters on request, such as conductivity, electric currents, energy flux, neutral winds, neutral temperature etc. In addition, modern data-base management would be available to archive data in a form suitable for requests in a generalised form e.g. listing all those occasions in a given year when the plasma velocity was greater than 1 km sec^{-1}, or when the electron temperature in the E region was significantly greater than the ion temperature.

If a suitable agreement can be reached between EISCAT and a major computing centre this plan will be implemented as soon as EISCAT data are available.

SCIENTIFIC PROGRAMME

Throughout 1980 almost all EISCAT's equipment had been installed but in the absence of a transmitter it was impossible to carry out the planned incoherent-scatter observations. It was decided, therefore, to make as many observations as possible so that the existing equipment could be exercised under running conditions and any problems identified and corrected before the full system was in operation. A series of experiments was devised with this in mind, but some of these proved of genuine scientific interest and it is planned to continue these even when the transmitter is completed.

The simplest experiments use the antennas to observe radio sources. Normally the antenna is fixed so that the radio source drifts through the main beam, giving a smooth detected output which represents the power polar diagram of the antenna. From such a record it is possible to determine the flux density of the source, and in the case of the VHF antenna absolute measurements of flux densities will be valuable in establishing the flux density scale of radio sources at metre wavelengths.

On occasions, however, the signal from the source appears to vary. For example we have observed the regularly-spaced pulses from pulsars, where the variation occurs in the source itself. On other occasions the signal fluctuates rapidly and irregularly: these 'scintillations' are of two kinds and both are of geophysical interest.

When radio sources are observed through the outer atmosphere of the sun, irregularities in the interplanetary medium cause refraction, and if the angular diameter of the source is sufficiently small this refraction causes a variation in the apparent signal strength observed along the earth's orbit. It follows that the source appears to scintillate — and the observed scintillations are determined by the scale of the irregularities, by the movement of the solar wind and by the movement of the earth in orbit.

Last summer interplanetary scintillation was observed in a number of sources, including 3C 295. By repeating these observations using all three UHF antennas it will be possible to measure the scale of the irregularities, their velocity and their lifetime.

Scintillation can also occur as the result of refraction by irregularities in the ionosphere. When such scintillations are observed separately with both halves of the VHF antenna, the scintillations themselves are highly correlated but a small time difference can sometimes be detected, corresponding to the east-west velocity of the irregularities. It is now planned to use the split-beam option of the VHF antenna to observe neighbouring radio sources, two at a time, and so study the east-west and north-south structure of the irregularities and their velocity.

In addition to refraction in the ionosphere, the signals from radio sources are refracted in the atmosphere, especially at low elevation angles. This refraction is far more regular and can be predicted from local meteorological conditions. Measurements of this refraction already form part of the routine antenna pointing calibration. Further measurements are being made at the lowest elevations accessible to the UHF antennas: these will be important in any attempt to detect signals transmitted from Chatanika, which can only be observed near the horizon (see below).

Another passive experiment that has been carried out at intervals is the search for radio emission from aurorae. Early results were promising, showing 'spikes' in the detected signal during a substorm. However, it has not yet been possible to identify any spike positively with an auroral event, nor to observe the same event simultaneously at Kiruna and Sodankylä, and it is likely that many, if not all, of the spikes are the result of local interference.

Finally, in order to test the whole system as far as possible, incoherent scatter signals from the French station at St. Santin have been detected. This transmits a cw signal at 932.25 MHz for the first half of any second and at 934.75 MHz for the second half. By tuning two channels in the receiver to these frequencies and sampling the detected signals from each, an integration of half-an-hour was sufficient to display the pattern of transmission from St. Santin, and to give an estimate of the electron density at an altitude of about 650 km above the station.

The ability of EISCAT antennas to receive incoherent scatter signals from a distance of nearly 3000 km has prompted a proposal to use EISCAT to receive the signals scattered from a Chatanika transmission, thus observing the ionosphere in the polar region. This would require the EISCAT antennas to observe at 1295 MHz.

As it happens, observations have already been made successfully at this frequency by radio amateurs at Kiruna who used the EISCAT antennas to transmit messages via the moon to other amateurs all over the world, including New Zealand and California. Tests with the equipment used by the amateurs suggest that at 1295 MHz the antennas would have an aperture efficiency of more than 50% and a beamwidth less than 0.5°. Observations of a signal from Chatanika are therefore feasible.

EISCAT REPORTS PUBLISHED IN 1980

S.A. Kvalvik: EISCAT Technical Notes No. 80/20, 1980
Correlator buffer-memory for the EISCAT radar system.

P-S Kildal: EISCAT Technical Notes No. 80/21, 1980
EISCAT VHF-antenna tests.

J. Armstrong: EISCAT Technical Notes No. 80/22, 1980
EISCAT experiment preparation manual.

A. Farmer: EISCAT Technical Notes No. 80/23
EISCAT data gathering and dissemination.

S. Westerlund (Editor): EISCAT Meetings No. 80/5, 1980
Proceedings EISCAT Annual Review Meeting 1980.
Pohtimolampi, Finland, 14-18 April 1980.

B. de la Porte and K. Schlegel: Special Report, 1980
Review and Assessment of the EISCAT Data Handling Capabilities.

MEMBERSHIP OF COUNCIL AND COMMITTEES AT 31st DECEMBER 1980

	FRANCE	FINLAND	FEDERAL REPUBLIC OF GERMANY	NORWAY	SWEDEN	UNITED KINGDOM
COUNCIL	M. Blanc P. Creyssel M. Petit	O. Ranta A. Siivola	W.I. Axford G. Haerendel G. Preiss	O. Holt A. Omholt	B. Hultqvist M.O. Ottosson	H.H. Atkinson W.J.G. Beynon H. Rishbeth
SAC	P. Bauer J–C Ribes	J. Oksman	J.A. Fejer H. Kohl	E. Leer	R. Boström	H. Rishbeth T.B. Jones
AFC	J. Mirabel A. Schwerer	O. Ranta	G. Preiss M. Meinecke	L. Westgaard	M.O. Ottosson	G. Rowe J.D. Willcock

HEADQUARTERS SENIOR STAFF AT 31 DECEMBER 1979

T. Hagfors — Director
K. Folkestad — Associate Director
P. Williams — Associate Director*
J. Galt — Business Manager

*on secondment from SERC

EISCAT Staff at Annual Review Meeting, Pohtimolampi

EISCAT MEETINGS

COUNCIL
14th meeting, Paris, 24-25 April 1980
15th meeting, Chilton, 6-7 November 1980

SCIENTIFIC ADVISORY COMMITTEE
16th meeting, Garching, 5-6 February 1980
17th meeting, Monpazier, 28-29 May 1980
18th meeting, Tromsø 2-3 October 1980

ADMINISTRATIVE AND FINANCE COMMITTEE
14th meeting, Hamburg, 28-29 February 1980
15th meeting, Hamburg, 18-19 September 1980

EISCAT ANNUAL REVIEW MEETING
4th meeting, Pohtimolampi, 14-18 April 1980

BALANCE SHEET

Assets

FIXED ASSETS	At Jan. 1, 1980	Additions	Depreciation	At Dec. 31,1980	At Dec. 31, 1979
Pool:					
Transmitters	20,606	2,819	–	23,425	20,606
UHF-antennas	24,939	237	1,303	23,873	24,939
VHF-antenna	25,260	4,547	1,263	28,544	25,260
In Kind:					
Premises	1,445	–	30	1,415	1,445
Receivers	423	–	–	423	423
Time/frequency system	194	–	–	194	194
On-line computers	2,618	–	–	2,618	2,618
Total Pool/In Kind	75,485	7,603	2,596	80,492	75,485
CAPITAL OPERATING					
Spare parts	–	176	–	176	–
Instrumentation	–	156	–	156	–
Housing	18	1	1	18	18
Data processing system	735	102	119	719	735
Ancillary equipment and furniture	573	46	144	475	573
Motor vehicles	144	167	37	274	144
Total Capital Operating	1,470	647	300	1,817	1,470
Total Fixed Assets	76,955	8,250	2,896	82,309	76,955
CONTRIBUTIONS					
Pool — uncalled				3,000	3,000
CURRENT ASSETS					
Debtors				372	338
Prepayments and accrued income				139	70
Cash				5,919	8,005
Special account				1,749	2,955
Total Current Assets				11,179	11,368
				93,488	91,323

Notes on the Balance Sheet:

1. Remaining commitments due to main contracts: Transmitters, MSEK 3.3
   VHF-antenna, MSEK 0.27
2. In Kind expenditure by Nordic Associates is only included to the extent that fixed assets have been formally handed over as contributions to EISCAT.

AT 31 DECEMBER 1980

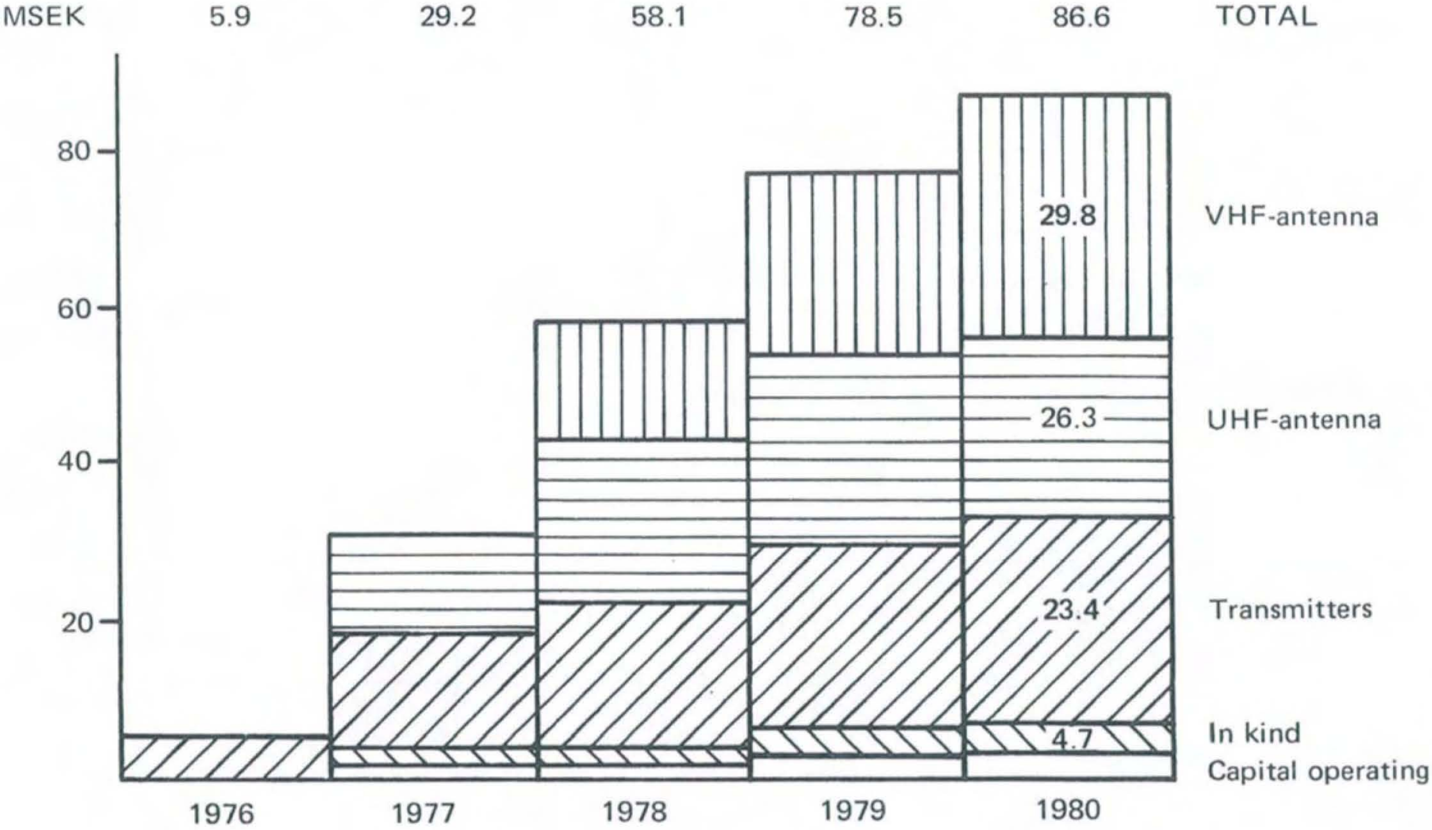
Liabilities

SEK/000

	At Dec. 31, 1980	At Dec. 31, 1979
CAPITAL		
Contributions		
Pool	81,136	76,630
Capital Operating	2,630	1,877
In Kind	4,739	4,739
	88,505	83,246
Un-called contributions	3,000	3,000
Depreciations	(4,381)	(1,500)
Total Capital	87,124	84,746
RESERVES		
General reserve	3,691	1,786
Special reserve	1,749	2,955
Total Reserves	5,440	4,741
LIABILITIES		
Provisions	508	485
Other liabilities	416	1,351
Total Liabilities	924	1,836
	93,488	91,323

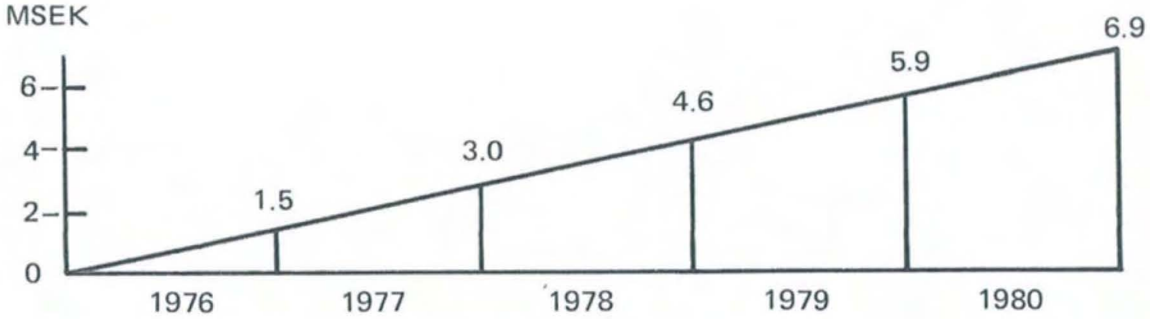
CAPITAL INVESTMENTS

The capital investments amounted to 86.6 MSEK at the end of 1980. the cumulative cash flow of the capital investments has been as follows:



OPERATING COSTS

The operating costs increased by 1.1 MSEK to 6.9 MSEK in 1980 but are not yet up to the level for full operations. The annual costs have had the following progress:



Figures quoted are current values at the time of expenditure.

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