DEDICATED RADIO-COMMUNICATION SYSTEM
FOR SOEKOR'S OIL EXPLORATION ALONG THE SOUTH AFRICAN COASTLINE

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SYNOPSIS

Soekor's exploration programme has moved totally offshore and expanded greatly in the past few years. Use of computers necessitated the exchange of data between offshore and land installations. At the same time the exploration programme is moving further offshore while the coastal stations of the Post & Telecommunications can not handle the volume of traffic that the oil drills present nor the data modes. A study of the transmission requirements revealed that a minimum of one voice channel per drill must be available at all times, while some 20M byte of data per oil drill per year will be transmitted. Facsimile will be needed at times, also as a back-up for the data systems. A study of publications revealed that only five of the eleven methods studied are viable, namely VHF-FM, Satellite, HF-telephony, HF-teleprinter and HF-data. These possibilities as well as their practical implementation was studied in depth. The effect of the atmospheric conditions on the propagation of VHF-signals around the coastline was studied and 17 sites identified and evaluated from the mouth of the Orange river to Port Elizabeth in respect of coverage, accessibility, facilities and cost. INMARSAT facilities and costs were evaluated as well as HF-systems. Finally a system was designed consisting of HF-telephony, separate "packet" HF radio data system, satellite telephony back-up and satellite high speed data as well as a limited VHF system. The entire system is complemented by marine telephony and telegraphy equipment. On-going system guidance in the form of propagation predictions is provided. Some existing equipment was used, while R950 000 has been spent to date on additional equipment.

SINOPSIS

Soekor se olie-eksplorasie program is in totaliteit verskuif na die see en het baie uitgebrei in die afgelope paar jaar. Die gebruik van rekenaars veroorsaak dat data tussen see en land installasies uitgeruil moet word. Terselfdertyd verskuif die eksplorasie-program al verder van die kus af weg, terwyl die kusstasies van die Pos & Telekommunikasie nie die volume verkeer kan hanteer wat die bore verlang nie en ook nie die data-modusse kan hanteer nie. 'n Studie van die versending vereistes het getoon dat 'n minimum van een spraak-kanaal per boor ten alle tye beskikbaar moet wees, terwyl sowat 20 Mega-greep se data per olieboor per jaar versend sal word. Faksimilee sal soms benodig word, ook as 'n rugsteun vir die data-sisteme. 'n Studie uit gepubliseerde materiaal toon dat slegs vyf van die elf bestudeerde metodes prakties uitvoerbaar is, naamlik BHF-FM, Satelliet, HF-telefonie, HF-teledrukker en HF-data. Hierdie moontlikhede sowel as hulle praktiese implimentasie is in diepte bestudeer. Die effek van atmosferiese toestande op die voortplanting van BHF-seine om die kuslyn was bestudeer en 17 terreine is geidentifiseer vanaf die mond van die Oranjerivier tot Port Elizabeth. Dekking, toeganklikheid, infrastruktuur en koste tov. elke terrein is geevalueer. INMARSAT fasiliteite en kostes is ook geevalueer sowel as HF-sisteme. Op die ou einde is 'n stelsel ontwerp wat bestaan uit HF-telefonie, aparte "pakket" HF radio data sisteem, satelliet telefonie rugsteun en satelliet hoë spoed data sowel as 'n beperkte BHF sisteem. Die hele stelsel word aangevul deur marine telefonie en telegrafie uitrusting. Riglyne vir bedryf van die stelsel in die vorm van frekwensie-voorspellings word deurlopend voorsien. 'n Klompie bestaande uitrusting was hergebruik, terwyl die aankoop waarde van bykomende uitrusting alreeds R900 000 beloop.

INTRODUCTION

When Soekor's oil-exploration programme moved from land to sea in the early seventies, the demands as far as communication were concerned was relatively minimal.

At first only one oil-drill at a time was used, and most communication was by means of HF radio-telephony. The use of computers was minimal and there was no need for data exchange. A small amount of facsimile was sent on HF, much to the detriment of the HF transmitters, as the transmitters were not made for continuous duty as demanded by facsimile transmission.

In the early eighties a VHF system as designed by Mr. Willie van Niekerk of Stellenbosch University was introduced. A Post & Telecommunication carrier-circuit was used to the nearest practical high-point ashore from the oil drill, where a remote VHF station was established for the short-haul out to sea. But as the oil-exploration programme moved further away from the shoreline the communication deteriorated, and a pressing need was felt for dedicated secure data, it became clear that a complete new system was needed.

In my appointment to Soekor's staff, I was instructed to examine all the possibilities and design a system that will be usable for the present and foreseeable future.

The basic requirements were laid down as follows:

1. To overcome communication problems specific to oil exploration along the SA coast.

2. To design a reliable, low maintenance system for voice, facsimile and data communication.

3. Suitable for 24 hours operation and simple to operate.

4. Quick pinpointing of faults so that technicians can proceed directly to the location of the fault.

5. Equipment placed at sea and remote sites must be easy to maintain. The design and layout of equipment must be such that faulty sub-assemblies can be exchanged and returned to Cape Town for repair,thus avoiding "field" repairs.

6. It would be an advantage if the equipment could also be used for marine purposes, including the sending of distress calls.

7. The system must be designed within the framework of the existing Radio regulations.

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CHAPTER 1

THE OBJECTIVES OF THIS PROJECT:

1. To overcome communication problems specific to Soekor's oil exploration along the S.A. Coast.

2. To study all possible propagation modes and technical possibilities and select the most viable ones.

3. To study the geography of the terrain and its effect on radio communication systems.

4. To evaluate existing infrastructure as well as solar and wind-energy where no mains supply exists.

5. To design a reliable low maintenance system incorporating voice, facsimile and data modes.

6. To implement the system using local suppliers and "in house" labour as far as possible.

7. System must have several "paths" to facilitate redundancy and a service life of at least ten (10) years.

CHAPTER 2

SOEKOR'S COMMUNICATION PROBLEMS

Before defining particular communication problems and needs, one must look at the characteristics of the offshore oil drills used along the South African coastline. The deep-water drills used at present are not "platforms" as they do not rest (stand) on the ocean bottom while drilling, but float in the ocean and are anchored by a system of anchors over the drilling site. They are thus subject to roll, pitch and yaw, although much less than an ocean going ship once it is anchored (see fig.2-1).

The drill can be divided into two systems. On the one hand there is the maritime side, such as watchkeeping, safety at sea, etc., while on the other there is the drilling operation. It is interesting to note that both maritime and Department of Mines rules apply.

This dual character of the drill is also evident in it's communication needs. On one side there is the marine communication needs, such as watchkeeping on 2182 kHz and VHF channels, ship-to-shore telephone calls, etc. The latter is done via the coastal radio stations of the Post & Telecommunication and falls outside the scope of this project.

On the other hand there is the large amount of communication needs pertaining to the drilling operation. The urgency of this communication makes the delays inherent in a multi-user system such as a coastal radio station unacceptable, while no facilities exist for the data modes such as ASCII and raw digital data.

2.1 MODES OF COMMUNICATION NEEDED

2.1.1 TELEPHONY (VOICE COMMUNICATION)

Each oil drill needs to be able to make calls to Soekor-Headquarters in Parow for discussion of drilling-operations, logistics, geology, geo-physics, etc. Calls must also be made to SOPELOG in the Indo-Atlantic building in Cape Town. Sopelog ("Southern Petroleum Logistics") provide a large number of personnel, catering, etc. for the drills. Calls must also be made to specialist contractors such as Schulmberger, Haliburton, Flopetrol, Rockplan and Gisor that do certain specialist work for Soekor.

This means that the system must be capable of supporting at least one radio-telephone call per drill simultaneously. The voice quality must be so good that it can be taken on an internal telephone system to offices in the Soekor-Headquarters complex. Furthermore the signal levels have to be high, as this system is also extended via leased P&T-lines to the Indo-Atlantic building in central Cape Town some 20 kilometers away.

The voice quality must be of such a high standard that persons not familiar with communication by radio may comfortably use the system. For this purpose the signal to noise ratio was defined to be 60 dB.

Last but not least, automatic switching between transmit and receive is

DRILLING A WELL

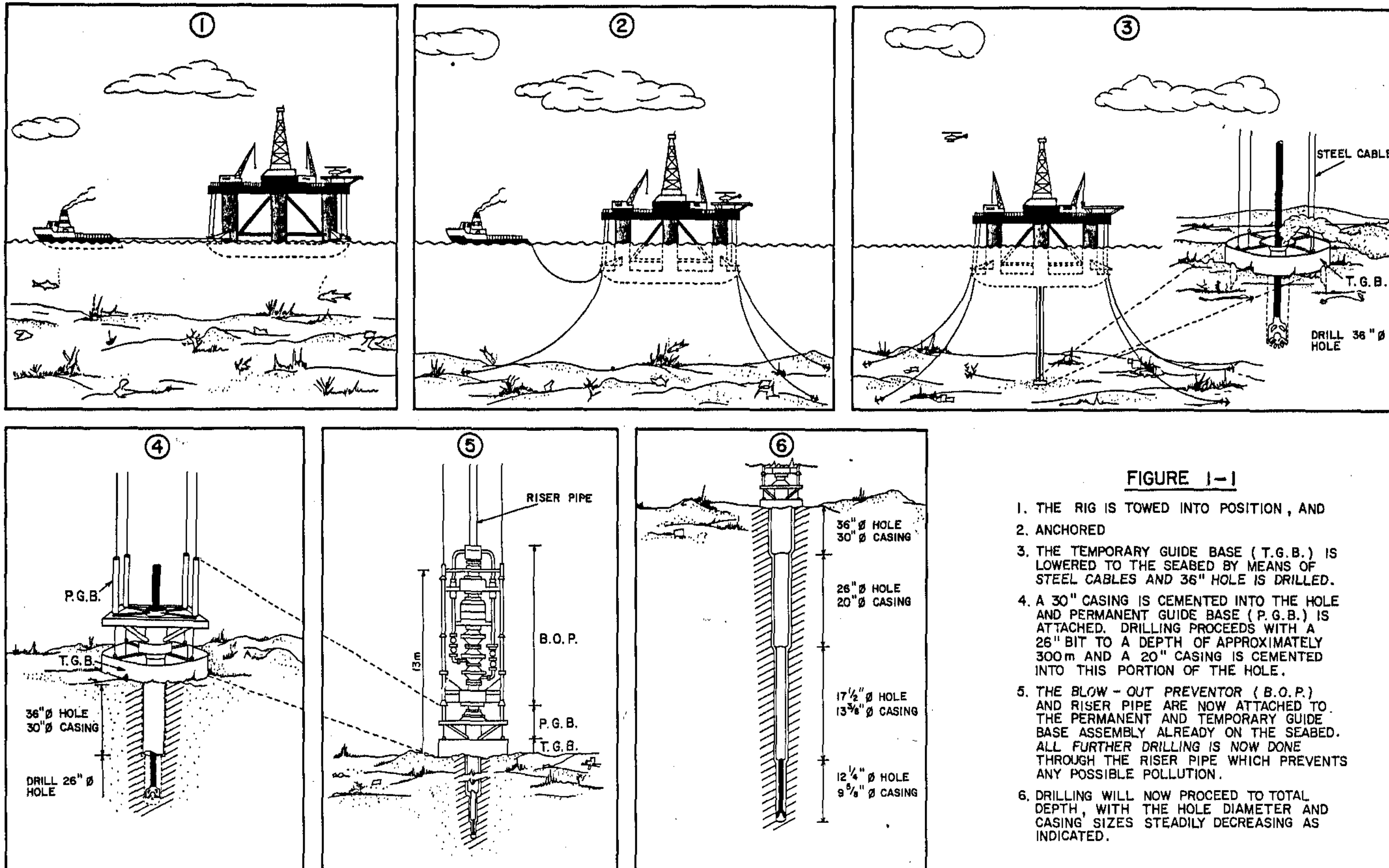


FIGURE 1-1

1. THE RIG IS TOWED INTO POSITION, AND
2. ANCHORED
3. THE TEMPORARY GUIDE BASE (T.G.B.) IS LOWERED TO THE SEABED BY MEANS OF *STEEL CABLES AND 36" HOLE IS DRILLED.*
4. A 30" CASING IS CEMENTED INTO THE HOLE AND PERMANENT GUIDE BASE (P.G.B.) IS ATTACHED. DRILLING PROCEEDS WITH A 26" BIT TO A DEPTH OF APPROXIMATELY 300 m AND A 20" CASING IS CEMENTED INTO THIS PORTION OF THE HOLE.
5. *THE BLOW - OUT PREVENTOR (B.O.P.)* AND RISER PIPE ARE NOW ATTACHED TO THE PERMANENT AND TEMPORARY GUIDE BASE ASSEMBLY ALREADY ON THE SEABED. *ALL FURTHER DRILLING IS NOW DONE* THROUGH THE RISER PIPE WHICH PREVENTS ANY POSSIBLE POLLUTION.
6. DRILLING WILL NOW PROCEED TO TOTAL DEPTH, WITH THE HOLE DIAMETER AND CASING SIZES STEADILY DECREASING AS INDICATED.

desired, as this will ease the pressure on the operator/s at Soekor-HQ.

2.1.2 DATA INTERCHANGE

At the moment there are three departments in Soekor that have a need for Data-transmission. However, it is expected that once a good system has been implemented, other users will appear, ranging from the cook's supplies to oceanographic data.

2.1.2.1 RESERVOIR ENGINEERING:

This department will transmit the largest amount of data. It is expected that this department will send 14Mbytes/year. This means that a total of $1,12 \times 10^6$ bits will be transmitted per year.

At first this seems to be a small amount per day (approx 307 000 bits/day) but unfortunately this data is obtained when boreholes are tested and needs to be sent in blocks of up to 1 Mbyte (8 M bits per run).

2.1.2.2 DRILLING ENGINEERING:

The departmental transmission consists of a two or three page daily report every morning. Although small in volume, this is the most important single report of all, and needs to be transmitted rapidly and correctly to Soekor-Headquarters.

2.1.2.3 GEOLOGY:

Geology will send a total of 4,86 M bytes per year on a daily basis. This is thus about 107 k bits per day.

2.1.3 FACSIMILE

In the normal day-to-day operation there is no demand for facsimile to be transmitted. It is foreseen however that, in the case of an engineering breakdown, this mode of communication may become of vital importance. In the event of complete failure of the data system, the required information may be transmitted by facsimile. Thus this mode may be seen as "back-up" for the data system.

CHAPTER 3

COMMUNICATION OPTIONS

As a starting point for the entire project, all the modes that could conceivably be used were listed as follows:

1. Dedicated VHF system
2. Microwave
3. Troposcatter
4. Earth orbiting satellites
5. High frequency (Short-wave)

    5.1 HF-Telephony
    5.2 HF-Teleprinter
    5.3 HF-Data
    5.4 HF-Facsimile
    5.5 HF-CW (Morse)

6. Meteor-scatter

A short study was done, based on publications, to decide if any given option offered enough merits for further in-depth study.

3.1 DEDICATED VHF SYSTEM

This was the system that received the most favourable consideration. The system was in use with a certain amount of success and it was felt that with improved facilities and equipment this was the best option.

It was realized that with planned new boreholes located up to 215km from the coast, not all planned boreholes could be covered from the shore on VHF. It was however, felt that the number that could be covered would be high enough to make VHF a viable option as the main system.

Because the stations would be unattended and remotely controlled from Soekor-Headquarters in Cape Town, the only mode considered was frequency modulation. Equipment using frequency modulation can incorporate automatic frequency control (AFC), may use squelch to cut down on "open channel" noise and provides excellent audio quality. VHF-FM also offers wide enough bandwidth to support data and facsimile on the audio channel.

The long ranges to be covered would need high sites on land. The sites that can be reached presently by road would in most cases not be at a high enough location above sea level. It was therefore decided that to get successful VHF coverage, helicopters must be used to reach the highest peaks along the coastline.

3.2 MICROWAVE

Microwave systems offer wide bandwidths for several channels and modes. The domestic telephone, telex, data and TV distribution is mainly carried by microwave on the trunk routes.

The problem associated with microwave systems are range, stability and infrastructure.

Firstly, the highest mountains near the coastline offers only about 110km line-of-sight distance. This includes the distance up to the coast line. As microwave propagation is line-of-sight, this would limit the use of microwave to relatively short distance off the coastline, especially on the West Coast, where the high mountains are located fairly deep inland (refer maps SA 1:250000 topographic series no's 2916 SPRINGBOK and 3117 CALVINIA).

The second problem of stability of the oil drills derived from the fact that microwave makes use of highly directional antennae, thus the alignment between stations must be held true to 0,1 degree of arc. As a drill is subject to several degrees of roll, sophisticated antenna alignment systems would be needed.

The third problem was that of infrastructure. A microwave system would need considerable land-station infrastructure. This would have to be relocated every time the drill is relocated, normally something that happens every other month on average.

3.3 TROPOSCATTER

Troposcatter (Tropospheric Scatter Propagation) or "forward scatter propagation" uses the layers/particles of the atmosphere at a height of about 15km above the earth to scatter energy over the horizon to the distant station between 300 to 800 km away.

Although the system does not need high sites on the land and landward stations are available in trailer mount configuration for easy relocation, the alignment of antennas is fairly critical. Thus the system is not practical for use on a drill that is subject to motion.

3.4 EARTH ORBITING SATELLITES

A wide variety of satellites now orbit the earth. Their purposes range from communication and navigation to "spying" missions.

A wide variety of systems and modes are available, but in the Southern Hemisphere the only one that the small scale occasional user could make use of is the INMARSAT system, specially created for marine use.

Notwithstanding the high cost of calls, it does hold advantages for Soekor.

These includes several modes, (i.e. Data, Telex, Voice and Facsimile), 24-hour availability and ready interface with the public telephone network.

3.5 HIGH FREQUENCY

High frequency (Short-wave) is one of the oldest forms of long-distance communication mediums in use, having been in use between Cape Town and London since 1922.

High-frequency communication for the distances from Cape Town that the drills will operate in the foreseeable future (800km max) will make use of "single-hop' propagation. This is normally a very good mode and not much affected by fading.

HF holds the major advantage of being free from constraints as far as distance offshore is concerned. It would thus be advantageous if operation ever extend to the extreme south tip of the Agulhas bank (240km offshore) or extends to the west of the K-field on the west coast (265km offshore) - see fig. 3-1.

From a point of logistics it also holds two major advantages, namely that no remote sites are involved and all equipment is under direct operator control and supervision.

The following modes of transmission were considered for HF:

1. Telephony
2. Teleprinter
3. Data
4. Facsimile
5. CW (Morse code)

3.5.1 TELEPHONY

The only viable modern efficient mode for consideration today is Single Side Band suppressed Carrier.

Double Side Band is wasteful of transmitted power and occupies unnecessary bandwidth.

For this reason DSB is no longer allowed on HF at sea. During the late seventies/early eighties a programme of reducing and finally removing it from HF was followed by international agreement.

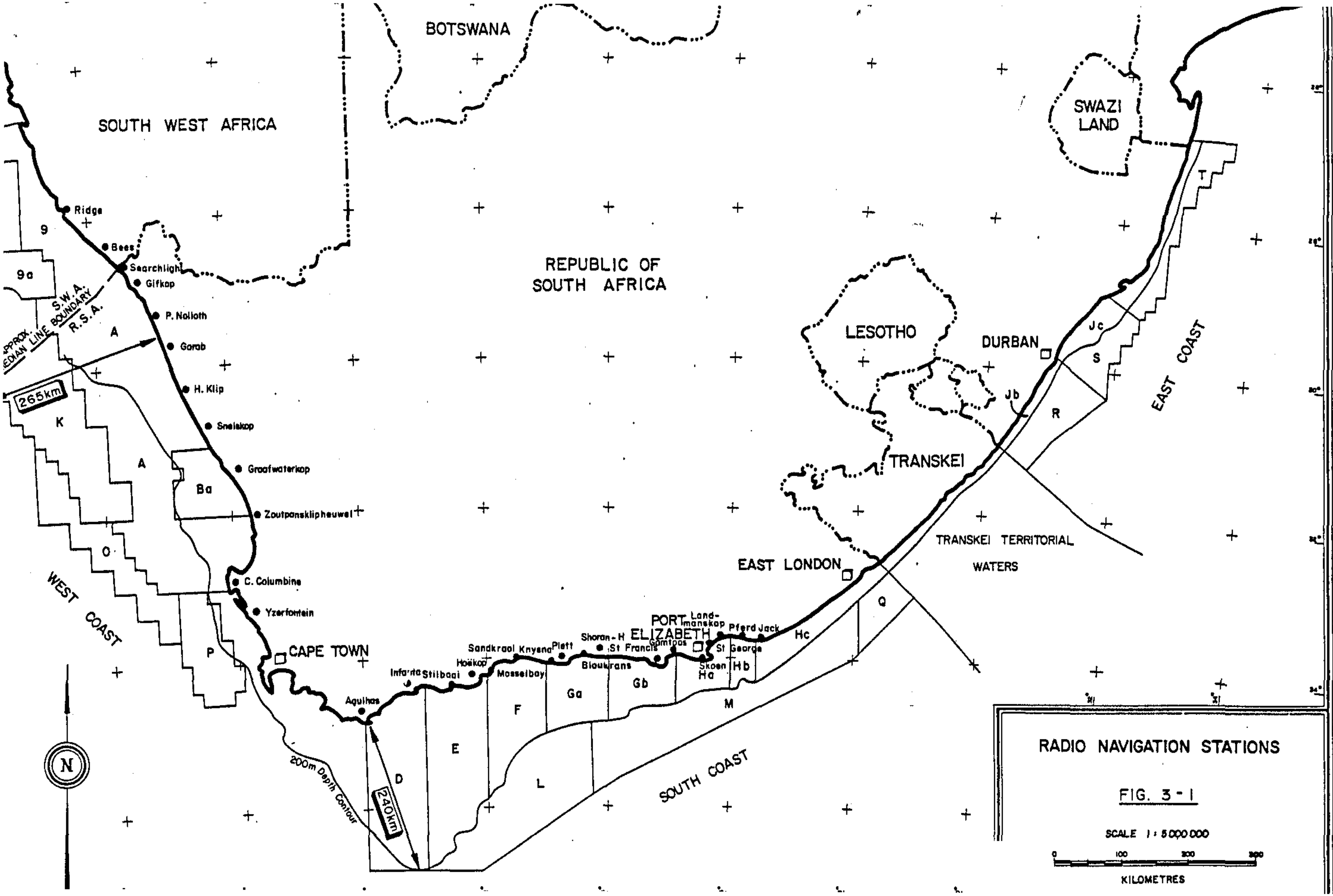
The standard channel bandwidth for SSB is now 2,8kHz.

3.5.2 TELEPRINTER

Line teleprinter was introduced on South African telegraph circuits in 1924 and the first telex exchanges placed into service in 1934 (Johannesburg) and 1935 (Cape Town).

Extensive use is made of Radio teleprinter (RTTY) on HF.

In RTTY use is normally made of two tones, one tone to indicate the 1 bit, and the other for the 0 bit. In practice the carrier frequency is shifted to produce the two tones. It is then referred to as frequency shift keying (FSK).



RADIO NAVIGATION STATIONS

FIG. 3 - 1

It is possible to introduce error correcting on RTTY circuits by using redundancy codes.

The most common redundancy code in use today is the highly efficient ARQ (Automatic repeat request) which was developed for radio telegraphy.

In ARQ each character contains seven bits against the five bits of the ordinary teleprinter (Baudot) code. The additional two bits are added in such a way that all characters sent contains three 1 bits and four 0 bits. When a faulty character is received, a repeat request is initiated by the receiving station, until the correct character is received. A character with the ratio 3x1 to 4x0 and corresponding to an ARQ teleprinter character will go undetected, but in practice these are few and far between.

The Post & Telecommunication coastal stations have supported this mode since 1979, where it is then called TOR (Telex over radio).

3.5.3 DATA

The major disadvantages of teleprinter modes is the fact that it only supports 32 characters. Thus lower case letters and symbols such as ^, @, %, <, *, [, etc. can not be sent. Furthermore raw computer or binary data can not be transmitted.

ASCII (American Standard Code for Information Interchange) supports 128 characters and is easily converted to or from other code systems for computer use such as Binary, hexadecimal or EBCDIC.

At the moment the P&T coastal stations do not support any data modes.

3.5.4 FACSIMILE

Some international uses of facsimile over radio are:

1. Transmission of photographs (e.g. for the press)

2. Transmission of weather maps.

3. Transmission of language texts that can not be handled by teleprinter or data (e.g. Chinese).

In the oil exploration as covered by this project the main use would be for engineering drawings and as an alternative for data/telegraphic transmission.

The major difficulty with facsimile is the bandwidth versus speed of transmission problem. At 2400 baud on a telephone line a typed A4 sheet takes approximately 50 seconds to be transmitted.

At 1000 baud on a VHF-FM radio link the same sheet's transmission takes two minutes. In practice, on the VHF system Soekor operates, we found that at long range (for VHF) the data rate must be reduced to 667 baud, thus the A4 sheet takes 3 minutes. On HF only about 200 baud can be used, thus the A4 sheet in question will take 10 minutes.

The second difficulty with facsimile is fading of the signal or interference during the transmission. This can cause "bad spots" in the picture or completely destroy a section or the whole picture.

The longer the transmission takes, the higher is the risk of fading and/or interference causing problems.

On the oil drill a number of RF producing devices and electrical machinery is packed in a small area. Our results on weather facsimile reception from Olifantsfontein (ZRO) proves that it is virtually impossible to reproduce a HF-facsimile on board an oil drill without some marking due to interference.

The HF radio-path from the South coast to Cape Town is also subject to short-duration fading of a few seconds at a time around mid-day to about 16h00. It is probably due to sporadic E propagation as it occurs when high solar flux is present and abnormally good VHF-propagation takes place.

The HF fading is not so severe as to interfere with telephony and telegraphy, but is expected to cause problems with facsimile.

3.5.5 CW (Morse)

This is the oldest form of radio communication.

The original binary code was developed by Professor Samuel Morse for his telegraph system. The system of morse telegraphy was in widespread use right through the world for more than a century.

It was gradually superceded in later years by other methods, mainly due to the low transmission rate. The British Post Office used morse on their telegraph circuits until 1955. The Canadian National Railways discontinued the last of their telegraph circuits in 1970. In South Africa the Post Office sent the last morse telegraph message on 23 February 1971.

A variation of Morse's code was adapted for use on radio-telegraphy and is still in use by Radio Amateurs, shipping, military forces and minor point-to-point links worldwide. The P&T coastal radio station in Cape Town (ZSC) still has six marine CW circuits active as well as a daily contact with Tristan da Cunha.

The mode is very efficient and will penetrate static and interference when virtually all other modes fail.

For Soekor manual telegraphy holds two major disadvantages:

As has been mentioned the first is speed of transmission. While a good operator may reach speeds of up to 30 words per minute, most communication takes place at a rate of 20 words per minute. In practical terms it means that a page such as this one will take an operator 15 to 22 minutes to transmit (a 50 baud teleprinter will take less than seven minutes and a 110 baud data transmitter about 3 minutes).

The second problem is that of personnel. At present the oil drills carry only one radio officer and he has to double as medical orderly as well. He has to do the marine traffic, radio-telephone calls, helicopter communication, etc. He also has to eat and sleep, thus relatively little time would be available for morse-telegraphy.

The two factors, i.e. time available plus low data rate, limits the amount of information that can be transmitted.

3.6 <u>METEOR SCATTER</u>

This technique makes use of the fact that meteors entering the earth's atmosphere leave a "trail" of highly ionized gas. RF signals at mid-band VHF may be reflected to establish radio communication.

Due to the short duration of an ionized path, meteor scatter is not suitable for voice modes of communication. Bursts of high speed data may be sent while the meteor trail lasts. The system then holds the rest of message until a trail again appears, something that may happen in a few seconds or a few minutes.

The overall average speed works out to between 20 and 75 baud, depending on power levels, but there may be long periods of no transmission path. As such, the system is mostly used for unattended low-rate data transmission from remote sites. Typical systems is the "Snotel" system in the USA used to monitor snowfalls on remote mountains, and in South Africa the data system used by the Department of Water Affairs.

3.7 <u>POSSIBLE VIABLE OPTIONS</u>

At this point a decision had to be made on the modes that warranted further study. The following modes were not pursued:

3.7.1 MICROWAVE

The fact that the system will only operate over line-of-sight paths severely limits the scope of use, i.e. the number of wells that can be covered. Secondly the motion of the drills makes this system virtually unusable. Lastly the landward infrastructure will be too costly.

3.7.2 TROPOSCATTER

This mode was also not pursued due to the motion involved.

3.7.3 HF-FACSIMILE

Due to the low speed that could be achieved, it was decided not to pursue this mode as well.

3.7.4 HF-CW (Morse)

The low data speed makes this system unattractive.

CHAPTER 4

SELECTED OPTIONS FOR FURTHER STUDY

The following options seemed the most viable and it was decided to pursue them in depth.

1. Dedicated VHF
2. Satellite
3. HF-Telephony, Teleprinter and Data

4.1 DEDICATED VHF

VHF coverage is not essentially "line of sight". VHF signals tend to follow the curvature of the earth to some degree and as such it is possible for VHF signals to reach beyond the optical horizon. Once the signals have reached this point and the signals is of sufficient strength, diffraction will take place.

Direct signals and diffraction are the only two modes that delivers consistent results. Other modes such as ducting, inversion, sporadic E, etc., are inconsistent and may at times even be a nuisance.

The first problem is to determine just how far over the optical horizon the radio horizon lies. No two publications are in agreement about this matter. The so-called K factor is given from 1,2 to 1,5. The CCIR (Comité Consultatif International Radio) however, gives the standard K for the coastline and seawards around South Africa as 1,47. This is higher than the factor of 1,38 generally accepted by the Council for Scientific and Industrial Research (CSIR).

The radio horizon is dependant on the tropospheric refractivity and is dependant on air pressure, temperature and humidity. Over the sea the humidity is usually high, resulting in a higher K-value than normally found over land.

4.1.1 ACTUAL TESTS

In the planning of a possible microwave link for the Mossgas platform, Soekor commissioned an actual test in the Mosselbay area to determine what tropospheric refraction could be expected.

Two temporary upper-air weather stations were established, one in Voorbaai (Mosselbay) and the other on the drill "Actinia" about 100km away.

According to CCIR report 563-1, the following equation is used to calculate the effective earth radio coefficient (k-value).

$$k = \frac{1}{1+6,37.dN.10^{-3}}$$

dN is the mean refractive gradient of the first 1000 metres above the earth's surface and can be calculated as follows:

$$dN = N1 - NO$$

where:

N1 = radio refractivity at 1km above the earth's surface.

NO = radio refractivity at the earth's surface.
(Sometimes also called Ns)

The radio refractivity (N) can be calculated by the equation:

$$N = 77,6 \frac{P}{T} + 3,73 \times 10^5 \frac{.e}{T^2}$$

where:

P = atmospheric pressure (mb)
T = absolute temperature (°K)
e = water vapour pressure (mb)

The water vapour pressure (e) can in turn be derived from the equation:

$$e = H\grave{e}$$

where:

H = relative humidity

$$\acute{e} = 6,11 \left[\frac{19,7^t}{t + 273} \right]$$

where t is the dry ball temperature in °C

The standard values of the CCIR is given in figures 4-1 and 4-2 (Winter) and 4-3 and 4-4 (Summer).

4.1.2 TEST RESULTS

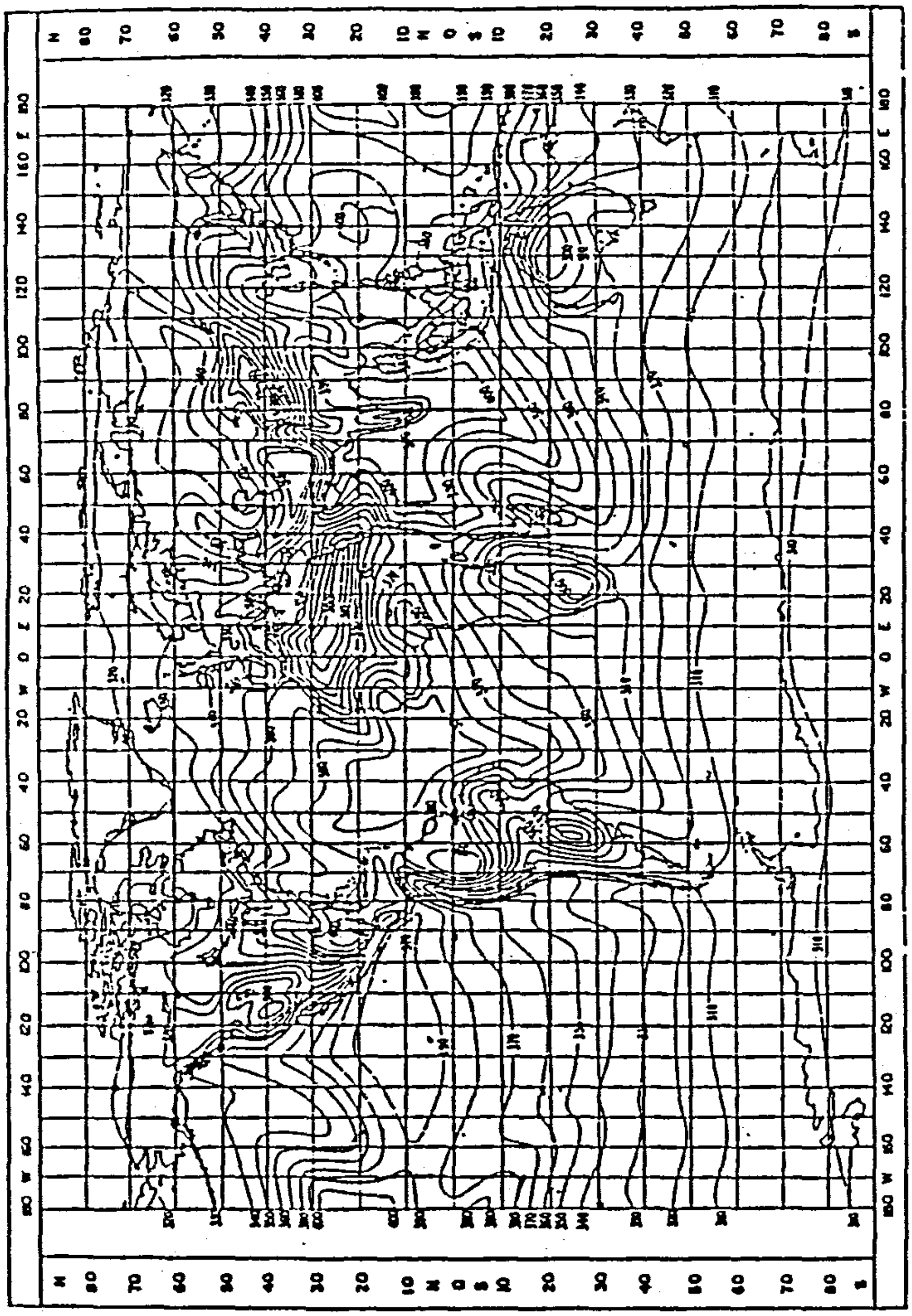
The results obtained is graphically shown in annexure A

The following is a summary of the results calculated for the parameter No,N1,dN and thus for k:

(1) Oil drill (Actinia)

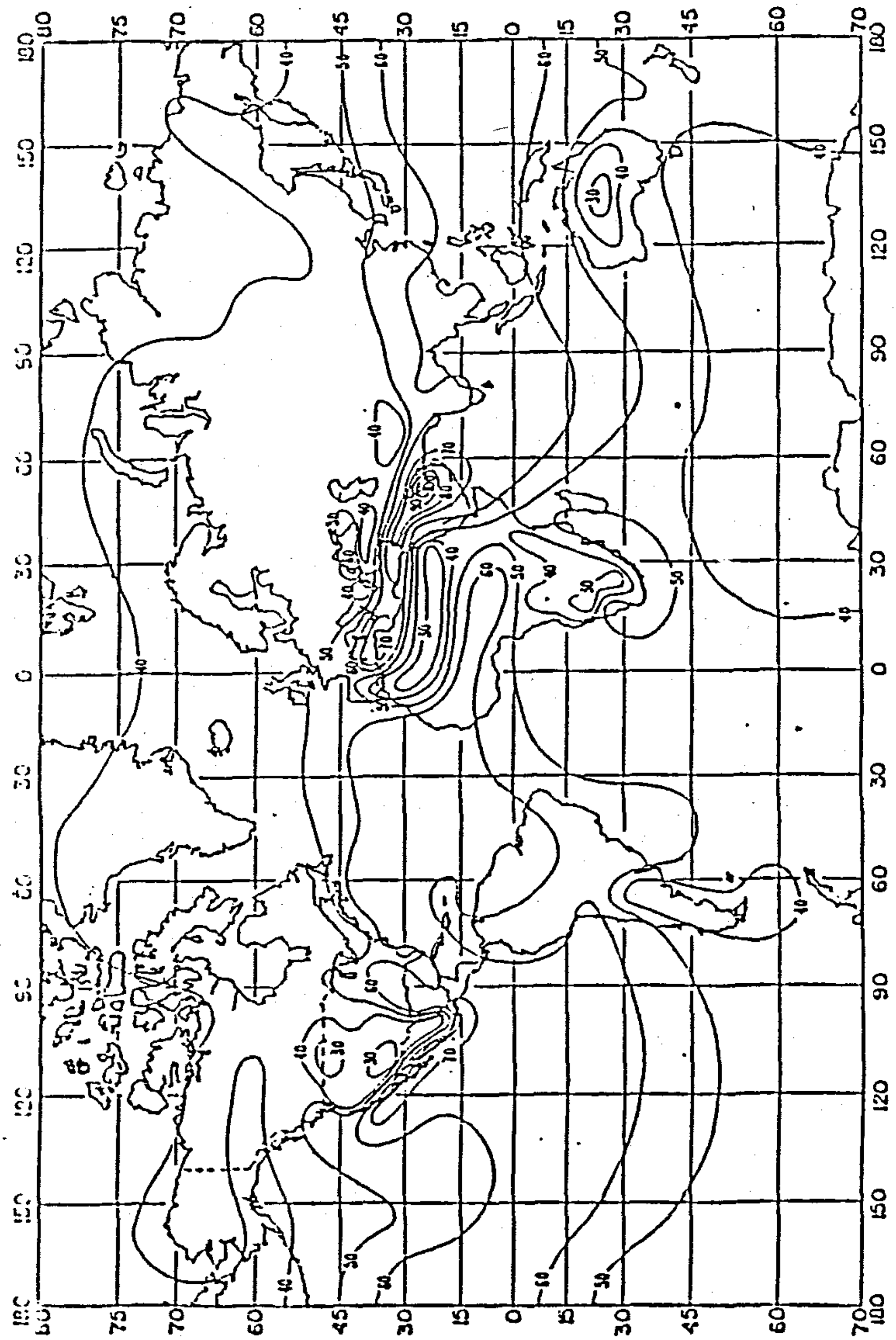
Parameter	Minimum	Maximum	Average
NO	317,36	356,07	337,73
N1	245,59	307,32	280,44
dN	-34,09	-99,21	-59,00
k	1,28	2,72	1,65

Fig 4.1



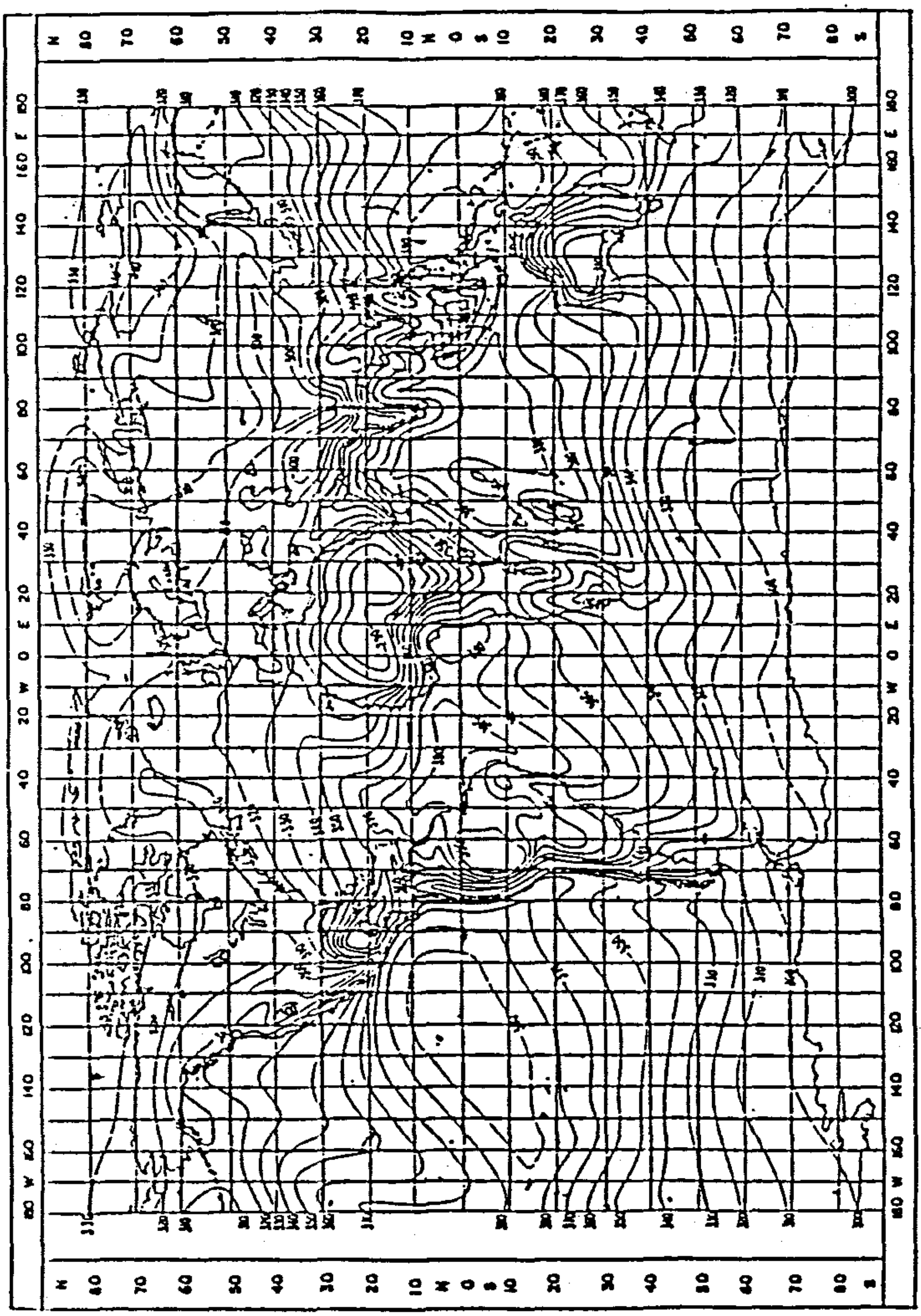
World-wide mean value of N_o : August

Fig 4.2

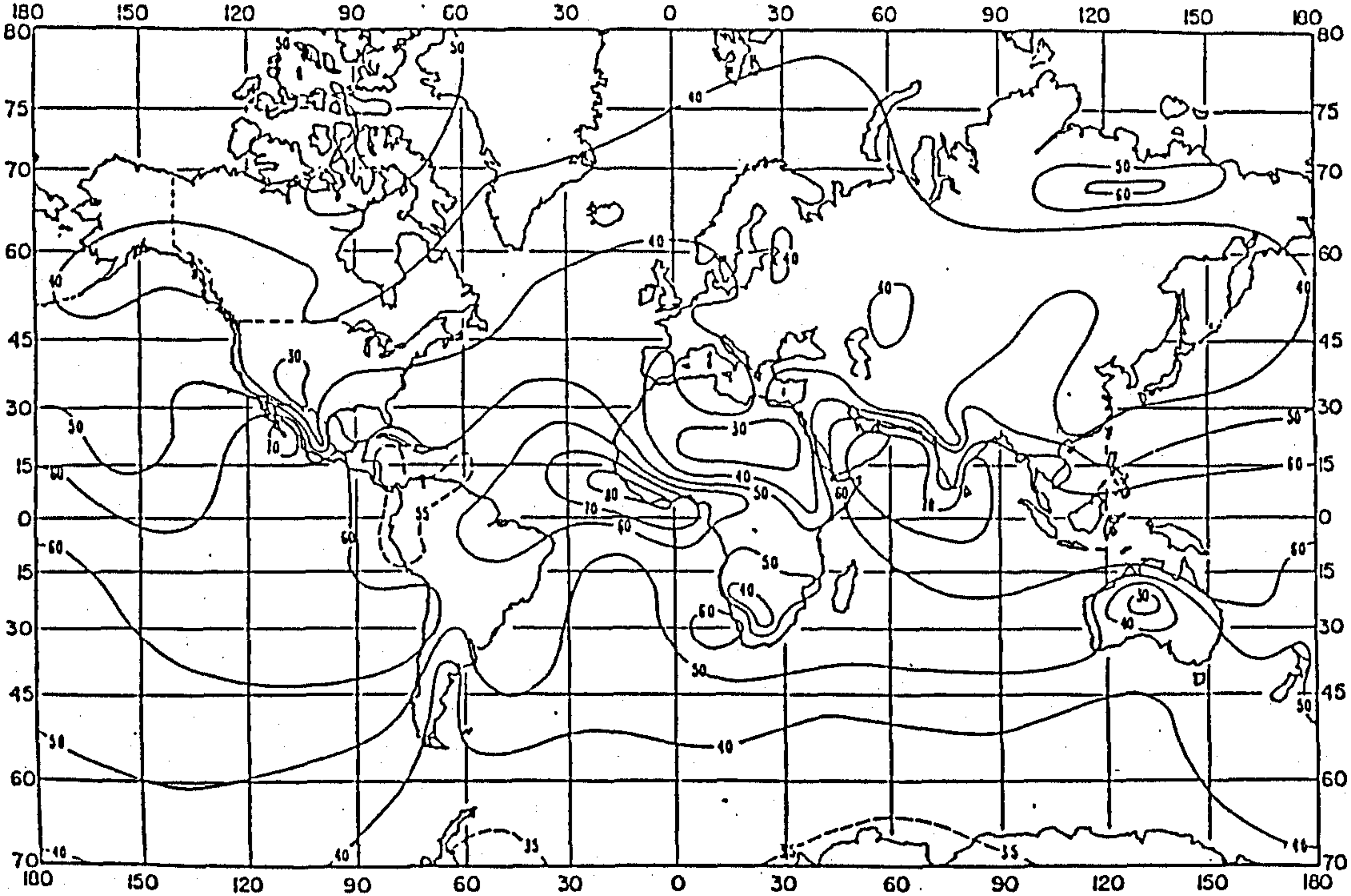


Monthly mean values of ΔN: August

Fig 4.3



World-wide mean value of N_s : February



Monthly mean values of ΔN: February

(2) Voorbaai (Mosselbay)

Parameter	Minimum	Maximum	Average
NO	297,34	354,67	326,83
N1	262,25	320,42	283,40
dN	-15,60	-75,45	-42,62
k	1,11	1,93	1,39

From the above can be seen that the landward side gives the worst results, and that is thus the value that has to be used.

To obtain a larger picture, the upper air records for Port Elizabeth and Cape Town over the same period as the Voorbaai - Actinia tests (22 Aug 87 to 14 Sept 87) were obtained from the Weather Bureau. Unfortunately the upper-air station at Alexander Bay was already closed down by August 1987.

A summary of the results calculated follows:

(3) Port Elizabeth

Parameter	Minimum	Maximum	Average
NO	301,18	348,68	331,08
N1	263,63	309,29	282,74
dN	-15,60	-75,45	-42,62
k	1,11	1,93	1,39

(4) Cape Town (D.F. Malan)

Parameter	Minimum	Maximum	Average
NO	260,53	334,54	303,17
N1	246,47	294,92	252,84
dN	-14,60	-77,32	-42,63
k	1,10	1,97	1,39

Comparing the dN values of Port Elizabeth, Mosselbay and Cape Town with the August value from the CCIR (Fig. 4-2), it can be seen that the landward value is some 85% of the CCIR value. The results from the Actinia again, gives a value 18% higher. Thus the overall route value will probably average out on a dN of -50.

On the West coast the geography is of such a nature that the landward stations have to be further inland than the South coast. As the climate is more arid than on the South coast, I decided to reduce the k-value to 1,33 for all calculations.

4.1.3 TRANSMISSION PATH LOSS

The radio signal is subject to the following losses from the transmitting antenna to the receiving antenna:

$$\text{Path loss} = 32{,}45 + 20 \text{ Log } F + 20 \text{ Log } D \text{ (dB)}$$

where F is the frequency in MHz and D is the distance between the antennas in km.

To calculate the overall signal levels from transmitter to receiver the following equation was used:

$$Pr = Pt + Gt - 32{,}45 - 20 \text{ Log } F - 20 \text{ Log } D + Gr$$

where Pr = Power of the received signal in dBW.
Pt = Transmitter power in dBW.
Gt = Transmit antenna gain.
Gr = Receive antenna gain.

Thus the equation gives the RF driving power in the receiver antenna terminals.

The needed driving power can be calculated from the receiver specifications using Ohm's law:

$$P = \frac{E^2}{Z}$$

Alternatively the received signal strength can be calculated using:

$$E = \sqrt{P.Z}$$

In the above two formules P = power in watt
E = Receiver sensitivity.
Z = Antenna impedance.

It will be noticed that no provision is made for tower height and feedline losses. If the feedlines run directly from the equipment to the antennas (i.e. tower height nearly equal feedline length), the gain due to tower height will be more than the feedline loss.

In practice provision must be made for fading, with most telecommunication authorities taking 50 dB as the minimum flat margin, plus a further 10 - 13 dB to make up for system deterioration due to the environment's effects on feedline connectors, antennas etc.

Once the signal reaches the radio horizon, further reliable communications takes place by means of refraction. Refraction is a very lossy means of propagation with the loss figure reaching 1 dB/km at 450 MHz.

No figures could be obtained in publications for the lower VHF frequencies, but it is the writers opinion that even as low as 34 to 35 Mhz, the diffraction loss is still in the vicinity of 0,5 to 0,6 dB per kilometer. This is based on practical results obtained with low band systems operating on frequencies mentioned. On high band around 150 MHz, it seems to be in the region of 0,8 dB/km.

The environmental noise level on the oil drills is so high that a minimum signal power level of -120 dBW must be assumed. This corresponds to approx 7µV into a 50Ω antenna input impedance (see figure 6-2 page 37). This leaves little flat fade margin beyond the radio horizon.

It can thus be seen that to reach out beyond the radio horizon need a high transmitter power, coupled with high antenna gain so as to obtain high ERP levels.

4.1.4. VHF SITE SELECTION

A map search was done to find suitable high sites, around the South African coastline from the mouth of the Orange river to Port Elizabeth, that could be used to facilitate complete VHF coverage as far out to sea as possible.

Once a site has been selected from the map, an on site inspection was done to see what the feasibility of the site was in terms of coverage, access and power. Discussions was also held with the owners to sound them out on their willingness to let Soekor use the site.

The positions finally chosen were:

Lekkersing	29°02' South	17°08' East
Nababeep	29°35' South	17°48' East
Leliefontein	30°35' South	18°05' East
Toringberg	31°02' South	18°00' East
Gifberg	31°46' South	18°41' East
Kapteinskop	32°40' South	18°31' East
Piketberg	32°48' South	18°43' East
Konstabelberg	33°07' South	18°01' East
Constantiaberg	34°03' South	18°23' East
Sneeukop	34°02' South	18°59' East
Soetmuisberg	34°32' South	19°54' East
Grootberg	33°56' South	20°53' East
Riversdale	34°01' South	21°08' East
Engelseberg	33°52' South	22°08' East
George	33°56' South	22°28' East
Langkloof	33°52' South	22°23' East
Cockscomb	33°34' South	24°47' East

A detailed investigation was carried out in respect of each site.

Detailed discussion of each site chosen and coverage profile are given in annexure B.

The essential parameters summarized in table 4-1.

TABLE 4-1 SUMMARY OF FACILITIES ON CHOSEN SITES

As an example the description and coverage profile for the George site is given in paragraph 4-1-5 and figure 4-5. The description and coverage profiles for all stations can be found in annexure B.

NAME	ALTITUDE	OFFSHORE COVERAGE	POWER AVAILABLE	ACCESSIBILITY
Lekkersing	701m	106km	Solar 800kJ/cm with wind back-up	Helicopter only
Nababeep	1313m	70km	Mains (from SABC)	Poor road
Leliefontein	1525m	88km	Solar 800kJ/cm	Fair road
Toringberg	548m	67km	Wind primary with solar back-up	Fair road
Gifberg	793m	73km	Mains (from ESCOM)	Fair road
Kapteinskop	650m	81km	Mains (from SAAF)	Excellent road
Piketberg	1027m	53km	Mains (from SABC)	Very good road
Konstabelberg	188m	52km	Wind primary with solar back-up	Helicopter and foot
Constantiaberg	928m	120+km	Mains	Excellent road
Sneeukop	1590m	125km	Mains (from ESKOM)	Very good road
Soetmuisberg	753m	80km	Mains (from SABC)	Very good road
Grootberg	1637m	112km	Wind primary with solar back-up	Helicopter only
Riversdale	600m	70+km	Mains (from SABC)	Good road
Engelseberg	1521m	133km	Wind primary with solar back-up	Helicopter and foot
George	576m	86+km	Mains (from SABC)	Good road
Langkloof	1618m	139km	Wind primary with solar back-up	Helicopter
Cockscomb	1350m	80+km	Solar and wind	Poor road

4.1.5 GEORGE

This is a 576m high point on the foothills of the George peak in the Outenikwa mountain range just outside the town of George and some 10km from the coast.

This was the original site used for the first system as designed by Mr. van Niekerk and as such Soekor has good infrastructure on the site as well as a number of year's experience of operation from this location. The site is SABC property and also used by ESKOM, Forestry, SA Radio League (Amateurs) and a number of private users. Access is by a good road, and it is even possible to walk there from a nearby railway stop (power siding is 600m away).

The site offers a clear take-off over a wide angle, as well as giving coverage of the P.W. Botha airport, Mosselbay landing field, Soekor office and stores in Mosselbay as well as most roads in between.

Coverage at a k-factor of 1,33 should be 96km (86km offshore). Experience has shown that reasonable communication can be obtained most of the time up to 150km away.

Coverage profile is shown in fig. 4-5.

4.1.6 POWER OUTPUT, ANTENNA GAIN AND RADIO REGULATIONS

From the coverage profiles in annexure B, it can be deduced that in many cases extensive use will have to be made of diffraction as drills will be located well over the radio horizon. This implies that a combination of low frequency VHF and high ERP (Effective radiated power) will have to be used.

Calculations, using formulas as discussed in section 4.1.3, lead to the conclusion that power levels of 75 watt coupled to antenna gain of 9 dB will have to be used for landward stations.

The licence section of the Post & Telecommunication (P&T) has a policy (as a result of international agreement) that ERP on VHF below 50 Mhz will be limited to 14,8 dBW. (Normally 15 Watt RF power into a 3 dB antenna). The P&T radio regulatory department indicated that they would be very reluctant to exceed this value.

Most VHF radio equipment available in South Africa has only been approved by the Post & Telecommunication Laboratories up to 30 Watt RF power output. This means that if Soekor wants to use this equipment at higher power levels, it will have to be tested by the P&T laboratories (POTLETIN) for higher power certification.

Low band VHF antennas with a gain of 9 dB will be large and ungainly and thus very difficult to handle, transport and erect. Windloading is also very high due to the large physical size.

On solar/wind-power sites the high power consumption will require a very large and expensive power supply installation. Twelve to fourteen solar panels may be required.

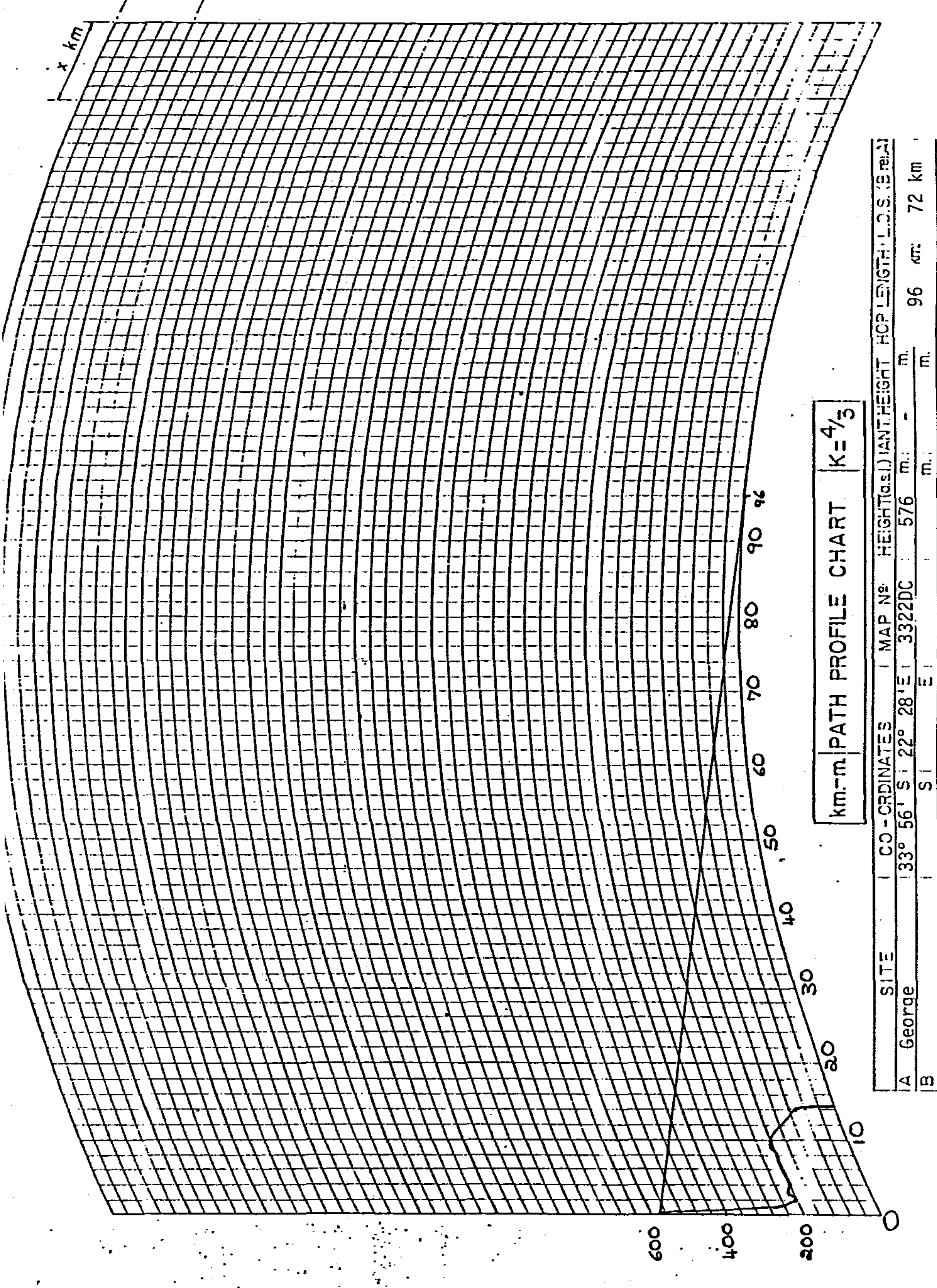


Fig 4.5
Path Profile Chart

It was further calculated that maintenance costs would be R66 000 per year at present cost (this excludes salaries!).

Last but not least, is the fact that in many cases, the only carrier circuit available is the SOR18 rural automatic carrier type (i.e. Nababeep, Leliefontein and Gifberg). This system uses "in-band signalling". Thus the P&T control signal will be superimposed on the audio of the speech. This causes interference and a distortion of the speech (the P&T remote controlled VHF-Marine station at Doringbaai suffers from this problem).

4.2 <u>SATELLITE</u>

Of all systems the only viable one for marine use is the INMARSAT system.

The INMARSAT system, operated by the International Maritime Satellite Organization, provides reliable and high-quality, global maritime satellite communication, unaffected by weather or ionospheric disturbances.

The operating cost is shared between participating countries to hold actual call costs to the lowest possible values.

INMARSAT communication satellites are placed into geostationary orbit and have fixed zones of coverage (see figure 4-6). Two of the three operational satellites can be accessed from South African waters. For each satellite in operation there is a spare unit already in orbit.

The satellites of interest to us in South Africa are:

a) Atlantic ocean region satellite at 26°W, with a spare unit located at 18°30' West.

b) Indian ocean region satellite at 63°E, with a spare unit at 60° East.

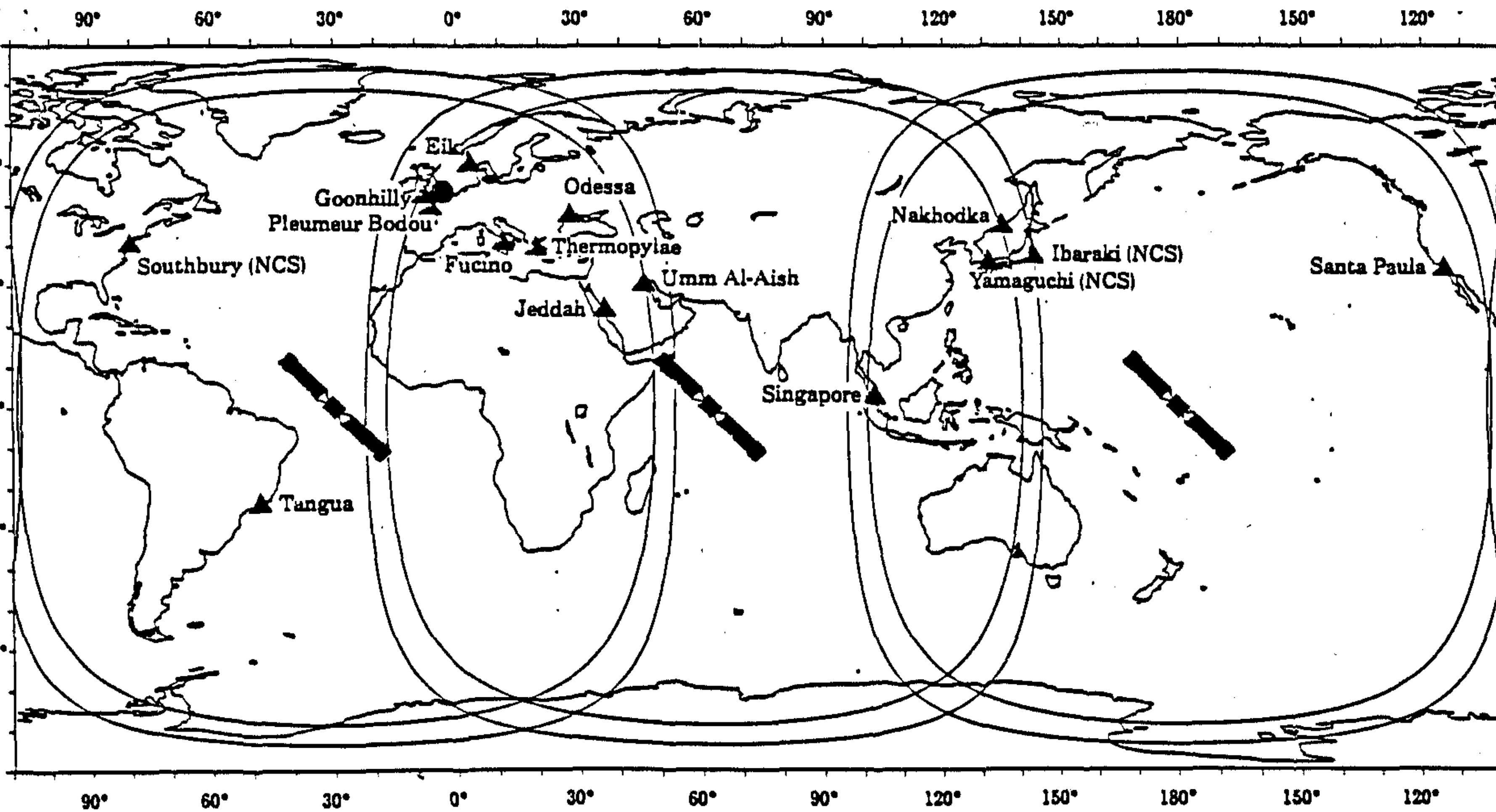
Vessels equipped with INMARSAT Ship Earth Stations are capable of communication with shore-based correspondents via the international telephone and telex network as well as other similarly equipped ships. The quality of communication is not dependant on distance between ship and coast earth station, the only condition being that they are both within the boundaries of an INMARSAT ocean region (i.e. have a "view" of the same satellite).

The following services are provided by the INMARSAT system:

a) Distress, urgency and safety communication.
b) Telephony
c) Telex
d) Telegram
e) Facsimile
f) Medium speed data
g) High speed data
h) Information and assistance service (i.e. Medical advice)
i) Slow scan television.

FIGURE 4-6

INMARSAT COVERAGE REGIONS



KEY

- ● Operations Control Centre
- ▲ Coast earth stations of the INMARSAT system
- ▬ Operational satellites

The INMARSAT system sea earth stations transmits in the frequency range 1636,5 Mhz to 1645,0 Mhz and receives in the the range 1535,0 to 1543,5 Mhz. A total of 339 channels is normally available.

Most installations use a parabolic dish antenna of 0,9m in diameter housed in a radome for protection against the elements. The antenna is stabilized so as to be constantly aligned with the satellite. Tracking information is derived from the ship's gyrocompass.

High data speeds up to 9600 baud can be handled by the satellites. Unfortunately the normal telephone circuit used from the Coastal Earth station to one's destination can only support 2400 baud. If higher speeds of operation is desired, special high-speed circuits must be hired.

Power output (EIRP) is normally about 36dBW, of this about 20 dB is derived from antenna gain.

Sea earth terminals may be equipped with two numbers, thus independent parties may share a terminal but receive their calls and accounts separately (the terminal can only support one call at a time).

In South African waters eight Coastal Earth Stations may be used, namely;

Via Atlantic ocean Satellite:	Southburg	(U.S.A.)
	Goonhilly	(U.K.)
	Fucino	(Italy)
	Pleumeur Bodou	(France)
	Tangua	(Brazil)
Via Indian Ocean Satellite:	Yamaguchi	(Japan)
	Eik	(Norway)
	Thermopylae	(Greece)

Normally the most cost effective route for calls to South Africa is via Goonhilly. Calls cost $10 per minute. Most Coast Earth Stations offer a reduced night rate. This may be used to considerable advantage by callers from the South African area. As an example, Southburg's night rate lasts until 12h00 local time, thus covering almost half the local working day. They offer a rate to Britain and Western Europe at $4/min, with calls to South Africa being $5/minute.

By exploiting the "Night rates" of different stations, some 14 out of the 24 hours may be at reduced rates.

4.3 HIGH FREQUENCY

High frequency radio systems using the bands from 1,6 to 30 Mhz have been popular since the 1920's in applications where relatively long distances must be covered at a relatively low cost under relatively light traffic load. Recent advances in satellite communications have usurped many of the traditional applications, but communication by satellite tends to be expensive.

The behaviour of HF-signals depends on the heights and densities of the layers of ionised gases which comprise the ionosphere. The gases in the earth's upper atmosphere are ionized by radiation from the sun. The energy from this radiation is able to release electrons from gas molecules so that they become positive gas ions. The number of ions formed depends on the intensity and duration of the radiation from the sun. Thus ion formation vary with the seasons as well as a 11 year and other cycles.

The ions are more dense at certain layers that others, so that different layers form. These layers are not sharply defined and also varies in height with seasons and time of day.

The layers of most interest are:

D layer: Virtual height 80km. Reflect low frequencies. Useless for HF communication and may introduce attenuation.

E layer: Virtual height 110km. May at times be used for communication below 4 Mhz. May become very highly ionized ("sporadic E") and reflect even VHF signals. During this activity HF communication may be disturbed or even totally disrupted.

F1 layer: Virtual height 190km. Maximum single hop range 3000 km.

F2 layer: Virtual height 350km. Maximum single hop range 4000 km.

During the night the D region disappears, the E layer move upwards to about 150km and the F layers combine.

Single hop propagation is the desired mode for Soekor's HF communication. It gives high signal levels and not so highly suspect to fading and other disturbances as multiple hop propagation.

4.3.1 TELEPHONY

The mode now used almost universally for HF telephony is single sideband (SSB).

The main advantages of HF systems lie in the ability to provide communication over great distances at low cost. This makes HF ideal for communication between remote islands, settlements, camps and expeditions where the density of calls is low.

One of the major applications of HF is in the Marine field. The INMARSAT system and VHF has made inroads into HF but it is still in extensive use over the frequency range of 1,8 to 30 Mhz.

Perhaps the most limiting disadvantage of HF is the fact that for each voice or data channel a separate frequency must be assigned. This makes it impossible to carry high volume telephony circuits via HF. Therefore HF is now only used for remote areas with low density traffic and no longer for high density international circuits.

HF point-to-point links is still extensively used in the South Pacific, South Atlantic and certain African areas.

4.3.2 TELEPRINTER

The simplest form of data communication, namely morse code telegraphy, used simple on/off keying.

On/off keying is not a satisfactory method of transmitting radio telegraphy as it is difficult to detect the "space" when background noise is high. The most common alternative method is Frequency Shift Keying (FSK). With this method the RF carrier is shifted a small amount, thus two distinct frequencies are used for "mark" and "space". This has the advantage of having a form of frequency diversity, as intelligence may be obtained either from the "mark" or "space" signals.

Originally shifts in excess of 1,5 kHz was used, but later 850Hz. With the introduction of operational amplifiers, excellent audio frequency filters could be designed, making narrower shifts practical. Although 400 Hz is still in use, 170 Hz is now almost universal.

One of the major advantages of SSB transmitters is that any tone applied to the microphone appears as a RF output spaced a certain distance from the assigned "carrier" frequency. Thus two tones from a telegraph keyer fed into a SSB transmitter will give two FSK frequencies.

Similarly FSK frequencies tuned by a SSB receiver will appear as two tones in the audio circuits after combination with the Beat Frequency Ocillator signal. By tuning "up" or "down" the audio values may be varied to suit the demodulator in use. Thus the intelligence may be detected as long as the "mark" and "space" is in correct spacing to each other. Spacing within the assigned channel bandwidth is of little importance.

Radio teleprinter operation lends itself to a number of error correcting codes. The most common in South Africa is autospec and ARQ.

Autospec is in very limited use, only being used on three circuits by the Post & Telecommunication stations at Olifantsfontein and Derdepoort (ZUD) for the Dept of Environmental affairs communication with bases in Antarctic, Gough and Marion.

ARQ is now in widespread use.

This code was developed from the 5-bit Baudot Code by H.C.A. van Duuren in the late 1940's. This is an error detecting code utilizing seven bits for each symbol, but of the 128 combinations that exist, only those containing 3 marks and 4 spaces are used. These are 35 of these, so the 32 characters and control signals of the CCITT-2 code can be accommodated.

The advantage of the ARQ system is that it offers protection against single errors. If signal arrives so mutilated that some of the code groups no longer represent the 3:4 ratio, a repeat (ARQ) signal is generated by the receiving station and the mutilated information is retransmitted.

The disadvantages of ARQ over Baudot is that it contains 7 bits per character as to the 5 bits of the Baudot code and two frequencies are needed for it's operation.

British radio amateurs developed a single frequency telex system known as AMTOR.

Basically this system sends a few characters (normally three) and then switches to receive to obtain a clearance or repeat from the receiving station on the same frequency. It is thus basically a single frequency ARQ system.

The major advantage is that the system's equipment requirements is very modest.

The system was adapted for commercial marine use and is then known as SHITOR. It sees a fair amount of use around the British Isles.

4.3.3 DATA

High-speed data is not possible on HF. This is simply because the bandwidth available on HF is limited. Until recently the only systems in use were teleprinter systems, but lately "packet radio" appeared on the scene.

In contrast to conventional Radio teletype (RTTY) the packet protocol has many advantages. These advantages can improve data communication by providing error-free message transfers and also better utilize available RF spectrum.

Standard RTTY has no built-in error correction. If the signal fades or is jammed during transmission, then all or part of a message may be garbled or lost.

Forward error correcting (FEC) does provide a certain amount of correction or at least indication of errors. The "Autospec" system for instance, provides forward error correcting and if a received character is so mutilated that after two sets of comparisons it cannot be reconstructed, a space is left in the text in place of the character. This alerts the human operator to the fact that a character has not been received. It is especially useful when the received message is not in plain text (e.g. meteriological codes).

Under severe static conditions, like weak signal reception at night, a large amount of errors are still present.

ARQ is a superior system, but needs two-way operation to function. Most errors are taken care of, only the very few with the ratio 3:4 slipping through.

The packet radio protocol uses a 16-bit cyclic redundancy check code that is appended to each packet transmission. The receiving station creates it's own 16-bit code from the received package message and compares it to the transmitted 16-bit code. The receiving then sends back an acknowledgment or a negative acknowledgment. The sending station then proceeds with the next packet or repeats the previous packet.

A major advantage of packet over RTTY is the frequency sharing capability. The system uses time division multiplexing to let many stations share the same radio frequency.

The major advantage of packet radio over teleprinter is that it can transmit the full ASCII character set. Thus non-text information may be exchanged error free (i.e. computer files, formatted documents, spread sheets, data bases and even graphic pictures).

Other advantages includes "digipeating", i.e. any station can operate as a repeater, as well as "store and forward" operation. This increases the range of operation.

A packet system may be computer or micro-processor driven, utilizing such techniques as UHF/VHF/HF radio system selection, or HF adaptive scanning.

CHAPTER 5

From the study done, the following conclusions can be drawn:

1. Existing technology and infrastructure can be used to solve Soekor's communication problems.

2. The most viable modes are HF-SSB, HF-Data, limited VHF-FM and the INMARSAT system.

3. The geography and distances from Cape Town as well as the need for regular relocation makes the large-scale use of remote VHF equipment impractical.

4. Existing infrastructure, especially that of the Post & Telecommunication may be used to compliment a private system.

5. It will be possible to design a reliable low maintenance system that will fulfill all present needs and can be expanded to meet future needs.

6. The system can be implemented using "in house" labour and/or local (Cape Town based) expertise.

7. A large number of "paths" may be established so as to facilitate redundancy. The system will be able to have a life-span well in excess of ten years.

CHAPTER 6

FINAL SYSTEM FOR IMPLEMENTATION

After study of Soekor's needs in respect of communication and of viable options the following overall system was decided upon:

1) HF-SSB voice system.
2) HF-Packet radio system.
3) INMARSAT Satellite terminals
4) VHF-FM link (South coast only)
5) Normal marine HF and VHF
6) VHF-AM Air radio
7) Workboats

The sub-systems will complement and act as a back up to each other in case of failure.

6.1 HF-SSB VOICE SYSTEM

This will be the main speech channel between oil drills and Soekor's Headquarters, as well as stores, Mosselbay office and George helicopter base.

It is a straight-forward SSB system utilizing HF.

One set of frequencies stretching over the spectrum 2,5 to 13,5 Mhz is untilized as "calling" channel. This is monitored by all stations mentioned. If a message or conversation is going to last more than a few minutes, the call is moved to a "working" channel, leaving the "calling" channel free for other users. Working channels stretch from 3 to 9 Mhz but will change with operating range from Cape Town. (i.e. we will "return" channels and obtain new ones as needed from the Post Office).

Other callers on the calling frequencies from time to time include the navigation department, workboats, seismic ship and even helicopters.

The system has been so configured to be easily workable by non-technical personnel.

Upon my appointment to Soekor I found that five types of radio were in use on HF-SSB, namely Motorola, Transworld, Scientific Radio, Sailor and Sait (Skanti). To standarise as far as possible it was decided to use Sailor at sea and Transworld for land stations. This eases maintenance and spares logistics.

One of the requirements for the equipment installed at sea was that it must be capable of acting in the full HF marine role as well (covering all marine frequencies and having auto alarm while capable of operating off a battery system).

The Sailor 1000B system with the "free-running" option was decided on. These sets operate from 24 Volt DC and incorporate the standard marine distress alarm. They were ordered with optional lower sideband installed, as the latter is available to Soekor for use on our (non-marine) systems. Battery back-up is provided (see Annexure C).

The space constraints on the drill forces the use of a vertical antenna system. After investigation and testing the choice was the South African manufactured ZS Electroniques XWBDA400 vertical whip. The Sailor matches well to this antenna and the results has been most satisfactory (figure 6-1).

Tests were done on oil drills to determine environmental noise levels as no figure could be obtained in publications for electrical noise on drills in the radio spectrum.

The maximum noise power encountered on the drills was in the 3 Mhz region where it reaches -105 dBW. (50 μVolt on a 50 Ω antenna system). This was on one particular drill and due to one particular AC drive unit. This particular noise was bands of energy 100 kHz apart and moving across the spectrum, so that lower level signals could be understood most of the time. For the rest the noise power did not exceed -107 dBW (32 μV). See figure 6-2.

Radio Operators on the drills report that the noise on the lower frequency is occasionally a nuisance but normally signal levels are so high that they override the noise.

Landward stations may only make use of pre-set channels, but the ability to programme them locally was seen as a major advantage over crystal changing or new PROM integrated circuits. This was the main reason for choosing the TRANSWORLD system.

A further advantage of the system is that it consists of a 100 Watt exciter driving a 400 Watt linear amplifier. Thus if the linear amplifier fails the signal will drop by 6 dB but a station will remain on the air. The 100 Watt transceiver section can also be operated on 12V battery power (see annexure D). The three "working channels" use split-site receivers and transmitters to reduce interference.

The units include a telephone coupler so that the system can be extended into the building, thus reducing human traffic into the radio room.

The antenna is a three-wire travelling wave dipole system of 46 metre overall length. It is mounted on a 22 metre mast standing on the roof of the Soekor Building. The roof is 1600 m² of earthed metal, thus providing an excellent ground plane located well above the surrounding area. This roof is a stable ground plane that does not vary with season, rainfall, etc.

The transmitters of the "working channels" being located some distance from the main buildings in a container, use three-wire travelling wave dipoles on 36m high masts. This places all antennas at the same height above ground.

The configuration has a high take-off angle, exactly matching the needs of the ranges of communication that are spanned.

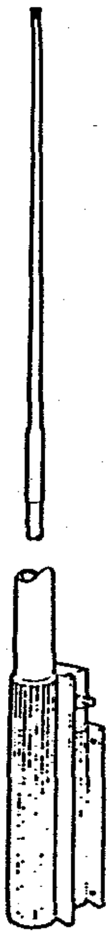
6.2 HF PACKET RADIO SYSTEM

Packet radio in South Africa is used by the amateur radio community and the military.

ZS ELECTRONIQUES (PTY.) LTD.

XWBDA

DIELECTRIC WIDEBAND HF VERTICAL ANTENNA



LOW ANGLE OF RADIATION - IDEAL FOR MEDIUM TO LONG RANGE COMMUNICATIONS

1,5-30 MHz WITH NO TUNING. VSWR BETTER THAN 2:1 ACROSS THE BAND

POWER RATINGS OF 150, 400 ND 2000 PEP

ANTENNA ELEMENTS FIBREGLASS ENCAPSULATED

OVERALL LENGTH WHEN ASSEMBLED 7 METRES

MAXIMUM LENGTH FOR TRANSPORT 3,5 METRES. MAXIMUM ELEMENT DIAMETER 40 mm

THE XWBDA SERIES OF ANTENNAS USE A DIELECTRIC PRINCIPLE TO OBTAIN VERY WIDE BAND MATCHING TO RADIO EQUIPMENT WHILST HAVING A LOW OVERALL SIZE. THE ANTENNA ELIMINATES ANTENNA TUNING UNITS AND NOTHING HAS TO BE ADJUSTED IN THE ANTENNA. ADDITIONALLY, NO GROUND PLANE IS REQUIRED. THE ANTENNA CAN BE MOUNTED IN ANY POSITION.

THE XWBDA/V ANTENNAS ARE EASILY AND QUICKLY ASSEMBLED AND IN AN EMERGENCY CAN EVEN BE HAND HELD. CONSEQUENTLY, THEY ARE PARTICULARLY SUITABLE FOR RAPID DEPLOYMENT IN MILITARY SITUATIONS WHILST THEIR SMALL SIZE MAKES THEM IDEAL FOR MARINE APPLICATIONS, BUILDINGS IN CONFINED SPACES — IN FACT ANY APPLICATION WHERE SIMPLICITY, SMALL SIZE AND HIGH RELIABILITY ARE REQUIRED.

FREQUENCY RANGE:	1,5-30 MHz
VSWR:	BETTER THAN 2:1
LENGTH:	7,0 METRES
MASS:	6 Kg
POWER RATING:	150,400 and 2000 W PEP
WIND SURVIVAL:	160 KM/H
WIND LOADING:	350 N AT 45 M/S

WHEN ORDERING SPECIFY TYPE OF ANETNNA AND POWER RATING REQUIRED.

ALL CORRESPONDENCE:
P.O. BOX 1577
RANDBURG
SOUTH AFRICA
2125

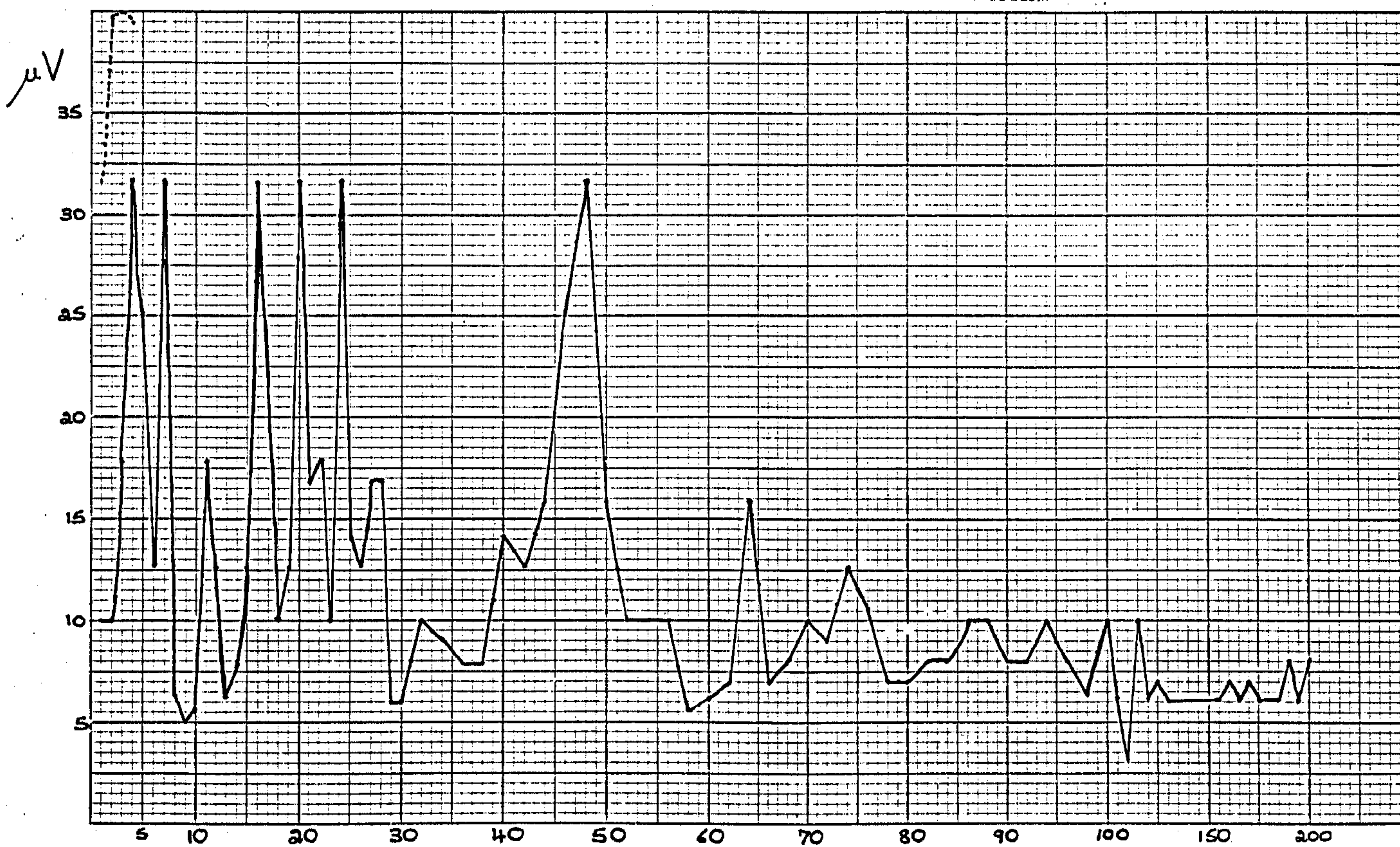
ZS ELECTRONIQUES (PTY) LTD.

PHONE: (011) 793-1051/2/3
TELEX 4-25458

FACTORY:
72 WAKIS AVENUE,
STRIJDOM PARK EXT. 2,
RANDBURG.
2194

Fig 6.2

Radio-frequency noise levels encountered on an oil drill.



The Cape Provincial Administration has attempted to use packet radio for civil defence using equipment manufactured mainly for the amateur radio market. The technical complexity of the equipment plus personnel turnover defeated the administration's non-technical operators.

For Soekor's system it was decided to look for a system that required no radio expertise from the system operators (basically a "fit and forget" system).

The only system that could be found was the Scientific Radio packet data system. This system makes use of an IBM compatible computer to control the radio equipment. The computer user thus need not understand radio equipment, radio propagation etc. to successfully use the equipment (see annexure E).

The SR-812 HF system utilizing the SR-380 100Watt transceiver was selected so as to make a HF "Wide area network".

Initially three stations will be installed on the drills and one at Soekor HQ in Parow (Cape Town). Similar antenna configurations to the SSB voice system are used (travelling wave dipole in Cape Town and Wide-band whips for the drills). The system is so configured as to self-select the operating frequency through a call and scanning process. Therefore wide-band antennas are a must.

6.2.1 SOFTWARE

The communication software package is located on the hard drive in a subdirectory. The software program automatically boots (loads) and runs whenever the computer is turned on or reset. The program is menu driven, providing the operator with "user-friendly" information about system status and operation. The software will be installed by a trained technician prior to adding the station into an existing network.

The communications software package allows the operator to send a message, one line at a time or as complete files (documents) to other stations. The menu driven screens provide the operator with instructions about the operation of the system. With little or no training, an operator can send a message to another station with no knowledge of the radio system used to transfer the data. Messages can be automatically printed on paper or saved (as a file) on the computer hard drive.

The computer controls the network, radio equipment and message processing. The system operates like a telephone network, calling and connecting with a station before exchanging messages. If that station is busy or does not answer then the operator is notified in plain language about system status.

The computer can be multi-tasked. Received messages will be put out on the printer while the computer is in use for other tasks. Message files may also be loaded to or from "floppy-discs" while transmission or reception is in progress.

The Software had to be adapted as Soekor uses EPSOM computers. The printer addressing differs from the standard IBM as does certain video screen functions.

6.2.2 *HF FREQUENCY SELECTION*

The data system provides an adaptive HF feature in packet mode. When the Adaptive feature is selected, the station can automatically find an HF frequency, from a list of pre-installed frequencies, that will allow communication.

The adaptive HF feature can be selected from the OTHER Functions menu (from the Help Menu) or can be pre-installed to automatically be selected upon entering Communicate mode from the Main Menu. The latter was selected for the Soekor system.

There are separate lists of allocated frequencies allowed for each station. When receiving in the adaptive mode, the system scans the stations list of allocated frequencies. When "calling" or attempting to connect, the system uses the allocated frequencies for the selected destination. Normally these frequencies would be the same in receive and transmit scanning but in complex networks they may differ to improve network throughput and decrease congestion by creating sub-networks within a large network.

The computer controls the HF transceiver frequency and mode via an RS-232 link. The computer also controls the receive dwell time and initiates the call connect process. The Terminal Node Controller assembles and disassembles Packets, keys the radio, and provides the "selcall" function.

In Adaptive mode the system is using the Packet protocol connect status as a "Selcall" for frequency scan stop. The receive dwell time is about 7 seconds per channel. This allows for 2 call attempts on each channel per scan. The transmit (or calling) end will try "X" times on each channel before giving up. The number of attempts (X) for each channel is twice the number of installed channels. There are about 3.5 seconds between each connect attempt. This scheme guarantees at least one valid attempt per channel dwell time.

In HF propagation paths are always changing. Time of day, season, sun spot number and multipath conditions are just a few examples of phenomena that can impair communications and cause destructive interference between stations. The Adaptive HF feature in the data system can automatically select a suitable channel for communication. This automation makes HF radio almost as easy to use as dialling a telephone. A trained operator is no longer required to establish a link by finding an open channel to establish contact or selecting the appropriate frequency for the time of day. Placing a call is as simple as selecting a destination and pressing the "Enter" key.

In practice we found that internal programming of the Terminal Node Controller (Modem) between the computer and radio on board the drill suffers from corruption due to fluctuation and noise on the mains supply. This happens as soon as drilling is in progress. A Constant Voltage Transformer (CVT) was inserted in the mains power supply to overcome this problem.

6.3 INMARSAT SYSTEM

The three oil drills will each be equipped with a Marconi Marine

Oceanray 2 shipboard earth station (see annexure F).

The terminal will be equipped for Voice, Data and facsimile.

The voice facility (telephone) will only be used in the event of a total failure of the other voice communication modes, i.e. the HF-SSB,VHF-FM and normal marine channels via coastal stations.

The terminal will be equipped with a 2400 baud Quattro modem. This will be used for urgent high-volume data and as a back-up for the package radio system.

The facsimile facility will mainly be used for graphic data such as engineering drawings that can not wait until the next helicopter flight (i.e. in the case of a breakdown).

Furthermore the facsimile will act as a further back-up in case of failure of both data systems.

The terminal will normally be locked for outgoing calls, one key being kept by the Captain and the second by the drilling engineer.

6.4 VHF-FM LINK

This is a refinement of the original VHF system and will only be used on the South coast to cover the Knysna to Witsand region.

It consists of two independent systems made up as follows:

6.4.1. System one consists of a repeater on the foot hills of George Peak (33°56' South 22°28' East) operating around 150MHz. The base station for this system is in the Soekor office in Voorbaai at Mosselbay. (34°09' South 22°06' East).

6.4.2 System two is similar to system one, except that the repeater on George peak is linked on 450 MHz to Riverdale where a second repeater around 150 MHz is activated (again a 30 watt unit with a 6 dB antenna).

6.4.3 Both systems are accessed in the George/Mosselbay area by handheld and vehicle radios during helicopter operations, to communicate with the drills, Soekor office Mosselbay and Soekor-HQ Cape Town about crew changes, helicopter loads, etc.

Both systems give full (100%) coverage up to 100km out and variable communication up to 150km.

The console in Cape Town extends to a large number of special handsets in the headquarters building. This provides selected personnel with "desk to drill" communication. The system also interfaces with the PABX but then the call switching is then controlled by the console's operator.

6.5 NORMAL MARINE HF AND VHF

The drills contain a full shipboard installation consisting of two HF transmitters and receivers (main and emergency unit - the latter with battery back-up).

The normal marine calls as well as private calls home by crews are carried via this system.

In case of failures of the Soekor HF and VHF, calls are made with the marine sets via a P&T coastal station through the telephone system. This is the voice back-up prior to satellite as the cost of calls is about 5% of satellite costs.

At times the VHF conditions on the South Coast is so good that the coast can be reached and calls placed via Port Elizabeth radio (ZSQ), from west of Mosselbay. This reduces the cost to callers, plus giving better voice quality.

6.6 VHF-AM AIR RADIO

All the drills are equipped with a small air-band VHF radio for communication with helicopters serving the drill. A range of 60-70 km is usually obtained with this mode of communication.

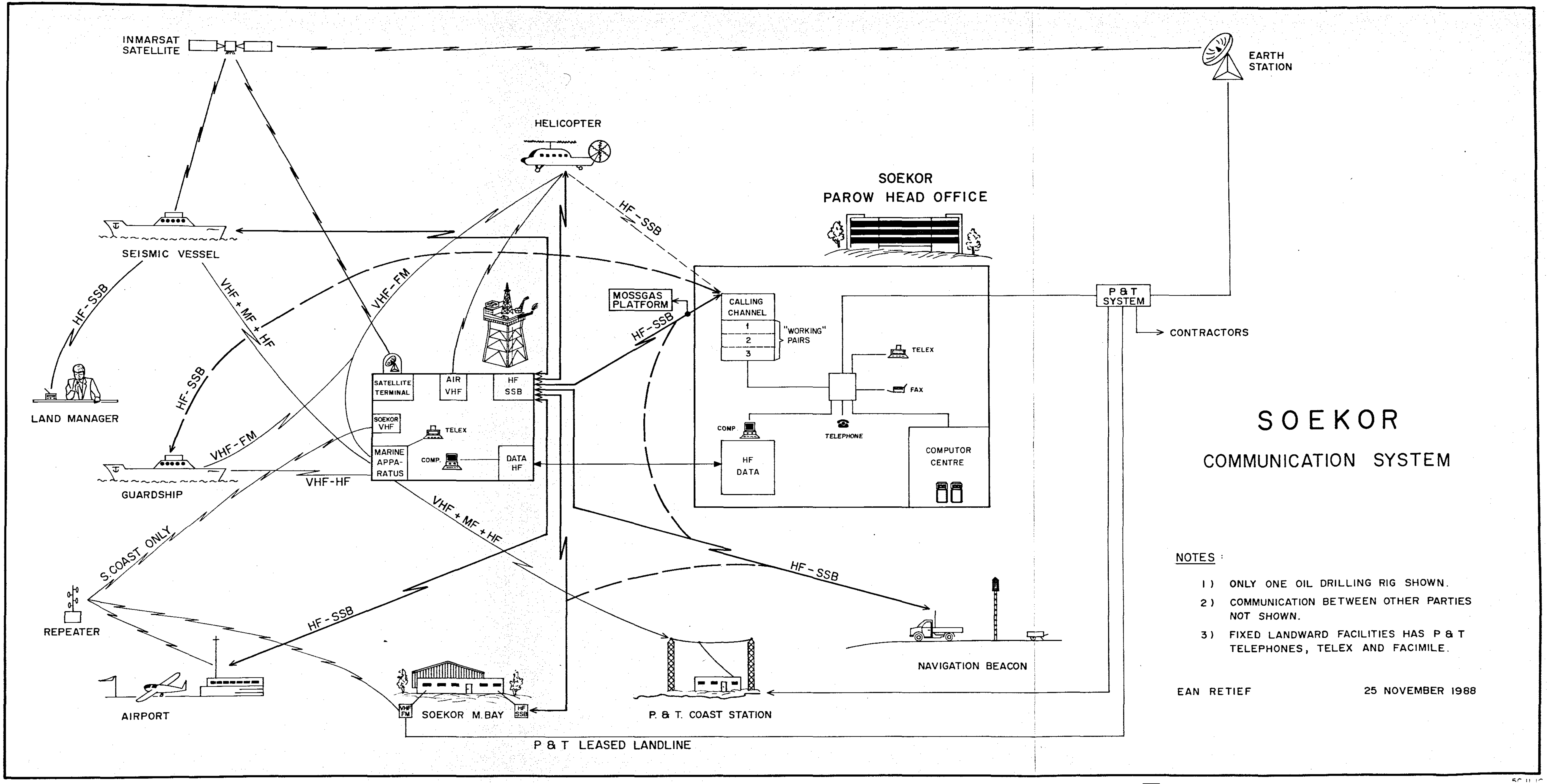
The helicopters are also equipped with marine VHF-FM and a greater range is obtained with this (90km). This is due to the higher power used and the gain antenna employed on the drill.

Some of the helicopters also have HF-SSB working into the Soekor HF-SSB calling channels.

6.7 WORKBOATS

Each drill is attended by a workboat (tug) acting as a guardship while other workboats carry cargoes to and fro from port.

Each workboat has marine VHF-FM, marine HF-SSB as well as the calling frequencies of the Soekor HF-SSB system.



SOEKOR

COMMUNICATION SYSTEM

NOTES :

1) ONLY ONE OIL DRILLING RIG SHOWN.
2) COMMUNICATION BETWEEN OTHER PARTIES NOT SHOWN.
3) FIXED LANDWARD FACILITIES HAS P & T TELEPHONES, TELEX AND FACIMILE.

EAN RETIEF

25 NOVEMBER 1988

CHAPTER 7

ON-GOING SYSTEM OPERATION

Unlike a VHF/UHF system, a system primarily based on HF can not be of the "fit and forget" type.

The use of unqualified radio operators on the landward side means that they must be guided through the intricacies and variations of a HF system. Furthermore the HF bands are in a constant state of change due to the sunspot cycle, solar flares, time of the year, time of day and even weather conditions.

To compound these problems, a drill's position changes on average every other month, mobile land stations operate from different positions and the ships and aircraft in the system are in motion.

Thus the operators have to keep track of a vast number of variables that will soon defeat them if clear guidelines are not laid down. The full-time operators still has a "feel" for changing conditions, but the occasional operators find themselves completely lost if they are not given guidance.

One might find a person maintaining a navigation beacon complaining: "Last time 4Mhz worked fine from Hondeklipbaai, but now I get no communication!"

The person complaining does not realise that "last time" was several months ago, not at the same time of day and that drill is now 300km away against the 100km of the previous occasion.

The operational guidance of the system has thus been divided into two components, namely the "Static" and "Dynamic".

7.1 STATIC PROPAGATION PREDICTION

The basis for this is the very good propagation curves published every month by the Department of Microelectronics and Communications Technology of the CSIR (see annexure G).

From the planned activity programme for the next month the relevant parameters are selected to produce a set of frequencies for use during the coming month.

A common compromise frequency is calculated that is to be monitored by all parties. This set of frequencies is calculated in such a way that any station in the system should be able to "raise" any other station at any given time. The given frequency is thus a trade-off between distant and close-by stations, as well as between stations ranging from 18 to 400 Watt ERP.

Once communication has been established the stations may select a better frequency from the list or operator experience. However, when the contact has been concluded, all parties must return to the monitoring frequency and keep a listening watch.

The common monitoring frequency works very well, as one can always use another station to attract the attention of the wanted station, either using the same frequency or another system. In this way several "paths" are available to "set-up" a contact if necessary. It also enables an occasional user to join the system at any moment in time.

7.2 DYNAMIC PROPAGATION PREDICTION

This takes two forms, firstly there is the constant evaluation of the results, via personal monitoring, log-book keeping by the main stations and regular personal conversations with the operators. This information is used to tailor the monthly predictions in light of operating experience.

The second is an "off the air" monitoring programme of station WWV in Boulder, Colorado USA.

One of the most useful developments in the study of the sun's effect on radio propagation was an offshoot of Radar development in Canada during the second world war. This was mostly due to work done by A.E. Covington for the National Research Council of Canada.

Covington found that when solar noise at 2800 MHz was measured the amplitude of this noise corresponded to the Zurich sunspot number (Wolf number). These two factors tied in with the ionization density of the F2 layer and hence with the maximum usable frequency (see figure 7-1).

Accurate measuring equipment was developed and continuous monitoring of what is now called solar flux was started in 1947. For some years now this 2800 MHz data (now known as the Ottawa figure) has been measured at 17h00 GMT and sent automatically to Boulder in Colorado, USA. From here it is sent out again at 18h00 GMT by station WWV of the National Bureau of Standards (U.S.A.). It is part of a brief propagation bulletin carried in the "Geo alert" slot at 18 minutes past the hour.

Unfortunately station WWV is rarely audible in the Western Cape region in the evenings. Signals are fairly low level and obscured by other time signals. Thus the information can usually not be taken down here before the next morning when the Ottawa data is some 14-16 hours old. Station WWV is even poorer during wintertime when short-path propagation from the USA is very bad. Regrettably the sister station WWVH in Hawaii that is very strong all day on the long path in winter does not carry the "Geo alert".

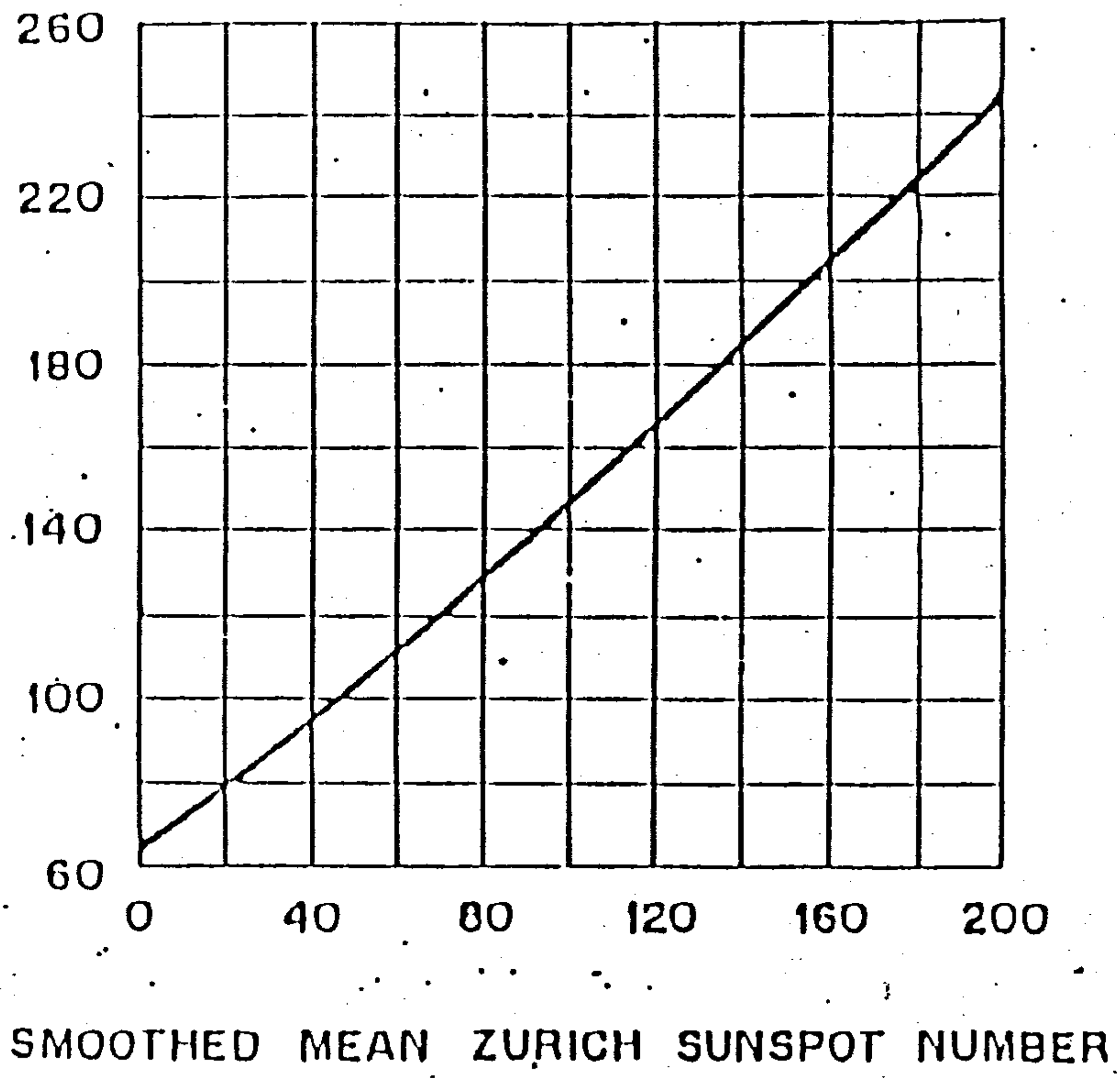
Still enough useful information can be extracted to make it a most useful short-term propagation tool.

The hourly bulletin gives:

a) Solar flux (Ottawa number)
b) Geomagnetic A index.
c) Boulder K index.
d) Brief statement of solar and geomagnetic activity in the past 24 hours.
e) Predicted solar and geomagnetic activity in the next 24 hours.

(a) and (b) are changed at 18h00 GMT and the others are updated every

Fig 7.1



Relationship between smoothed
n Zurich sunspot number and smoothed
n 2800-MHz solar flux.

three hours (03h00, 06h00, 09h00 GMT ....).

The easiest parameters to use are the brief statements (d+e). Although this refers to the Boulder (Colorado) area, one can compare the statement of Boulder activity with one's observation of ones own location. Keeping the comparison in mind, one can now draw conclusions for one's own area from the 24 hour forecast given by WWV.

The solar flux can be used to keep track with the sunspot numbers (fig. 7-1). This is the most up to date way to obtain the sunspot count other than observing the sun (by projection) and keeping one's own records.

The next step is to chart the solar flux, A-index and K-index on a graph on a daily basis.

It will be noticed after a few months of graph-keeping that the three parameters tends to peak at 28 day intervals. This corresponds to the sun's rotational period.

During periods of high values, disturbances may occur. Operators are thus advised to try and clear as much traffic as possible before a peak is reached.

Solar flares can also be detected up to 36 hours in advance. Sudden bursts of solar activity are accompanied by ejection of charged particles from the sun. They normally reach the earth's atmosphere 24 to 36 hours after the outburst.

Major flares are announced by station WWV. The timing of the flare is announced and the flare is given a rating. Some hours later, if the particles are intercepted by Geostationary satellites placed in orbit solely for this purpose, a "proton event" is announced. Due to the reception delays, it is normally only possible to issue a 12 to 24 hour warning.

First indication that something is about to happen is a rise of about 10 points in the solar flux value. This means an increase in maximum usable frequency, thus better long range communication and degraded night-time local operation between 2,2 and 4 MHz. This conditions is exploited to run high quality radio-telephone calls to France and the U.K. for crew members who reside in Europe.

The above is supplemented by propagation warnings received from the Magnetic Observatory of the CSIR at Hermanus.

On several occasions however, the WWV data gave warning more than 24 hours before Hermanus.

The Hermanus warnings however are very useful if no data can be received from WWV (i.e. in the winter months).

In the near future it is intended to evaluate certain computer programme packages, with the view to using these programmes to rapidly disseminate data so as to assist in prediction and propagation warnings.

7.3 OPERATORS

Coupled to the prediction service is constant pressure that has to be brought on certain operators that ignore laid down monitoring frequencies and simply change frequencies on "gut feel". They regard propagation predictions as "bone throwing" and of no value. However, the results are starting to convince most of them that a viable case can be made for using predictions.

On the other hand, the better operators provide a constant stream of feedback, such as observations, suggestions and probing tought-provoking questions. This has resulted in an accumulation of experience, that is used to tailor predictions and operating procedures. This results in day to day improvement of overall system operation.

ANNEXURE A

ATMOSPHERIC STUDY RESULTS

Fig. A-1

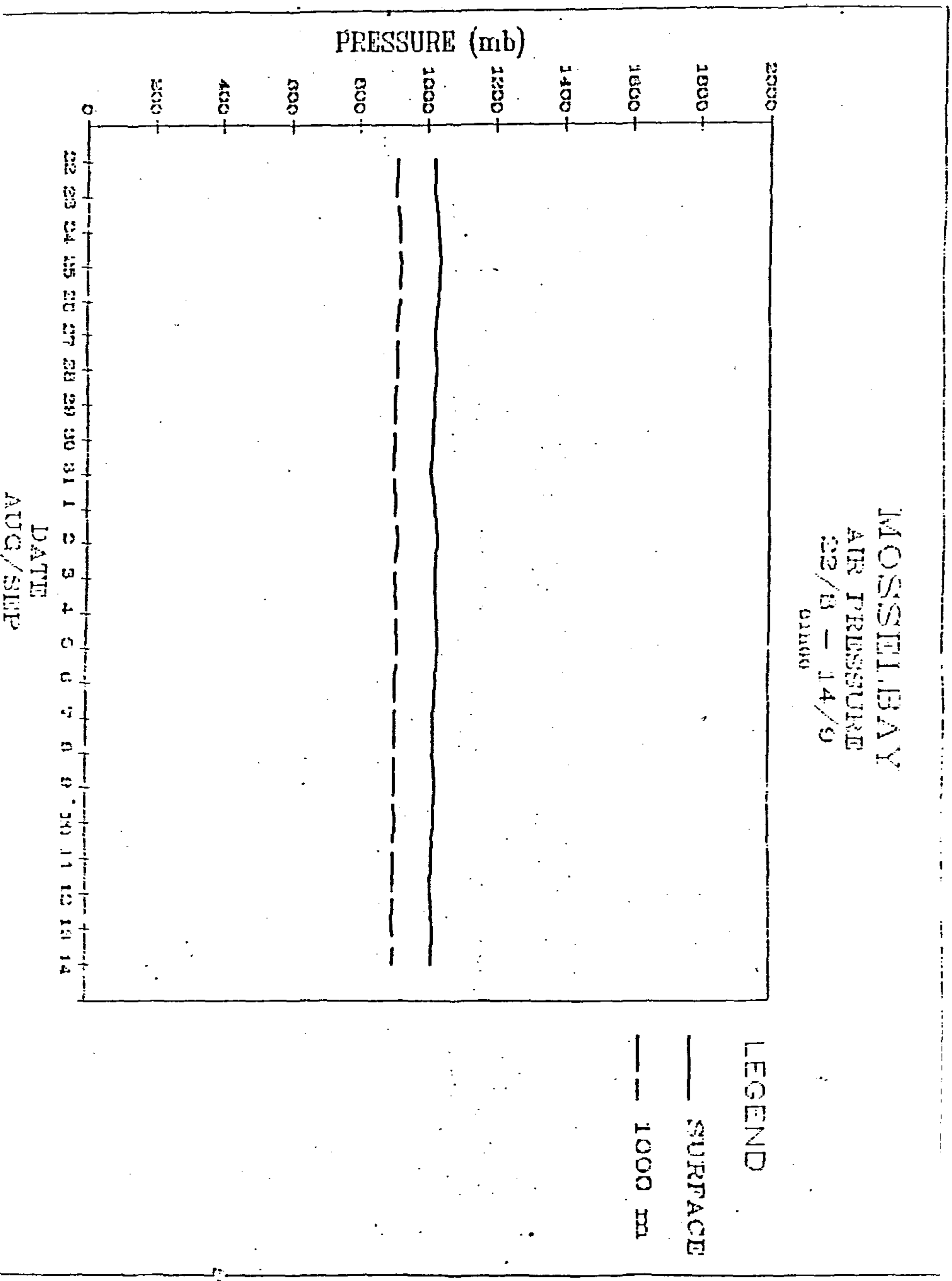

MOSSELBAY
AIR PRESSURE
22/8 – 14/9
PRESSURE (mb)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14
DATE
AUG/SEP
LEGEND
SURFACE
1000 m

Fig. A-2

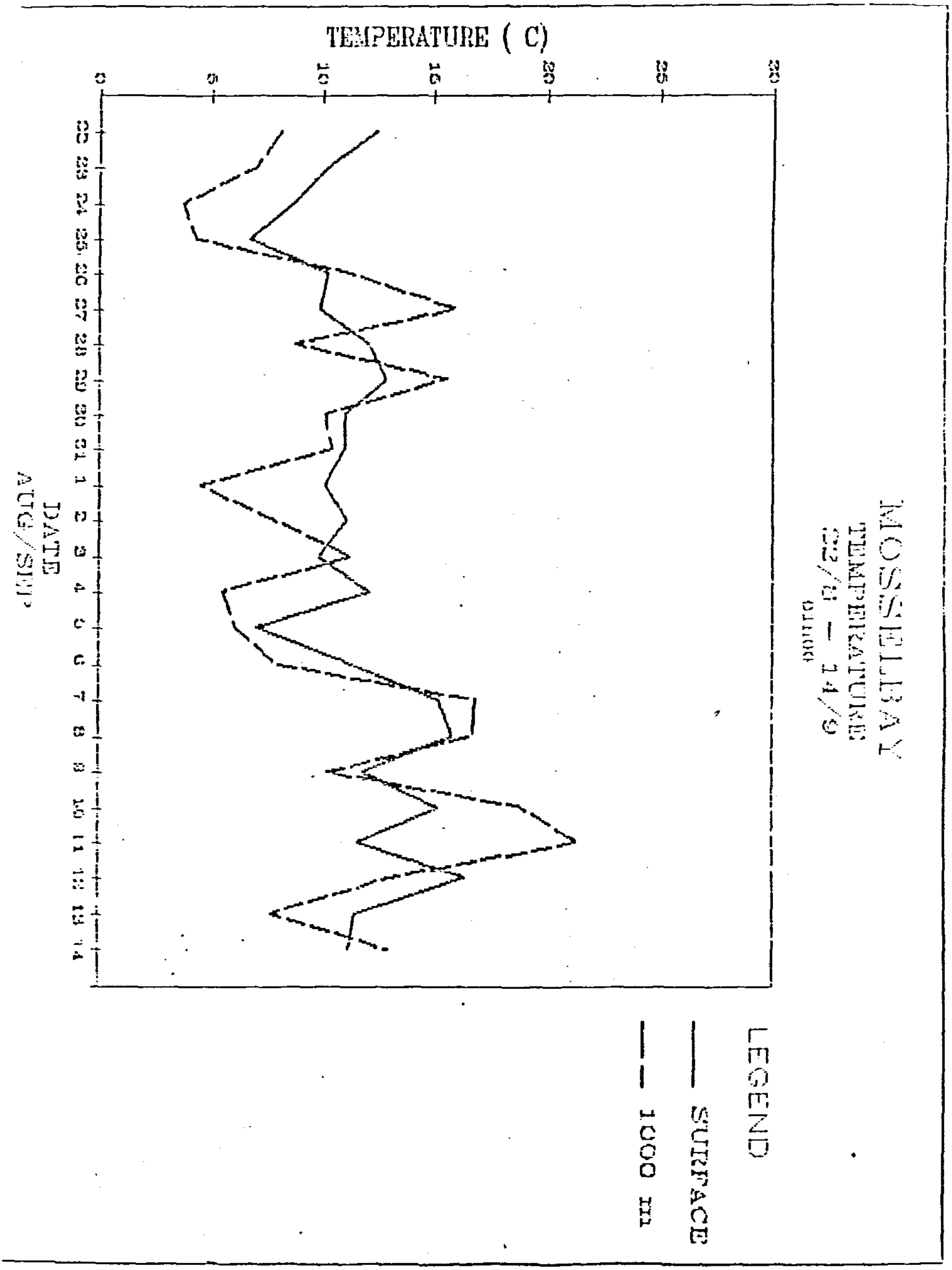

MOSSELBAY
TEMPERATURE
LEGEND
SURFACE
1000 m
TEMPERATURE (C)
DATE
AUG/SEP

Fig. A-3

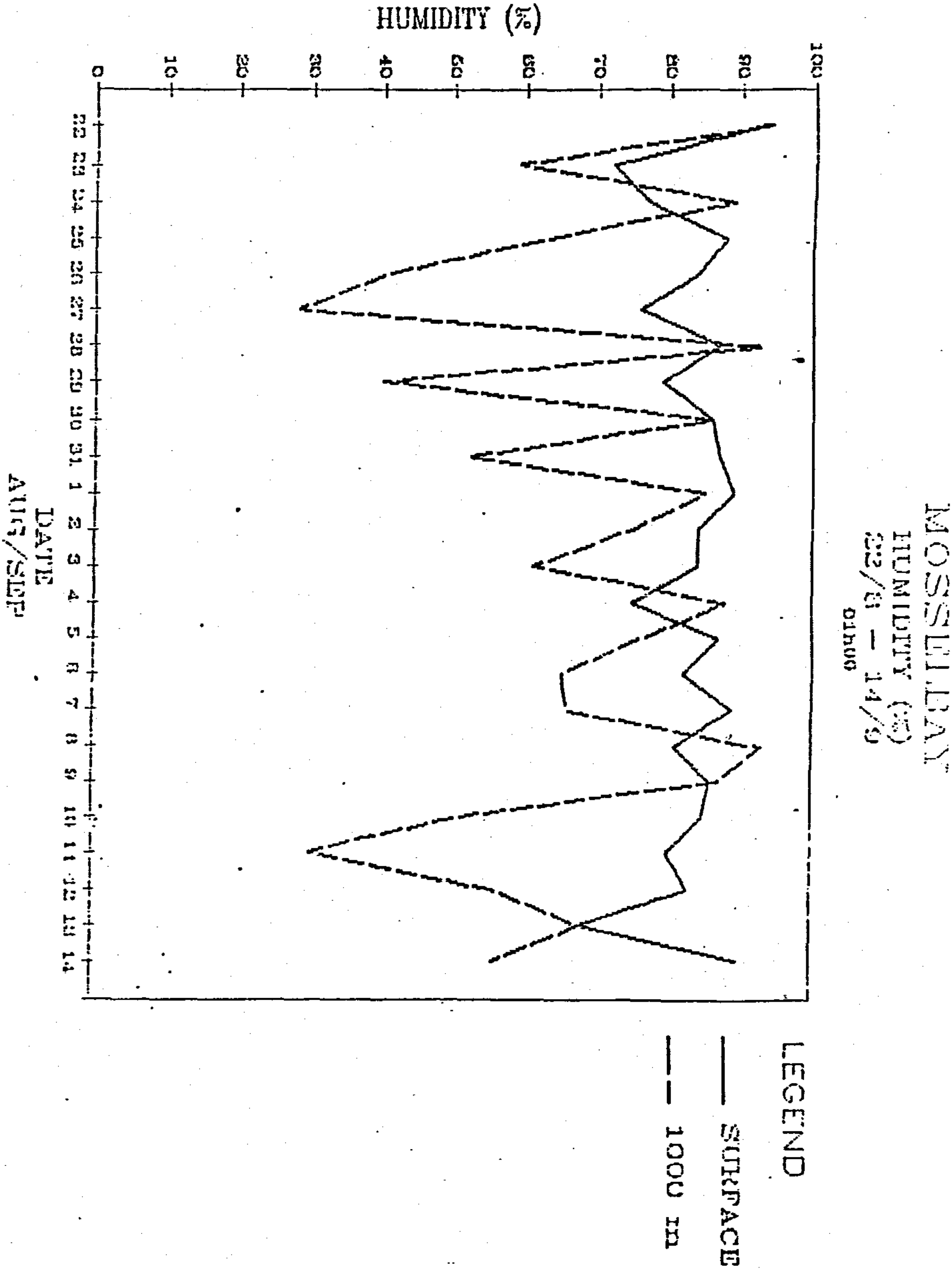

MOSSEL BAY
HUMIDITY (%)
22/8 - 14/9
01h00
HUMIDITY (%)
0
10
20
30
40
50
60
70
80
90
100
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14
DATE
AUG/SEP
LEGEND
SURFACE
1000 m

Fig. A-4

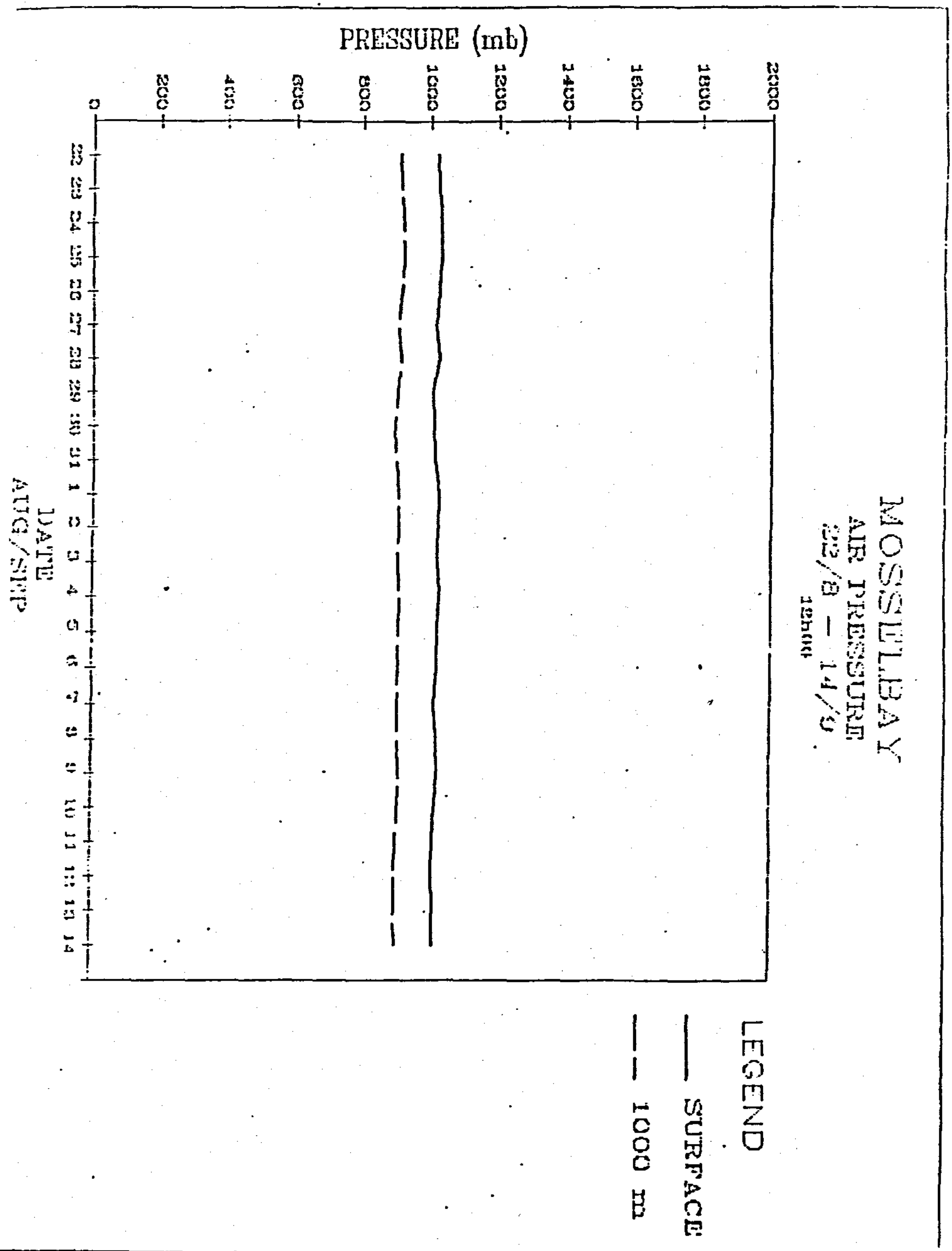

MOSSELBAY
AIR PRESSURE
22/8 – 14/9
12h00
PRESSURE (mb)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DATE
AUG/SEP
LEGEND
SURFACE
1000 m

Fig. A-5

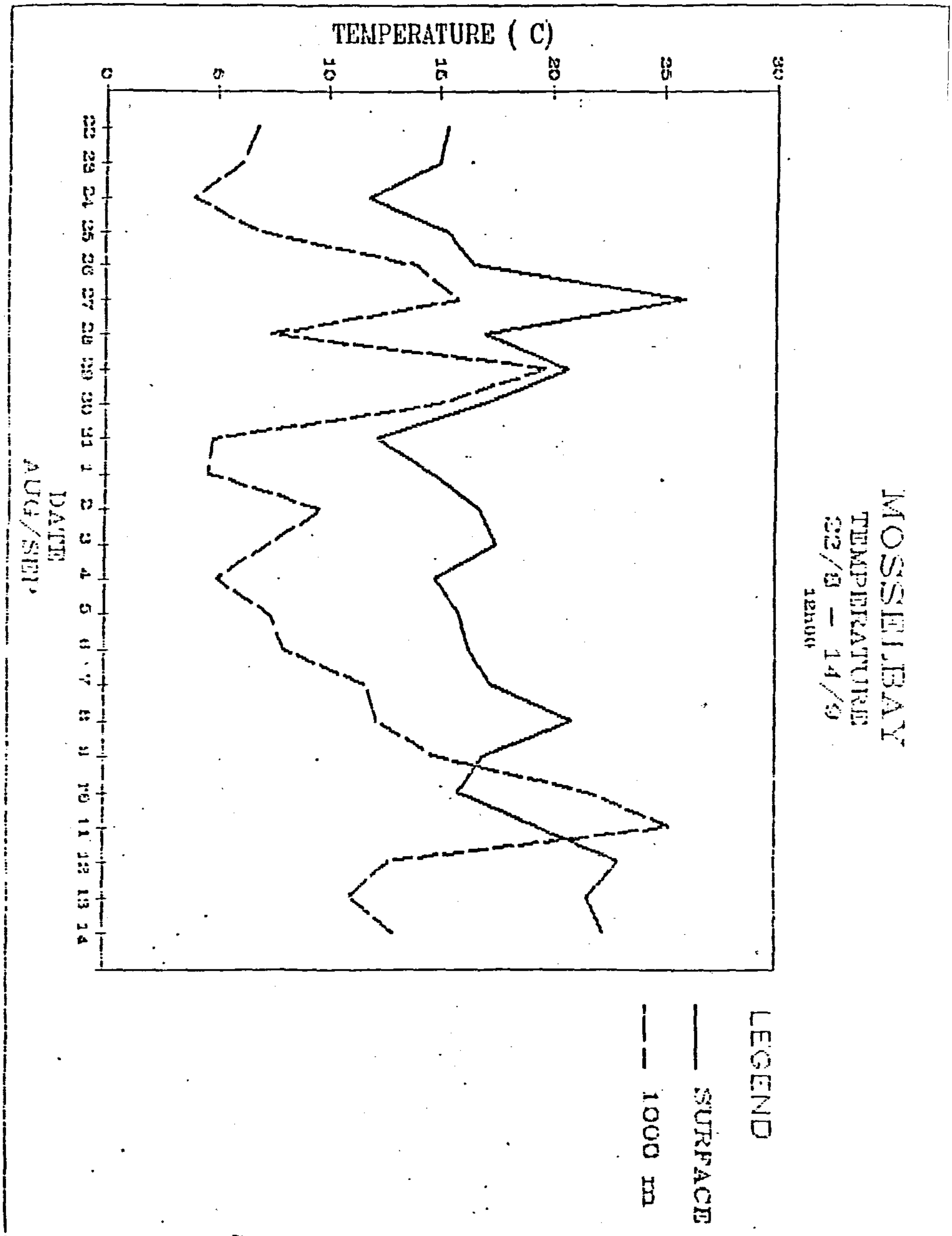

MOSSELBAY
TEMPERATURE
22/8 - 14/9
12h00
TEMPERATURE (C)
0
5
10
15
20
25
30
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14
DATE
AUG/SEP
LEGEND
SURFACE
1000 m

Fig. A-6

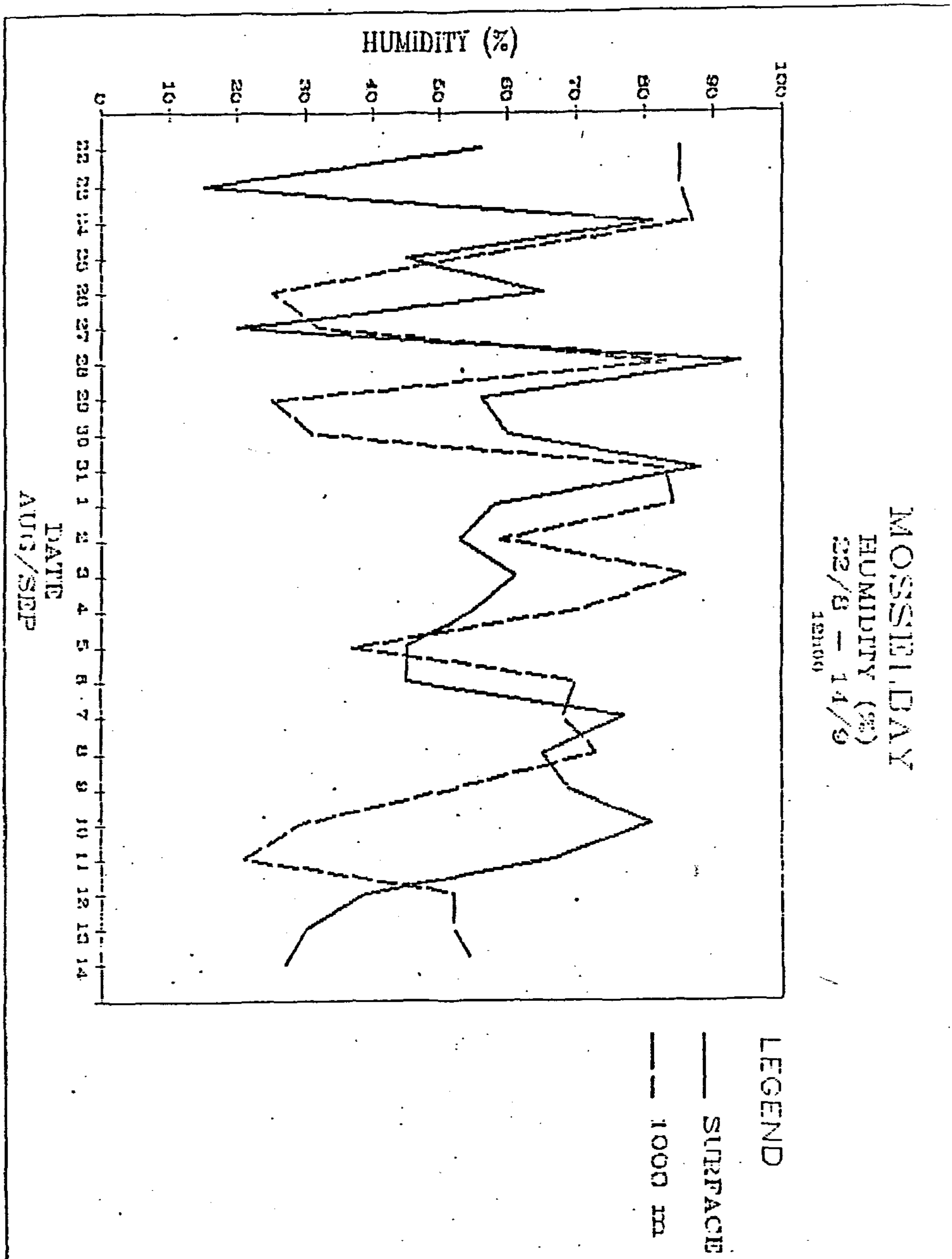

MOSSELBAY
HUMIDITY (%)
22/8 – 14/9
12h00
HUMIDITY (%)
0
10
20
30
40
50
60
70
80
90
100
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14
DATE
AUG/SEP
LEGEND
SURFACE
1000 m

Fig. A-7

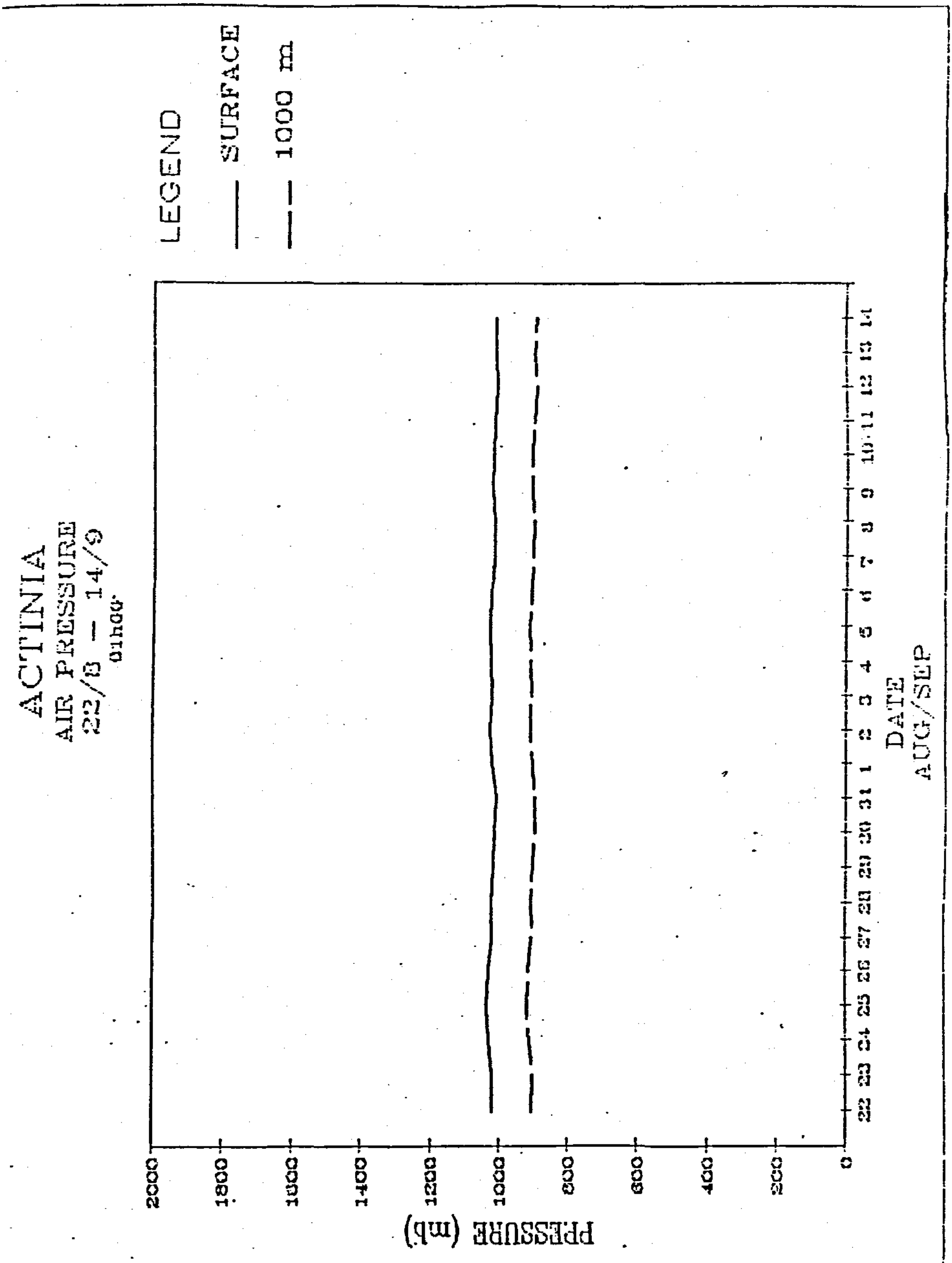
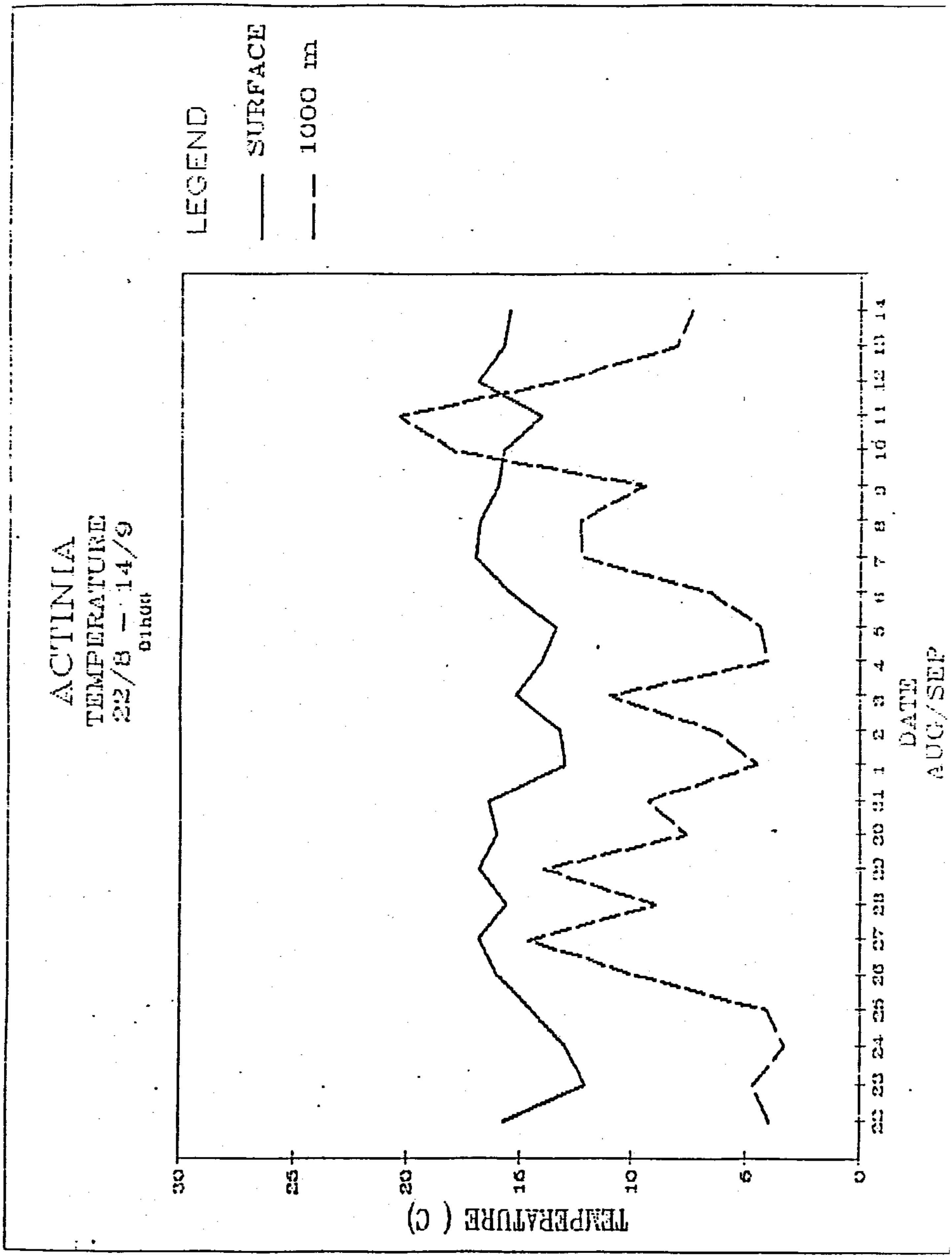
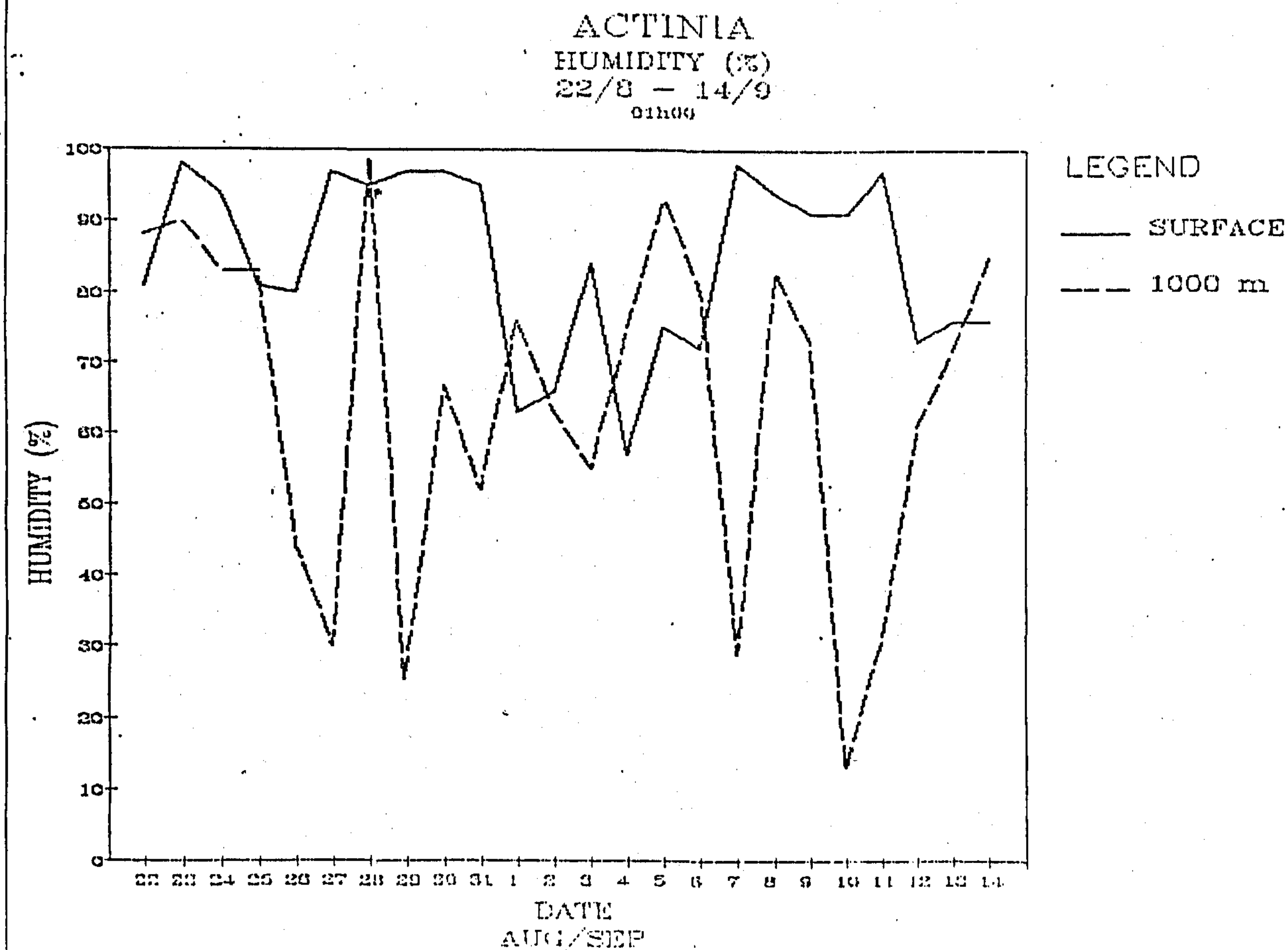
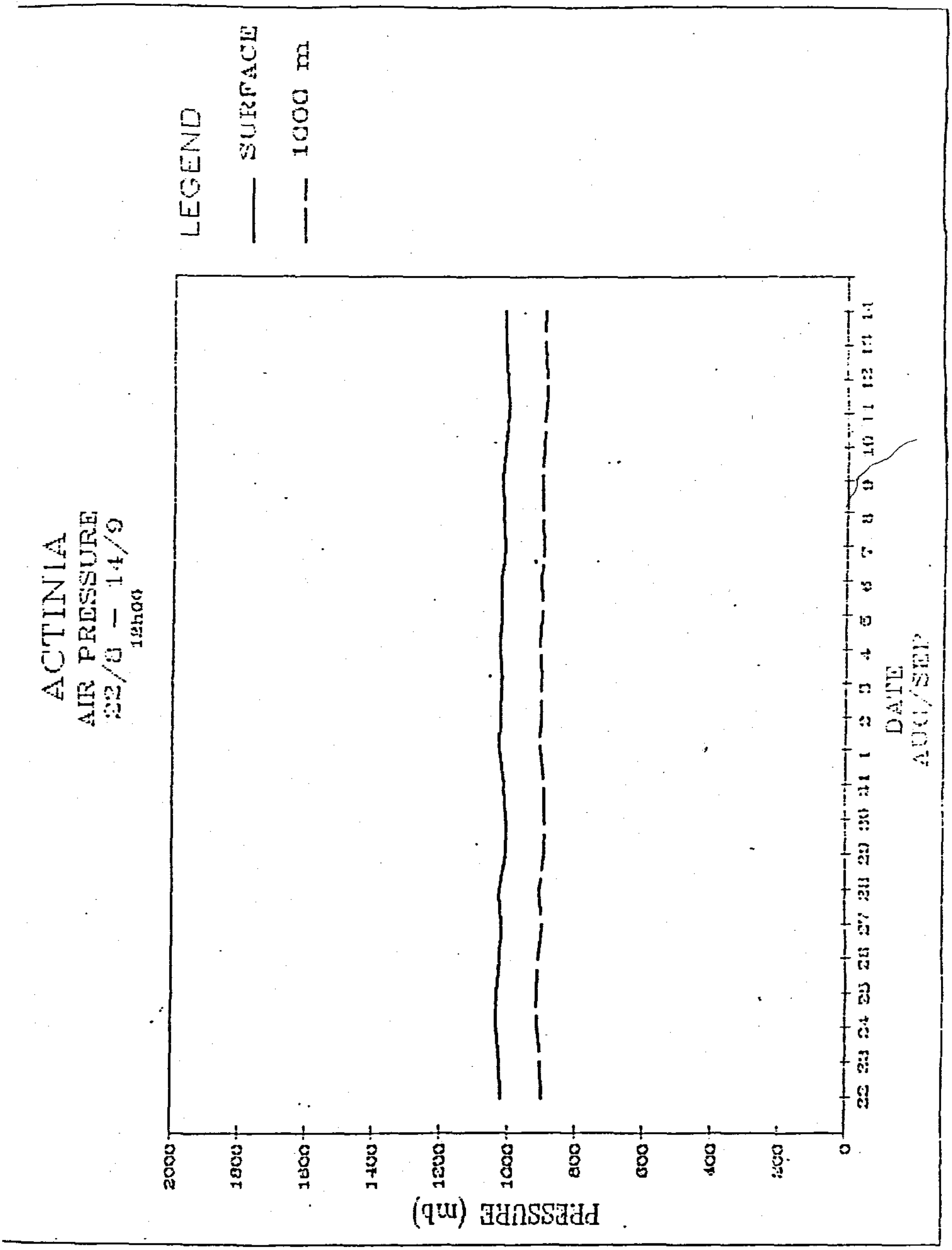
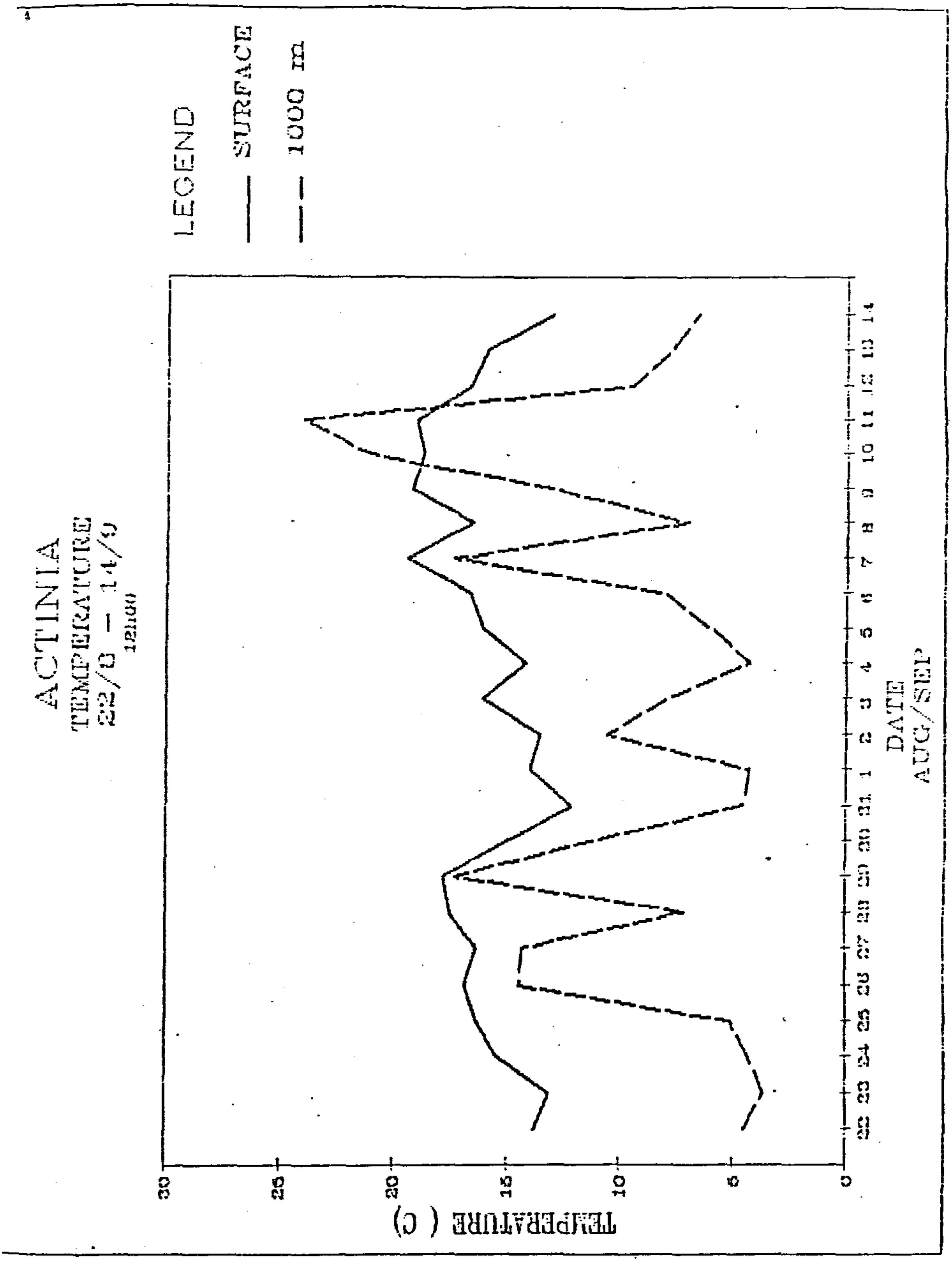

ACTINIA
AIR PRESSURE
22/8 — 14/9
LEGEND
SURFACE
1000 m
PRESSURE (mb)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DATE
AUG/SEP
22
23
24
25
26
27
28
29
30
31
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Fig. A-8


ACTINIA
TEMPERATURE
22/8 – 14/9
LEGEND
SURFACE
1000 m
TEMPERATURE (C)
0 5 10 15 20 25 30
DATE
AUG/SEP
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14

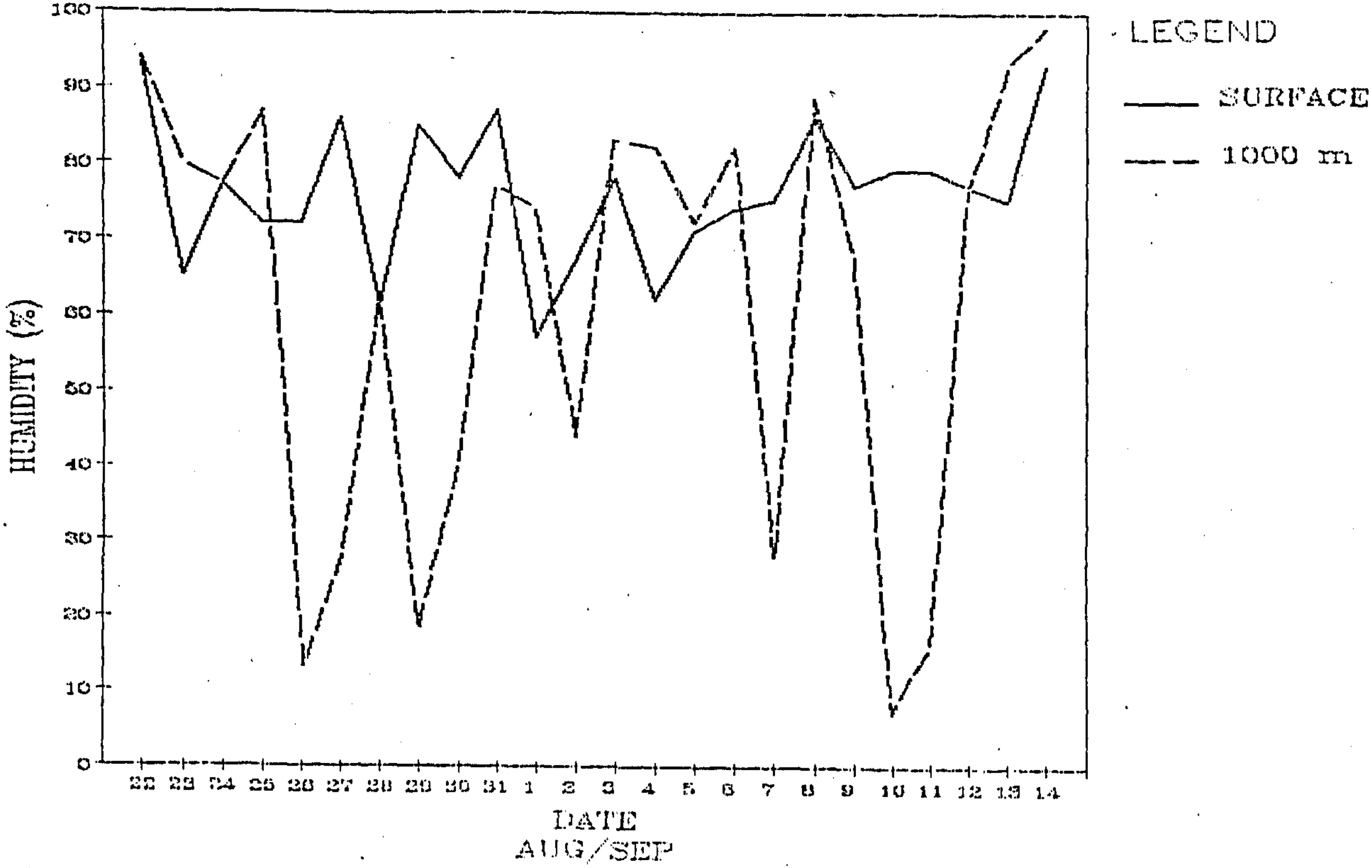

ACTINIA
HUMIDITY (%)
22/8 – 14/9
01h00
HUMIDITY (%)
100
90
80
70
60
50
40
30
20
10
0
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14
DATE
AUG/SEP
LEGEND
SURFACE
1000 m


ACTINIA
AIR PRESSURE
22/8 - 14/9
12h00
LEGEND
SURFACE
1000 m
PRESSURE (mb)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
DATE
AUG/SEP


ACTINIA
TEMPERATURE
22/8 – 14/9
12h00
LEGEND
SURFACE
1000 m
TEMPERATURE (C)
0
5
10
15
20
25
30
DATE
AUG/SEP
22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14

ACTINIA

HUMIDITY (%)
22/8 – 14/9
12h00



ANNEXURE B

VHF SITE SURVEY

1. Lekkersing

This is a 701m high peak in the Richtersveld mountains near the settlement of Lekkersing and 30km from the coastline.

The site is inaccessible by motor vehicle and not practical to reach on foot. The only practical method of reaching the site is by helicopter. The peak has a flat top about 175m in diameter, making helicopter approach easy, but is rocky and uneven, but a landing site can be cleared.

No mains power supply exist. The area receives an average solar irradiation of 800 kJ/cm^2, and is thus an excellent proposition for a photovoltaic power system.

The meteorological station at Port Nolloth some 34km away has a mean annual windspeed of 3,1 m/s. The Lekkersing site is not on the coast as is Port Nolloth, but against that we have the fact that it's elevation is 701m above sea level against the 4m of Port Nolloth. Thus the same sort of mean annual windspeed can be expected. This is born out by the fact that O'Okiep deeper inland has a mean annual windspeed of 3,3 m/s.

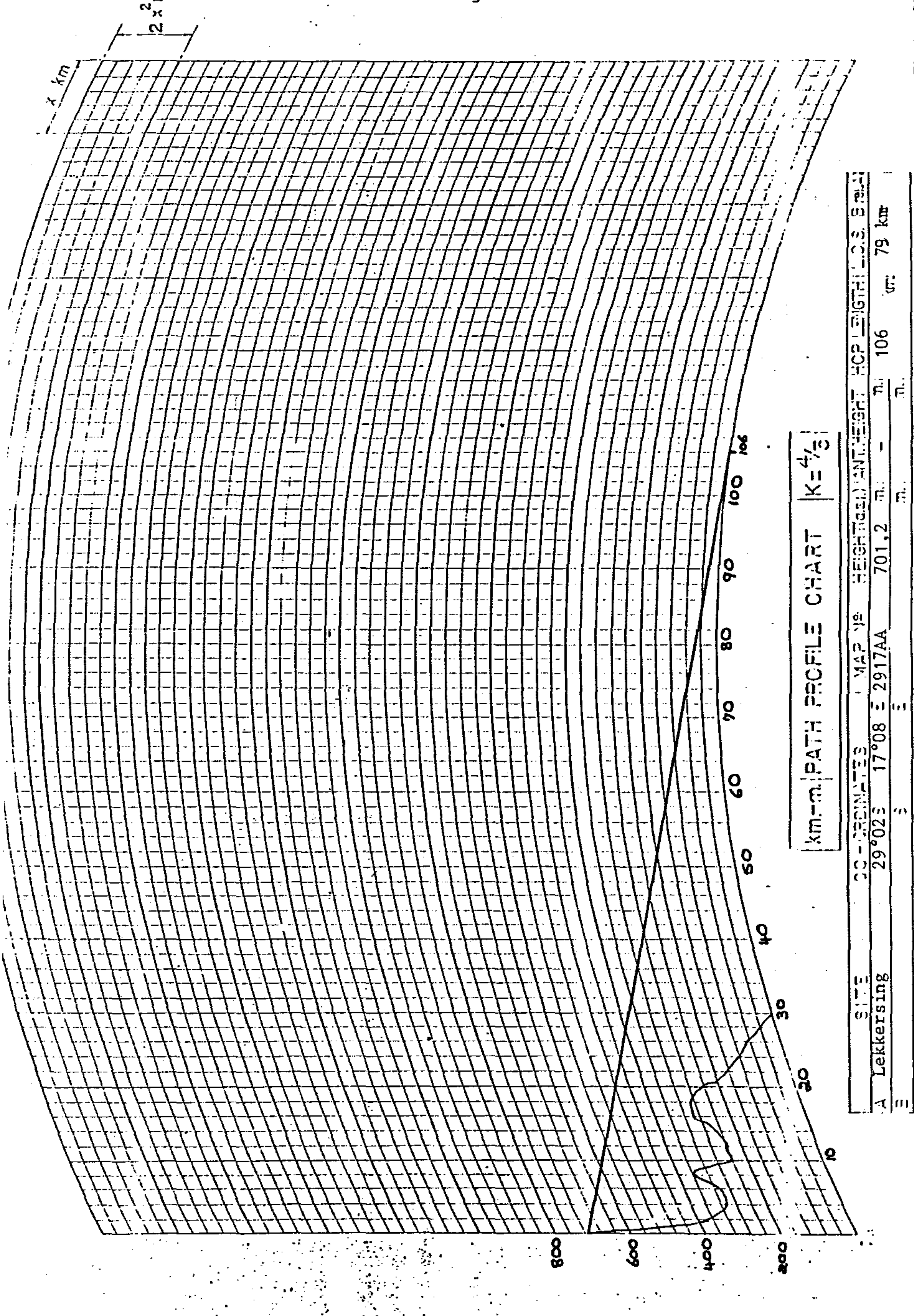
Windspeed in the 3 to 4 m/s range is not considered high enough for primary power, thus this site is good for solar (photovoltaic) primary power with a wind charger for occasional "boost" charge at times of high winds.

No infrastructure of any kind is in existence.

Coverage from this site at a k-factor of 1,33 will be 106km, thus 76km offshore.

Coverage profile is shown in figure B-1.

Fig B-1


2 x² m
x km
km-m PATH PROFILE CHART
K= 4/3
SITE | CO-ORDINATES | MAP № | HEIGHT a.s.l. | ANT. HEIGHT | HOP LENGTH | L.O.S.
A Lekkersing | 29°02 S 17°08 E | 2917AA | 701,2 m | - m | 106 km | 79 km
B | S E | | m | m | |
10
20
30
40
50
60
70
80
90
100
106
800
600
400
200

2. Nababeep

This is a 1313m high peak in the Spektakelberg mountains near the town of Springbok and 75km from the coastline.

The site is accessible by a poor road. It is already occupied by the SABC, P&T and several other users.

Mains power can be obtained from the SABC and antennas may be placed on their tower by approved users.

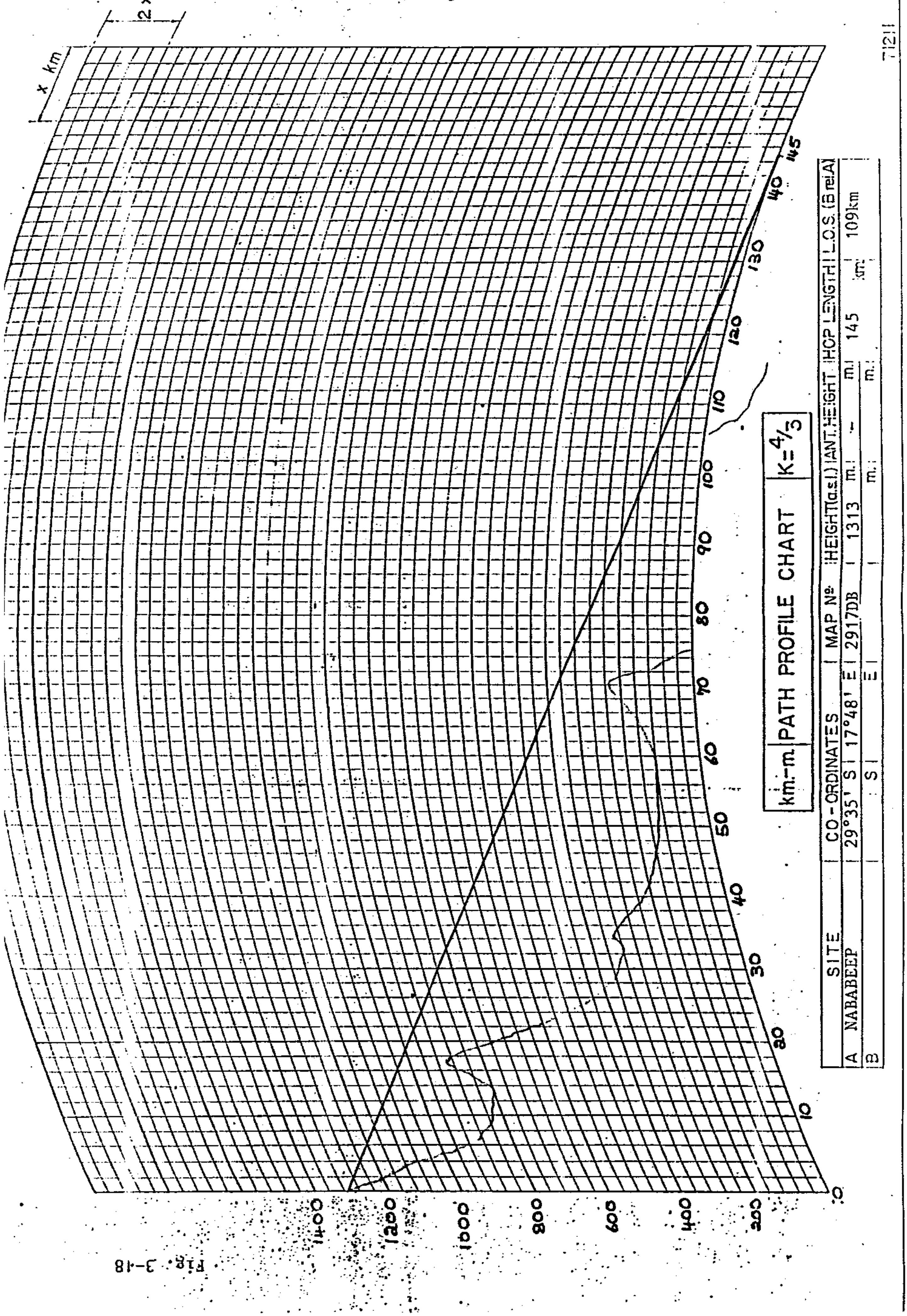
At time of writing rental of site cost R100 p.a., power R600 p.a. and use of the SABC tower R500 p.a.

Private users must erect their own buildings to house equipment. Due to fog, buildings may "leak", not withstanding the dry climate. It is essential that roof openings be well sealed.

Coverage from this site at a k-factor of 1,33 will be 145km, thus 70km offshore.

Coverage profile is shown in figure B-2.

Fig B-2


x km
2x²m
PATH PROFILE CHART
km-m
K=4/3
SITE | CO-ORDINATES | MAP Nº | HEIGHT(a.s.l.) | ANT. HEIGHT | HOP LENGTH | L.O.S. (B rel A)
A NABABEEP | 29°35' S 17°48' E | 2917DB | 1313 m | - m | 145 km | 109km
B | S E | | m | m | |
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
145
200
400
600
800
1000
1200
1400
7121 SH.2
Fig. 3-18

3. Leliefontein

This is a 1525m high peak in the Kamies mountains near the village of Kamieskroon and 68km from the coastline.

The site is accessible by a fair road. It is already occupied by ESKOM who have allowed SOEKOR to use it's building and 24 metre high mast.

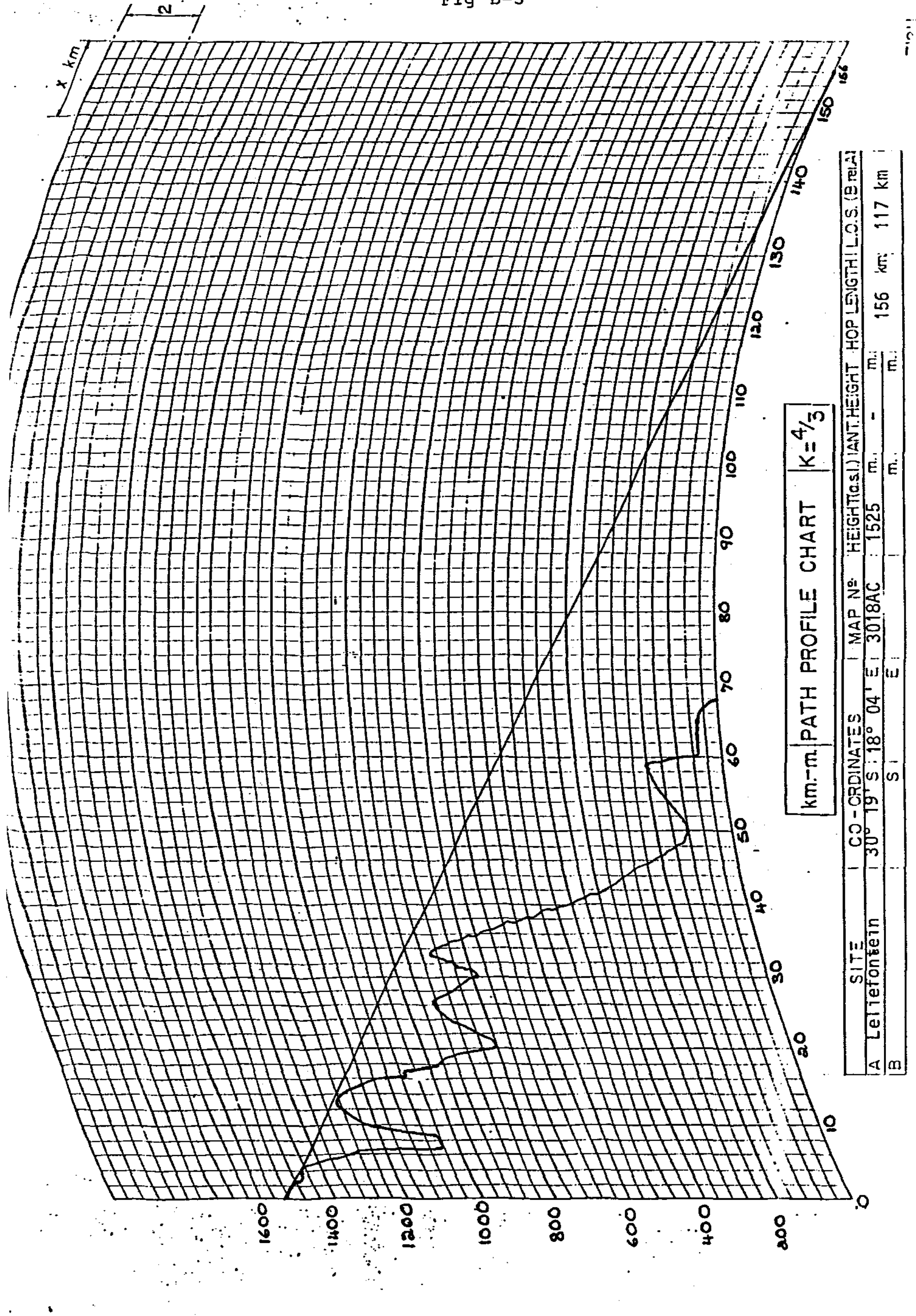
Solar irradiation is high (800 kJ/cm^2) and ESKOM use only photovoltaic power. Soekor has used this site with a photovoltaic system to power a 34/41 Mhz system with no power supply problems, notwithstanding the fact that a very small solar cell system was used.

Wind is very light at most times and not considered a practical proposition.

Coverage from this site at a k-factor of 1,33 should be 156km, thus 88km offshore. We used this site to communicate with an oil drill 180km away. The antenna on the drill was placed 28m high. Thus the k-factor became 1,35. However, most of the time good communication was not possible. This was in part put down to the mountainous terrain towards the coast. Thus an alternative site, namely Toringberg closer to the coast was also evaluated, notwithstanding that it is at a lower elevation above sea level.

Coverage profile is shown in figure B-3.

Fig B-3


x km
$2x^2$ m
km.-m.
PATH PROFILE CHART
K= 4/3
SITE | CO-ORDINATES | MAP Nº | HEIGHT(a.s.l.) | ANT.HEIGHT | HOP LENGTH | L.O.S. (B rel.A)
A Leliefontein | 30° 19' S 18° 04' E | 3018AC | 1525 m. | - m. | 156 km | 117 km
B | S | E | | m. | m. | |
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 156
1600 1400 1200 1000 800 600 400 200

4. Toringberg

This is a 548m high hill on the farm of the same name of Mr. van Eeden. It is located near the settlement of Molsvlei west of Bitterfontein and some 27km from the coastline.

The site is accessible by farm track from the homestead of Mr. van Eeden. No infrastructure exits on the hill but it is a good site for the erection of towers and buildings. Mr. van Eeden has indicated that Soekor may occupy the site free of charge.

It is located in an area of high solar irradiation (700 kJ/cm^2) but unfortunately located on the edge of the West Coast fog belt. Thus many hours of sunlight may be lost. However, next to the homestead is a P&T microwave tower that is entirely solar powered.

The site seems to be perfect for wind power. It is the highest hill in the vicinity and thus open to wind from all directions. A fairly deep gully exist up the hill from the seaward side and will help to channel the predominant onshore wind onto the site.

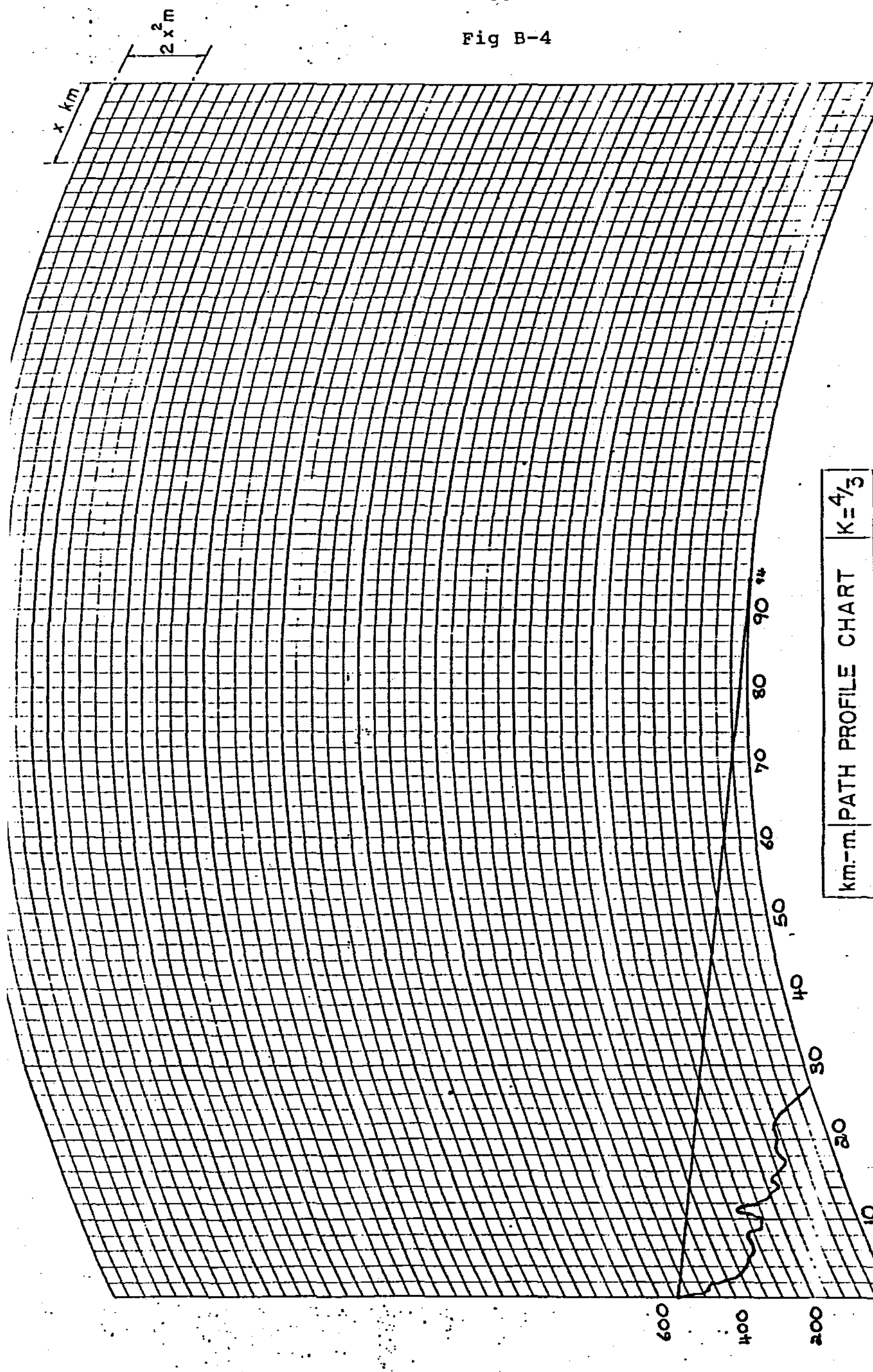
At Mr. van Eeden's homestead approximately 88m below the crest of the hill a WG910 (50 Watt) windcharger is erected at low height. (approx 2,5m above ground). This unit charges a 12 Volt battery system that in turn powers the household lights and a portable TV set. Mr. van Eeden states that this small charger has been sufficient for years and he has not been left without lights or TV. He states that except for times of fog, the wind blows at a reasonable rate for most of the time.

There is no infrastructure in existence on the hill.

Coverage from this site at a k-factor of 1,33 will be 94km.

Coverage profile is given in figure B-4.

Fig B-4



	SITE	CO-ORDINATES		MAP Nº	HEIGHT(a.s.l.)	ANT.HEIGHT	HOP LENGTH	L.O.S.(B rel A)
A	Toringberg	31° 02' S	18° 00' E	3117BA	548 m.	- m.	94 km	70 km
B		S	E		m.	m.		

5. Gifberg

This is a 793m high mountain near Klawer, just south of Vanrhynsdorp and some 40km from the coastline.

The site is accessible by a fair road. It is already occupied by the SABC, P&T, ESKOM and a multitude of other users.

Mains power is available from ESKOM at normal rural rates. Private users must erect their own infrastructure. At the time of publication the owner of the site Mr. van der Westhuizen charges R50pm for use of the site. The SABC must also be compensated for use of the approach road.

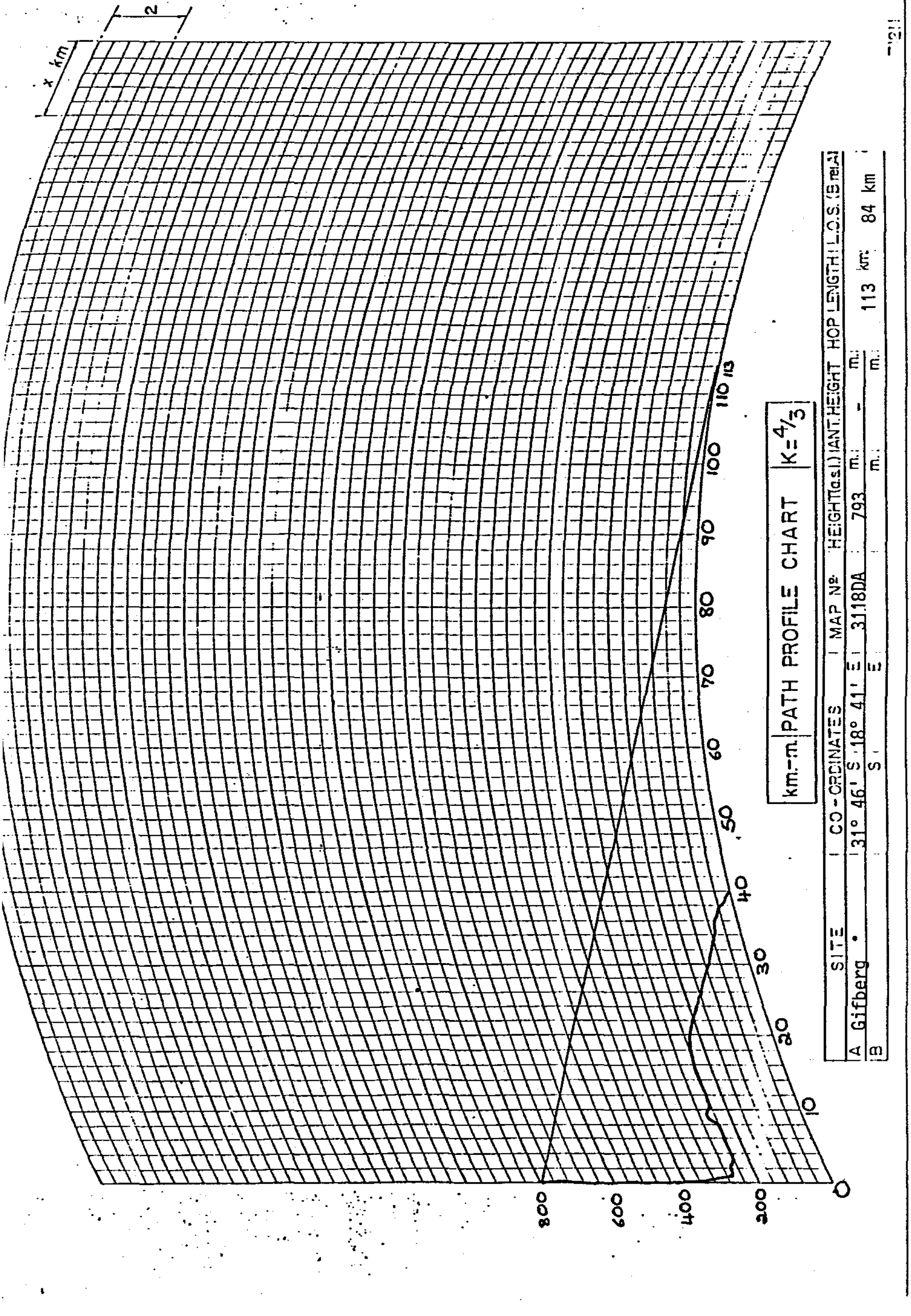
The site is on top of a sheer cliff face that drops away vertically for about 400m. Soekor has obtained the right to place their tower right on the edge of the cliff, thus making it an ideal VHF site for "take-off" towards the sea.

Coverage at a k-factor of 1,33 will be 113km (73 km from shore). This was borne out by practical tests to an oil drill.

The site is subject to high winds and thus low band VHF antennas are subject to severe windloading. As a result large aluminium antennas are easily damaged. It is advisable to use stainless steel antennas. Even these are sometimes damaged by wind.

Coverage profile is shown in figure B-5.

Fig B-5


x km
$2x^2$ m
0 10 20 30 40 50 60 70 80 90 100 110 113
800 600 400 200
km-m. PATH PROFILE CHART K=4/3
SITE | CO-ORDINATES | MAP No | HEIGHT(a.s.l.) | ANT.HEIGHT | HOP LENGTH | L.O.S. (B rel A)
A Gifberg • 31° 46' S 18° 41' E 3118DA 793 m. – m. 113 km 84 km
B S E m. m.
SH 2

6. Kapteinskop

This is a high point of 650m on the extreme west of the Piketberg mountains some 21km from the coast.

The site is occupied by an Air Force radar station. Several private users have been allowed to use the site. Access is by an excellent road, but unannounced visits is not allowed.

Mains power is available from the Air Force.

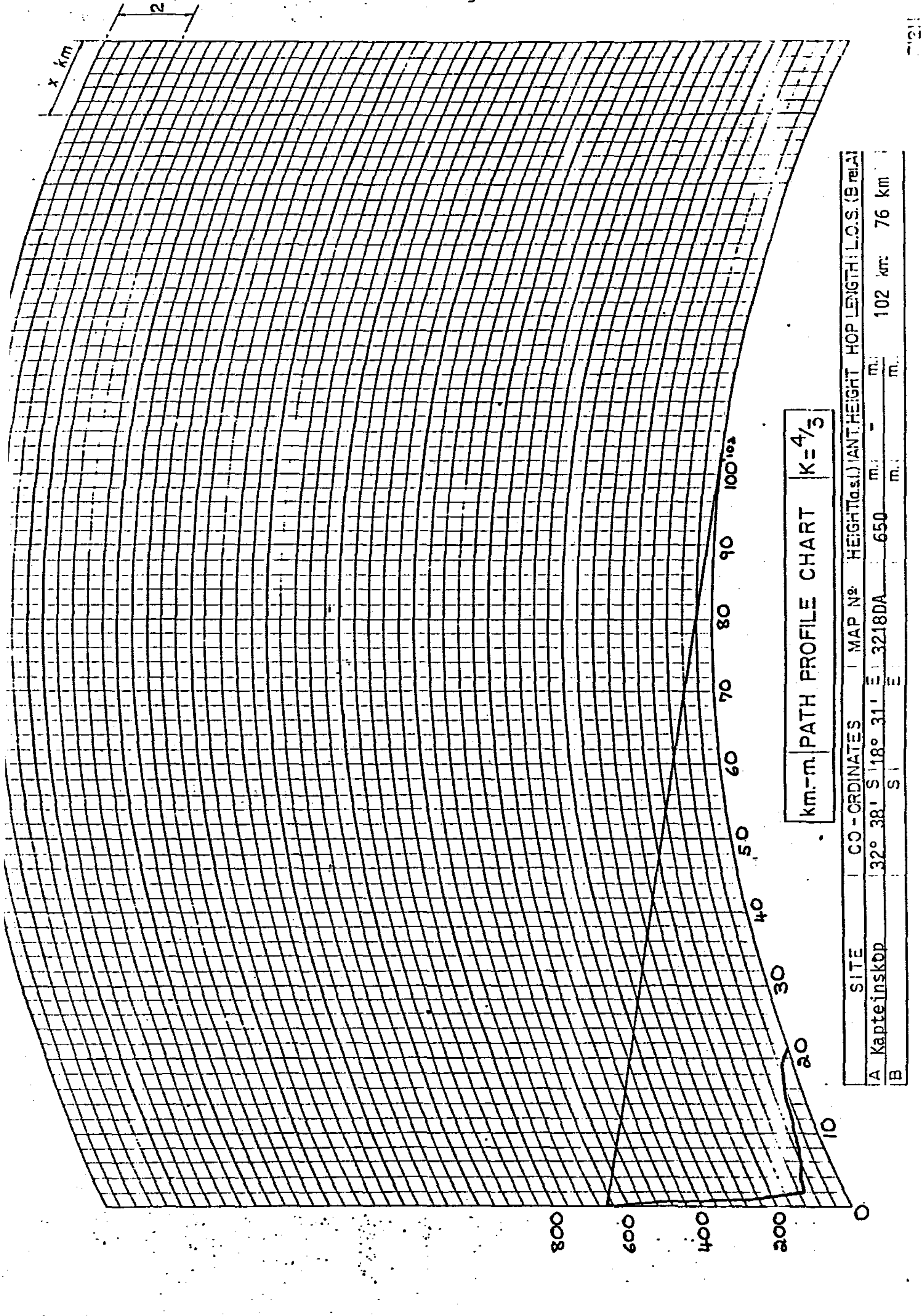
Users must erect their own buildings and antenna masts.

Coverage to the southwest is limited by the radome of the radar station.

Coverage at a k-factor of 1,33 will be 102km, thus 81km offshore.

Coverage profile is shown in figure B-6.

Fig B-6


x km
2 x² m
km.-m.
PATH PROFILE CHART
K=4/3
SITE
CO-ORDINATES
MAP №
HEIGHT (a.s.l.)
ANT. HEIGHT
HOP LENGTH
L.O.S. (B rel A)
A Kapteinskop
32° 38' S 18° 31' E
3218DA
650 m
- m
102 km
76 km
B
S
E
m
m
0
10
20
30
40
50
60
70
80
90
100
200
400
600
800

7. Piketberg

This is an SABC site on virtually the highest point of the Piketberg.

Accessibility is by a good road to this 1027m high point some 55km from the coastline.

Mains power is supplied by the SABC at a present cost of R600 per year while rental of the site cost R100 per year.

Users must erect their own infrastructure.

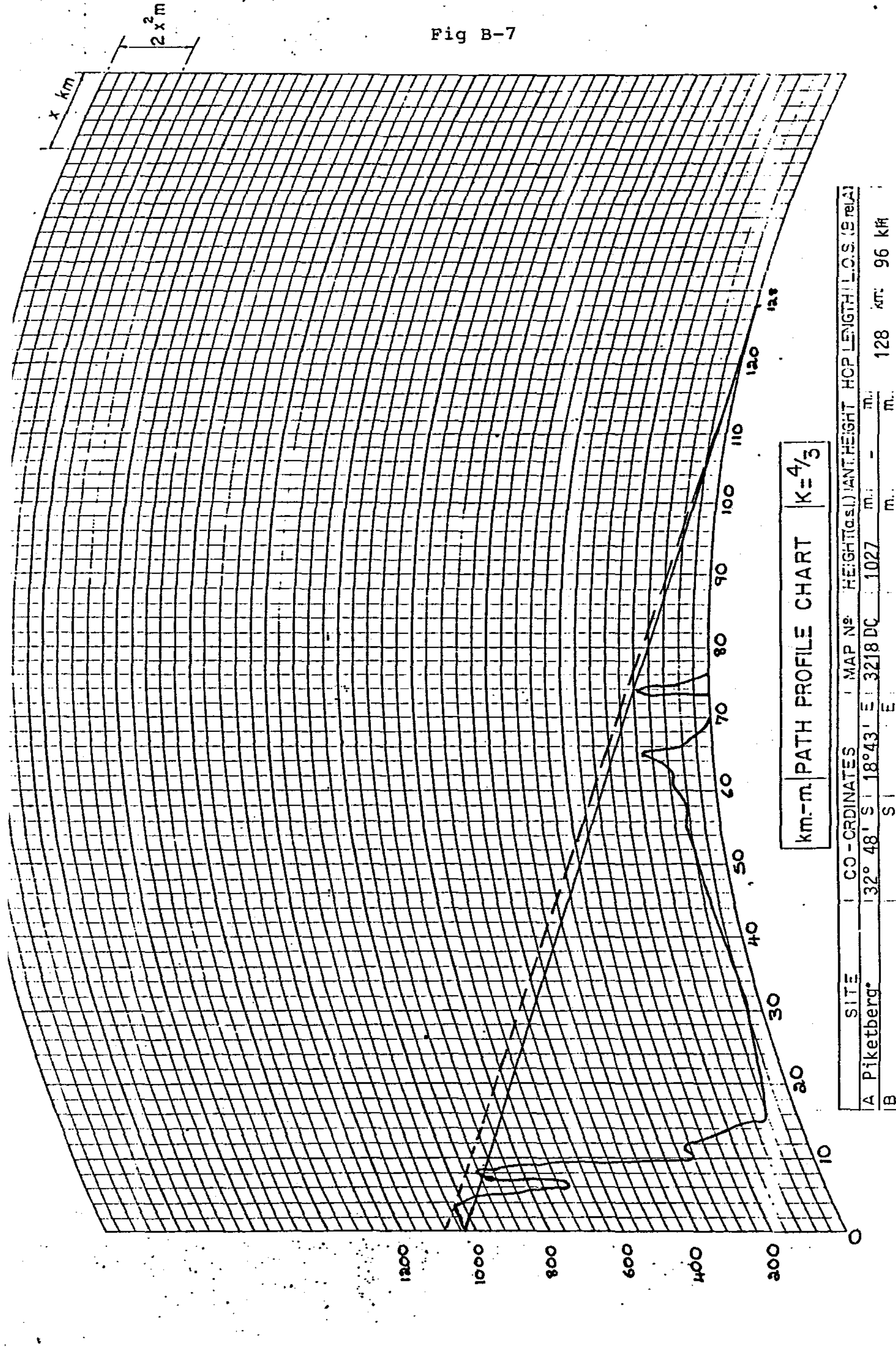
The site is slightly covered to the Northeast, but gives good cover to the Southeast where the coastline is 75km away. Thus this site and Kapteinskop compliment each other.

Coverage at a k-factor of 1,33 will be 128km if a tower with a height of at least 53m is used.

Coverage profile is shown in figure B-7.

From the coverage profile it can be seen that the Postberg mountain (hills) on the western side of the Langebaan lagoon may present a problem if a borehole is sited fairly close to the coast and in line with Postberg. This will only affect a small arc from Piketberg (about 8°) affecting an area of approximately 800 km^2. To cover this area a site on the Postberg nature reserve was also evaluated.

Fig B-7



2 x² m
x km
km.-m.
PATH PROFILE CHART
K=4/3
0
10
20
30
40
50
60
70
80
90
100
110
120
128
200
400
600
800
1000
1200
SITE
CO-ORDINATES
MAP No
HEIGHT (a.s.l.)
ANT. HEIGHT
HOP LENGTH
L.O.S. (B rel A)
A Piketberg*
32° 48' S 18°43' E
3218 DC
1027 m.
- m.
128 km
96 km
B
S
E
m.
m.

8. Konstabelberg

This is a 188m high hill in the Postberg private nature reserve on the small land edge west of the Langebaan Lagoon.

The hill has a flat top suitable for helicopter operations. Once a station has been established, one can drive to a nearby abandoned mine site and walk the remaining 600m or so to service and/or maintain equipment.

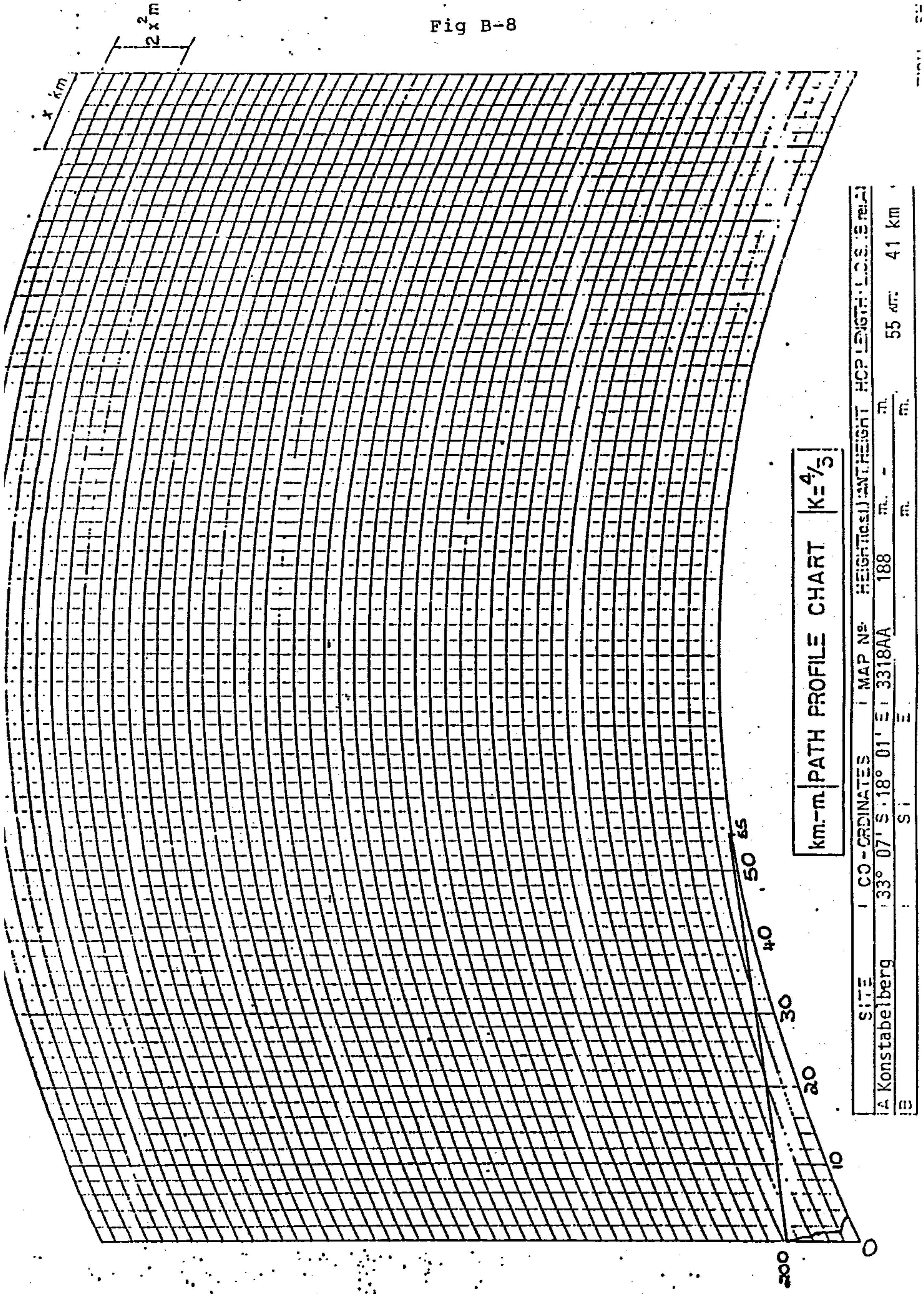
No power or infrastructure exist on the site.

The site receives a solar irradiation of about 700 kJ/cm^2 but is subject to fog. The site is open on all sides, while surrounding meteorological stations report high average wind speeds, thus one can safely assume average wind speed of 4 m/s or more, thus making it a prime wind power site.

Coverage at a k-factor of 1,33 should be 55km, thus 52 offshore.

Coverage profile is shown in figure B-8.

Fig B-8


x km
2 x² m
km-m PATH PROFILE CHART K=4/3
SITE | CO-ORDINATES | MAP No | HEIGHT (a.s.l.) | ANT. HEIGHT | HOP LENGTH | L.O.S.
A Konstabelberg | 33° 07' S 18° 01' E | 3318AA | 188 m | - m | 55 km | 41 km
B | S E | | m | m | |
0
10
20
30
40
50
55
300

9. Constantiaberg

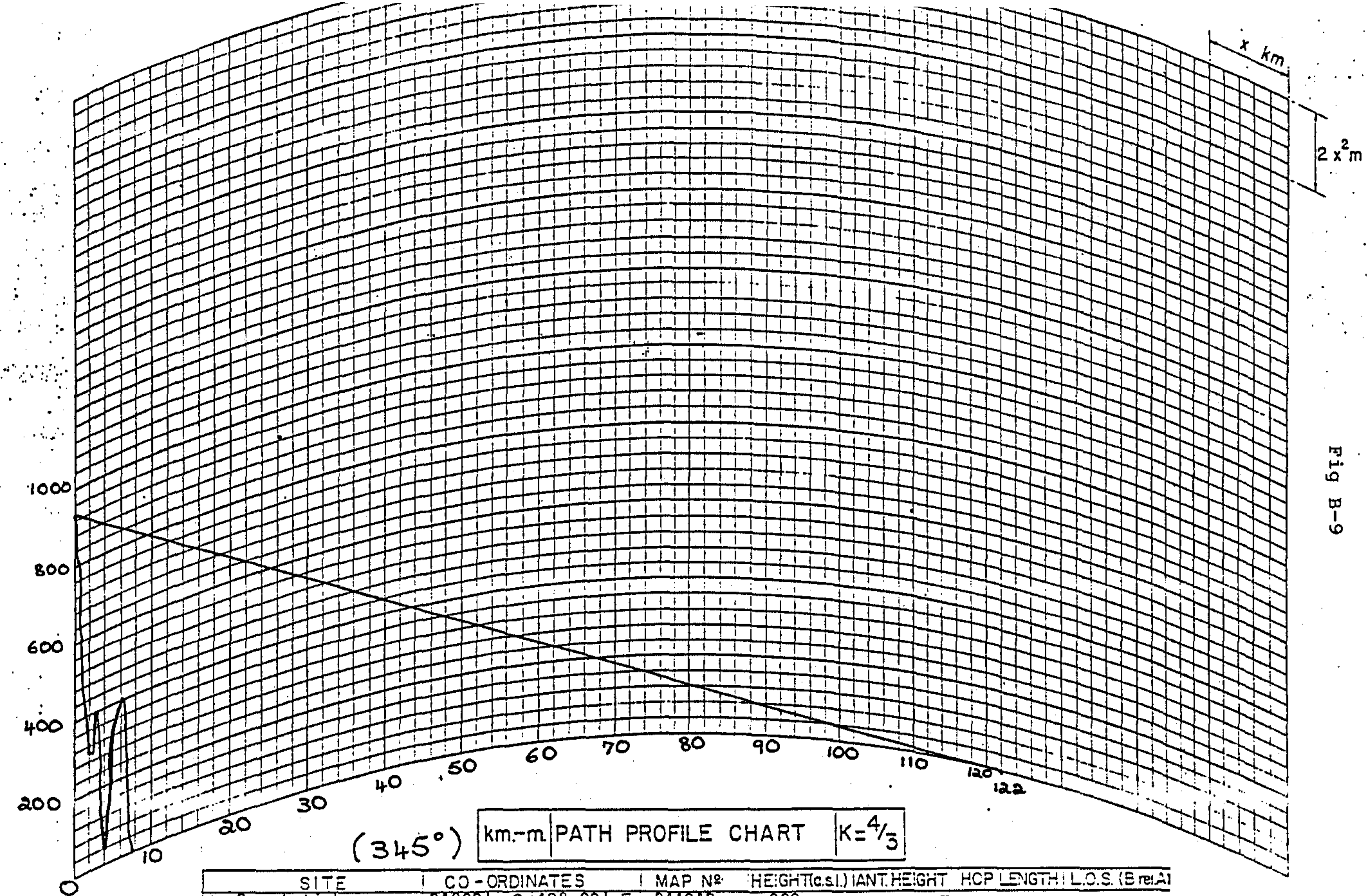
This is a 928m high peak virtually in the centre of the Cape Peninsula.

The site is accessible by excellent road. The site was developed by the SABC and mains power may be obtained from them. The same rates as Nababeep applies (3.1.4.2).

Coverage at a k-factor of 1,33 should be 121km in a 220 degree arc stretching from 125° to 345° true north bearing.

Near the site is a Weather Bureau remote controlled Radar station. This station operates on a frequency of 5,6 Ghz and radio wave reflection from ships is obtained from 160 km away.

Coverage profile is shown in figures B-9, B-10 and B-11(345°,270° and 165°) respectively.

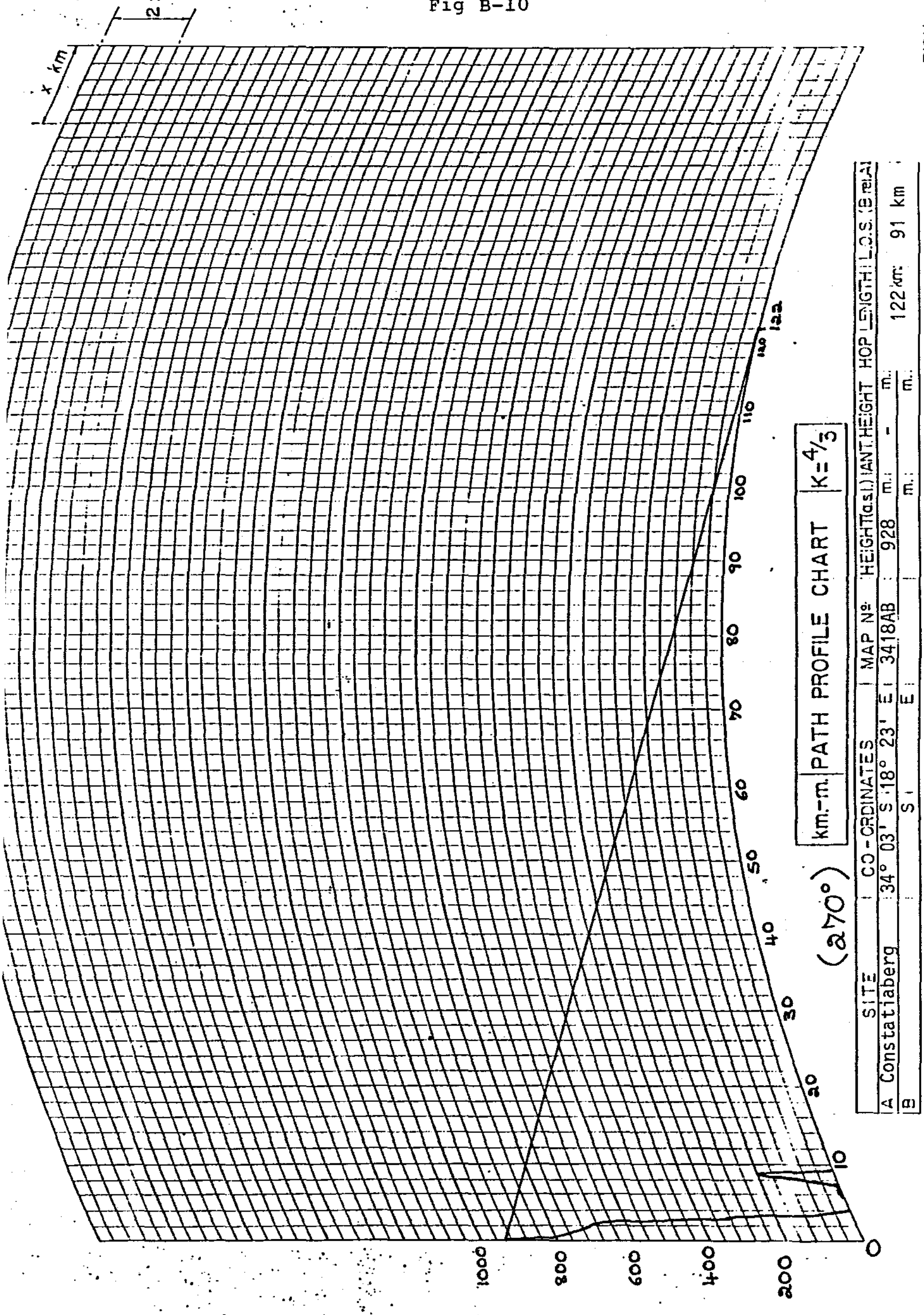


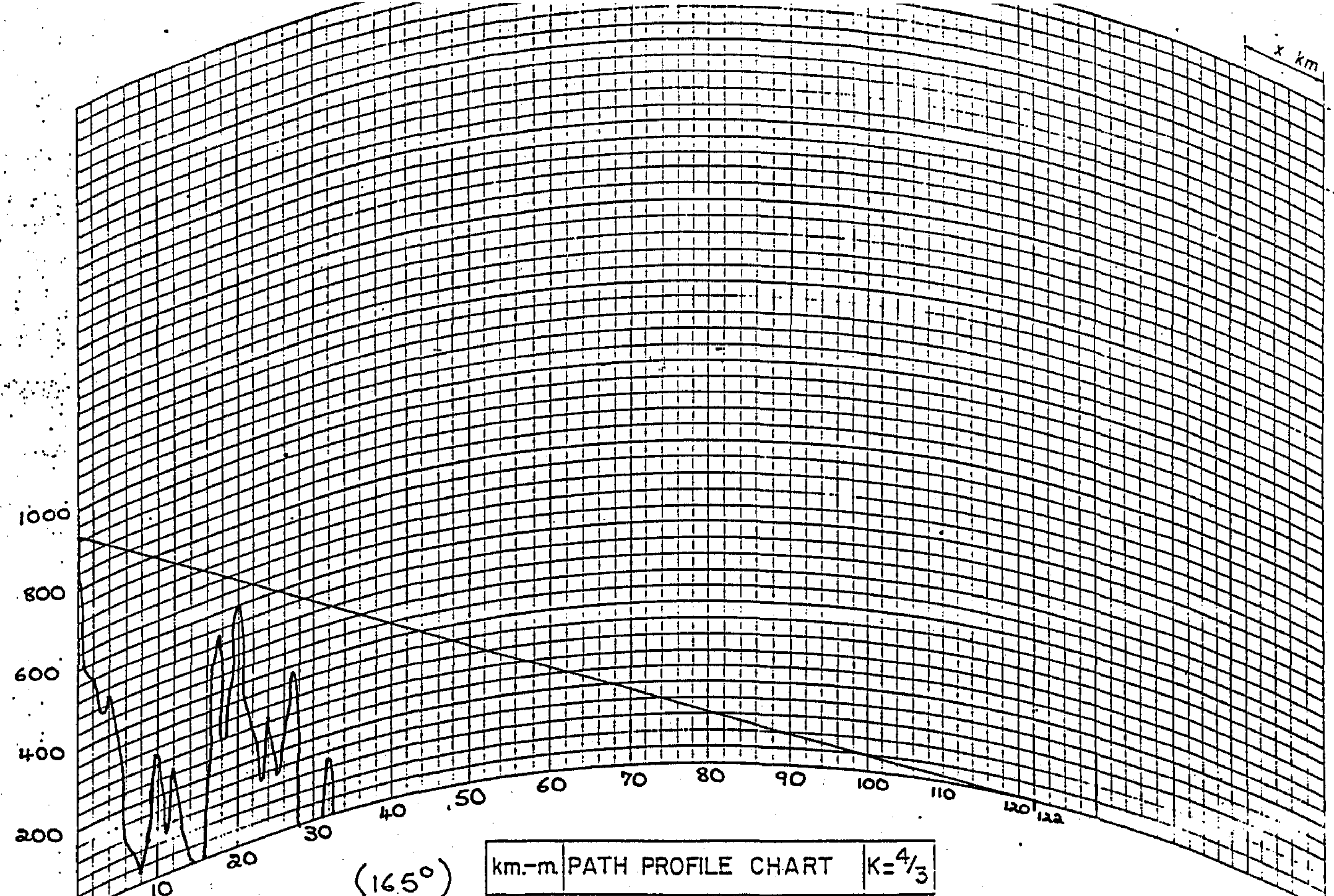
SITE	CO-ORDINATES		MAP No	HEIGHT (a.s.l.)	ANT.HEIGHT	HCP LENGTH	L.O.S. (B rel A)
A Constatiaberg	34°03' S	18° 23' E	3418AB	928 m.	– m.	122 km	91 km
B	S	E		m.	m.		

Fig B-9

T211 SH. 3

Fig B-10


2 x² m
x km
(270°)
km.-m.
PATH PROFILE CHART
K=4/3
SITE
CO-ORDINATES
MAP No
HEIGHT(a.s.l.)
ANT.HEIGHT
HOP LENGTH
L.O.S. (B rel A)
A Constatiaberg
34° 03' S 18° 23' E
3418AB
928 m.
- m.
122 km
91 km
B
S
E
m.
m.
0
10
20
30
40
50
60
70
80
90
100
110
120
122
200
400
600
800
1000



SITE	CO-ORDINATES	MAP Nº	HEIGHT (a.s.l.)	ANT. HEIGHT	HCP LENGTH	L.O.S. (B rel A)
A Constantiaberg	34° 03' S 18° 23' E	3418AB	928 m.	- m.	122 km	91 km
B	S E		m.	m.		

Fig B-11

10. Sneeukop

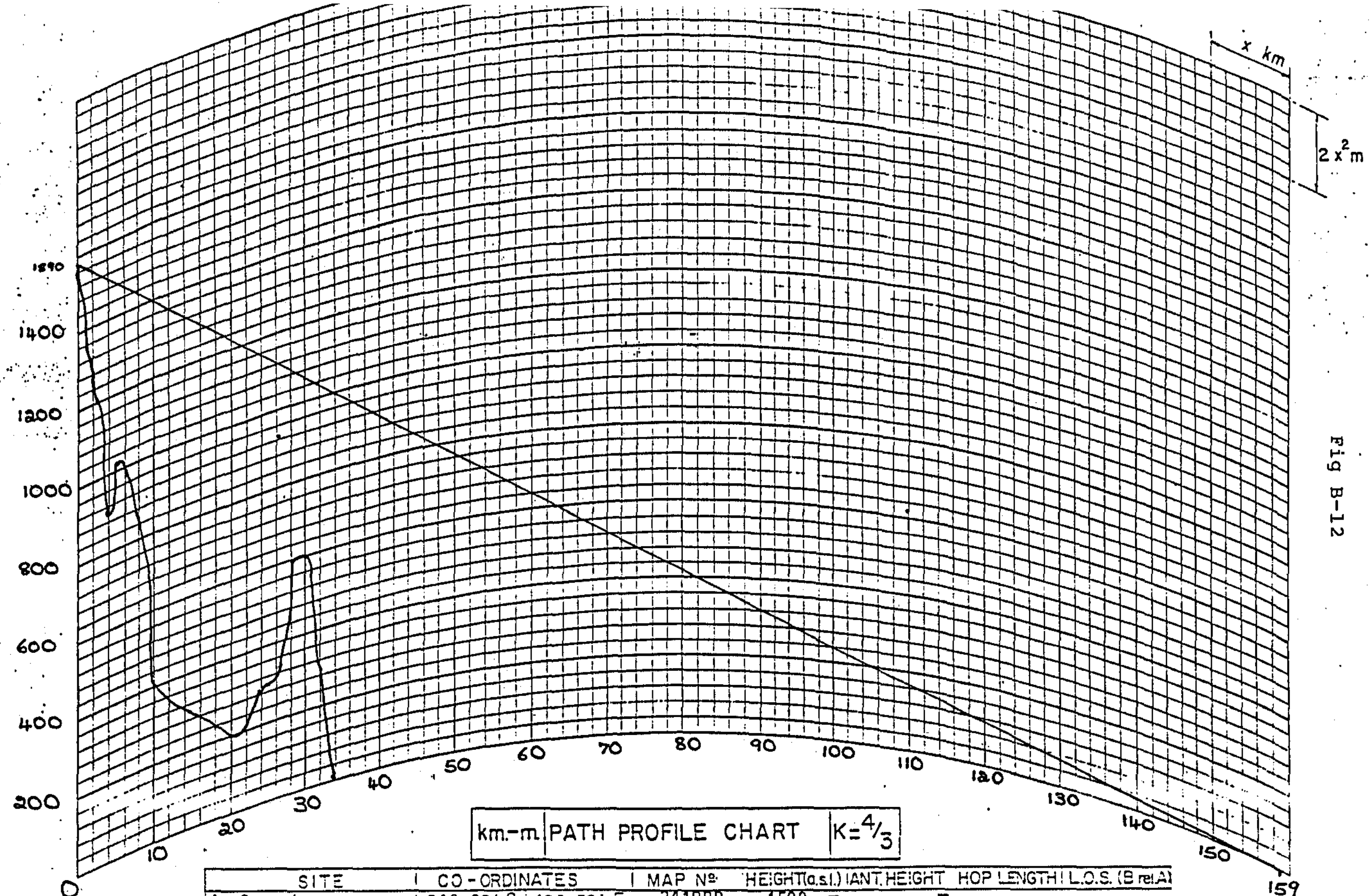
This is a 1590m high peak in the Hottentots Holland mountain range some 34km from the coast at Cape Hangklip.

The site is accessible by good road. The site was originally developed by the P&T for a microwave tower but several other users including ESKOM now occupies the site. ESKOM has indicated that Soekor may use their building, tower and mains power.

The site suffers from severe high winds and snowfalls. Thus only stainless steel antennas will survive.

Coverage from this site at a k-factor of 1,33 will be 159km, thus 125km offshore.

Coverage profile is shown in figure B-12.



SITE	CO-ORDINATES		MAP Nº	HEIGHT(a.s.l.)	ANT. HEIGHT	HOP LENGTH	L.O.S. (B rel A)
A Sneeukop •	34° 02' S	18° 59' E	3418BB	1590 m.	- m.	159 km	120 km
B	S	E		m.	m.		

Fig B-12

T211 SH. 2

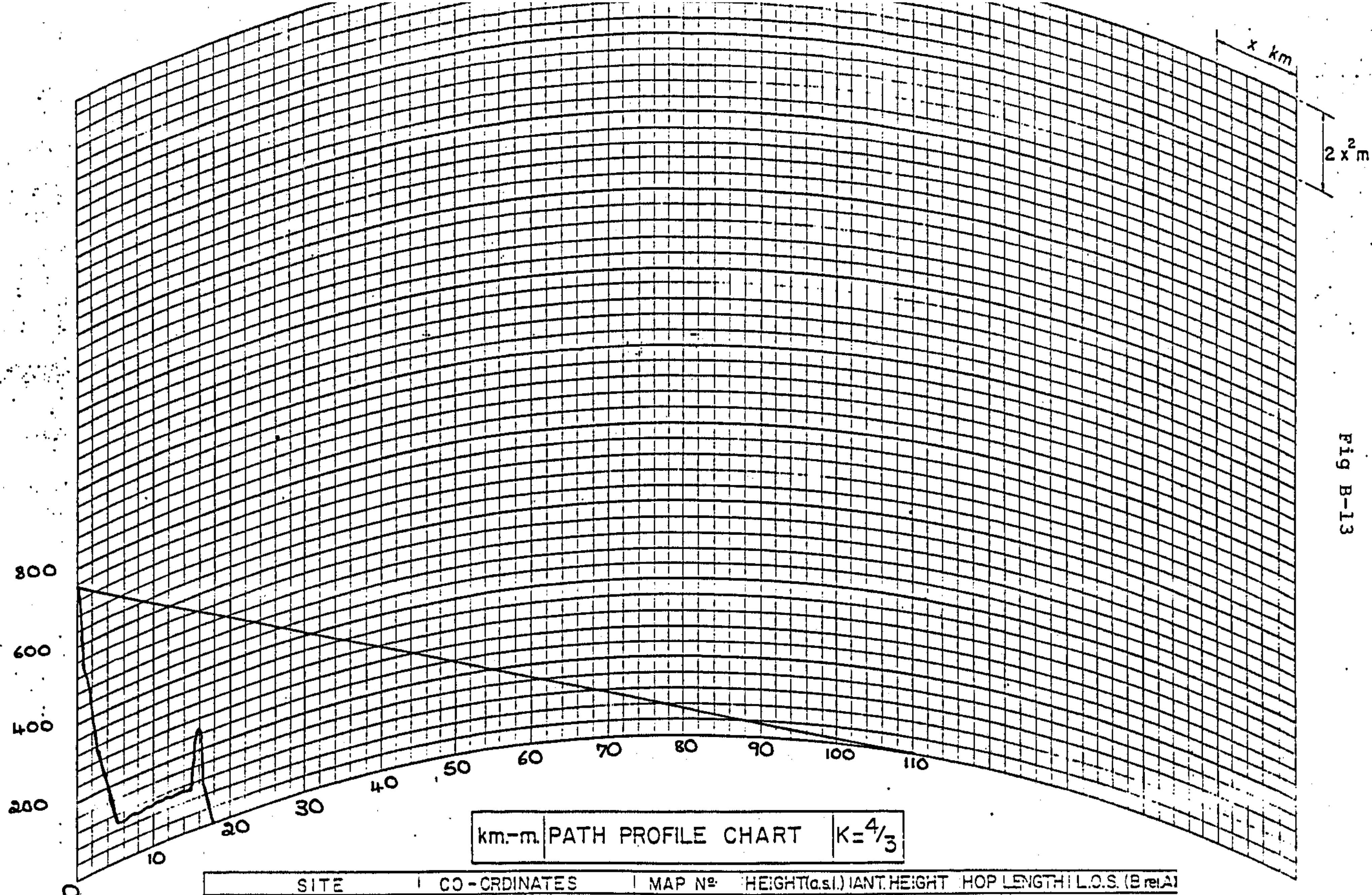
11. Soetmuisberg

This is a 753m high point in the Bredasdorp mountains near the town of Napier some 30km from the coast.

This is a SABC site and accessible by a very good road. Power can be obtained at SABC rates similar to Nababeep and other SABC sites.

Coverage from this site at a k-factor of 1,33 will be 110km, thus 80km offshore.

Coverage profile is shown in figure B-13



SITE	CO-ORDINATES		MAP Nº	HEIGHT(a.s.l.)	ANT. HEIGHT	HOP LENGTH	L.O.S. (B rel A)
A Soetmuisberg	34° 32' S	19° 54' E	3419BD	753 m.	- m.	110 km	82 km
B	S	E		m.	m.		

Fig B-13

12. Grootberg

This is a 1637m high peak in the Boesmansbos Wilderness area near Heidelberg some 50km from the coastline.

The site can only be reached by helicopter in good weather. The top of the peak is small and rocky.

No mains power exist. The average solar irradiation is 600 kJ/cm^2. The peak is subject to very high winds. Thus it is suitable for wind power, but a type of windcharger must be used that can withstand severe windstorms.

No infrastructure of any kind exist on the peak. The reserve is under control by the Dept. of Nature Conservation of the Cape Provincial Administration.

At a k-factor of 1,33 the coverage will be 162km, thus 112km offshore.

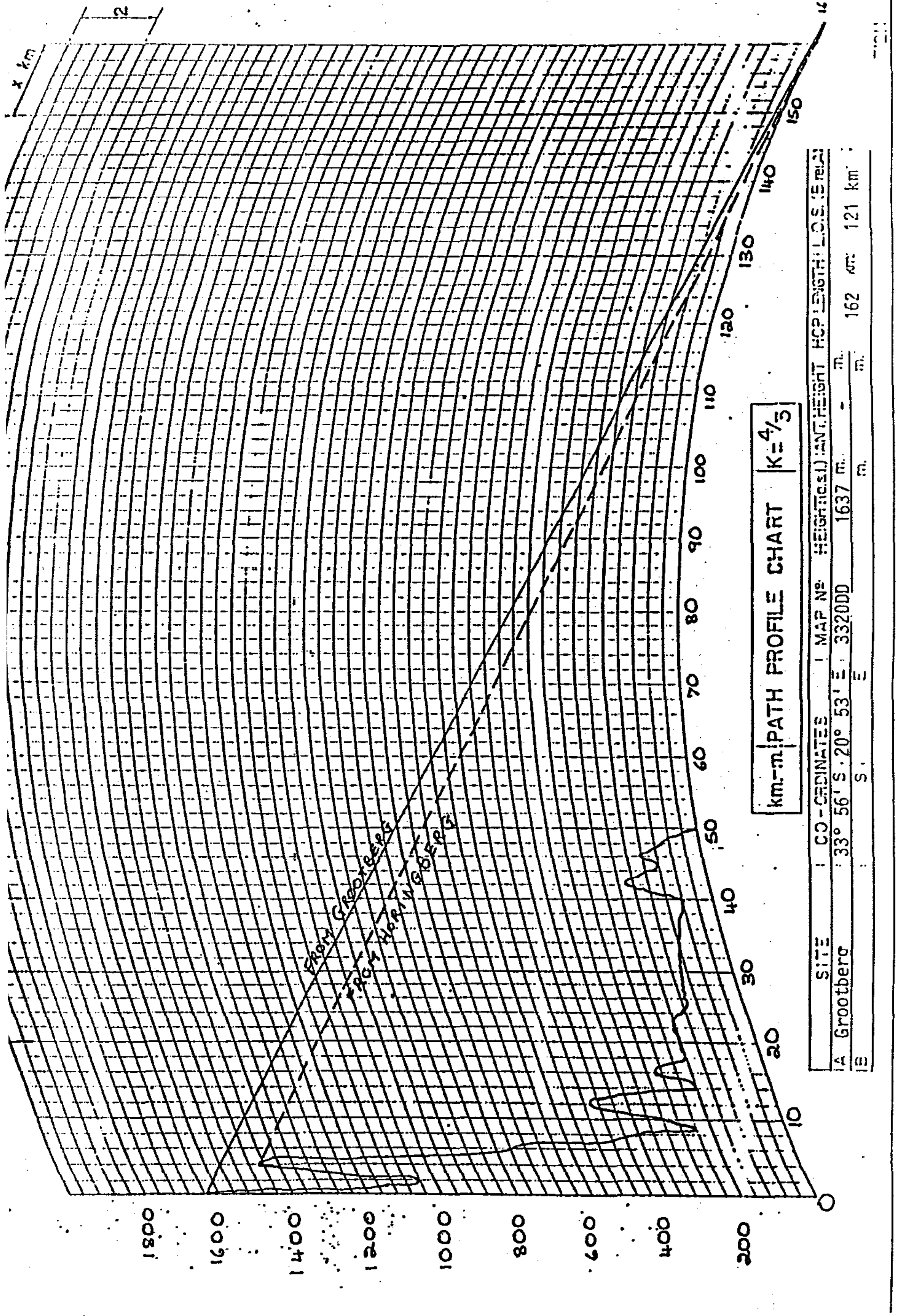
Coverage profile is shown in fig. B-14

A lower peak called Horingberg exist 4km seawards from Grootberg. This peak offers a small plateau, thus is far more suitable for helicopter operations.

This peak at an elevation of 1450m only offers 152km coverage. (106km offshore).

Coverage profile of this lower peak is shown as a broken line in figure B-14.

Fig B-14



PATH PROFILE CHART
km-m
K= 4/3
FROM GROOTBERG
FROM HORINGBERG
x km
2 x m
SITE
CO-ORDINATES
MAP No
HEIGHT (a.s.l.)
ANT. HEIGHT
HOP LENGTH
L.O.S.
A Grootberg
33° 56' S 20° 53' E
3320DD
1637 m.
- m.
162 km
121 km
B
S
E
m.
m.
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
163
200
400
600
800
1000
1200
1400
1600
1800

13. Riversdale

This is a high point in the Amandelbosberg about 23km north-west of the town of Riversdale and 40km from the coastline.

The 600m high hill is a SABC site also occupied by ESKOM and reached by a good road.

Power is available from the SABC at R600 p.a. while site rental is R100 p.a.

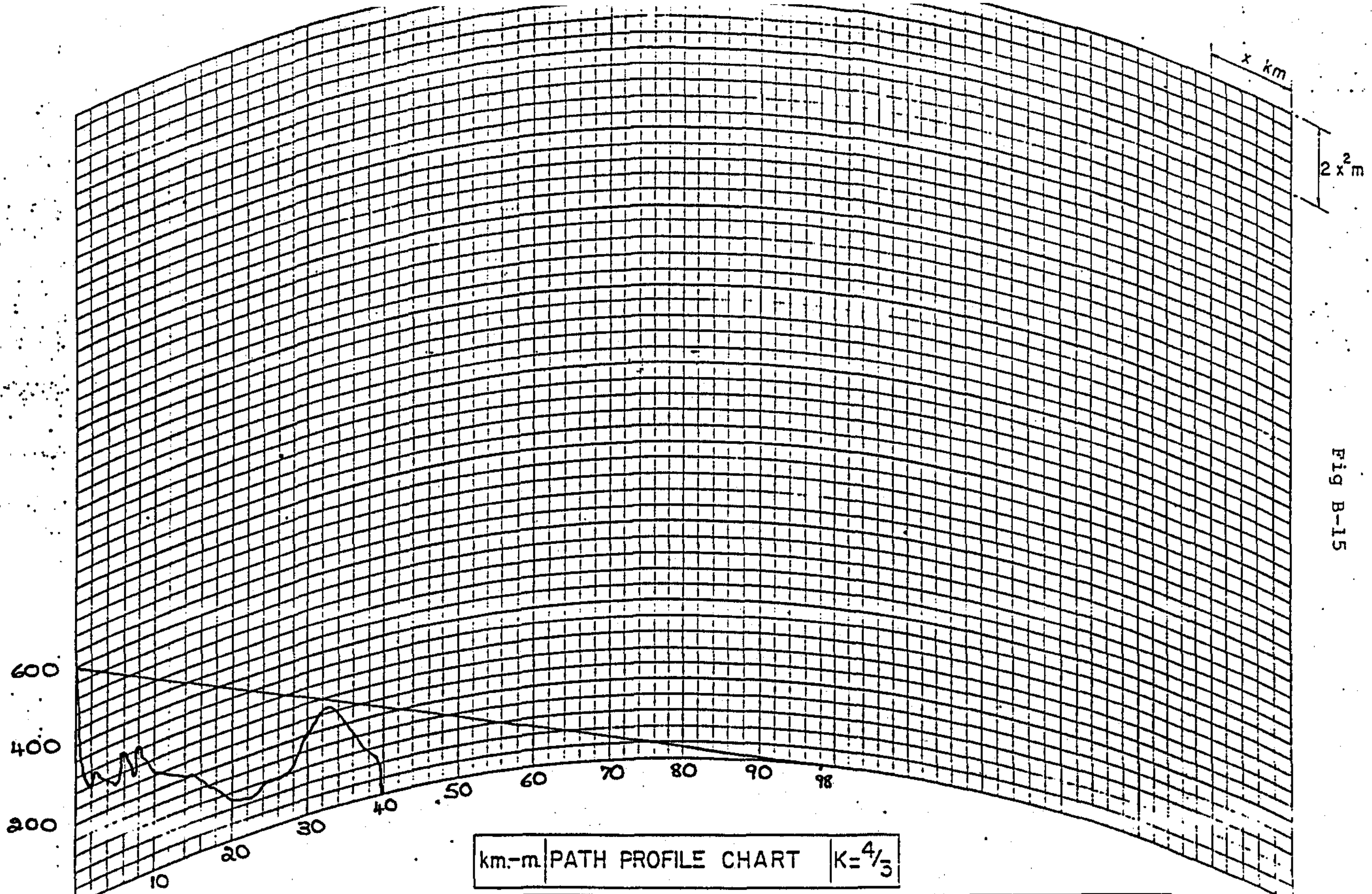
Users must erect their own building. We have found that a proper building is a must, because glassfibre or similar enclosures is subject to severe condensation and, subsequently, equipment in such enclosures suffers from all sorts of malfunctions due to moisture.

The site is also subject to fairly high winds, thus doors, etc. on such buildings must be of good quality.

The site offers a clear take-off towards the sea and at a k-factor of 1,33 coverage of 98km should be obtained (58km offshore).

We have found that practical coverage at 150 Mhz extends to 110km while reasonable communication is possible most of the time at ranges of up to 150km.

Coverage profile is shown in figure B-15.



SITE	CO-ORDINATES		MAP Nº	HEIGHT(a.s.l.)	ANT.HEIGHT	HOP LENGTH	L.O.S. (B rel A)
A Riversdale	34° 01' S	21° 08' E	3421AA	600 m.	- m.	98 km	74 km
B	S	E		m.	m.		

Fig B-15

14. Engelseberg

This is a 1521m high peak in the Jonkersberg nature reserve north of Groot Brakrivier and 23km from the coastline.

This peak is most interesting as it is virtually on the 22° latitude and thus in line with a very active oil exploration area.

The peak offers a flat plateau suitable for helicopter operations. It is possible to leave or approach the site on foot without resorting to mountain climbing by following a forestry firebreak. This offers a good "escape route" for maintenance personnel if evacuation by helicopter becomes impossible due to rapid weather deterioration.

The peak is situated near Mosselbay and George from where Soekor conducts helicopter operations at present.

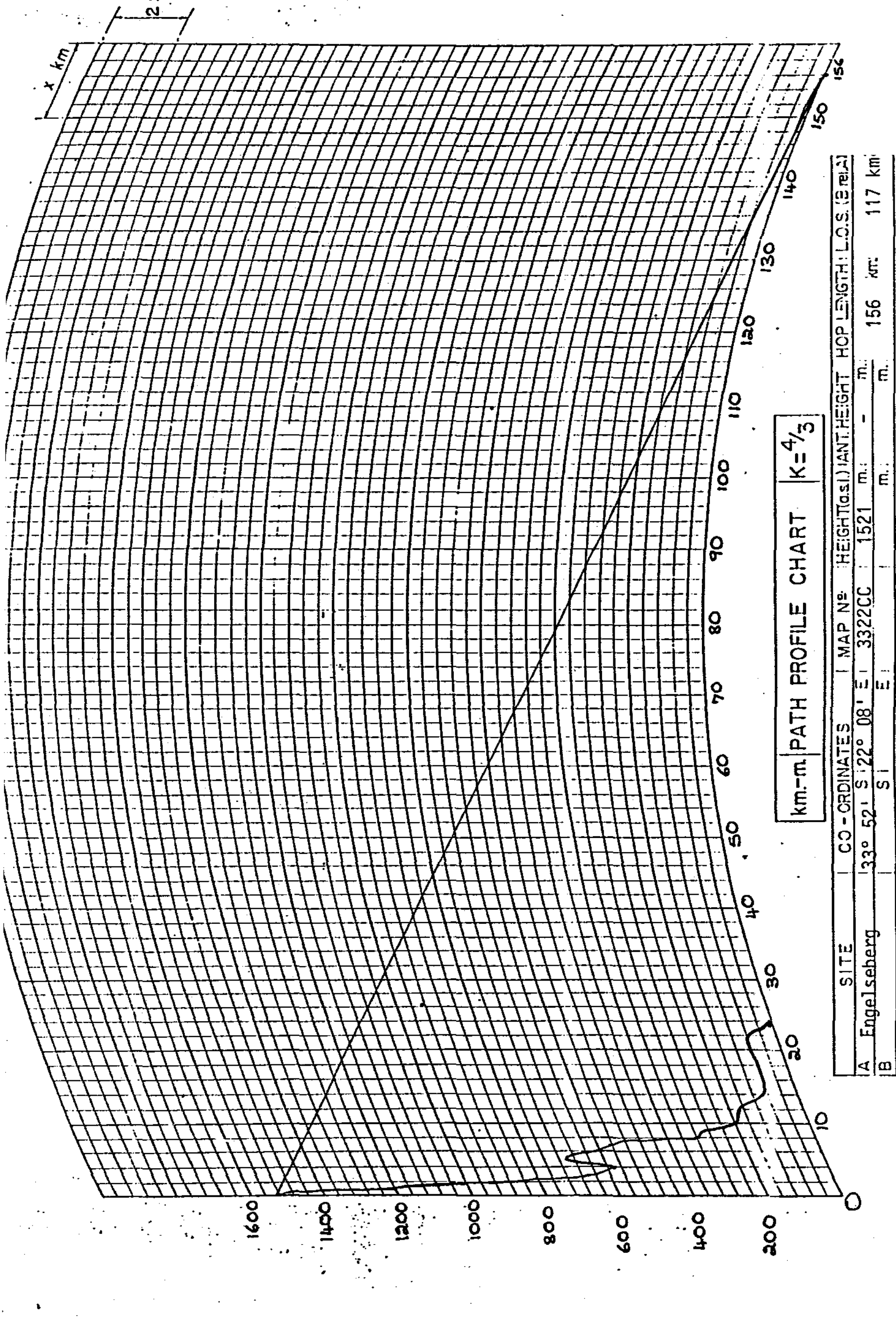
Solar irradiation is 600 kJ/cm^2 and the forestry personnel indicate that there is always some wind present on the site. However, there are many days that the peak is covered in cloud.

Coverage at a k-factor of 1,33 will be 156km, thus about 133km out to sea.

The site is above the snow line and at times above the altitude that hail is formed. This may result that at times the signals are ducted above the inversion layer, while the signals from the landward base station and the drill's at sea are trapped below the temperature difference layer. (It may not be a serious problem for the nearby base station, but may seriously affect the drill weaker signal.)

Coverage profile is shown in fig. B-16.

Fig B-16


x km
2x² m
km-m.
PATH PROFILE CHART
K=4/3
SITE
CO-ORDINATES
MAP No
HEIGHT(a.s.l.)
ANT.HEIGHT
HOP LENGTH
L.O.S.(B rel.A)
A Engelseberg
33° 52' S 22° 08' E
3322CC
1521 m.
- m.
156 km
117 km
B
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
156
200
400
600
800
1000
1200
1400
1600

15. George

This is a 576m high point on the foothills of the George peak in the Outenikwa mountain range just outside the town of George and some 10km from the coast.

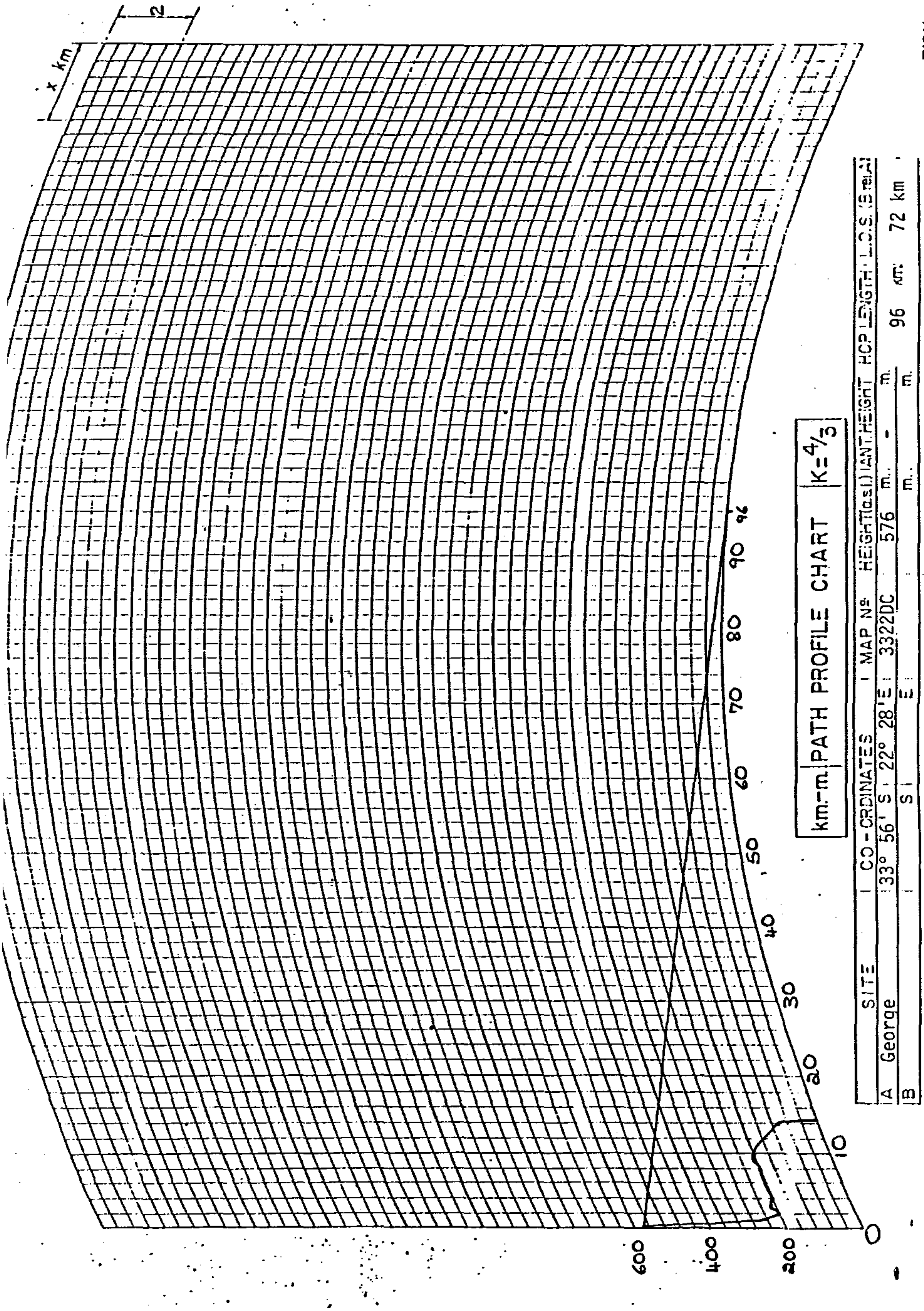
This was the original site used for the first system as designed by Mr. van Niekerk and as such Soekor has good infrastructure on the site as well as a number of year's experience of operation from this location. The site is SABC property and also used by ESKOM, Forestry, SA Radio League (Amateurs) and a number of private users. Access is by a good road, and it is even possible to walk there from a nearby railway stop (Power siding is 600m away).

The site offers a clear take-off over a wide angle, as well as giving coverage of the P.W. Botha airport, Mosselbay landing field, Soekor office and stores in Mosselbay as well as most roads in between.

Coverage at a k-factor of 1,33 should be 96km. (86km offshore). Experience has shown that reasonable communication can be obtained most of the time up to 150km away.

Coverage profile is shown in fig. B-17.

Fig B-17


x km
$2x^2$m
km.-m.
PATH PROFILE CHART
K=4/3
SITE
CO-ORDINATES
MAP Nº
HEIGHT(a.s.l.)
ANT.HEIGHT
HOP LENGTH
L.O.S.
A George 33° 56' S 22° 28' E 3322DC 576 m. - m. 96 km 72 km
B S E m. m.
0
10
20
30
40
50
60
70
80
90
96
200
400
600

16. Langkloof

This is the highest peak in the Langkloofberge, part of the Outenikwa range some 22km from the coastline.

The actual peak is unnamed and 2,5km seaward of the one known as Niekerksberg, a prominent landmark in the middel-Langkloof area.

The peak is 1618m high and it's trigonometric beacon makes out one corner marker of the Keurboomsrivier state forest.

The peak can only be reached by helicopter and no infrastructure of any kind exist.

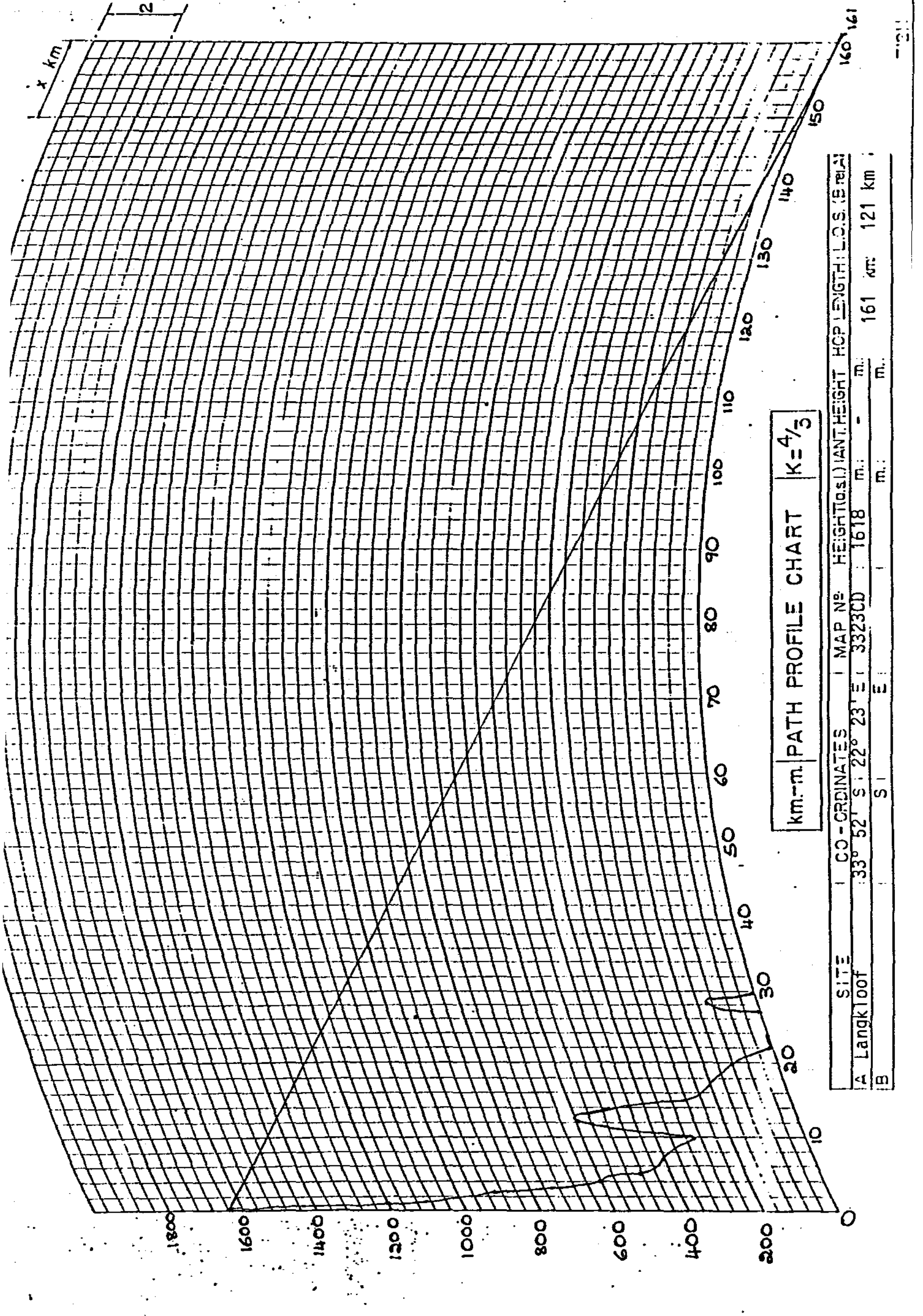
The site is suitable for wind energy as prime power and also receives and average solar irradiation of 600kJ/cm^2.

This site may suffer from the same problems as Engelseberg, namely; snow, high wind and temperature inversion problems.

Coverage from the site at a k-factor of 1,33 will be 161km, thus about 139km offshore.

Coverage profile is shown in fig. B-18.

Fig B-18


x km
2 x² m
km-m
PATH PROFILE CHART
K=4/3
SITE
CO-ORDINATES
MAP No
HEIGHT(a.s.l.)
ANT. HEIGHT
HCP LENGTH
L.O.S.
A Langkloof
33° 52' S 22° 23' E
3323CD
1618 m
- m
161 km
121 km
B
S
E
m
m
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
161
200
400
600
800
1000
1200
1400
1600
1800

17. Cockscomb

This is a 1758m high peak in the Groot-Winterhoek mountains about 88km northwest of Port Elizabeth and approximately 65km from the coastline.

Unfortunately it is not possible to reach the peak by road, but only up to 1350m elevation. No infrastructure exists.

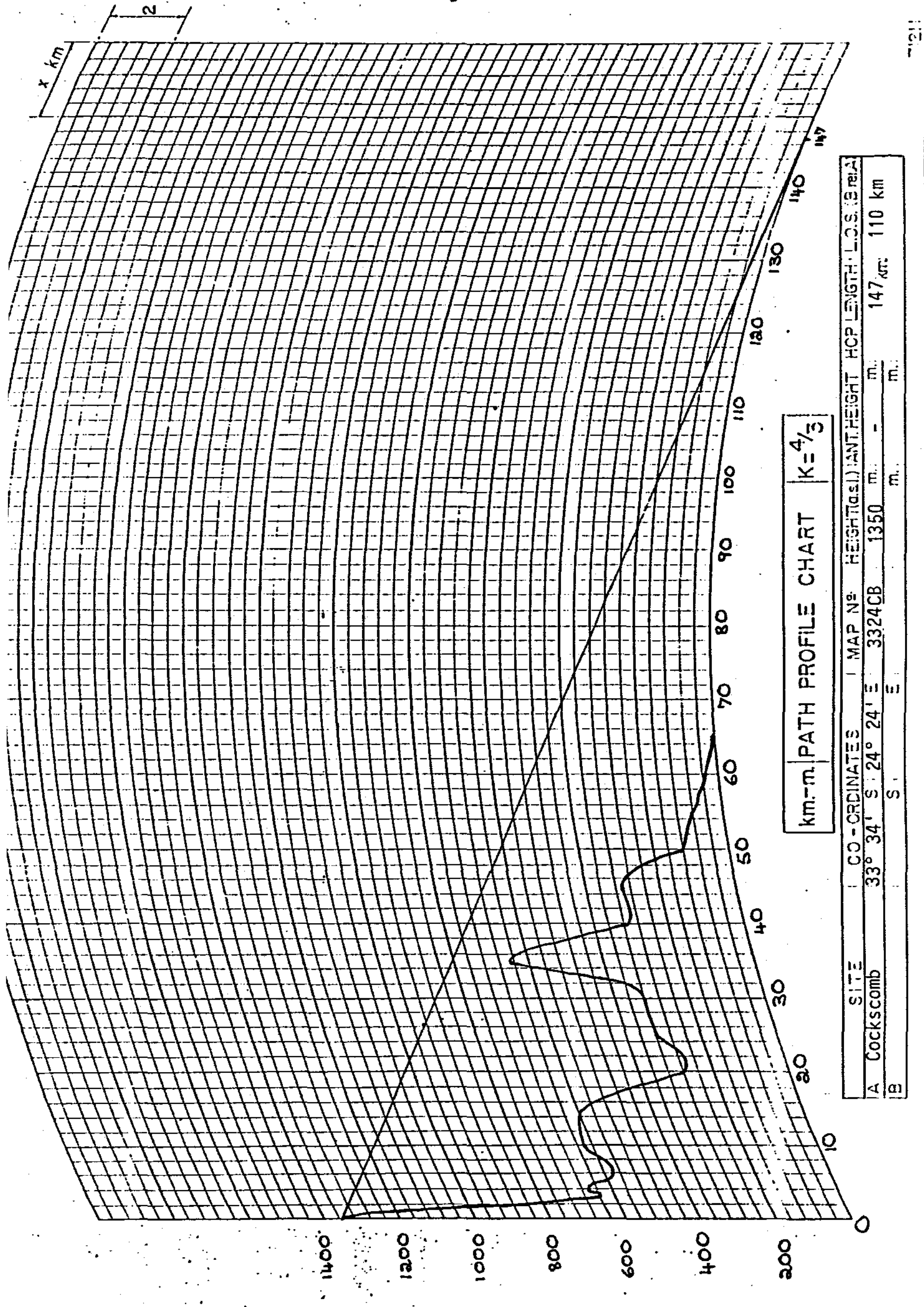
Solar irradiation is 600 KJ/cm^2.

Several private repeaters as well as two S.A. Radio League (Amateur) repeaters are in operation from this mountain. One of the amateur repeaters (on 145Mhz) gives coverage to mobile stations up to Graaf Reinet, nearly 150km away.

At a k-factor of 1,33 the seawards coverage will be 147km, thus just over 80km offshore.

Coverage profile is shown in figure B-19.

Fig B-19


x km
$2x^2$ m
PATH PROFILE CHART
km.-m.
K = 4/3
SITE | CO-ORDINATES | MAP Nº | HEIGHT(a.s.l.) | ANT.HEIGHT | HOP LENGTH | L.O.S. (B rel A)
A Cockscomb | 33° 34' S 24° 24' E | 3324CB | 1350 m. | - m. | 147 km | 110 km
B | S E | | m. | m. | |
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
147
1400
1200
1000
800
600
400
200

ANNEXURE C

OFFSHORE HF RADIO EQUIPMENT

"SAILOR"
SHORT WAVE PROGRAMME 1000/B

1250 Watt PEP (or 400 Watt PEP)
Multi-Purpose Station with Aerial Coupler
Full Automatic Radiotelex Station.

"SAILOR" SHORT WAVE PROGRAMME 1000/B

S. P. RADIO A/S · AALBORG · DENMARK

\ITRODUCTION

he SAILOR short wave programme 1000/B has been degned and produced by one of urope's leading manufacturers f maritime radio communication quipment.

he SAILOR short wave programme 1000/B complies with all iternational specifications such s CEPT, MPT 1224 (UK), R.S.S. 81 (Canada) and R.B. 211D (Autralia). All units, except the 1135, also comply with F.C.C. JSA).

FEATURES

- High transmitter output, 400 or 1250 Watt PEP, automatic aerial coupler and professional receiver design ensure maximum range and penetration under all conditions.
- Full duplex as standard.
- Automatic radiotelex - even with one aerial.
- Unique receiver design enables the station to be operated without blocking calls on radiotelex.
- Rack system ensures flexibility and ease of servicing.
- Professional, mechanical construction. Nylon-coated cabinet and front panel. All controls in mirror-finish, chromium plated brass or impact-proof plastic. Aerial coupler in mirror-finish, acid-proof, stainless steel. Insulator in teflon.
- Very compact construction of station and aerial coupler.
- Simple to install, aerial switch and dummy aerial as integral parts of the equipment.

EXCITERS

S1303

Frequency range:
1.6 - 8.5 MHz plus the maritime HF bands 12 - 16 - 22 and 25 MHz. Continuous 1.6-28 MHz as option.

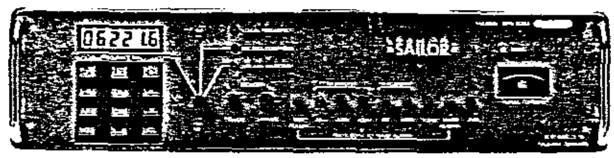
Transmission modes:
(speech, telegraphy, telex), A3J, A3A, A3H, F1, A1 and A2A. Optional switching between USB and LSB. Independent sidebands as option.

Frequency stability:
0° C - 40° C, less than ±25 Hz.

Long term stability:
Less than ±25 Hz.

Short term stability:
Less than ±2 Hz.

Remote control from automatic telex equipment possible.



S1303

S1304

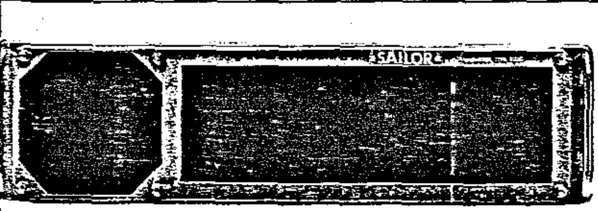
The S1304 has the same data as the S1303 except that the frequency selection is limited to a maximum of 256 programmed frequencies.

he SAILOR Programme 1000/B Consists of the ollowing Units:

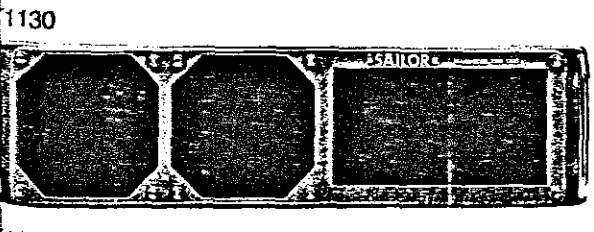
RANSMITTERS

he T1130 and the T1135
re both fully transistorized. Frequency range and transmission nodes as for exciter.
oad impedance: 50 ohm.

Transmitter	Output: AC supply	DC supply
T1130	500 W PEP $^{+\,0}_{-1.4}$ dB	500 W PEP $^{+\,0}_{-1.4}$ dB
T1135	1250 W PEP $^{+\,0}_{-1.4}$ dB	1000 W PEP $^{+\,0}_{-1.4}$ dB



1130



1135

AERIAL COUPLERS

AT1500

is used in connection with the T1130. Automatic tuning time is typically less than 5 seconds.

Aerial length: 5 - 16 metres.

Maximum output: 600 W PEP or 300 W RMS. (An automatic regulating system in the S1303/4 ensures that these values are not exceeded).

All connections are by means of a specially developed multiple plug in the base of the aerial coupler. (16×0.5 multi-cable + 50 ohm coaxial cable).

When installing, the aerial coupler need not be opened.

No tuning or pre-adjusting of the aerial coupler necessary.

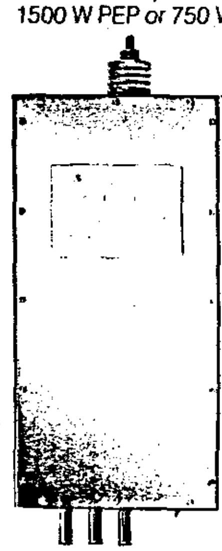
The aerial coupler is to be installed outdoors.

AT1505

is used with the T1135 and has the same data as the AT1500 except:

Aerial length: 9-16 metres.

Maximum output:
1500 W PEP or 750 W RMS.



AT1500

NTRODUCTION

oday all ships have a growing eed for communication. Error-ee telex via the SSB HF radio-lephone can close the com-unication gap where a printed essage is required.

elex connection with other hips as well as with any telex ubscriber in the world through e international telex network is ossible today with the SAILOR adiotelex system and the SAI-OR short wave programme.

he new technology has made possible to produce an ad-anced microprocessor control-d radiotelex modem which is e most economical telex com-unication system of today.

ll over the world, coast radio tations are being improved and utomatized so that they will ontinue to be able to meet the rowing demand for radiotelex ommunication.

GENERAL

he SAILOR radiotelex system as automatic error correction n telex transmission with 50 or 00 Baud speed in the maritime nd point-to-point applications.

he SAILOR radiotelex system rovides unattended trans-mission and reception of telex messages between the ship and he public telex network via a oast station - 24 hours a day.

he SAILOR radiotelex system as a screen-oriented text editor ith a 256 kbyte text memory, or easy operation, full soft-key ommands of all editing and sys-em commands are included.

System Operation

he SAILOR radiotelex system is apable of telex communication several error-correcting odes. When sending a telex, e operator selects the mode. hen receiving a telex, the sys-em automatically detects the ode of the incoming telex.

ARQ Operation

he ARQ-mode (Automatic Re-ansmission Request) is only orkable between two stations t a time, and provides private ommunication with some limit-d protection.

n ARQ-mode the two stations ommunicate direct with one nother. The information-send-g station transmits the data blocks of three characters. etween the blocks of charac-ers, the sending station waits for reply of a single character from e information-receiving station, indicating that the block has been well received, and the next block can be sent. If an error occurs, the receiving station requests a repetition. In ARQ-mode the direction of information can be changed.

FEC Operation

FEC-mode (Forward Error Correction) is used where a message from one information-sending station is to be received by more than one receiving station. In FEC-mode the message is sent in time diversity, which means that it is sent twice at intervals of a fraction of a second.

The receiving station thus has two chances to receive each character correctly. If both characters are mutilated a star is printed.

SEL/FEC-mode (Selective Forward Error Correction) allows selective calling of one or more stations. The message is transmitted in inverted format. Only the receiving station with the correct call code will receive the information.

SAILOR RADIOTELEX SYSTEM

The SAILOR radiotelex system consists of the following units.

Radiotelex Modem ARQ H1240

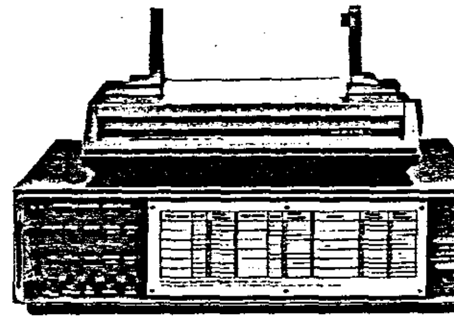
The SAILOR ARQ H1240 is designed for reliable service in demanding applications, providing a broad range of operating features and for simple but efficient control.

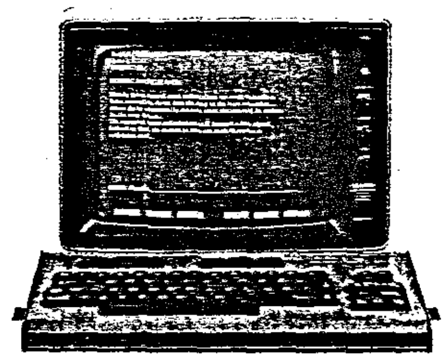
All operational controls can be carried out from the keyboard by easy-to-use commands.

The intelligence provided by the H1240 radiotelex modem enables fully automatic control of the complete radio station: Start the transmitter, tune it, establish the connection and transmit and/or receive messages. It can even control the scanning receiver searching for incoming calls, set-up the transmitter frequency (Programme 1000/B only), and handle the traffic without any operator intervention.

All H1240 radiotelex modems have storage capacity for 105 user programmed frequency pairs and call codes.

The built-in 256 kbyte character comprehensive text editor adds powerful dimensions to telex handling and becomes familiar to any user with a minimum of training. A large number of different messages can be stored in





the text memory for later transmission (separately or in groups).

The H1240 radiotelex modem supports a number of automatic modes, including unprotected/protected mode, public/secret save mode, operator programmable group command mode, and scan mode with automatic calls controlled by the reception of "FREE" signals. Software controlled channel quality evaluation and frequency tracking ensures optimum selection of frequency channels.

The H1240 radiotelex modem operates with standard 50 Baud transmission speed (100 Baud on radio side). As option H1240 can operate with dual speed twinplex modulation resulting in 100 Baud transmission (also 100 Baud on radio side).

Keyboard Processor H1249

The SAILOR H1249 keyboard processor includes full soft-key operation of system and editing commands for easy operation. Screen-oriented text editing facilities with 9600 Baud console transfer speed for fast file editing/display, file manipulation, and communication control.

Printer H1252

SAILOR H1252 hard-copy printer for multi-copying of communication message and file listening. Up to four different printers may be connected to the T-BUS system for dedicated printing of information.

Video Monitor H1253

SAILOR H1253 video monitor is for use with keyboard processor H1249.

FEATURES

- Error-correcting modem meeting CCIR Rec. 476-3 and the new 625 with 9-digit call codes and identification exchange.
- Unattended transmission and reception of telex messages - 24 hours a day.
- Full communications privacy using built-in high securi' on-line/off-line telex cipher.
- Automatic control of communication equipment with "FREE" signal scanning and automatic power-up of transmitter.
- Automatic channel quality evaluation and frequency tracking for optimum channel selection.
- Print spooler for message printing while other tasks are performed on the modem.
- Simple operation by use of soft-keys.
- Full screen-oriented word processing with 256 kbyte solid-state memory and message management.
- Standard- and double speed (100 Baud) operation with frequency- and space diversity.
- Storage capacity for 105 user programmable frequency pairs and call codes.
- IBM-PC/XT communications software.

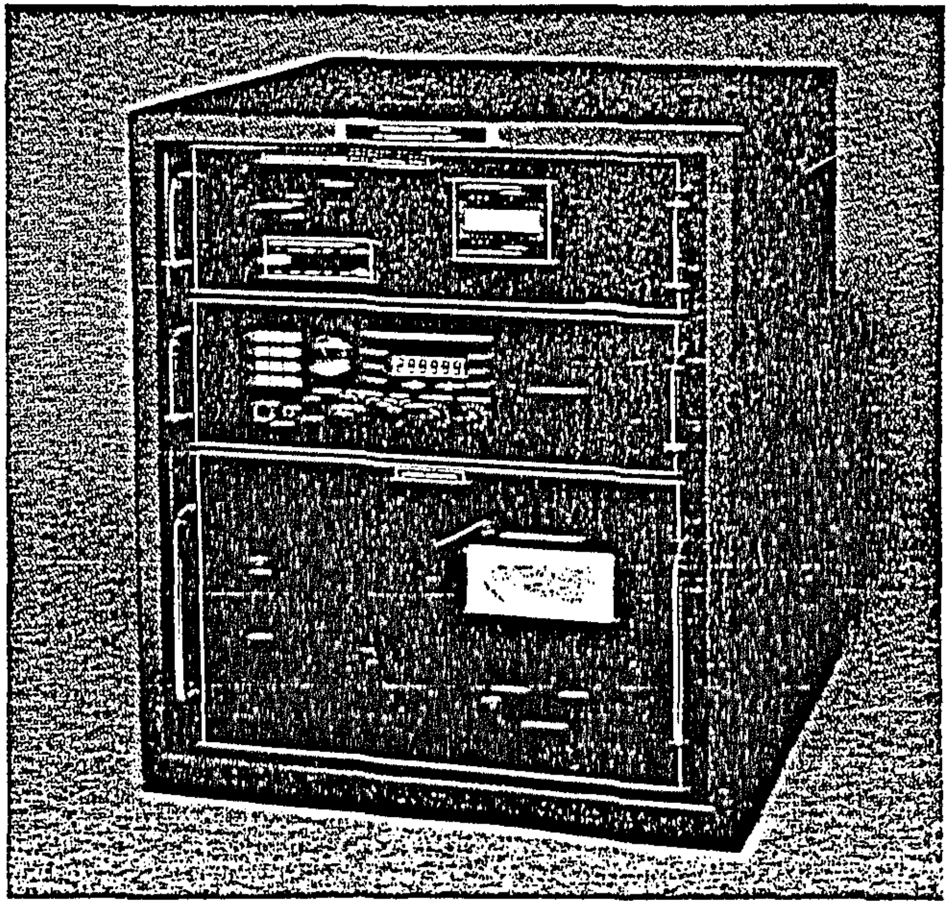
ANNEXURE D

RADIO EQUIPMENT INSTALLED AT SOEKOR HQ

TW1100 SYSTEM

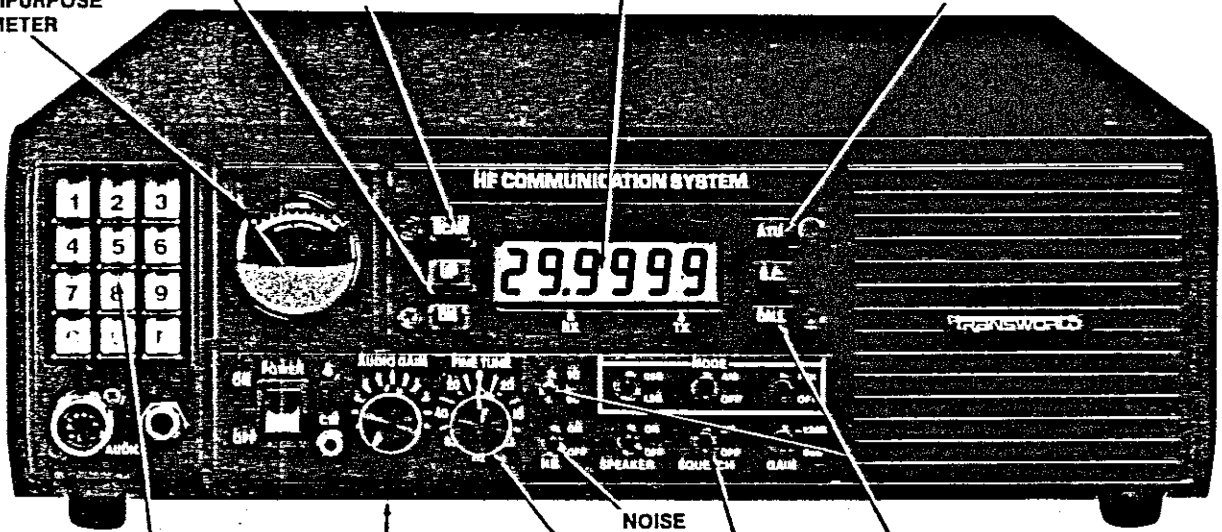
- 500W PEP

This is a compact economical system for voice operation. Consists of the TW100 Transceiver and TW500A amplifier with internal 115V/230V AC power supplies, mounted in a 19" rack cabinet. May also be specified as separate units for table mounting.



TW1100 System

TRANSWORLD™ for communications



The TRANSWORLD TW100 is an advanced synthesized HF transceiver covering the entire HF frequency range from 1.6 to 30MHz. The TW100 provides voice operation in the single sideband mode, radioteletype with the optional modem, and telegraphy. The transceiver is controlled by a microprocessor which provides the ultimate in operating flexibility with features such as 100 memory channels, continuous tuning, separate transmit and receive frequencies for half-duplex operation and channel scanning. The transceiver is controlled by a keypad and the channel number and frequency are shown on a large liquid crystal display. A special version, model TW100SX, is available which only displays channel numbers and requires an external channel programming/reprogramming unit.

The TW100 Series offers a wide range of options and accessories to provide advanced systems capabilities. Built-in options include full Remote Control Capability, Selective Calling and the TRANSCALL Adaptive System. The TRANSCALL system makes HF operation as simple as using a telephone. The operator simply "dials" the number (actually a three digit entry on the keypad) and presses the CALL button. The transceiver then automatically links up with the station being called and they together select the best available channel. When the connection is made, a telephone-type ringing signal alerts both stations. Additional accessory items include Antenna Tuners, Broadband Antennas, RTTY/FSK Modems and Linear Amplifiers.

MICROPROCESSOR CONTROL

A high performance microprocessor is used to control the synthesizer in the TW100. The inputs from the front panel keypad control the selection of the channel frequencies stored in the memory and permit the entry of new frequencies on the free tuning channel. The microprocessor also controls the large easily read Liquid Crystal Display which can be used to show both channel and frequency information. The use of the microprocessor provides great flexibility of control combined with simple operation and programming.

CIRCUITRY

The TW100 uses all solid state, broadband circuitry which eliminates all field adjustments and tuning. An upconversion design to the first IF at 75MHz, places images and spurious responses in the VHF range, where they are removed by simple low pass filters. The transmitter spectral purity is ensured by six 10-pole elliptical function filters selected by the channel switch. The second IF is at 1650kHz where the main selectively is provided by high performance 6-pole crystal filters. The receiver uses a high quality packaged diode balanced mixer with an intercept point of +11dBm. This gives the receiver exceptional dynamic range and freedom from

TW100

intermodulation and overload. The frequency control system is derived from one stable 5120kHz reference oscillator. A 10kHz phase locked loop covers 76.6 to 105MHz for the first conversion oscillator. The second 100Hz phase locked loop controls a TCXO operating at 73.35MHz to provide downconversion to 1650kHz. Direct loops are used giving great spectral purity and a simple easily serviced design.

OPERATING MODES
The standard transceiver is supplied for A3J, and A3H operation. USB, AME and CW operation is standard and LSB may be provided as an option. A separate power supply and modem are available for FSK (teletype operation). This power supply provides additional cooling for continuous operation at 100W (average) power output. The high performance FSK modem provides direct connection to any standard RTTY machine. As an option, high speed TX/RX switching is provided for simplex ARQ operation.

CONSTRUCTION
The case of the transceiver is a rugged frame formed by the diecast front panel and massive rear heatsink joined by side extrusions. The modules are mounted on a plate held between the two side extrusions, and the final amplifier mounts on the rear heatsink. The main circuitry is contained in 6 diecast boxes providing complete RF shielding and environmental protection. The six modules, the PA assembly, the RF filter module and the frequency selection module are all easily changed for field service. The entire transceiver is constructed from aluminum alloys and all external hardware is stainless steel for operation under the most severe environmental conditions.

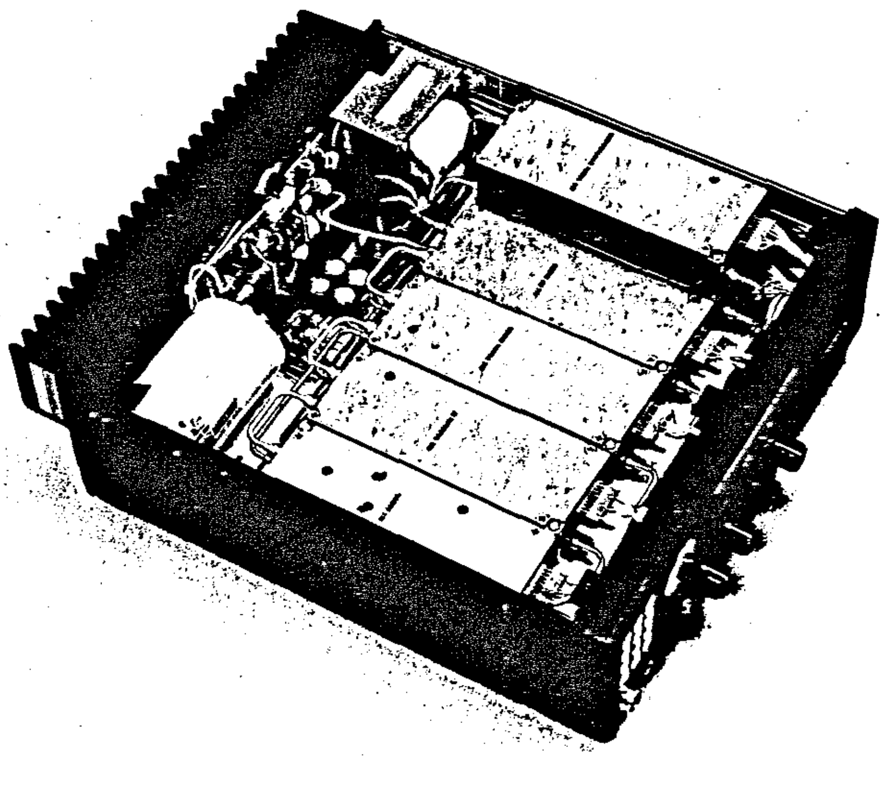
FULLY AUTOMATIC TUNING
When used in conjunction with the companion digital AT100 Automatic Antenna Tuner, efficient transceiver coupling to a wide variety of whip and wire antennas is fully automatic. Tuning time for the radio with coupler is typically 1 second.

AUDIO SYSTEM
The TW100 has two features that add greatly to operating convenience. The receiver audio squelch system is designed to respond only to voice signals and eliminates much of the background noise, characteristic of HF operation. The transmitter is equipped with a VOGAD which automatically adjusts the gain of microphone amplifier and provides maximum output power regardless of voice level. The TW100 has demonstrated compatibility with various COMSEC security devices. Please contact the factory for details.

FREQUENCY CALIBRATION
All channel frequencies are derived from a single high stability crystal oscillator. If it is ever necessary to adjust the frequency calibration, a single adjustment will set all channel frequencies. When greater stability is required, the HS10 High Stability Option incorporates a 1 part in 10^7 TCXO and also provides 10Hz digital incremental tuning in place of the receiver clarifier.

POWER SUPPLY
The TW100 operates directly from any 13.6V DC power source permitting direct operation from a vehicle or shipboard supply system. Provision is made for the internal installation of optional 28V DC or 115/230V 50/60Hz AC power supplies which are rated for SSB service. A base station power supply is also available for teletype service. This supply is rated for continuous service and provides forced air cooling for the transceiver power amplifier.

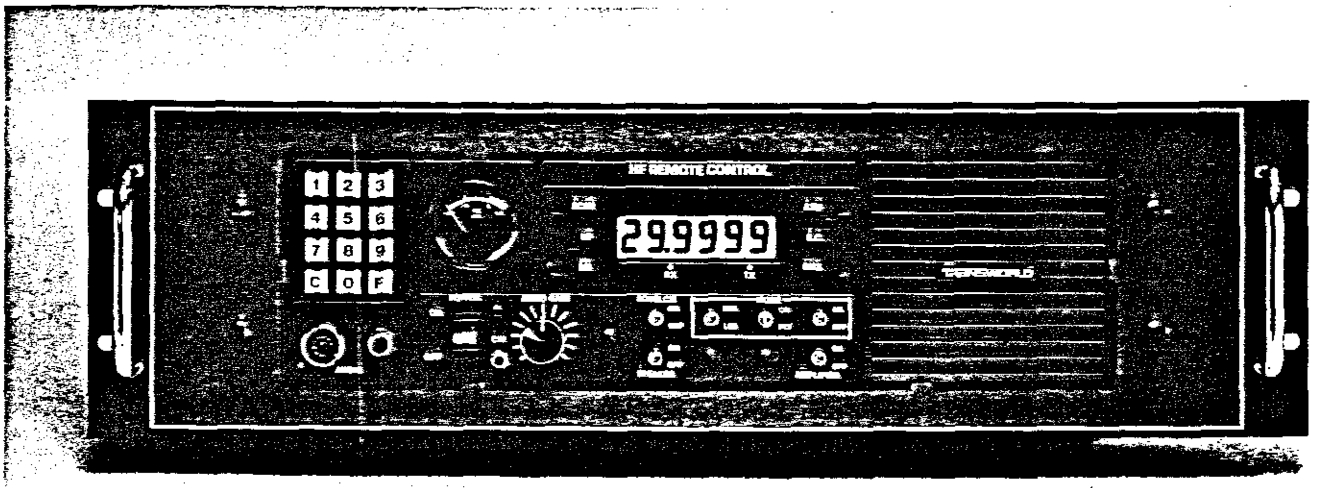
COMPANION LINEAR AMPLIFIERS
Companion all solid state linear amplifiers are available to boost the output power to either 500 to 1000 Watts output.



The modular design of the TW100 enhances serviceability.

TRANSWORLD™ for communications

TW5201



Rack Mounted Version

SIMPLE INTERCONNECTION

The TW5201 is designed for four or two wire interconnection with the associated radio. The standard interface is a four wire line (two pairs). This provides optimum performance. As an option, a two wire interface can be utilized but this must be specified at the time of order. Because of the high speed T/R switching required for ARQ and TRANSCALL operation, DC keying must be utilized in those applications. This requires "metallic" (DC continuous) lines with a maximum DC loop resistance of 2000 ohms.

ALTERNATE WATERPROOF MODEL

A fully waterproof (submersible) Remote Control Unit, model RT5201, is also available for use in mobile and other severe environmental conditions. While normally utilized with our RT series of paramilitary equipment, the RT5201 is fully compatible and interchangeable with the TW5201.

TRANSCEIVER COMPUTER CONTROL

The "RC" Remote Control interface installed in the radio provides selection of either the standard interface for use with the TW5201, or an RS232 serial interface with acknowledgment. This permits implementation of systems with full computer control of all radio functions using a series of "BASIC" functions.

TECHNICAL SPECIFICATIONS

REMOTE INTERFACE: 4 wire (standard), 2 wire (optional), 600 ohms nominal, bidirectional. ARQ and TRANSCALL installations require metallic (DC continuous) lines (max loop resistance 2000 ohms).
TRANSCEIVER INTERFACE: "RC" option, 4 wire (standard), 2 wire (optional), 600 ohms or RS-232 In/Out (optional).
LINE LEVELS: −10dBM to +3dBM
DATA TRANSMISSION MEDIUM: AFSK, U.S. standard tones.
DATA FORMAT: ASCII, 600 Baud, 8 Bits, with a synchronous simplex acknowledgment system sent in four byte bursts.
DISPLAY: Liquid Crystal (Channel Number, Frequency, Selective Calling Code, Link Status).
AUDIO: Internal Loudspeaker, 2 Watts output.
DISTORTION: Less than 5%.
MICROPHONE INPUT: Low impedance dynamic, internal gain control and speech compressor.
TRANSIENT PROTECTION: Metal Oxide Varister
POWER SUPPLY: 12 VDC @ 1 AMP max., 110/220VAC, 50/60Hz 25VA.
TEMPERATURE RANGE: −30 to +55C
SIZE: 5H × 13.5W × 6.25D in (12.7 × 34.3 × 15.9 cm).
WEIGHT: 6.25 lbs (2.84Kg).

Technical Specifications subject to change without notice.

TRANSWORLD™ for communications
TRANS WORLD COMMUNICATIONS, INC.
A SUBSIDIARY OF DATRON SYSTEMS, INC.
240 Pauma Place, Escondido, CA 92025 USA, Phone (619) 747-1079, Telex 695-433

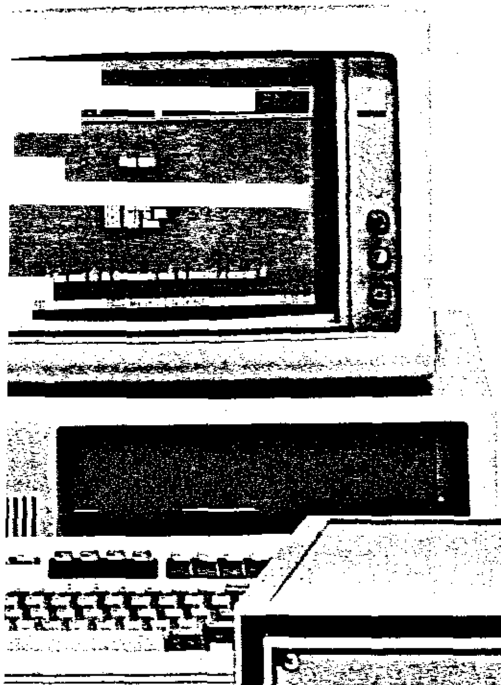
7/87PL

ANNEXURE E

DATA RADIO SYSTEM

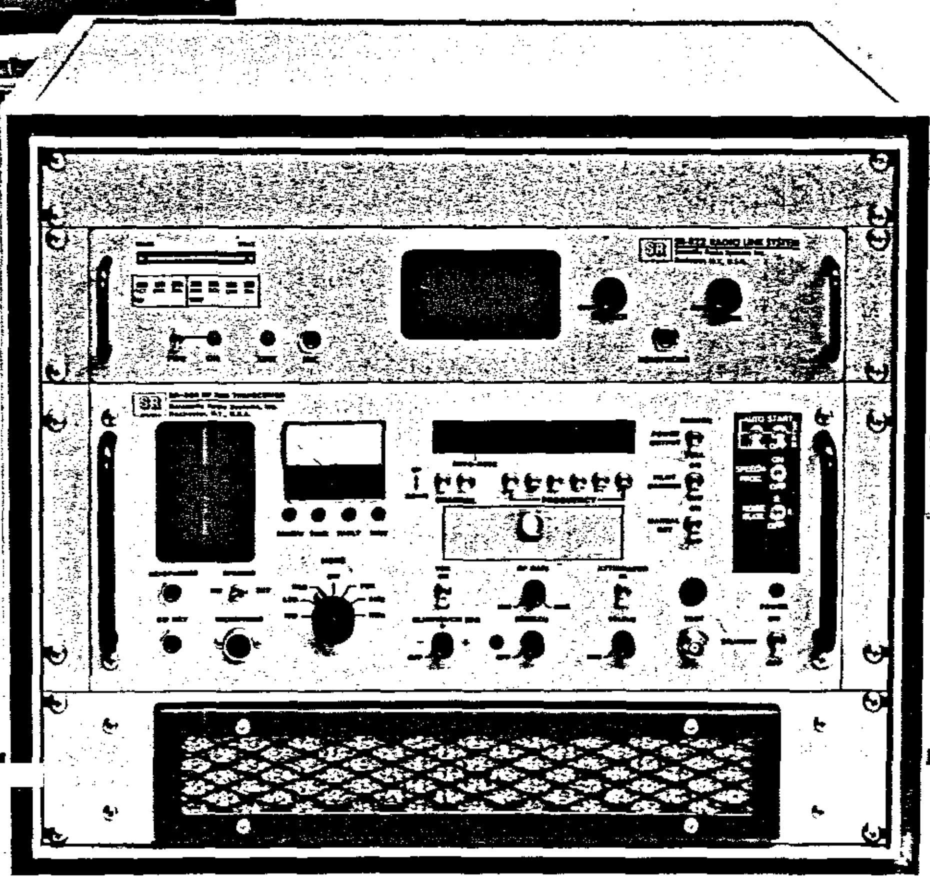
Scientific Radio Systems, Inc.

SRS Data System



Features:

- Error Free Packet Radio Networking
- Full Computer Remote Control
- 300 baud HF Packet
- 1200 baud or 2400 baud VHF/UHF Packet
- Multi-Mode-RTTY/ARQ/FEC/CW
- Adaptive HF
- Built in Text Editing
- Very User Friendly



SRS

Scientific Radio Systems (SRS) specializes in providing high technology communications systems to a variety of customers in over 120 countries throughout the world. These systems have proven very reliable in applications that include commercial, governmental, and full military. The SRS "DATA RADIO SYSTEM" is *the latest example of our continuing commitment to provide* *UNIQUE SOLUTIONS to* UNIQUE PROBLEMS.

Our System

The "DATA RADIO SYSTEM" offers a total network solution to data communications problems. The "SYSTEM" comprises the SR-822 Radio Link System family with the following possible configurations:

SR-822 Multi-Mode Controller *with optional HF and* VHF or UHF Links

SR-380 Micro Processor Controlled HF/SSB Radio

IBM® PC Computer

Communications Software Package

With the Data Radio System, users can operate HF/VHF or *UHF Packet, HF RTTY/ARQ/FEC/* CW. A complete packet network can be created with inexpensive hardware and user friendly software. Message traffic, spread-sheets, and other computer information can be transferred between users in an integrated network. The network supports both Radio Local Area Networks (LAN's) and Radio Wide Area Networks (WAN's) using the SX.25 protocol. LAN's are set up using VHF or UHF radios and WAN's are set up using HF radios with optional Adaptive HF to automatically select a suitable channel for communication. The integrated software package handles routing and connection automatically.

Gateways

Because the Data Radio System *is multi-mode, customers no* longer have to have separate *equipment specifically intended* for each mode. Now one sys*tem does it all. As an example,* an operator can send and *receive a message on RTTY and* then resend the same message *on VHF packet. Or as another* example, a VHF packet system *can send a message to a gate*way operator, and have it resent on HF ARQ. With the Data Radio System, operators can now transfer message traffic between dissimilar networks, and by utilizing Packet the messages are delivered ERROR FREE. This is a major *advantage to users who must* ensure the integrity of their *transmitted data.*

Message traffic from a VHF/ *UHF station is routed to an HF* gateway station for routing into the network. The SX.25 Gateway provides the routing information, frequency selection, and return acknowledgement of a delivered message to the origination station. No operator intervention is required for this operation. Each message is handled similarly to a Telex message that is sent to a store-and-forward system.

Software Package

The menu-driven screens, such as those shown, provide the operator with instructions about the operation of the system. With little, or no training, an operator can create, edit, and transmit a message to another station in the network with no knowledge of the radio system used to transfer the data. In fact, the radio equipment does not have to be in the same room with the computer equipment.

Main Menu

[F1] COMMUNICATE
[F2] CREATE/REVISE DOCUMENT
[F3] INSTALL
[F4] EXIT TO DOS
[F5] HELP MENU

Communications Menu

RECEIVED TEXT

POP-UP HELP MENU

ENTER MESSAGE

MODE=
PRESS [F10] FOR HELP

Pop-Up Menu

PRESS KEY TO SELECT
[F1] Printer on/off
[F2] File capture on/off
[F3] Change Capture File Name
[F4] SEND a File
[F5] Receive a File
[F6] Disconnect (Call)
[F7] Change station frequency
[F8] Change station Tx. ID
[F9] Connect (call)
[F10] More HELP

Pop-Up Menu

PRESS KEY TO SELECT
[F1] PACKET
[F2] RTTY (BAUDOT)
[F3] CW (MORSE)
[F4] ARQ
[F5] FEC
[F6] ASCII

Operators are notified in plain language about system connections, stations busy, frequency selected, mode of transmission, and call signs of stations in the network. Messages can be automatically printed on a printer and on a floppy disk.

The IBM® PC controls the network, radio equipment, adaptive HF, and message processing. The software package is very user friendly and operators no longer have to understand radio communications to use the system. Messages are transmitted and received in a Telex like format. The computer can be used for other processing functions such as spread sheets or word processing. When these functions are in use, the system sends a BUSY signal to anyone who tries to send a message. POP-UP menus are used to assist operators in placing a call, selecting a routing and controlling other features.

Untrained operators need only type a message to place a call on either voice or data. No working knowledge of the radio equipment is required to operate the system, and the radio can be located in another area away from the computer.

Files from the IBM® PC can be transferred using Packet to other IBM® PC's with compatible software. In fact, any file that can be stored on an IBM® PC can be transferred error free using Packet protocol.

NOTE OUR NEW ADDRESS
AFRITECH PTY LTD
P.O. BOX 98682 SLOANE PARK 2152
92 LANGWA STREET, STRIJDOM PARK
RANDBURG, REPUBLIC OF SOUTH AFRICA
TELEPHONE (011) 792-2825/6/7/8
FACSIMILE (011) 792-1747 TELEX 4-22673

Reg. No. 83/00385/07

Specifications
SRS Data System

GENERAL

requency Range Transmitters	1.6 MHz to 30 MHz 143 MHz to 174 MHz 400 MHz to 470 MHz
perating Modes HF	LSB, USB, AME, CW
perating Modes VHF	NBFM
ITE	SR-380 has 79 test points in the built in test
lodem Modes	Packet, RTTY, ARQ, FEC, CW
lodem Speed	300 baud on HF 1200 baud or 2400 baud on VHF or UHF

ANSMITTER

ower Output HF	150 Watts PEP 100 Watts average
ower Output VHF/UHF	10 Watts

/ER

nsitivity HF	0.5 micro volts for 10 db S+N/N
nsitivity VHF	0.15 micro volts (12 db SINAD)
nsitivity UHF	0.35 micro volts (12 db SINAD)

OMPUTER	IBM® PC
OFTWARE	Custom designed for SRS Data System
OWER REQUIREMENT	115/230 VAC 50/60 Hz

SRS
Scientific Radio Systems, Inc.
367 Orchard Street, Rochester, N.Y. 14606, U.S.A.
Telephone 716-235-2040 ▪ Telex 978-368
FAX 716-235-7827 ▪ SIRAD ROC

PACKET RADIO NETWORK

A network of stations using a single shared radio communications channel to transmit and receive messages error free.

Scientific Radio Systems
APPLICATION NOTE - PR-1

During the last ten years there have been tremendous improvements in network message switching developments using digital techniques. These improvements have largely been limited to wire-line (telephone) and line of sight (LOS) microwave radio systems. Little has been done to improve the transmission of data and message traffic over HF or VHF radio links. The volume of traffic, both voice and data, is constantly expanding, but the links that carry the traffic are not able to keep pace with the increased requirements. With a low in the current sunspot cycle the amount of usable HF frequency spectrum is reduced and the number of users of that spectrum has increased. On VHF/UHF there is a similar demand for more users in the already crowded spectrum.

The reduction in available spectrum, the increase in message volume, and the increase of users of the HF and VHF/UHF spectrum have caused a situation that requires a re-evaluation of the current system. It is obvious that message traffic will continue to grow in volume and that the number of users will also continue to grow. The sunspot cycle, which affects HF propagation, will not show any marked improvement before 1990 so a means must be found to better use the available spectrum and to improve the performance of communications systems used to transmit message traffic.

The problem is how to:

A). Send and receive message traffic, <u>virtually error free</u>, to a widely dispersed group of recipients utilizing nonwire-line circuits (wireless).
B). Have near real time message transfer.
C). Transfer message traffic between dissimilar radio and data systems (HF / VHF / UHF)
D). Improve the utilization of existing radio links (HF/VHF/UHF)without further congestion.
E). Further improve VHF/UHF channel utilization by integrating voice and data on the same channel on a non-interference basis.

A Packet Radio Network can address each of these problem areas and provide users with a cost effective solution. By utilizing Packet Radio users can now establish networks to pass message traffic in a local area and directly interface to wider area networks.

BENEFITS OF PACKET RADIO

SPEED - Packet radio operates at 1200 baud on VHF/UHF and up to 300 baud on HF.

ACCURACY - Packet is virtually error free. Data received will be exactly as it was sent. Cyclic Redundancy Checks (CRC) are used for error checking.

EFFICIENT FREQUENCY UTILIZATION - Unlike other modes (RTTY, Voice) many packet stations can interleave use of a single channel without interfering with each other.

GATEWAY OPERATIONS -

Local area networks (LAN's) using VHF/UHF radio equipment can interface to Wide Area Networks (WAN'S) using HF radio equipment to provide error free communications over great distances. This interface between dissimilar networks is a major advantage of a packet network because it isolates the network to optimize its resources while still allowing networks to interconnect with each other when necessary. Gateways will also provide connectivity with existing land-line or satellite networks, RTTY or ARQ networks or other in place networks that use RS-232.

HARDWARE TRANSPARENCY -

A packet radio controller is transparent to the user. Information is presented to the controller and is transmitted with no change. Computer programs may be transmitted in their original language without changing control characters or formats. Message traffic may be transmitted with special format or printer characters unchanged.

ANNEXURE F

TECHNICAL SPECIFICATION OF INMARSAT TERMINAL

Oceanray 2 Technical Data

Frequency Range:
Transmitting 1636.5 – 1645.0 MHz
Receiving 1535.0 – 1543.5 MHz

Tuning:
339 channels (25 KHz steps)

Transmit EIRP:
36 dBW + 1 – 2 dB

Receive G/T:
= – 4 dB deg K min

Communication Modes:
Voice: Duplex/Simplex Narrow Band Frequency Modulation (NBFM) with companders
Data: Duplex/Simplex (NBFM) without companders
Telex: Duplex/Simplex Bi-Phase Shift Keying (BPSK) (4.8 Kbps, 1.2 Kbps)

Muting:
Voice activated noise muting

Antenna:
0.9m parabolic reflector, 4 axis gyrostabilised with autotrack

Gyrocompass Interface:
D.C. stepper 1/6 degree steps
A.C. synchro 1 or 2 degrees per revolution

Power supply:
115/230V A.C. 50/60 Hz single phase (440V A.C. would use an additional transformer)

Environmental conditions for ADE:

a) Temperature Range	– 35 to + 55 deg C
b) Relative humidity	95% at 40 deg C
c) Spray	Solid droplets from any direction
d) Icing	up to 2.5cm of ice
e) Precipitation	up to 10cm/hour
f) Wind	Normal operation up to 100 knots
g) Vibration	Peak amplitude (mm)
4 – 10 Hz	2.54mm
10 – 15 Hz	0.76mm
15 – 25 Hz	0.40mm
25 – 35 Hz	0.23mm

Environmental conditions for BDE:

a) Temperature Range	0 to + 40 deg C
b) Relative humidity	95% at 40 deg C
c) Vibration	Peak amplitude (mm)
4 – 15 Hz	0.76mm
15 – 25 Hz	0.40mm
25 – 35 Hz	0.23mm
35 – 40 Hz	0.13mm
40 – 50 Hz	0.07mm

Motion:

a) Roll	+/– 30 deg period 8 sec
b) Pitch	+/– 10 deg period 6 sec
c) Yaw	+/– 80 deg period 50 sec
d) Surge	+/– 0.2 g
e) Sway	+/– 0.2 g
f) Heave	+/– 0.5 g
g) Turning rate	6 deg/sec
h) Headway	30 knots

Dimensions and Weights:
(1) New ADE including radome:
Height = 1300mm,
Diameter = 1350mm,
Dish Diameter = 900mm,
Approximate Weight = 60 kg
(2) BDE: Height = 290mm,
Width = 510mm,
Depth = 490mm,
Approximate Weight = 14 kg
(3) R.F. Unit:
Height = 518mm,
Depth = 260mm,
Width = 378mm,
Approximate Weight = 36 kg

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ANNEXURE G

MONTHLY RADIO PROPAGATION PREDICTIONS AS PUBLISHED BY THE CSIR

ISSN 0033 7986

REEKS
SERIES
E T P

SUID-AFRIKAANSE WETENSKAPLIKE
EN NYWERHEIDNAVORSINGSRAAD

NASIONALE INSTITUUT VIR TELEKOMMUNIKASIENAVORSING

RADIOVOORTPLANTINGVOORSPELLINGS VIR SUIDELIKE AFRIKA

MAART 1989 MARCH

NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

RADIO PROPAGATION PREDICTIONS FOR SOUTHERN AFRICA

SOUTH AFRICAN COUNCIL FOR
SCIENTIFIC AND INDUSTRIAL
RESEARCH

RADIOVOORTPLANTINGVOORSPELLINGS VIR SUIDELIKE AFRIKA

RADIO PROPAGATION PREDICTIONS FOR SOUTHERN AFRICA

CONTENTS INHOUD

A Users Manual is available on request.

'n Gebruikers Handboek is op versoek beskikbaar.

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JOHANNESBURG.

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2

VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

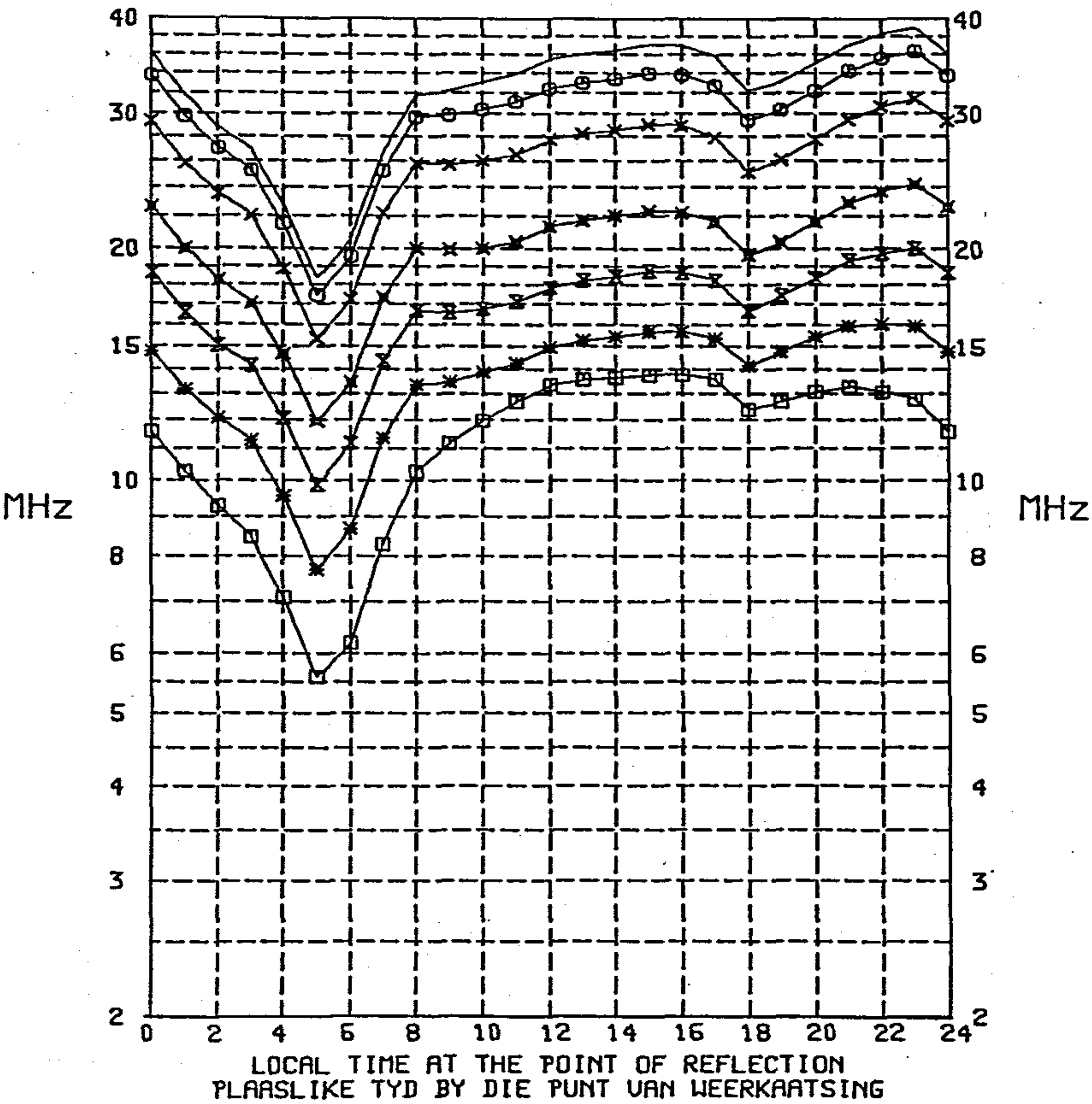
PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

PUNT VAN WEERKAATSING — LENGTEGRAAD : 0 - 50 O

LONGITUDE : 0 - 50 E

POINT OF REFLECTION — BREEDTEGRAAD: 0 DEGREES S

LATITUDE:



	MI	KM	E LAYER/LAAG
–	2500	4000	
⊕	2000	3200	
×	1500	2400	
⌧	1000	1600	
⧗	750	1200	8
✱	500	800	
⊡	0	0	

3

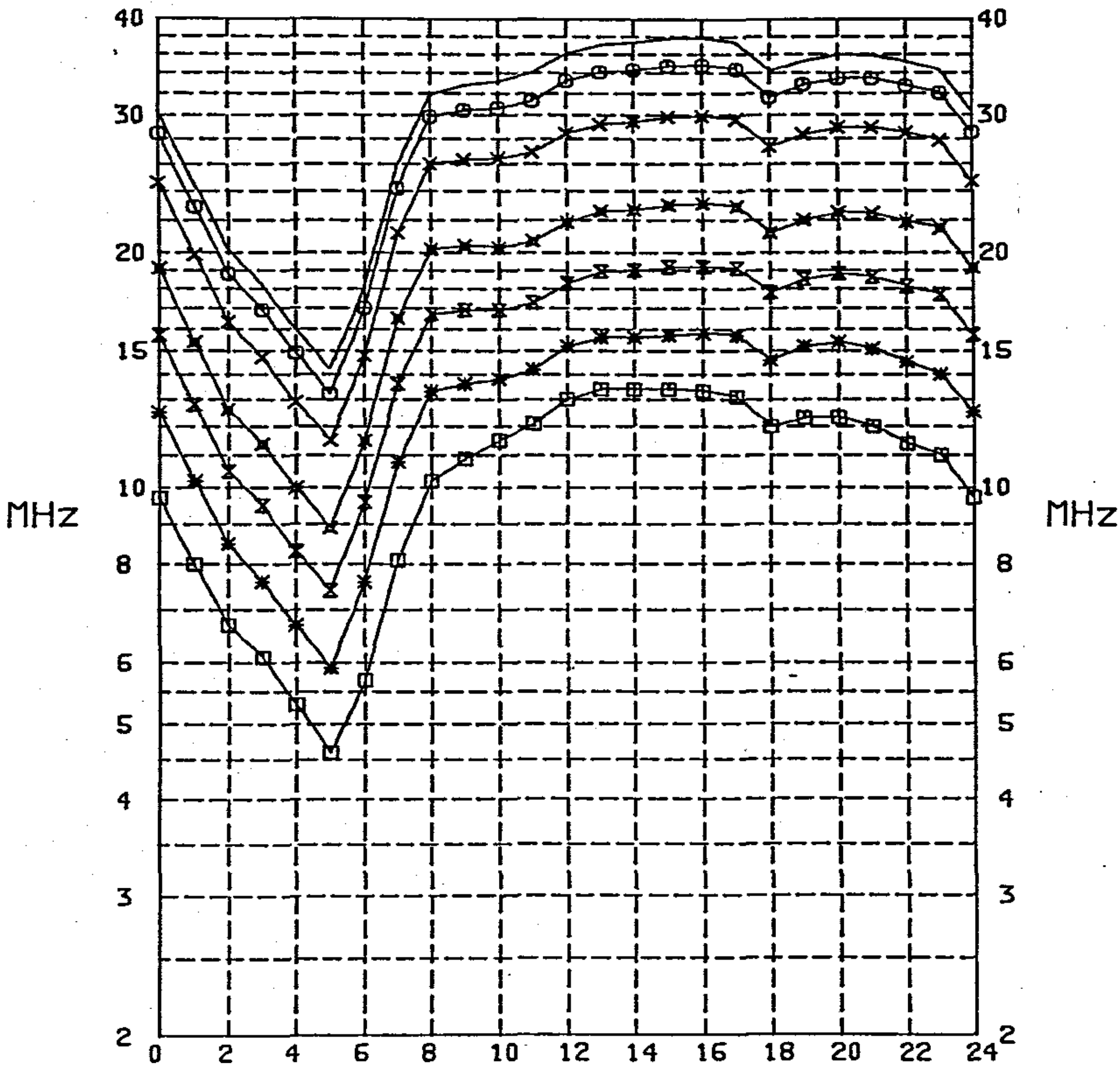
VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

PUNT VAN WEERKAATSING — LENGTEGRAAD : 0 - 50 O

POINT OF REFLECTION — LONGITUDE : 0 - 50 E

BREEDTEGRAAD, LATITUDE, 10 DEGREES S



LOCAL TIME AT THE POINT OF REFLECTION
PLAASLIKE TYD BY DIE PUNT VAN WEERKAATSING

E LAYER/LAAG

	MI	KM
-	2500	4000
⊕	2000	3200
X	1500	2400
⌧	1000	1600
⧗	750	1200
✳	500	800
⊞	0	0

4

VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

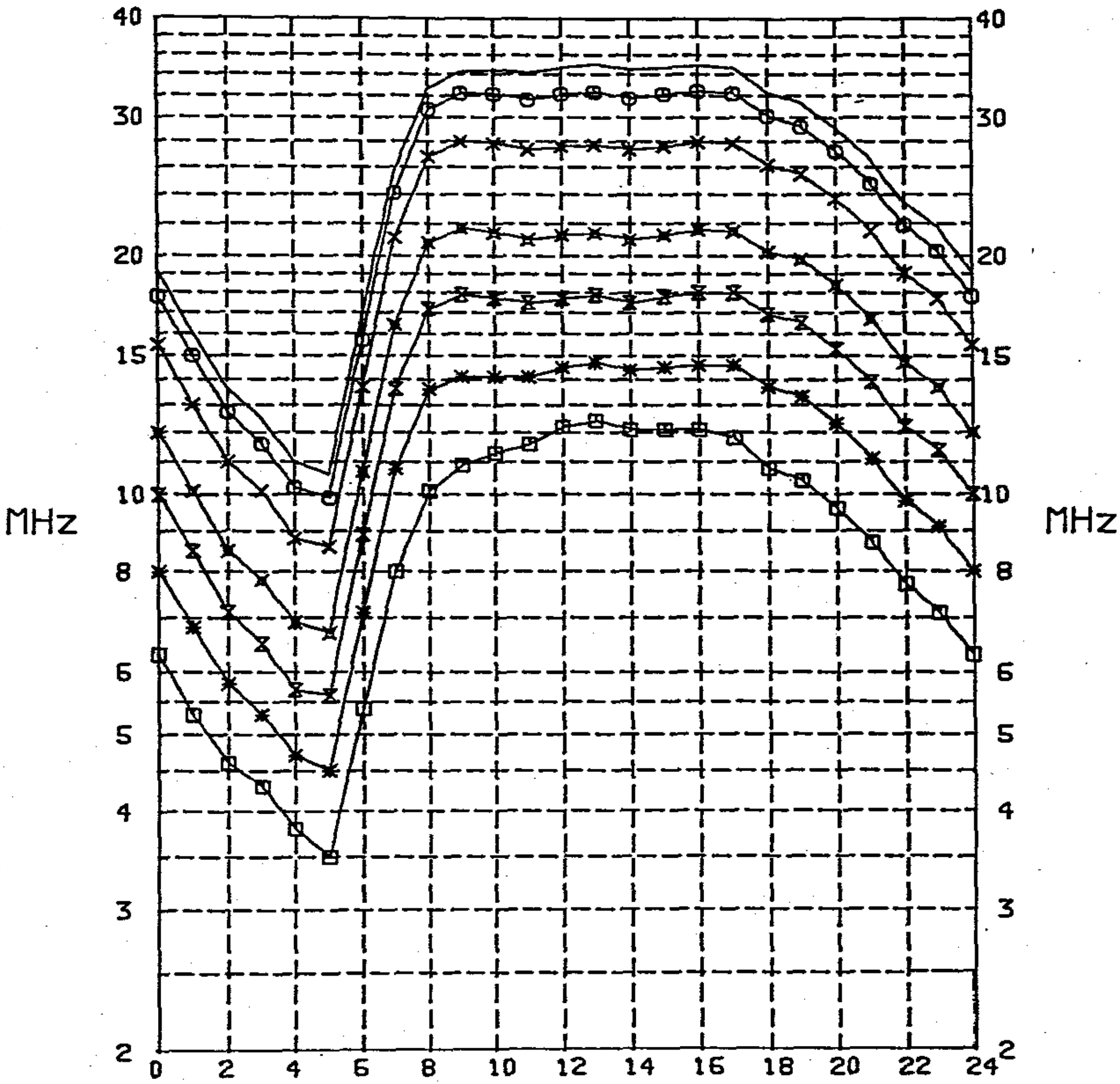
PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

PUNT VAN WEERKAATSING — LENGTEGRAAD : 0 - 50 O

LONGITUDE : 0 - 50 E

POINT OF REFLECTION — BREEDTEGRAAD: 20 DEGREES S

LATITUDE:



LOCAL TIME AT THE POINT OF REFLECTION
PLAASLIKE TYD BY DIE PUNT VAN WEERKAATSING

E LAYER/LAAG

	MI	KM
-	2500	4000
⊖	2000	3200
X	1500	2400
⌘	1000	1600
⧗	750	1200
✳	500	800
⊡	0	0

S

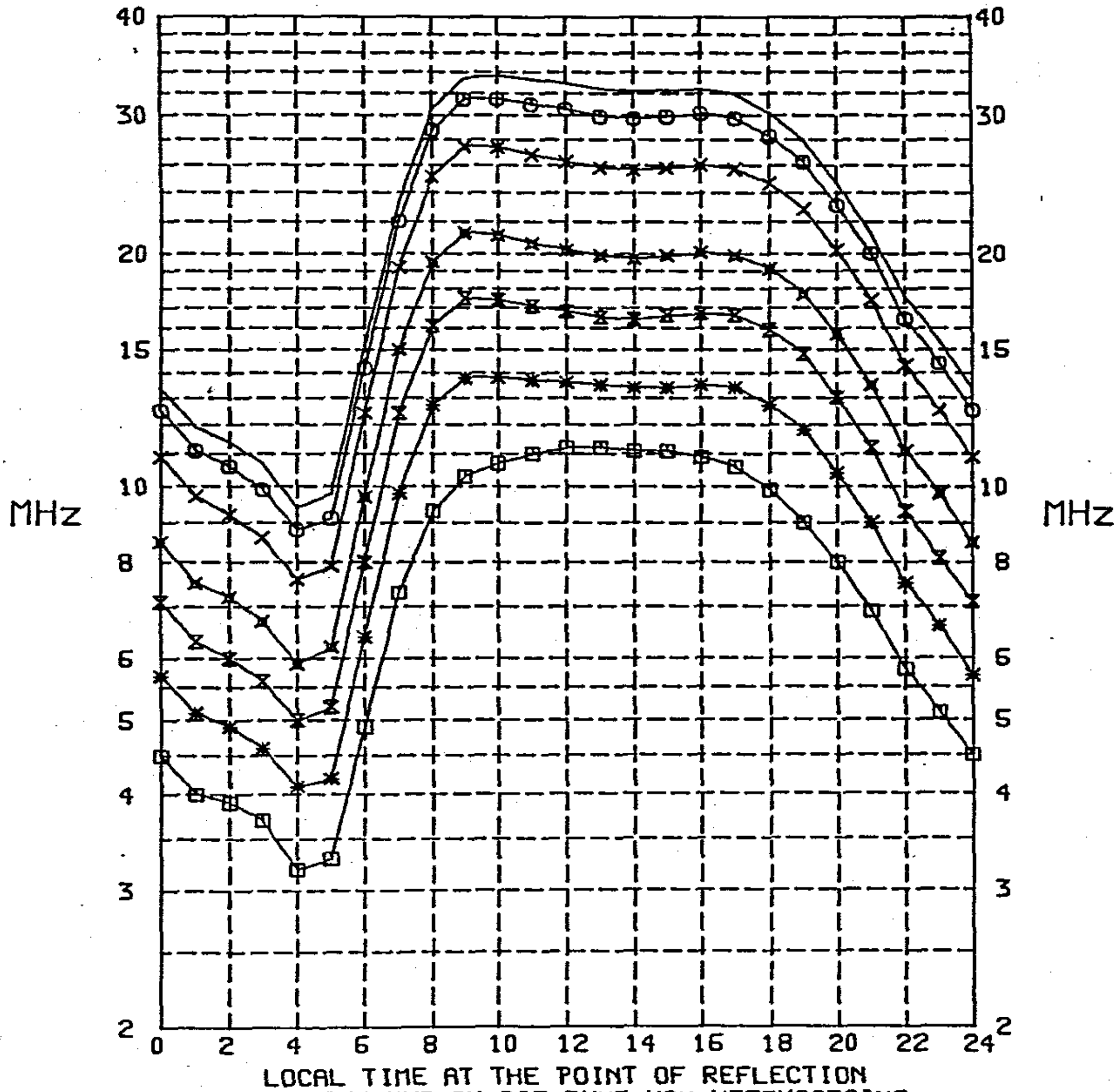
VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

PUNT VAN WEERKAATSING — LENGTEGRAAD : 0 - 50 O

POINT OF REFLECTION — LONGITUDE : 0 - 50 E

BREEDTEGRAAD: / LATITUDE: 30 DEGREES S



LOCAL TIME AT THE POINT OF REFLECTION
PLAASLIKE TYD BY DIE PUNT VAN WEERKAATSING

	MI	KM
-	2500	4000
O	2000	3200
X	1500	2400
⌘	1000	1600
⧗	750	1200
*	500	800
□	0	0

E LAYER/LAAG

6

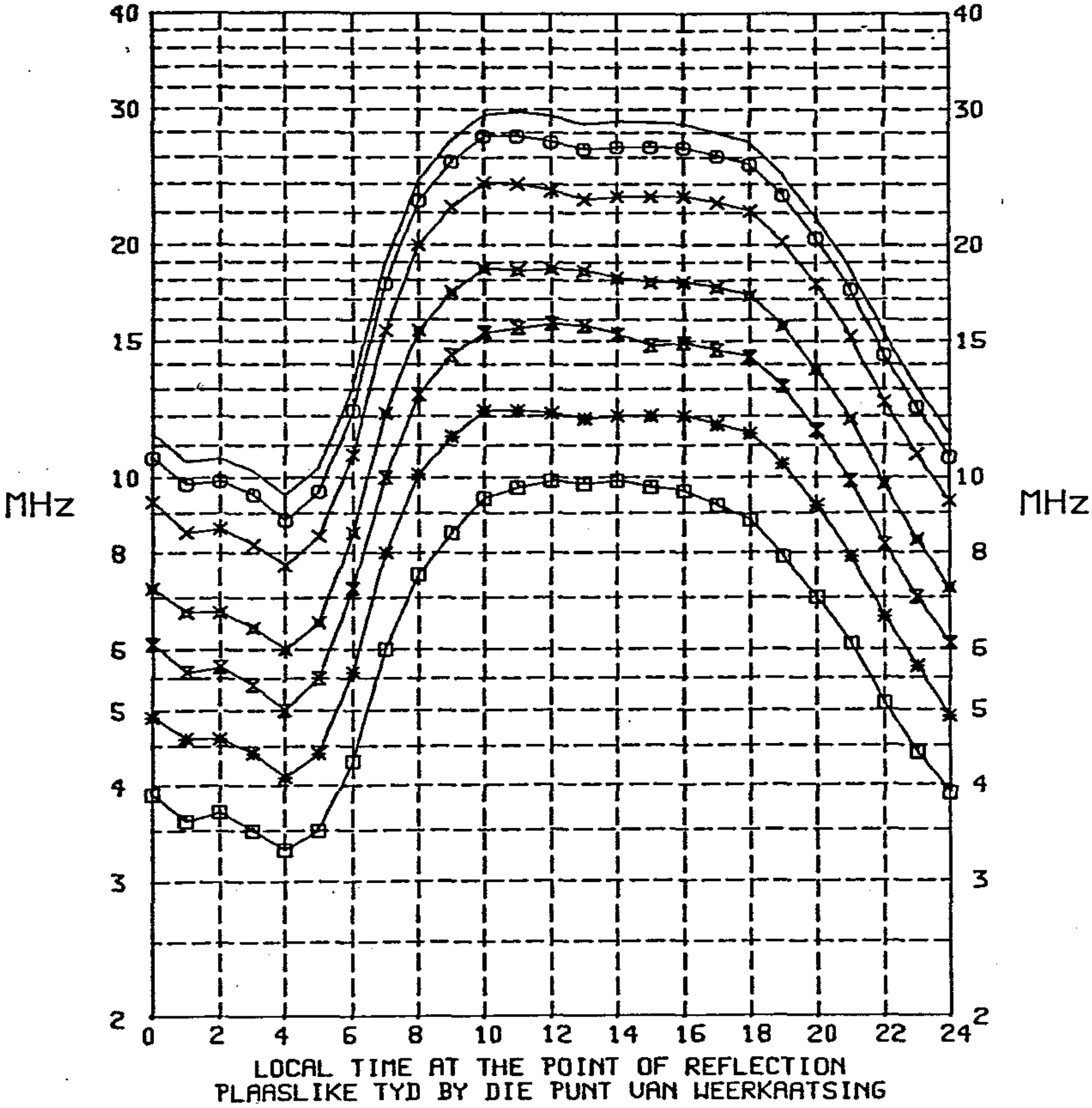
VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

PUNT VAN WEERKAATSING

POINT OF REFLECTION

LENGTEGRAAD : 0 - 50 O
LONGITUDE : 0 - 50 E
BREEDTEGRAAD, LATITUDE, 40 DEGREES S



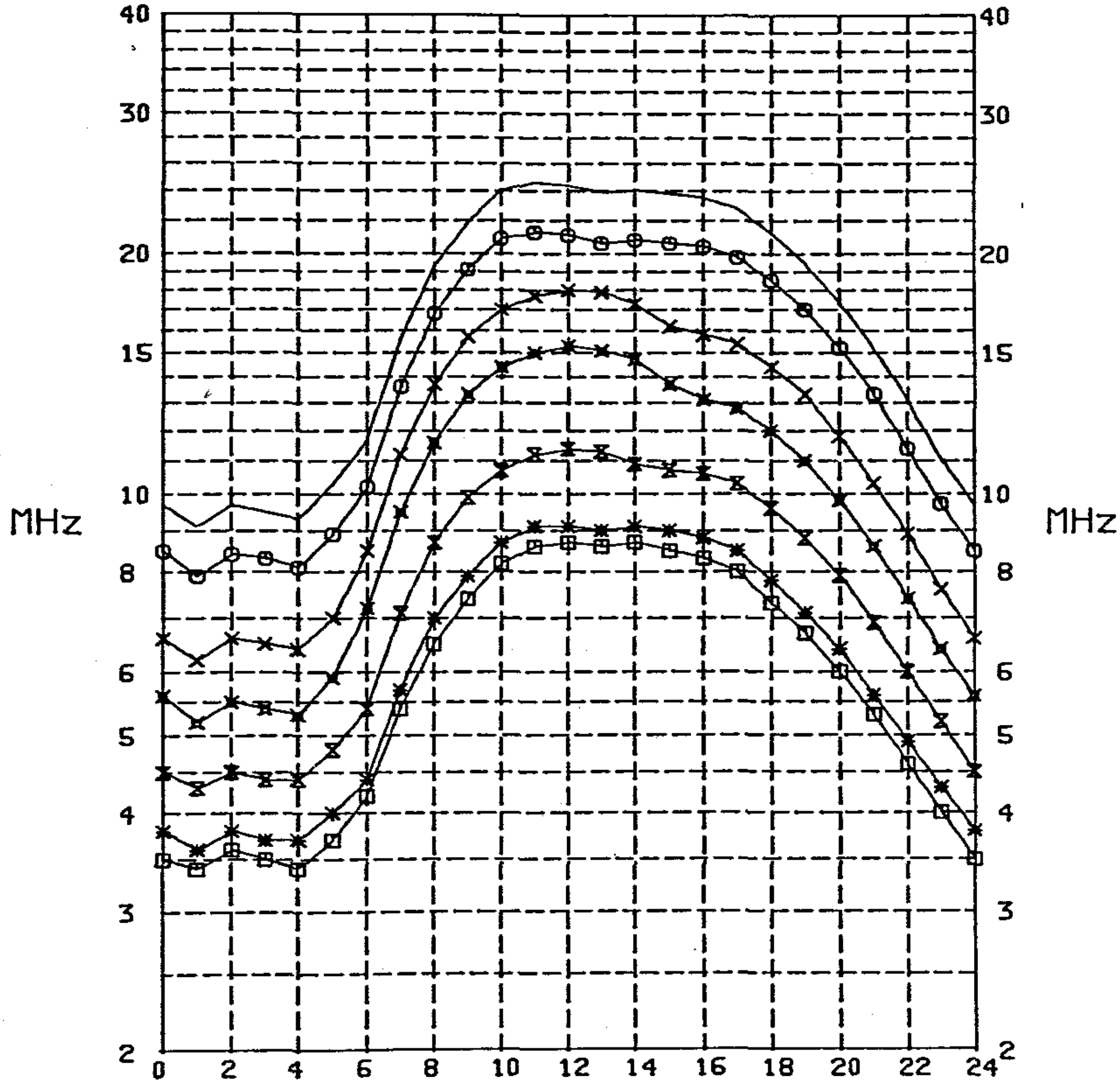
LOCAL TIME AT THE POINT OF REFLECTION
PLAASLIKE TYD BY DIE PUNT VAN WEERKAATSING

	MI	KM	E LAYER/LAAG
–	2500	4000	
O	2000	3200	
X	1500	2400	
⌧	1000	1600	4 10 11 12
⧗	750	1200	4 9 10 11 12
✳	500	800	
⊡	0	0	

VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

PUNT VAN WEERKAATSING	LENGTEGRAAD : 0 - 50 O LONGITUDE : 0 - 50 E
POINT OF REFLECTION	BREEDTEGRAAD: 50 DEGREES S LATITUDE:

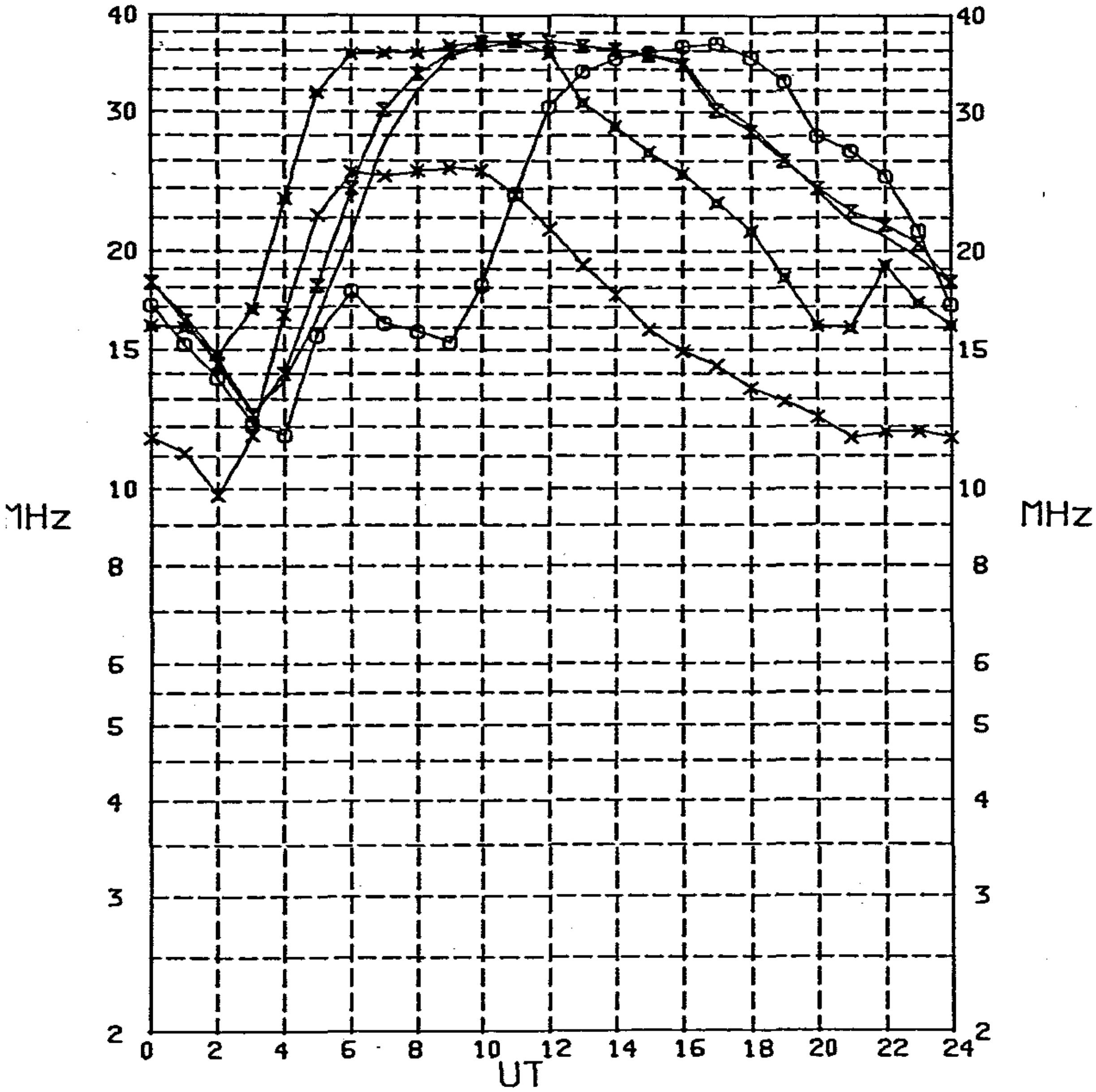


LOCAL TIME AT THE POINT OF REFLECTION
PLAASLIKE TYD BY DIE PUNT VAN WEERKAATSING

	MI	KM	E LAYER/LAAG
-	2000	3200	
⊙	1500	2400	
X	1000	1600	4 5 6 7 8 9 10 11 12 13
⌘	750	1200	4 5 6 7 8 9 10 11 12 13
⧖	500	800	5 6 7 8 9 10 11 12
✳	250	400	
⊡	0	0	

8

VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES
VIR GEBRUIK OP SEKERE LANGAFSTANDVERBINDINGS
PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES
FOR USE ON CERTAIN LONG-DISTANCE CIRCUITS



- JOHANNESBURG-LONDON/LONDEN

⊙ JOHANNESBURG-WASHINGTON (via Atlantic/route/Atlantiese roete)

× JOHANNESBURG-PERTH (short path/kort roete)

⌘ JOHANNESBURG-TOKYO (short path/kort roete)

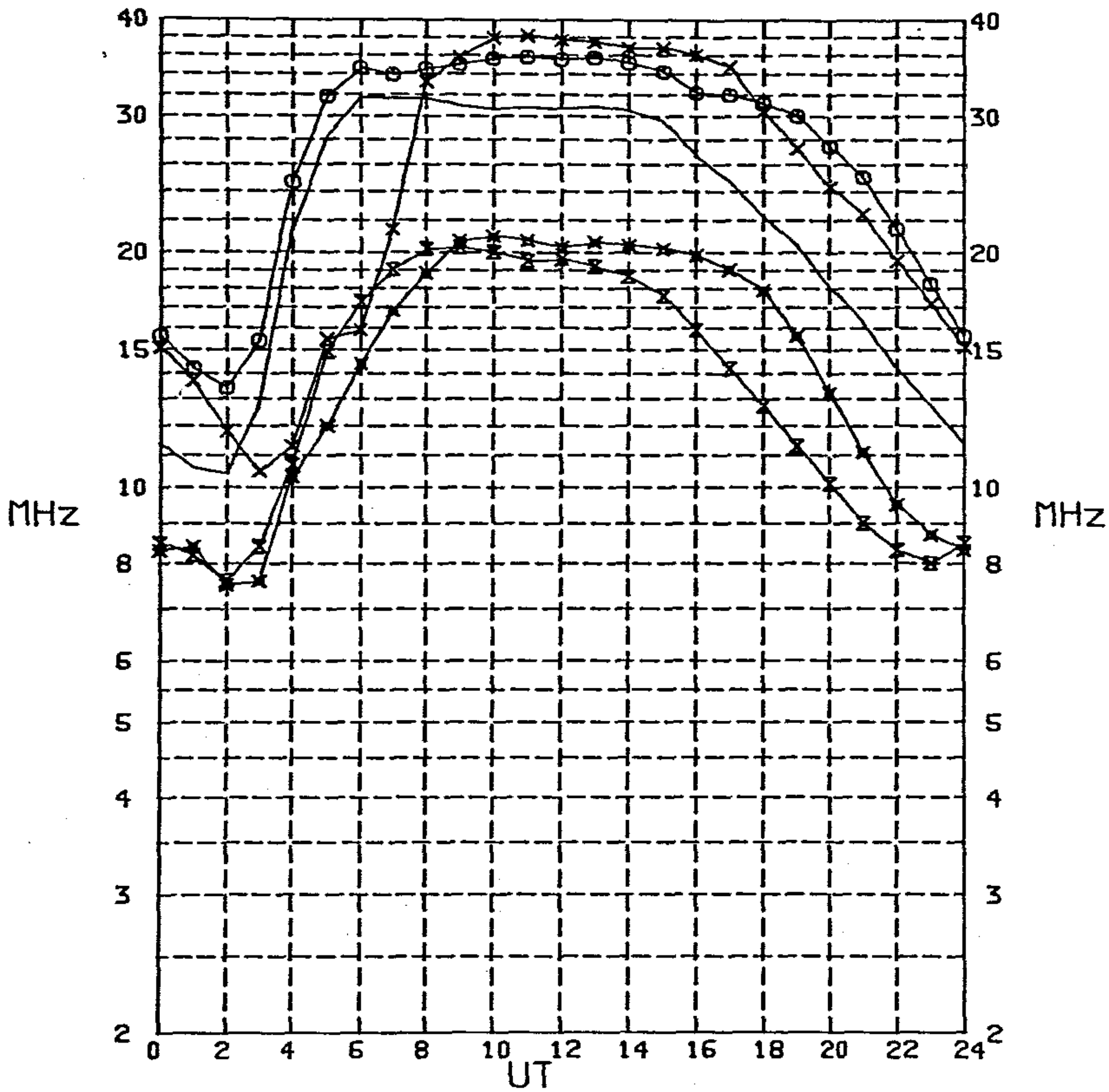
⧖ JOHANNESBURG-FRANKFURT

VOORSPELDE WAARDES VAN GUNSTIGSTE VERKEERFREKWENSIES

VIR GEBRUIK OP SEKERE LANGAFSTANDVERBINDINGS

PREDICTED VALUES OF OPTIMUM TRAFFIC FREQUENCIES

FOR USE ON CERTAIN LONG-DISTANCE CIRCUITS



- PRETORIA-MAURITIUS

⊕ PRETORIA-SEYCHELLES/SEYCHELLE

X PRETORIA-ASCENSION

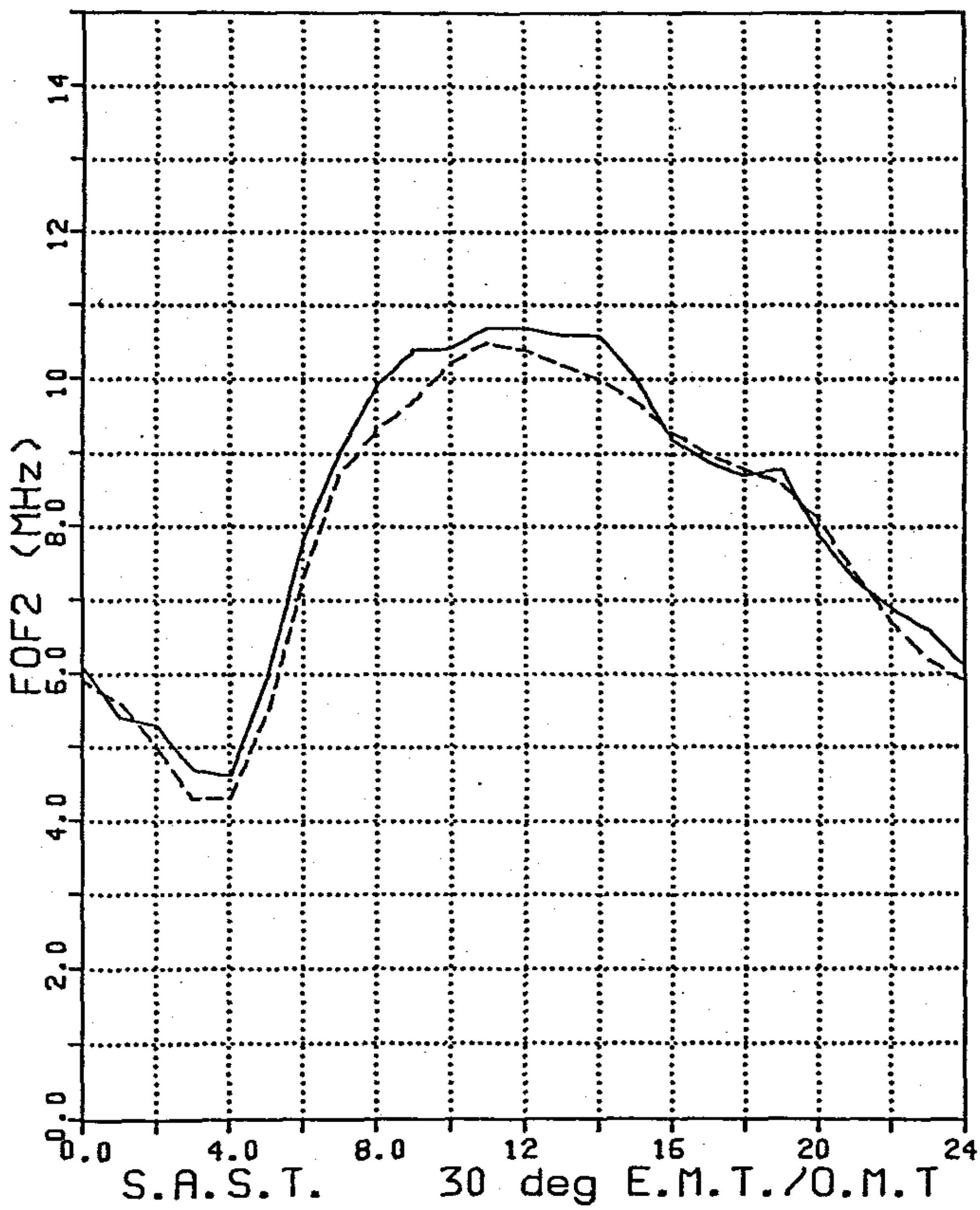
ЖX PRETORIA-S.A.N.A.E.

⧗ PRETORIA-MAWSON

WAARGENEEMDE EN VOORSPELDE WAARDES VAN F2 KRITIEKE FREKWENSIE (VERTIKALE INVALSHOEK)

OBSERVED AND PREDICTED VALUES OF F2 CRITICAL FREQUENCY (VERTICAL INCIDENCE)

JANUARY 1989 JANUARIE JOHANNESBURG



—— Median observed values / Mediaan waargeneemde waarde

---- Predicted values / Voorspelde waardes

BIBLIOGRAPHY

ANDERSON F: "Backscatter - use it for nets" Radio ZS Volume 38 No 1 January 198. (South African Radio League).

CCIR Report 563: Radio Meteriological Data. Kyoto 1978.

DANIELSON G. & WALKER R: "Radio and Line Transmission. Volume 3: 1980 Butterworth Press.

DIAB R: Wind Energy in South Africa: Thesis for Doctorate in Geography: University of Natal.

DIJKSTRA H. & FRANX C: Solar panels for terrestrial applications: December 1978 Philips Technical information 052.

GURR R: "Broadband High Frequency Antennas" Radio ZS Volume 42 No 3 March 1988 (South African Radio League).

HALL G. et al: The ARRL Antenna Book: 1984 American Radio Relay League.

Inmarsat Maritime Users Manual: First Edition: 1984 International Marine Satellite Organization.

JASIK H. et al: Antenna Handbook: 1961 Mc Graw-Hill New York.

JESSOP G. & HEWES R: Radio Data Reference Book: 1985 Radio Society of Great Britian.

KENNEDY G: Electronic Communication systems. Second edition: 1977 McGraw - Hill International.

LEVENTHAL L: Z80 Assembly Language programming. First Edition: 1979 Osborne/McGraw-Hill.

MORRISON M. & MORRISON D: "Packet Radio" Practical Wireless Volume 59 No 12 December 1983.

NASHELSKY L: Introduction to Digital computor Technology. Second Edition: 1977 John Wiley and Sons.

Radio Communication Handbook, Volume 2: 1977 Radio Society of Great Britain.

RODDY D. & COOLEN J: Electronic Communications Second edition: 1981 Reston Publishing Company.

SCHIERS H: "AO - 10 Ground Station Analyses" Orbit Magazine No 14 May/June 1983 (AMSAT).

SR-822/SR-812 Data Radio Systems. Operator - Maintenance Manual: May 1988 Scientific Radio.

STRAUB P: "HF Wire Antennae" Radio ZS Volume 42 No.6 June 1988 (South African Radio League).

SYLEDIS Network design December 1985: SERCEL Nantes, France.

The Post Office Guide 1986.

The South African Yearbook 1986.