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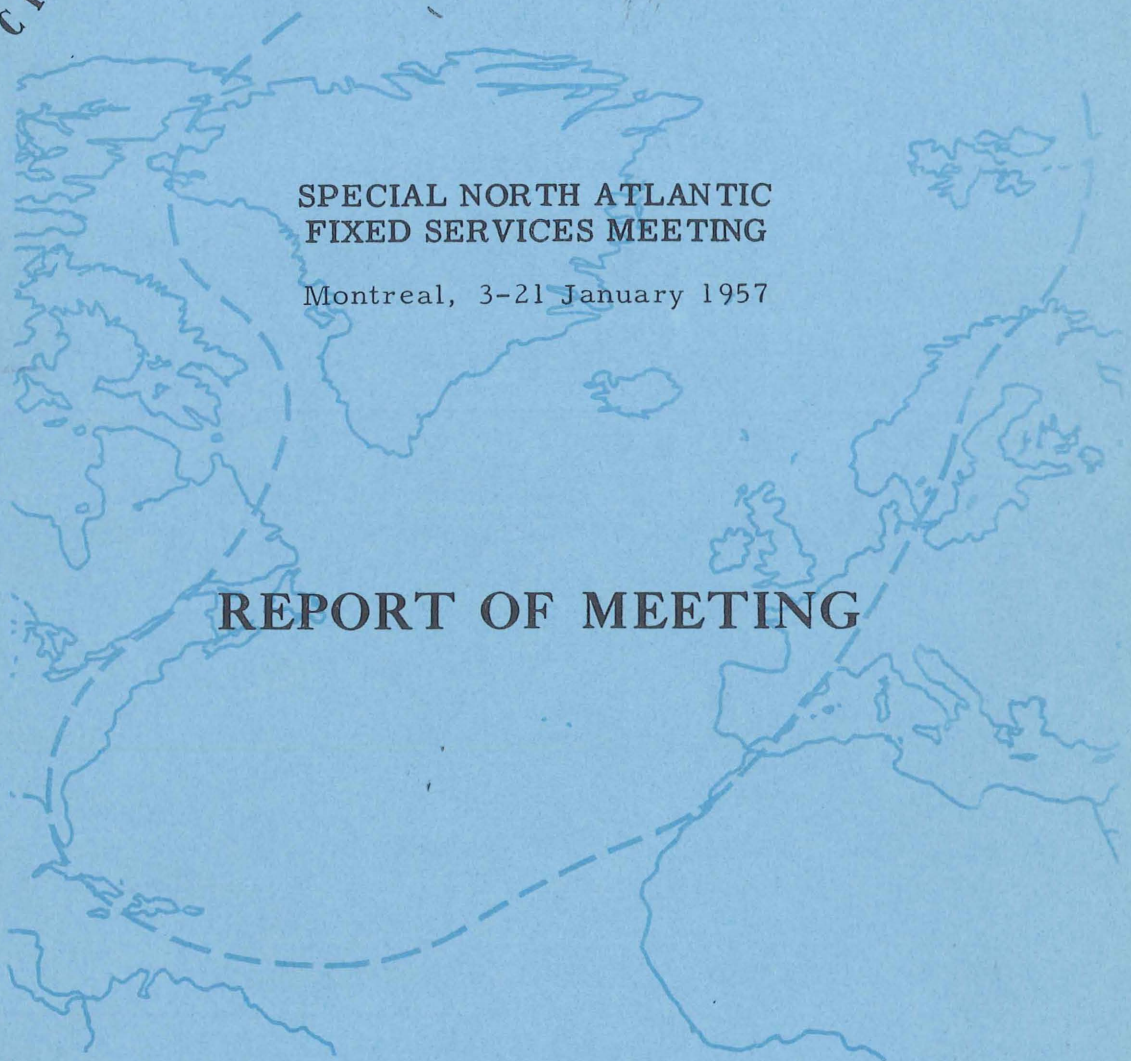
INTERNATIONAL CIVIL AVIATION ORGANIZATION



SPECIAL NORTH ATLANTIC
FIXED SERVICES MEETING

Montreal, 3-21 January 1957

REPORT OF MEETING

Approved by the Meeting
and issued by authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

SPECIAL NORTH ATLANTIC FIXED SERVICES MEETING

Montreal 3 - 21 January 1957

SUPPLEMENT NO. 1

The Council, at the Second Meeting of its Thirtieth Session on 6 February 1957, took action as indicated herein on the recommendations of the Special North Atlantic Fixed Services Meeting.

The Council approved, without comment, Recommendations Nos. 4 to 10, 12 to 15 and 18 to 22 inclusive and took action on the remainder as set forth hereunder.

Recommendation No. 1 (page II-1)

The Council approved the technical and operational aspects of this recommendation and decided that it would consider as soon as practicable what arrangement should be recommended for implementation. The Council directed the Secretary General to invite contracting States concerned to communicate to him, preferably by 1 April and not later than 1 May 1957, their intentions in respect of the provision of cable facilities indicated in this recommendation and to provide also information on points covered in paragraph 1.2 (a), (b) and (c), which the Meeting considered were significant in the final choice to be made.

Recommendation No. 2 (page II-2)

The Council approved this recommendation and noted that it would only become applicable if the arrangements in Recommendation No. 1, using the cable, are not decided upon.

Recommendation No. 3 (page II-2)

The Council approved this recommendation and noted that the Air Navigation Commission would study the manner in which the intention of the recommendation might best be expressed in the NAT Regional Plan.

Recommendation No. 11 (page II-9)

The Council approved this recommendation noting that the practicability of using separate antennae for transmitting and receiving was closely related, among others, to questions of cost as indicated on Page II-7, paragraph 1.9.

Recommendations Nos. 16 and 17 (page II-18)

The Council approved these recommendations on the understanding that the initial purpose of designating channel assignments was to show the overall requirements for teletypewriter channels and that the specific channel assignments indicated might be revised before the VHF Forward Scatter or VHF Forward Scatter/Cable System is brought into operation.

Recommendation No. 23 (page II-21)

The Council approved this recommendation and noted that this approval constituted in part the action referred to in the footnote marked with two asterisks on page 2 of Annex I of the 1956 Agreement on Joint Financing of certain Air Navigation Services in Iceland (C-WP/2260) and that the remaining part of the action required is covered in Recommendation No. 24.

Recommendation No. 24 (page II-21)

The Council deferred action on this recommendation until after the method of linkage to be established between Reykjavik and Shannon/Prestwick is known.

Note

The Council noted that the Joint Financing Conference had provided financially for the improvements to the transmitters at Rjupnahead but that action to implement these improvements had been related by the Conference to the outcome of the Special NAT Fixed Services Meeting. The Council understood the intent of Recommendation No. 24 was to recommend deferment of implementation until after the situation with respect to the proposed cable between Iceland and the United Kingdom had been clarified (Recommendation No. 1) at which time the Meeting proposed that the views of States should be sought on the desirability of implementing the improvements. In deferring action on Recommendation No. 24 the Council reserves for later consideration the question of whether or not States views should be sought.

Recommendation No. 25 (page II-22)

The Council approved this recommendation and noted that this approval constituted the action referred to in the note at the foot of page 2 of Annex I to the 1956 Agreement on Joint Financing of certain Air Navigation Services in Greenland and the Faroe Islands (C-WP/2259) and in the note marked with a single asterisk at the foot of page 2 of Annex I to the 1956 Agreement on the Joint Financing of certain Air Navigation Services in Iceland (C-WP/2260).

Note

The Council noted that the RTT circuits referred to in part (2) of the preamble and in the second last line of the recommendation were those specified by the Technical Committee of the Joint Financing Conference (Geneva 1956) (paragraph 76 (i), C-WP/2258) and for which provision had been made in the Greenland and Icelandic Agreements (Annex I, page 2, C-WP/2259 and C-WP/2260). These RTT circuits had been included in the Agreements on the basis that no steps should be taken to implement them until the Meeting on VHF Forward Scatter had been held. In respect of the interim Manual Circuits between Goose Bay and Godhavn and between Prins Christians Sund and Reykjavik, the Council noted that the Joint Financing Conference had also included these circuits in the Greenland and Icelandic Agreements on a similar basis (paragraph 76, C-WP/2258).

In approving Recommendation No. 25 the Council recognized that this action constituted clearance to proceed immediately with implementation of the Manual Circuits referred to above, but that action to implement the RTT Circuits should be deferred pending a later review in the light of the development of the VHF Forward Scatter or VHF Forward Scatter/Cable project.

Recommendation No. 26 (page II-24)

The Council approved this recommendation and noted that it covered services in Greenland and Iceland for integrating ATC and Communication Centres with the VHF Forward Scatter or VHF Forward Scatter/Cable System and that financial provision had been made in Recommendation No. 34 for such of these services for which Joint Financing was requested.

Recommendation No. 27 (page II-25)

The Council approved this recommendation and directed the Secretary General to invite contracting States concerned to undertake the investigation recommended.

Recommendations Nos. 28 to 32 inclusive (pages III-1 and III-2)

The Council noted that implementation of the VHF Forward Scatter or VHF Forward Scatter/Cable System, together with communication services required for integration, was the responsibility of the States within whose territories the facilities would be installed and recommended to the States concerned the methods for coordinating implementation and securing coordination of procurement and engineering aspects as set forth in these recommendations. The Council instructed the Secretary General to give all practicable assistance to the Coordinating Group, if requested, and to inform States that the Council would be willing to undertake consideration of any relevant matters referred to it.

Note

The Council considered that the methods referred to in these recommendations offered an appropriate way of meeting the essential requirements of:

(a) securing the required performance of the communication system;

(b) assuring the engineering coordination necessary for effective operation as a system;

(c) obtaining the most rapid implementation.

Recommendations Nos. 34 to 37 inclusive (pages IV-1 and IV-2)

The Council approved the parts of these recommendations addressed to States participating in the 1956 Danish and Icelandic Joint Financing Agreements and instructed the Secretary General to invite action by them as indicated in the recommendations.

The Council also approved the parts of these recommendations under which it will assume certain responsibilities, and directed the Joint Support Committee in this respect to make appropriate recommendations to it in due course as necessary. The Council understood the provisions of paragraph 2 of Recommendation No. 35 as indicating that the action specified would be taken only when both the conditions regarding Joint Financing and the construction of stations which are not to be jointly financed had been assured.

- END -

FOREWORD

INTERNATIONAL CIVIL AVIATION ORGANIZATION

SPECIAL NORTH ATLANTIC FIXED SERVICES MEETING

Montreal, 3 January 1957

F O R E W O R D

This report contains the recommendations of the Special North Atlantic Fixed Services Meeting. The report will be reviewed by the Council of ICAO and approved with such modifications as may be deemed necessary. States concerned will be notified of Council action.

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LETTER OF TRANSMITTAL

To: The President of the Council

From: The Chairman of the Special North Atlantic Fixed Services Meeting, January 1957

I have the honour to submit herewith, for the consideration of the Council, the Report of the Special North Atlantic Fixed Services Meeting held in Montreal from 3 January to 21 January 1957.

J.C. Farmer
Chairman

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Agenda Item 2: (A) Consideration of essential system characteristics that require standardization from engineering and operational aspects including radiofrequency requirements.

(B) Cost of installation and operation.

(C) Technical coordination required for implementation.

Agenda Item 3: Review of the NAT Regional Plan with a view to recommendations concerning amendments to the existing fixed service plan, including means for integration with the Aeronautical Mobile Services, that should be made when a VHF forward scatter communication system is implemented.

Agenda Item 4: Consideration of the measures required to ensure the availability of the necessary financial means for implementing the system.

SECTION I. - CHAIRMAN'S REPORT

PART 1. - General

1.- PLACE AND DURATION OF THE MEETING

1.1 The Special North Atlantic Fixed Services Meeting was convened at ICAO Headquarters Office, Montreal on Thursday, 3 January 1957 and completed its work on 21 January 1957.

2.- OFFICERS OF THE MEETING

2.1 Mr. J.C. Farmer (United Kingdom) was elected Chairman of the Meeting and Mr. A. Lindestam (Sweden) was elected Vice-Chairman.

3.- REPRESENTATION

3.1 The Meeting was attended by the representatives of the following States and International Organizations:

CONTRACTING STATES

CANADA

Mr. H.A.L. Pattison	Chief Delegate
Mr. I.G. Barrowman	Delegate
Mr. O.L. Britney	Delegate
Mr. R.C. Graham	Delegate
Mr. B.J. McIntyre	Delegate
F/O J. Nyhuus	Adviser

DENMARK

Mr. H.T. Mølgaard	Chief Delegate
Mr. L. Søndergaard	Delegate
Mr. N.E. Holmblad	Adviser
Mr. P.K.B. Laursen	Adviser

FRANCE

Mr. G. Peidenis	Chief Delegate
Mr. L. Danel	Delegate
Mr. G.P.C. Dillard	Delegate

GERMANY (Federal Republic of)

Dr. F. Hentschel	Chief Delegate
Dr. F.U. Schmidt-Ott	Delegate

ICELAND

Mr. B. Jonsson	Chief Delegate
Mr. F.A.H. Diego	Delegate
Mr. E. Palsson	Delegate
Mr. S. Thorkelsson	Delegate

IRELAND

Mr. W.G. Algar	Chief Delegate
Mr. G.E. Enright	Delegate

ISRAEL

Mr. Y. Gaulan	Chief Delegate

NETHERLANDS

Mr. H.E. Moeshart	Chief Delegate

SPAIN

Comandante F. Tordesillas	Observer

SWEDEN

Mr. A. Lindestam	Chief Delegate

UNITED KINGDOM

Mr. J.C. Farmer	Chief Delegate
Mr. A.J. Bourne	Delegate
Mr. R.G. Fall	Delegate
Mr. N.J. Tolliday	Delegate
Mr. S.R. Brown	Adviser
Mr. L.J.I. Nickels	Adviser
Mr. M. van Hasselt	Adviser

UNITED STATES

Mr. C.H. Smith	Chief Delegate
Mr. R.C. Kirby	Delegate
Mr. H.R. Sanderson	Delegate
Mr. E.V. Shores	Delegate
Mr. R.Bateman	Adviser
Mr. W.W. Broomall	Adviser
Mr. D.K. Child	Adviser
Mr. H.G. Gatlin	Adviser
Lt. Col. R.E. Larson	Adviser
Mr. A.L. Lebel	Adviser
Mr. W.J. McKnight	Adviser
Captain J.T. Nolan	Adviser
Mr. R.M. Ringoen	Adviser
Dr. R.J. Slutz	Adviser

INTERNATIONAL ORGANIZATIONS

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

Mr. C.C.E. Bellringer	Observer
Mr. H.T. Blaker	Observer
Mr. F. Ellis	Observer
Mr. H.A. Ferris	Observer
Mr. A.W. Loke	Observer
Mr. H. Wiles	Observer

INTERNATIONAL FREQUENCY REGISTRATION BOARD (IFRB)

Mr. J.A. Gracie	Observer

4.- SECRETARIAT

4.1 The Meeting was assisted in its work by Mr. F.M. Booth and Mr. C.S.H. Tsiang. Mr. P. Oomen, Acting Chief, Communications Section acted as Secretary during the first part of the Meeting and Mr. H.R. Adam, Acting Chief, Ground Branch during the latter part.

5.- LANGUAGES

5.1 The Meeting was conducted in both English and French, the language services being under the supervision of Mr. F. Dufau-Labeyrie.

6.- APPROVAL OF THE AGENDA

6.1 The Agenda transmitted to the Meeting by the Air Navigation Commission was amended, the amended version appearing on page I-1. The changes in the Agenda concerned a regrouping of the problems contained in the original Agenda.

7.- WORKING ARRANGEMENTS

7.1 The Meeting established three Committees (A, B and C), as follows:

Committee A: To deal with Agenda Item 2, with the understanding that the material collected under Item 2 (B) for the establishment of cost data would be passed to Committee C for finalization.

Committee B: To deal with Agenda Item 3.

Committee C: To deal with Agenda Item 4.

A "Committee of the Whole" dealt with Agenda Item 1.

In addition, a Coordinating Committee was established to plan and review the progress of the work of the Meeting as a whole.

7.2 The following officers were elected for the Committees A, B and C:

Committee A - Mr. E. V. Shores (United States), Chairman; and Mr. Moeshart (Netherlands), Vice-Chairman;

Committee B - Mr. H. T. Mølgaard (Denmark), Chairman; and Mr. Danel (France), Vice-Chairman;

Committee C - Mr. H. R. Sanderson (United States) Chairman; and Mr. G. Piedenis (France), Vice-Chairman.

7.3 The Committees formed the following Working Groups to examine and report on specific problems:

Working Group of Committee A on Frequencies - Rapporteur, Mr. O. L. Britney (Canada).

Working Group B-1 on Revisions to the NAT Plan - Rapporteur, Mr. R. G. Fall (United Kingdom)

Working Group B-2 on Integration of Mobile with Fixed Services - Rapporteur, Mr. O. L. Britney (Canada).

PART 2 - REPORT ON THE AGENDA

Adoption of Agenda

After some discussion during the first Plenary session, the Meeting decided to amend the Agenda as transmitted by the Air Navigation Commission. However, the amendments did not alter the substance of the Agenda, it being agreed that the changes introduced neither added to nor subtracted from the problems included in the original, but were considered desirable to facilitate the work of the Meeting. The Agenda as amended appears on page I-1.

Agenda Item 1: Consideration of specific proposals for a NAT Fixed Service Communications System using ionospheric forward scatter propagation and determination of the capability of such a system in respect of (a) the basic requirements of inter-centre speech between major ATC centres; and (b) the requirements for teletypewriter circuits serving these centres.

Consideration of Specific Proposals

1.1 The proposal of the United States that the Meeting recommend that the use of VHF Forward Scatter be selected as offering the most suitable and readily available means of meeting the stated requirements for reliable inter-centre speech communications linking Gander, Reykjavik and Prestwick/Shannon was studied in the light of extensive documentation that had been submitted by the United States and an exposé by experts in special aspects of the subject.

1.2 Particular attention was given to the results of a lengthy series of observations that had been made in the United States on a number of diverse circuits several of which were operated in circumstances similar to those proposed.

1.3 A number of the technical aspects of VHF Forward Scatter System were discussed in detail in order to determine whether such a system could satisfy the operational requirements with a sufficiently high reliability, and with the required quality of telephony and telegraphy channels.

1.4 The Meeting agreed, after considerable discussion, that VHF Forward scatter offered an acceptable solution to the problem before the Meeting; however, it was also agreed that there was a need to consider both complete and partial alternative systems.

1.5 In this connection, Iceland presented a proposal for a cable connection in lieu of an ionospheric scatter circuit between Iceland and Scotland, and indicated its fullest support for the urgent need for a speech circuit between controllers and for improved teletypewriter connections. The Iceland proposal described the advantages that might be obtained through a cable connection instead of a scatter propagation link between Iceland and Scotland. Of particular interest were the standards of service that could be expected and the experience in respect of cable failures that have been accumulated over many years;

as an approximate figure of failure probability, one interruption in three years was given. An average duration of interruption of from 10-14 days was given with 20 days as being a reasonable figure for the maximum period. With respect to the question of assurance that the cable would be installed, it was indicated that a definite answer to this question could be expected within three months if the views of the Meeting were favourable to the possibility of using the cable.

1.6 During the discussion on the merit and de-merit of the cable project, it was pointed out that there could be no economic justification for two cables but that the present RTT circuit might provide a back-up for telegraph channels having regard to the unlikelihood of frequent occurrence of failures.

1.7 The United Kingdom also proposed an alternative solution, based on the need to satisfy ATC requirements for speech channels, and to effect immediate improvement in teletypewriter facilities. The UK proposal contained a phased plan of implementation and in particular, the plan provided for the immediate use of the Transatlantic Telephone Cable in the very important liaison between Gander and Prestwick/Shannon without contractual obligations of a long term character, and for the later use of the proposed United Kingdom-Iceland Cable. The proponents of the latter plan for phased implementation felt that there was a need to combine the encouraging possibilities of forward scatter and other facilities so as to assure progressive improvements and to minimize undue risk if the expected performance of the Forward Scatter System were not fully realized. If the Forward Scatter System was satisfactorily demonstrated over a single link, it should be financially attractive to extend it forthwith.

1.8 The Meeting adopted Recommendation No. 1 found in Section II of this Report, which defines in broad terms the system recommended by the Meeting.

European Terminal of VHF Forward Scatter System if a cable Iceland-Scotland is not decided upon

1.9 The Meeting considered a variety of technical and operational factors relating to the choice of site for the European terminal and after an extensive presentation of viewpoints agreed to Recommendation No. 2.

Agenda item 2(A): Consideration of essential system characteristics that require standardization from engineering and operational aspects including radiofrequency requirements.

Performance requirements of ionospheric scatter system and essential characteristics

2.1 With respect to Agenda Item 2 (A), the Meeting based its work on the assumption that the "prime contractor" concept referred to in Rec.30 would be employed, and on the further assumption that the implementing States would arrange

subsequent to this meeting to establish an appropriate coordinating body to assure complete cooperation and coordination in carrying out their responsibilities for implementation of the VHF Forward Scatter/Cable or VHF Forward Scatter project. A proposal by a Prime Contractor, for acceptance by the implementing States, would include detailed system design with antennae, equipment types and characteristics standardized to the extent necessary to insure proper functioning as an integral system.

2.2 With these points established, it was decided that only certain essential system characteristics should be standardized, and these to the extent necessary to:

(a) assure performance reliability of the system;

(b) establish minimum channel requirements and flexibility of channel utilization;

(c) provide adequate safeguards against the development of serious frequency interference problems which might otherwise occur; and

(d) achieve reasonable economy.

2.3 The system reliability expected to be achieved is stated under Recommendation No. 4 (for the teletypewriter, sub-paragraph (a)), and for the telephone channel (sub-paragraph (b)). To achieve this reliability and to minimize harmful interference the meeting agreed to Recommendations No. 5 and No. 6.

2.4 The performance specification itself was based partly on the anticipated performance of systems already developed, and partly on the actual operational performance which would be required of such a system in practice.

2.5 By limiting system characteristic specifications to those referred to above, the meeting considered that the implementing States and contractors would have maximum flexibility to make use of the latest advances in equipment, design, and selection of modulation techniques on the basis of the latest technical data available at the time of inviting tenders, and with the possibility of subsequent revisions being permissible up to the point of actual implementation.

Under these conditions, it was felt that it would be possible to assure that the system actually implemented will meet the basic aviation requirements as established in Recommendation No. 4.

2.6 Possible standardization of other elements of the system not specifically referred to here, such as teleprinter modulation rates, is intended to be left to the implementing States. It was assumed that this would be done in consultation with the selected Prime Contractor.

2.7 The frequency aspects of the VHF Forward Scatter System were gone into thoroughly and in this regard the meeting was greatly assisted by the availability

and participation of Mr. John A. Gracie, IFRB. The conclusions of the meeting with respect to the coordination of the selection, assignment and use of frequencies in the Forward Scatter System will be found at paragraphs 1.11 to 1.16 of Section II.

Reasons for selection of a two-frequency system

2.8 The first "scatter" circuits were operated in the band between 30 Mc/s and 40 Mc/s. Propagationally these frequencies appeared to offer the most promise of furnishing the desired service with the transmitter powers available at that time. Frequencies below about 25 Mc/s suffered considerable absorption thus introducing the same problems as did the HF operations. Frequencies above about 40 Mc/s were not used primarily because of the added power that was necessary to ensure reasonable circuit reliabilities.

2.9 Experience has shown that operation of VHF Forward Scatter Systems below the MUF for "F2" layer propagation has resulted in harmful interference over long distances to other services which, at times, is so serious as to completely disrupt, for hours at a time, entire systems consisting of hundreds of stations. Interference can also be experienced by the scatter signal due to "back scatter" circuits from other services. A third form of interference was to the received scatter giving rise to serious multipath distortion. (It is now believed, however, that the last type of interference may be avoided in the future by improved design of antennae used with VHF Forward Scatter Systems and special design of terminal equipment for telegraph services.)

2.10 One method of avoiding mutual interference with other services would be to clear individual frequencies in the 31.7 to 41 Mc/s band in which Fixed Services are permitted to operate under ITU Radio Regulations in all Regions. It appears that this would permit economical and efficient operations of the necessary ionospheric scatter circuits on the assumption that the anticipated improvement by the reduction of "back scatter" will be achieved.

2.11 The circuits under consideration fall in ITU Regions 1 and 2. Region 1 includes the European Coast and Iceland while Region 2 encompasses Greenland and the East Coast of North America. Although none of the circuits will fall in Region 3, it is noted that harmful interference caused by VHF Forward Scatter operations may be world-wide.

2.12 The ultimate long-term solution to the frequency problem would almost certainly seem to lie in world-wide allocation through the International Telecommunications Union of a band or bands of appropriate frequencies above 30 megacycles exclusively to meet the requirements for VHF Forward Scatter Systems. It would appear to be premature for the Special NAT Fixed Services Meeting to develop specific recommendations for ITU action in this regard. The matter, however, should be reviewed by ICAO before the next ITU Administrative Radio Conference.

2.13 In any case the time required to formulate and eventually reach international agreement on world-wide allocation of the necessary exclusive band or bands of frequencies even if relatively narrow could not be less than about five years.

For this reason it is considered impractical to await this solution to the problem and the Meeting should be prepared to go forward with plans for installation of the scatter stations recognizing that it will be necessary to select and use individual frequencies in accordance with the applicable provisions of the ITU Radio Regulations so as to minimize the probabilities of harmful interference.

2.14 In this connection studies of existing VHF Forward Scatter Systems together with development work reported at the Meeting indicate that it is practicable to operate a given scatter station on frequencies which are selected so as to reasonably assure that they will remain above the MUF for F2 layer propagation and at the same time permit the desired service to be rendered. The penalty for operation on higher frequencies is a requirement for higher power or reduced circuit reliability. On the other hand the use of frequencies above the MUF for F2 layer propagation very greatly reduces the problem of long distance mutual interference with other services. The use of higher frequencies above 50 Mc/s is therefore a method of achieving the desired service by using frequencies which will not extensively give rise to F2 layer propagation.

2.15 There would be no objection from a performance aspect to single frequency operation of the system on the basis that the single frequency selected would be above the maximum MUF for F2 layer propagation that is expected to occur both over the transmission path and over the interference paths. It is noted, however, that continuous use of such a frequency would result in increased running costs because of the higher power required to retain the necessary circuit reliability.

2.16 It has been determined that with a station operating with two available frequencies, one in the 30 to 40 Mc/s band and the other above the maximum frequency which will permit F2 layer propagation, the lower frequency could be used during most of the eleven-year sun spot cycle. The higher frequency would be required during day periods of high sun spot activity. For instance, had the lower frequency been selected in the order of 40 Mc/s the high frequency would have been required for periods ranging up to several hours per day during the winter months in 1956 and 1957.

2.17 In the selection of the higher frequency it must be recognized that if a frequency of the order of 55 Mc/s has to be used the circuits will be operating in bands allocated under existing ITU Radio Regulations to other types of service and therefore operation is only permissible on a non-interference basis.

Agenda Item 2 (B): Cost of installation and operation

2.18 Estimated costs for the VHF Forward Scatter/Cable and VHF Forward Scatter System were developed in considerable detail by the Committees dealing with engineering aspects and transmitted to the Committee considering financial aspects. The results appear in Supplement B of the Report.

Agenda Item 2 (C): Technical coordination required for implementation

Organization and Time Schedule for Implementation

2.19 The Meeting agreed that the question of implementation of the VHF Forward Scatter System/Cable or VHF Forward Scatter System presented many unusual features. In particular, the closest possible coordination in technical planning and implementation would need to be sustained through all phases of the work. To provide means for accomplishing this a Coordinating Group of Representatives of States within whose territory the terminals will be installed was recommended (Recommendation No. 28).

2.20 Also because the proper functioning of the system as a whole, together with the detailed planning and coordination of implementation, will necessitate the closest possible coordination of engineering, procurement and installation aspects, the Meeting agreed that responsibility for the overall control and completion of the project should be placed in the hands of a single Prime Contractor selected by the States concerned (Recommendation No. 30). Certain aspects relating to contracts were also the subject of Recommendations (Recommendations Nos. 31 and 32).

2.21 Consideration was also given to the question of maintaining good operation after implementation. It was suggested that provision should be made for manufacturers experts to visit forward scatter stations regularly to ensure such operation. The Meeting recognized that this question was largely a matter for the States concerned but was of the opinion that full consideration should be given to the suggestion in the preparation of relevant contracts or agreements.

2.22 The Meeting also prepared a time schedule for implementation based on certain assumptions respecting dates by which a complete implementation could be expected to begin. The schedule suggested represented the best estimate that could be made in the light of information available. However, the need to take all practicable steps to expedite implementation was strongly emphasized and the hope was expressed that a more rapid implementation might be possible.

Agenda Item 3:* Review of the NAT Regional Plan with a view to recommendations concerning amendments to the existing fixed service plan, including means for integration with the Aeronautical Mobile Services, that should be made when a VHF forward scatter communication system is implemented

3.1 The Meeting examined this item by considering those circuits in the current NAT AFTN Plan which might become redundant or require rerouting with the implementation of a VHF Forward Scatter/Cable or a complete VHF Forward Scatter System. It was noted that the Prestwick-Reykjavik manual circuit shown in the current plan had been discontinued and following a review of the circuits now in operation, the Meeting agreed that none of them should be discontinued until come time after the VHF Forward Scatter/Cable or VHF Forward Scatter System was put in service. (See Recommendation No. 18).

* See statement of Sweden in Appendix A.

Existing and Proposed Circuits likely to require re-examination

3.2 It was agreed that the status of the following existing and proposed circuits could be affected by the introduction of the VHF Forward Scatter/Cable or VHF Forward Scatter System and that they should be reviewed at an appropriate time following the introduction of this system (See Recommendation No. 19).

Gander-London	Gander-Reykjavik
Gander-Shannon	London-Reykjavik
Narssarssuaq-Reykjavik	Prestwick-Reykjavik
Prestwick-Stavanger	Raykjavik-Thule
Reykjavik-Nord	

This list excludes those circuits considered by the Joint Finance Conference (Geneva, 1956). It was agreed that the Gander-London and Gander-Shannon circuits were those most likely to be retained for reasons of increased traffic. To ensure that no operating terminal would discontinue any of the circuits listed without adequate examination of its overall requirement by the States concerned, the Meeting adopted Recommendation No. 20.

Circuits Reykjavik-Thule and Reykjavik-Nord

3.3 The Meeting noted that when the FICs at Nord and Thule are implemented there might be some advantage in considering the replacement of these two circuits in the NAT Plan by Nord-Narssarssuaq and Thule-Narssarssuaq circuits, connection to Reykjavik being effected over the Narssarssuaq-Reykjavik VHF Forward Scatter link.

Circuit Prestwick-Stavanger

3.4 The Meeting was of the opinion that the need for this circuit as a NAT Plan requirement, namely to serve as a standby for the London-Reykjavik circuit, would no longer exist with the introduction of the VHF scatter or cable circuit to Reykjavik but did not recommend its deletion pending its consideration by the 4th EUM Meeting. (See Recommendation No. 21).

Review of recommendations for improvements to the NAT Fixed Services Plan

3.5 The Meeting reviewed COM Recommendations 1-13 of the Third NAT RAN Meeting and Recommendations 45 and 51 of the Special NAT RAN Meeting (Paris, 1956) and taking into account that air traffic in the North Atlantic increases 100% every five years and jet operations are about to be introduced, the Meeting considered that the recommendations for improvements to NAT fixed service facilities contained in COM Recommendations 1-13 of the Third NAT RAN Meeting have become increasingly important and should be implemented and/or progressed with minimum delay.

3.6 The Meeting gave particular consideration to Third NAT RAN COM Recommendations 2, 3 and 7 and recognized the desirability of

(a) implementing the triangulation of the New York-London circuit via San Juan as soon as possible;

(b) utilizing to better advantage a southern circuit for traffic to New York and affecting early improvement to the Santa Maria - New York circuit;

(c) joint visits by Air Traffic Control and Communication personnel at station level so that both aspects may be coordinated simultaneously;

(d) considering the deployment of error correction to radiotele-typewriter circuits in the North Atlantic region as a specific technique capable of improving reliability.

3.7 With regard to the deployment of error correction equipment the Meeting adopted Recommendation No. 22.

Consideration of circuits referred to the Meeting by the Joint Financing Conference (Geneva, 1956)

3.8 The Meeting noted that while the Joint Financing Conference had recommended the inclusion of:

(i) the RTT links between Gander and Prins Christians Sund and Prins Christians Sund and Reykjavik;

(ii) the improvements to Reykjavik-London RTT link at Reykjavik;

this had been on the basis that implementation should be deferred until the findings of this Meeting were known.

3.9 The Joint Financing Conference recognized that a delay in the implementation of either the RTT links or the VHF Forward Scatter System would occur and that the effects of this could in part be overcome by the installation of the following interim aids:

(i) a manual circuit between Prins Christians Sund and Reykjavik to provide an outlet for air/ground reports;

(ii) a direct manual circuit between Godhavn and North America for handling Greenland MET data.

3.10 The Meeting considered:

1) The dates by which the various new circuits and improvements to the Reykjavik terminal of the London-Reykjavik circuit could be implemented;

2) The operational advantages to be gained by implementing these various facilities and the relative gains arising from particular aspects;

3) The relative costs of the various possibilities and concluded, assuming approval by Council within one month of this Meeting, that:

i) manual circuits between Godhavn and Goose Bay and Prins Christians Sund and Reykjavik could be installed by late 1957 at an estimated cost of $32,000;

ii) RTT circuits between Gander and Prins Christians Sund and Prins Christians Sund and Reykjavik could be installed by Spring, 1958 at an estimated cost of $345,000;

iii) a highly selective receiver with associated antenna could be installed at the Reykjavik terminal of the London-Reykjavik circuit by June 1957 at an estimated cost of $20,800;

iv) the balance of improvements to the Reykjavik terminal of the Reykjavik-London circuit would take 15 months from date of approval.

The Meeting accordingly made Recommendations Nos. 23, 24 and 25.

Agenda Item 4:* Consideration of the measures required to ensure the availability of the necessary financial means for implementing the system

4.1 The Meeting examined this item by considering (a) methods of financing, (b) estimated costs of those parts of the system requiring Joint Financing, and (c) an implementation schedule for obtaining the necessary financial assurances.

Methods of financing

4.2 After discussion, the Meeting agreed to the use of Joint Financing, utilizing Article VI of the existing 1956 Danish and Icelandic Agreements, as a means of implementing those parts of the system requiring Joint Financing through ICAO. The Representative of Canada indicated that he would recommend that his Government provide that part of the system located in its territory, and the Representative of the United Kingdom indicated that his country would not require Joint Financing for that part of the system

*See statement of Sweden in Appendix A.

located in its territory. On the other hand, the Representatives of Denmark and Iceland -- and to a limited extent Ireland --indicated that the actual provision of Services by their Governments was dependent upon Joint Financing through ICAO.

4.3 The Delegation of the United States indicated, on behalf of its Government, its willingness to assume its share of the financial responsibilities incident to the implementation of the VHF Forward Scatter System or the VHF Forward Scatter/Cable System in Greenland and Iceland, subject to the appropriation of funds by the United States Congress.

4.4. The French Delegation indicated that, from the point of view of method, it had no objection to the integration of the financing of the new system in the Geneva Agreements of September 1956 without any of the clauses of these agreements being altered or amended. The French Delegation was guided in this by considerations of efficiency, and wish to ensure that the implementation of the system was initiated, as soon as possible. However, if subsequent to the Meeting and upon consultation of the States it were to appear that the consensus obtained is not sufficiently wide for the provisions of Article VI of the Agreement to come into effect, and that therefore, new Agreements prove to be necessary, the Council of ICAO should as soon as possible, convene a special Meeting charged with the study of a new method of financing; the Council should, beforehand, undertake the study provided in paragraph 2 of Recommendation No. 1, of the Geneva Conference. These Agreements would indeed be more equitable if they did not place the financial burden associated with the facilities concerned solely upon civil aviation.

4.5 The Canadian and United Kingdom Delegations indicated that, in so far as they were finally satisfied, they were willing to recommend that, on the basis that the VHF Forward Scatter or the VHF Forward Scatter/Cable System will be implemented as a whole, their Administrations give consideration to the acceptance of their responsibilities under existing Joint Financing Agreements.

4.6 An exchange of views in the Meeting on user charges as an alternative to Joint Financing was not pursued to any definite conclusion. It was noted, however, that the Council had taken action with regard to Recommendation 3 of the Geneva Joint Financing Conference, "Examination of the problem of levying charges for the use of jointly financed Services", directing that the Air Transport Committee give consideration to the inclusion of an appropriate agenda item when framing the agenda for a future ICAO Conference on Charges for the Use of Air Navigation Facilities.

Estimated costs of those parts of the system requiring Joint Financing

4.7 The Meeting discussed the cost of establishing the system as a whole. The Meeting then approved appropriate descriptions of the Services and approved estimated capital costs and annual operating and maintenance expenses for the Greenland and Icelandic portions of the network, as shown in Appendices 1 - 12, Supplement B of this Report.

In accordance with paragraph 1, Part C of the Financial Annex to the 1956 Joint Financing Agreements, the Meeting agreed that for administration of the Services to be provided by Denmark and Iceland, an amount of 10% for administration may be charged on the total annual operating and maintenance expenses, except that in so far as the projected cable link was concerned, only 5% would be charged by Iceland (which would simply counterbalance on this item the 5% Iceland normally absorbs pursuant to Article II of the 1956 Joint Financing Agreements). The Meeting agreed that the rate of depreciation for buildings be 6.6% per annum and that the rate of depreciation for equipment be that specified in Part C, paragraph 2.2 of the Financial Annex of the existing Agreements; namely, 10% per annum for antenna towers and counterpoises, machinery and tools and communications equipment, 20% per annum for vehicles, and 5% per annum for storage tanks. It was also agreed that the rates of interest and insurance premiums be the same as those specified in paragraphs 3 and 4 of Part C of the Financial Annexes. In connection with insurance premiums, the Committee noted that the Council had taken action with regard to Recommendation 2 of the Geneva Joint Financing Conference. "Examination of the possibility of insuring on replacement values", approving the Recommendation and noting that the Joint Support Committee had requested the Secretary General to take the action indicated. The Meeting recast the agreed capital costs in the form of Annex II - Inventory of the existing Agreements and calculated insurance premiums at the rate of 3/4% per annum. It was further agreed that 50% of the annual rental for the cable between ATC centres in Iceland and the United Kingdom, if provided, be jointly financed as annual operating expenses under the Icelandic Joint Financing Agreement.

4.8 Accordingly the Meeting utilizing the data shown in Appendices 1 - 12 in Supplement B of the report, agreed to recommend that these Services be jointly financed pursuant to Article VI of the 1956 Joint Financing Agreements and that, for the purpose, the Article V limit of the Danish Agreement be increased by an amount of 385,574 United States dollars and the Article V limit of the Icelandic Agreement be increased by an amount of 434,591 United States dollars. (See Recommendation No 34 in Part IV of Report).

Implementation schedule for obtaining the necessary financial assurances

4.9 In view of the great urgency for implementing the system and taking into account the implementation schedule which Committee A had developed, the Meeting agreed that necessary statements by implementing States and consents to Joint Financing should be furnished preferably by 1 April 1957 but not later than 1 May 1957. (See Recommendation Nos. 35 and 36). It was noted that under Article VI of the 1956 Joint Financing Agreements consents would be needed from governments responsible in the aggregate for not less than 90% of the Article VII total assessments in respect of the last calendar year for which assessments have been made. It was further noted that the Secretariat would transmit advance copies of the Report of this Meeting to Belgium, Italy, Norway and Switzerland as soon as possible, calling their attention to the implementation schedule for obtaining the necessary financial assurances.

Steps to be taken in the event that sufficient consents are not received by 1 May 57 to apply Article VI of the 1956 Geneva Agreements

4.10 The Meeting discussed two proposals on this matter. The Representative of the United States proposed that, in the event consents to Joint Financing are not received by 1 May 1957 from States responsible in the aggregate for 90% of the total annual costs of the forward scatter project, the Council of ICAO forthwith open for signature new Joint Support agreements covering the forward scatter services (including the necessary communications links incident thereto) in Greenland and Iceland, these agreements to be identical with the standard Geneva Agreements in all respects save the Article dealing with the percentage of adherences necessary to bring them into effect and the percentage of consents necessary for the addition of new Services under Article VI. The new figure should be fixed at eighty (80%) percent.

4.11 The Representative of France, on the other hand, proposed that under such circumstances the Council of ICAO convene, as soon as possible after consultation of the States concerned, a Special Meeting charged with the study of any new solutions for the Joint Financing of the facilities concerned; and that the Council undertake as a matter of the highest priority the study provided in paragraph 2 of Recommendation No. 1 of the Geneva Conference, for subsequent submission to this new Meeting.

4.12 At the conclusion of the discussion, the Meeting agreed upon a general recommendation urging the Council, in the event that sufficient consents are not received by 1 May 1957, to forthwith give consideration to the initiation of whatever steps appear appropriate to assure implementation of the system with a minimum of delay. (See Recommendation 37 in Part IV of Report).

Site for VHF Forward Scatter System in Iceland

4.13 In considering the costs of the Forward Scatter Stations in Iceland, the Meeting noted that difficulty might arise in finding a single site for both Reykjavik-Narssaq and the Reykjavik-Europe circuit if the latter is installed. It further noted that the cost of two separate stations would be considerably greater than that of a single station. It was, therefore, very desirable that every effort be made to discover a single site at which terminals for both circuits could be located. Also because of problems of accommodation of staff, power supplies, etc., it was emphasized that if at all practicable the sites should be in the proximity of Reykjavik. The Icelandic Representatives indicated that they were fully aware of the need to find this kind of site and would make every effort to do so.

SECTION II.- PART 1 - REPORT AND RECOMMENDATIONS ON FACILITIES AND SERVICES

Part 1 - VHF Forward Scatter/Cable or VHF Forward Scatter System

Recommendation No. 1:* VHF Forward Scatter/Cable System

1.1 That there be installed a point-to-point system of Forward Scatter to connect Gander, Southern Greenland, Reykjavik and Prestwick/Shannon, providing one (1) direct speech and four (4) teletypewriter channels;

1.2 That the Forward Scatter link between Iceland and Prestwick/Shannon be deleted from the Plan provided that reasonable assurance is given by the implementing governments prior to May 1, 1957 that:

a) a cable will be provided no later than the Spring of 1959 which both technically and administratively will be connected to the Forward Scatter links so as to form one complete and integrated system;

(b) such cable will provide one (1) direct speech and four (4) teletypewriter channels for aeronautical use;

c) the financial considerations are reasonable and satisfactory.

Siting of European Terminal of VHF Forward Scatter System if the cable specified in Recommendation No. 1 (b) is not decided upon.

1.3 Taking into account the following technical and operational factors:

a) The problems of siting;

b) The existing and likely development of North Atlantic air traffic and the communication requirements associated therewith;

c) The advantages and disadvantages of possible sites from a frequency interference aspect;

d) The requirement for ready communications access to the VHF Forward Scatter System from a relatively large number of places in Europe;

e) The possibility of integrating the proposed station with existing communication facilities from an administrative and staffing aspect;

*See statement of United Kingdom in Appendix A.

f) The operational necessity for the earliest practicable implementation of the system as a whole;

and while noting that in respect of some of these factors and in particular (b), a site at Shannon offered features of merit, the Meeting agreed to the following recommendation.

Recommendation No. 2:* Location of the European Terminal of the Forward Scatter System

That the European terminal of the VHF Forward Scatter System should be implemented in the United Kingdom unless subsequent to this Meeting such implementation is found to be impracticable because of frequency problems and:

That the European terminal of the VHF Forward Scatter System be installed in Ireland in the event that frequency problems prevent implementation in the United Kingdom.

Inclusion of VHF Forward Scatter/Cable or Forward Scatter System in North Atlantic Regional Plan

1.4 As a consequence of the foregoing recommendations and in order to avoid the possibility that the component links of the system might be considered as separate complete requirements instead of as a system, the Meeting made the following recommendation.

Recommendation No. 3: Amendment of the NAT AFTN Regional Plan

That the Council incorporate the VHF Forward Scatter System described in Recommendations Nos. 1 and 2 into the North Atlantic Regional Plan as a complete integrated system of fixed service communications.

*See statement of United Kingdom in Appendix A.

Performance requirements

1.5 The reliability of the VHF Forward Scatter System is anticipated to be of a high order, due to the propagation characteristics of the system. This high reliability can be easily degraded if the overall equipment reliability is not of a high standard.

1.6 It was considered necessary, therefore, to specify the propagation reliability required, and to separately specify the percentage of time during the year which should not be exceeded for outages due to system planning, design, equipment construction and installation which could be attributed to the contractor.

Recommendation No. 4: VHF Forward Scatter System Reliability

That the VHF Forward Scatter System should be capable of achieving the following performance requirements:

a) Teletypewriter Channels

The performance achieved in respect of any teletypewriter channel over a single link of the system should be such that the character error rate is 0.1% or better (not more than one error in every thousand transmitted characters) for 99% of the total number of 10-minute periods in a year. This means that more than one error in every thousand characters may occur during 1% of the total 10-minute periods in a year. A reduction of up to 20% in the normal message rate on account of the use of error correction methods is tolerable if necessary in order to achieve this performance.

Note: Provision has been made in the capital cost estimates (Item 1) for Greenland and Iceland to allow for the possible provision of error correcting devices.

b) The performance achieved in respect of any telephone channel over a single link should be such that the following test-tone signal to noise (RMS) ratios are achieved (i) better than 6 decibels for at least 99% of the year, and,
(ii) better than 15 decibels for at least 90% of the year.

Note 1: In the foregoing specification the test-tone signal is a single frequency tone input to the transmitter adjusted to 6 decibels below that sufficient to produce 100% modulation. The signal to noise (RMS) ratio is measured at the output of the receiver (3 kc/s bandwidt at the receiving station. This corresponds to the basis of measurement adopted by the CCIR*.

*Note 2: The quality of service associated with a test-tone signal to noise (RMS) ratio of 6 decibels corresponds to a CCIR "operator to operator" grade of speech circuit which would give an intelligibility of about 90% on unrelated words, and would be just useable for controller to controller communications.

The quality of service associated with a test-tone signal to noise (RMS) ratio of 15 decibels corresponds to a CCIR "marginally commercial" circuit which would give approximately 100% intelligibility. When signal to noise conditions of this order prevail, a satisfactory service should be available between controllers over two or three links.

Note 3: The percentages of time specified do not include the time during which an outage occurs or the quality of service is degraded due to equipment performance or failure; also they do not include the times when the service is degraded or lost because of interference from other services or from man-made noise arising from sources external to the equipment of the system.

c) Performance of equipment

The percentages of time relating to the performance as specified 3.1.2. (a) and (b) should not be reduced by more than 1.5% because of design, equipment and construction factors which are reasonably assignable to manufacture and installation. However, this performance requirement need not become applicable until after an initial period of adjustment and training of approximately one year.

d) Interfering emissions

The radio frequencies used and the design arrangements should be such as to achieve minimum interfering emissions consistent with the state of the art.

* See CCIR Recommendation No. 99, London 1953.

Equipment and Site arrangements

1.7 The Meeting considered that the performance requirements embodied in the preceding Recommendation would require certain physical arrangements, power capabilities and operational features in respect of certain components of the system and included these requirements in the following Recommendation.

Recommendation No. 5: Essential Specifications for VHF-Forward Scatter System

That the following specifications should be accepted as essential requirements in order to meet the performance required of the VHF Forward Scatter System as an integrated system.

a) Each transmitting station of the system should be capable of feeding to its antenna a peak envelope power of the order of 100 kW. Full standby electronic equipment and primary power sources should be provided (Two transmitters, each capable of feeding a peak envelope power of 50 kW to the antenna and which may be connected in parallel would meet the requirement for peak power capability and stanby).

b) Each transmitter should be capable of operation on two frequencies, one of which is selected from the 30-45 Mc/s band and the other from the 45-60 Mc/s band.

Note While radio frequencies for assignment to stations of the system should be selected from the bands 31.7 to 41 Mc/s and 50 to 60 Mc/s (Paragraph 1.11), the Meeting considered that transmitters should be capable of being set up on two frequencies, one in the band 30-45 Mc/s and the other in the band 45-60 Mc/s.

c) Facilities should be associated with the transmitters at each station to provide for a change of transmissions between the two available frequencies and for an adjustment of power with minimum outage to the circuit. These facilities should enable a change of frequency to be set up within 15 minutes. After the change has been set up it should be possible to make the change within 10 seconds.

Note This provides for a maximum period of 10 seconds when the transmitter may be off the air. At the same time it permits operation on reduced power while the two 50 kW transmitters are consecutively withdrawn from use. The 15-minute period refers to the setting up time for each of the individual transmitters.

d) Transmitting and Receiving antenna gains (for plane wave) of about 18 decibels relative to a dipole at the same height should be provided together with siting of the antenna appropriate for ground reflection reinforcement of the pattern.

Note The realized gain of the antennae should be as high as practicable, consistent with economic and other factors. Antennae having gains of the order of 18 decibels (plane wave) relative to a dipole have been found suitable in existing VHF Forward Scatter circuits. If antenna having plane wave gains lower than 18 decibels should be proposed, it should be demonstrated that such antennae have compensating advantages from the standpoint of realized gain, reduction of multipath effects or other advantages which would outweigh the lower value of plane wave gain.

e) Receiving arrangements should provide for space-diversity reception normal to the path at each station.

f) Antenna sites should be selected so as to be isolated from man-made noise sources.

g) Uniformity in equipment such as antennae, modulation characteristics, equipment capabilities and operating features should be achieved where necessary. (Such uniformity should be achievable by coordination through a Prime Contractor.)

Emission requirements

1.8 In order to minimize interfering emissions to the extent consistent with the state of the art, the Meeting considered that two-frequency operation was essential, and, that certain provisions should be specified regarding the selection of frequencies to accomplish this, together with specifications limiting unwanted emissions. The Meeting embodied its conclusions on this matter in the following Recommendation.

Recommendation No. 6: Emission Requirements for VHF Forward Scatter System

That the following specification be accepted in establishing the system specifications:

a) The design of antenna should be such that the front-to-back ratio is at least 30 decibels and front-to-minor lobe ratio is at least 18 decibels; (see also para. 1.19).

b) The frequency assignments to stations of the system should be such as to permit operation at all times sufficiently above the monthly median hourly F2-4000 MUF, as specified by Recommendation 9.

c) Spurious emissions should not exceed the levels specified in paragraph 1.18.

d) Facilities should be available to permit the power fed to the transmitting antennae to be adjusted to appropriate levels over a range of at least 20 decibels (100:1). (See Recommendation 13).

Operational and Cost Factors

1.9 The Meeting recognized that considerable flexibility exists in respect of system arrangements that could be adopted. It considered, however, that for operational standardization and for minimum cost, the following features were important.

For Operational Standardization

(a) The availability of duplex teletypewriter operation between each station;

(b) An agreement on modulation rate(s) to be used (baud speed).

For Minimum Cost

(a) Dual transmitters arranged to feed additively and each designed to permit efficient operation at less than maximum power.

(b) Use of common antenna for both transmitting and receiving; to make this possible frequency assignments providing at least 2 Mc/s separation between the transmit and receive frequencies will be required (See also para. 1.15 and Recommendation No. 11).

(c) Use of the same antenna for both frequencies assigned to the transmitter.

Frequency Selection and Planning

Recommendation No. 7: Frequency Assignment for VHF Forward Scatter System

That a frequency assignment plan for all stations of the projected VHF Forward Scatter System be established by the Administrations concerned as soon as practicable;

That in the establishment of this plan the Administrations concerned be guided by the material given in paragraphs 1.10 to 1.20 and Recommendations 8, 9, 10, 11, 12 and 13 hereunder.

Comment In establishing a frequency assignment plan it is expected that the final frequencies chosen will be influenced to some extent by proposals that may be submitted by those offering to supply equipment and antennae for the system. On the other hand, it would appear necessary in the first instance to aid suppliers in formulating their proposals, that tentative frequency

assignment plans be prepared taking into account the limitations in selection that might be imposed by current frequency usage and the difficulties of assuring the absence of harmful interference, or where necessary, the clearance of particular frequencies. In addition to aiding possible suppliers in the preparation of their proposals, tentative assignment plans would also seem necessary in order to enable other Administrations and the IFRB to explore the difficulties that may arise if such plans were implemented. Consequently, in giving effect to this Recommendation, the Meeting envisages the development of a final frequency assignment plan in two stages, namely a provisional plan to provide a basis for proposals and for evaluation of possibilities of interference to other services or of the need for clearance action.

Recommendation No. 8 Coordination of Assignments

That specific frequencies assigned to particular stations should be selected by the licensing administrations in accordance with all applicable provisions of the Convention and Radio Regulations of the International Telecommunications Union. Until suitable allocation provision can be made, full coordination with any affected Administration should be accomplished as an interim measure to accommodate specific VHF Forward Scatter operations in any given area.

Recommendation No. 9 Operation above F2-4000 MUF

That, in the absence of the allocation of a band or bands of radio frequencies for exclusive use of VHF Forward Scatter Systems, radio frequencies should be selected to permit the operation of VHF Forward Scatter circuits in such a manner that the actual frequency in use at any station at any given time can be a radio frequency which is at least 20% above the median monthly hourly F2-4000 MUF as predicted by the Central Radio Propagation Laboratory (CRPL) Series D Bulletins or similar data.

Comment With the system contemplated, it will be essential to ensure that at all times the frequency actually in use is at least 20% above the median MUF corresponding to the time of transmission in order to minimize the possibility of interference to or from other services. Use of lower frequencies will normally result in harmful interference to a large number of stations unless it has been found practicable to clear the frequency concerned.

Recommendation No. 10: Economy in use of Frequency spectrum

That, because the greatest practicable economy in the utilization of the frequency spectrum is of great importance, fullest consideration be given to possibilities offered by equipment designs or system arrangements that would achieve significant economies in the use of the frequency spectrum.

Recommendation No. 11: Use of Single Antenna

That, because using separate antennae for transmitting and receiving at a particular station may offer the possibility of economies in use of the frequency spectrum and other advantages over a system using at least one common antennae for transmission and reception, the practicability of using separate antenna be given careful consideration in respect of one or more of the circuits of the VHF Forward Scatter System.

Recommendation No. 12: Reduction of Interference - General

That, because radiation in directions other than the main lobe will increase the probability of harmful interference, all practicable steps should be taken to keep such radiation to a minimum having due regard to economic aspects.

Comment In addition to being important with respect to minimizing the possibility of interference to other services, the maximum practicable suppression of radiation in directions other than the main lobe of the antenna pattern is desirable in order to avoid interference and multipath effects within the system itself. These effects may degrade, in particular, the teletypewriter service and to a lesser extent the telephone service.

Recommendation No. 13: Interference due to sporadic E propagation

That, in order to reduce the possibility of harmful interference due to sporadic E propagation, facilities should be available to permit the power fed to transmitting antennae to be adjusted to appropriate levels over a range of at least 20 decibels (100:1).

Comment During sporadic E propagation conditions, very large increases in signals received over the ionospheric scatter circuit normally occur thus permitting a substantial reduction in transmitter power without affecting the performance of the circuit. Such conditions will be observed and it will be most desirable in order to minimize the possibilities of harmful interference to other services to reduce the transmitter power to the lowest value consistent with the required performance of the circuit. The Meeting considered that the possibility of reduction to 20 db below maximum power should be available.

Recommendation No. 14: Exclusive frequency band(s) for VHF Forward Scatter System

That the Air Navigation Commission give consideration to the advisability of including as an item for consideration by an appropriate meeting, the question of the need for the allocation of a band or bands of radiofrequencies for exclusive use of VHF Forward Scatter Systems.

Comment. The need has already been foreseen for a special COM Meeting towards the end of 1958 to prepare for the ITU Radio Conference tentatively scheduled for the latter part of 1959. If it is considered advisable for ICAO to coordinate the views of Contracting States, from the aspect of aeronautical fixed services, on the question of an exclusive allocation for VHF Forward Scatter Systems, it would appear that the Meeting contemplated would offer an appropriate occasion.

Guidance Material on Frequency Selection & Planning

1.10 General

1.10.1 The Meeting considered that the following material should be used as a guide in further studies by administrations and others in the process of determining the specific frequencies to be used in a Forward Scatter System. In submitting the material the Meeting recognized that the figures given were based on a knowledge of what is considered practicable in the light of the present state of the art; and that further developments or alternative techniques to those considered in arriving at the figures may permit other figures to be acceptable.

1.10.2 The Meeting recognized that the greatest practicable economy in frequency utilization was a major consideration and that where better figures from this aspect than those specified could be achieved without loss of performance or undue expense or complication of equipment this would be a very desirable feature.

1.11 Frequency requirements

1.11.1 The transmitters of the system should be designed to permit consecutive operation on two frequencies in the band 30 to 60 Mc/s one of which should be selected from the band 31.7 to 41 Mc/s and the other from the band 50 to 60 Mc/s.

1.11.2 The specific frequencies assigned to particular stations should be selected by the licensing administrations in accordance with all applicable provisions of the Convention and Radio Regulations of the International Telecommunications Union. Until suitable allocation provision can be made full coordination with any affected administration should be accomplished as an interim measure to accommodate specific VHF Forward Scatter operations in any given area.

1.11.3 It is strongly recommended by frequency experts that in order to minimize the possibility of interference the interested administrations select the frequencies to permit the operation of VHF Forward Scatter circuits in such a manner that the actual frequency in use at any station at a given time be one which is at least 20% above the median monthly hourly F2 - 4000 MUF as predicted by the Central Radio Propagation Laboratory (CRPL) Series D Bulletins or similar data.

1.11.4 CRPL predictions for November 1956 (i.e. for approximately winter sun spot maximum conditions) indicate that when operating on a frequency which is 20% above monthly median hourly F2-4000 the probable duration of an interfering signal being radiated by F2 propagation is given by the following figures:

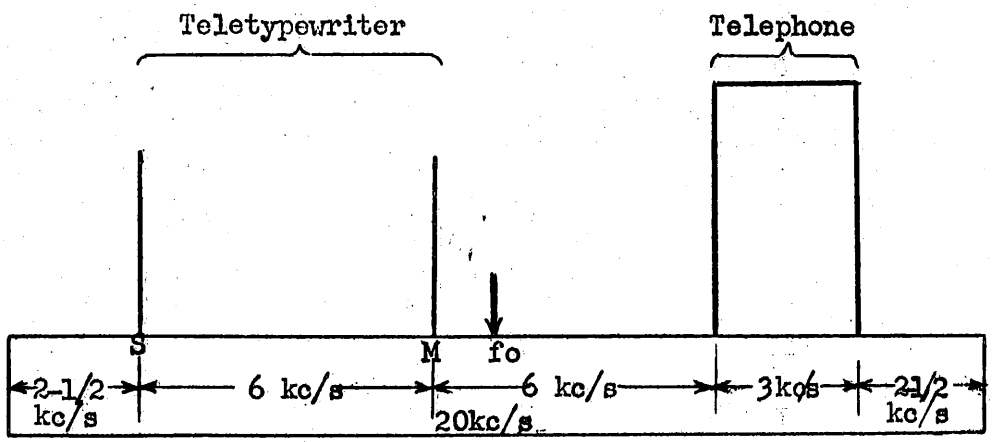
a) during 3 hours on 7% of the days of the worst month;

b) during an additional 2 hours on 3% of the days of the worst month. This gives a total period of about 8 hours per month during the worst month. This figure may be expected during 2 to 4 months of 2 to 3 years of the sun spot cycle. It should be noted that the margin of 20% above the predicted F2-4000 MUF is not expected to require frequencies which are above 60 Mc/s for VHF Forward Scatter circuits.

1.11.5 Reasons for choice of a two-frequency system per transmitter together with additional information on this matter are given in the Chairman's Report (Page I-10).

1.12 Frequency Bandwidth requirements

1.12.1 The bandwidth required in respect of each frequency providing one telephony channel and four teletypewriter channels should be taken as 20 kc/s. This requirement is based on the following:



fo = assigned frequency

Example of bandwidth occupancy of scatter transmission for 4-channel time division multiplex in conjunction with single side-band telephone.

1.12.2 The above bandwidth allowance is based on a single side-band reduced carrier telephone channel and four teletypewriter channels, the latter derived by time division multiplex. Owing to the effects of Doppler shifts due to meteor trails and possible multipath effects the shift of frequency required for mark and space is relatively large compared with normal HF practice. The Meeting recognized that alternative systems may offer the possibility of a reduction in the bandwidth that should be allowed for in the operation of the system but that it was reasonable to expect that any other systems of modulation e.g. narrow band frequency modulation or keying would require a comparable bandwidth for a similar performance.

1.12.3 The Meeting further considered that the system under consideration could probably be extended to eight teletypewriter channels (time division) within the same bandwidth and possibly to sixteen channels (time division) also, although it may be necessary to use error correcting techniques in order to secure the same order of performance. An additional telephone channel, however, would require an additional bandwidth. This additional bandwidth would not exceed 4 kc/s if a single side band amplitude modulation system is used.

1.13 Separation of receiving frequencies at the same site

1.13.1 In principle, receiving frequencies at the same site should have a minimum separation of the order of 200 kc/s.

1.13.2 A separation of 200 kc/s is desirable in order to allow for the possibility that received signal strengths over different paths may differ markedly at times such as may occur when one signal is due to the scattering effect and the other is due to ionospheric reflections. The Meeting recognized that a separation of 200 kc/s between receiving frequencies may unduly restrict availability of frequency channels in some areas where stations of several VHF Forward Scatter Systems are relatively close. It was considered that in such circumstances a smaller separation than 200 kc/s may be practicable. The Meeting further recognized that if a smaller separation than 200 kc/s could be used without loss of performance or undue expense or equipment complication, this would be desirable.

1.14 Separation of Transmitting frequencies at a given location

1.14.1 In principle, all transmitting frequencies used at a given location should have a minimum separation of the order of 200 kc/s.

1.14.2 Separation of transmitting frequencies at the same location is necessary in order to avoid coupling between the transmitters which would give rise to spurious radiation.

1.15 Separation between Transmit and Receive frequencies

1.15.1 For planning purposes, the minimum separation between transmitted and received frequencies at a particular station should be taken as 2 Mc/s but it should be recognized that when final proposals are received, it may be necessary to accept other figures.

1.15.2 The actual separation may be governed by a number of factors such as the use of the same antenna for transmission and reception and the desirability of obtaining similar polar diagrams for these two functions. The Meeting recognized that the difference between transmitted and received frequencies should be kept as small as practicable having due regard to design difficulties and economic and technical considerations.

1.16 Possibility of repeating the use of the same frequency in the same system

1.16.1 For planning purposes, the minimum separation between any frequencies used in the system should be assumed to be 50 kc/s.

1.16.2 The Meeting considered that because of the possibility of occasional normal F2 or sporadic E propagation it was prudent to adopt for planning purposes a minimum separation of 50 kc/s between any frequencies used in the system. However, further consideration should be given to the possibility of repeating the use of the same frequency within the system under suitable conditions of geographical separation and orientation of transmission paths.

1.17 Sporadic E layer Propagation

1.17.1 Consideration has been given to the question of interference to and from ionospheric scatter circuits which might arise from sporadic E layer propagation. The nature of sporadic E and its occurrence is complex and has not yet been reduced satisfactorily to systematic prediction techniques of the same quality as those available for F2 layer transmission.

1.17.2 Data from some of the experimental scatter circuits may be used in estimating the frequency of occurrence, at 50 Mc/s, of sporadic E propagation and the resulting intensities of the interfering fields; and a further recently published report* is available for estimating the dependence on frequency and distance, and the probability of occurrence above certain threshold levels.

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* National Bureau of Standards Circular "World Wide Study of Sporadic E", by E.K. Smith.

1.17.3 Of the experimental scatter circuits, the Fargo Churchill experimental scatter path is taken to be most representative of the geomagnetic latitude belt in which the proposed ICAO VHF Forward Scatter circuit paths will be located. While there is evidence of an approximate, 2 to 1 variation from year to year in the number of hours of occurrence, there is inadequate data to specify this variation statistically or its relation, if any, to the solar cycle. The following data were obtained from the 825 mile Fargo Churchill path, using 50 Mc/s, for the year 1952, together with some supplementary information relating to the 1000 mile Goose Bay--Søndre Strømfjord circuit, using 48 Mc/s, for the year 1953.

Table I

Numbers of Hours of Es Observed*

	Local time	Fargo-Churchill 50 Mc/s-1952	Goose Bay - Søndre Strømfjord 48 Mc/s-1953
Yearly total		219 hrs.	277 hrs.
Diurnal Distribution	00-02 hrs.	65	14
	02-04	14	5
	04-06	7	2
	06-08	3	1
	08-10	2	1
	10-12	0	0
	12-14	0	1
	14-16	0	3
	16-18	0	33
	18-20	4	80
	20-22	33	96
	22-00	91	41

* Footnote for table:
Es is considered to have been observed if the signal intensity exceeded, at some time during the period, the level corresponding to the field intensity threshold used in Table II. During most of the observed period the threshold was not exceeded.

Table II

Percentage of Time that Hourly Median Field Intensity Exceeds 5μ V/m for 1 Kw Radiated Power Fargo-Churchill 50 Mc/s

Yearly (1952)	1.0%
Winter (Nov, Dec, 1951, Jan, Feb. 1952)	0.16%
Spring (Mar, Apr, 1952)	0.14%
Summer (May, Jun, Jul, Aug, 1952)	2.2%
Autumn (Sept, Oct, 1952)	0.2%

1.17.4 The probability of occurrence of sporadic E propagation decreases in the 30-60 Mc/s range by approximately 50% for each increase of 15 Mc/s in frequency. Thus the probability of such interference at a frequency of 55 Mc/s is about one-half of the probability at 40 Mc/s.

1.17.5 Interference caused by sporadic E layer propagation is likely to be most marked at distances of the order of 1000 miles and the probability of receiving such interference, and the intensity of the interference, falls off quite sharply on either side of this distance. For example, the probability of interference being experienced at distances of either 750 or 1200 miles is only 50% of the probability of interference at 1000 miles; in addition, the probable intensity of the interference, when this is experienced, is only 50% (6 db down) on the level of interference which would be experienced at 1000 miles. The possibilities of interference at distances exceeding 1500 miles are negligible.

1.17.6 It will be noticed, from the foregoing, that the distances over which propagation by sporadic E is most effective are of the same order as those involved in the proposed VHF Forward Scatter circuits. Hence, when propagation by sporadic E is present, there is a normally considerable increase in the strength of the received scatter signal and it is possible to reduce the power radiated by the scatter system transmitter without detracting from the efficiency of the scatter circuit. Such reduction in transmitter power causes a corresponding reduction with level of interference to other services which might be caused by sporadic E propagation; and it is most desirable that the facility for making such a reduction in power supplied to the transmitting antenna, to the extent of at least 20 db (a power ratio of 1:100) should be incorporated in the specification for ionospheric scatter transmitting systems.

1.18 Spurious Radiations

1.18.1 For any spurious radiation the mid-frequency of which lies below 120 Mc/s, the mean power supplied to the antenna should not exceed the value of 200 milliwatts.

1.19 For any spurious radiation the mid-frequency of which is above 120 Mc/s, the mean power supplied to the antenna should not exceed 25 milliwatts.

1.19 Radiation pattern

1.19.1 It is pointed out that one of the factors which will influence the mutual interference between VHF Forward Scatter services or between such services and other services will be radiation outside the main lobe of the antenna radiation pattern. It is, therefore, most important that such radiation should be reduced to the minimum practicable having due regard to economic aspects.

1.19.2 Typical antennae in use in present day scatter systems are known to have forward gains of about 20 decibels relative to a dipole, and horizontal beamwidths of the order of 8 to 12 degrees at half-power points. With respect to radiation outside the main lobe, approximately the following typical characteristics have been achieved:*

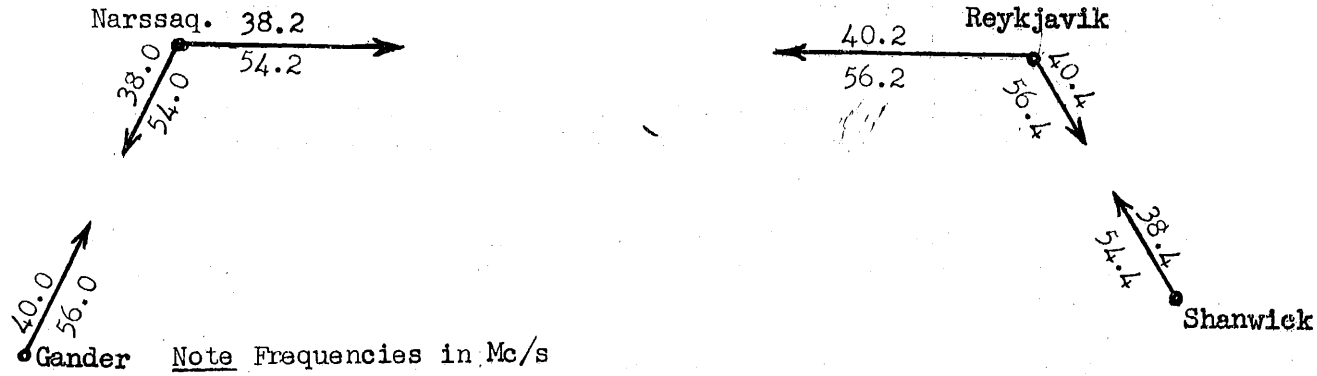
	Ratio to forward maximum radiation
Back radiation	30 decibels
1st side lobe	12 decibels
2nd side lobe and other side lobes	18 decibels

* It is understood further work has been done to effect improvement in these characteristics but final results are not yet available.

1.19.3 There is some reason to suppose that the following figures could be achieved by careful design.

	Ratio to forward maximum radiation
Back radiation	40 decibels
1st side lobe	18 decibels
2nd side lobe and other side lobes	24 decibels

1.20 Example of possible frequency assignment taking into account the above consideration



Note Frequencies in Mc/s

The specific frequencies in the above example have been selected for illustration only, and have no significance in respect of the selection of frequencies for the system.

VHF Forward Scatter Arrangements

Recommendation No. 15: Speech Circuit Arrangements

That the VHF Forward Scatter System should include provision for direct speech communications between the following pairs of adjacent centres:

Gander	-	Narssarssuaq
Gander	-	Reykjavik
Gander	-	Prestwick/Shannon
Narssarssuaq	-	Reykjavik
Reykjavik	-	Prestwick/Shannon

and; That the arrangements should permit (a) conference type speech coordination simultaneously between the above designated four centres and (b) full flexibility in either patching a channel completely through from end centre to end centre (e.g. to provide one channel linking Gander and Prestwick/Shannon) on a continuing basis or setting up individual channels linking adjacent centres (e.g. to provide separate channels Gander - Narssarssuaq, Narssarssuaq - Reykjavik, etc.)

and; That selective calling facilities should be provided

and; That equivalent access to the system should be provided to Air Traffic Controllers at Prestwick and Shannon.

Teletypewriter Circuit Arrangements

1.21 Having taken into account:

a) the forecast of the ICAO Special Implementation Panel that a 20% per annum increase in the air traffic can be anticipated on North Atlantic routes;

b) the number of separate existing AFTN circuits presently linking the locations to be connected by the VHF Forward Scatter/Cable or VHF Forward Scatter System;

c) the possibility of providing much increased overall capacity by the use of a cooperative group of three or four channels instead of discrete channels;

d) the increased possibility of avoiding retention of existing facilities solely on traffic grounds if extra capacity is provided in the system;

e) the particular problems of specifying and costing storage facilities in advance of the contractual stage.

The Meeting agreed to the following recommendations:

Recommendation No. 16:* Assignment of VHF Forward Scatter Circuits

That

a) a discrete teletypewriter circuit be provided between ATS units;

b) facilities be provided for air/ground stations to have ready access to ATS units as well as other air/ground stations;

c) the remainder of the communications traffic now carried on the AFTN should have access to at least two of the four teletypewriter channels.

Recommendation No. 17: Provision for automatic distribution and storage systems

That in preparation of specifications for invitations to bid implementing States by direct coordination should determine the desirability and practicability of including provision for automatic distribution and storage systems for use on up to three of the four teletypewriter channels.

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* See statement of Canada in Appendix A.

Note

In order to provide for the possible inclusion of the foregoing method of channel utilization, the estimated capital cost or the VHF Forward Scatter /Cable installations in Iceland and Greenland include a sum of $5,000. at each location.

SECTION II - PART 2 - REPORT AND RECOMMENDATIONS ON FACILITIES AND SERVICES

Part 2. - Implications on the NAT Regional Plan

Recommendation No.18: Retention of Existing Circuits

That no existing circuits be deleted from the plan until after a VHF Forward Scatter/Cable or VHF Forward Scatter System has been implemented for a sufficient period to judge operational performance and, where appropriate, the traffic potential at that time.

Recommendation No.19: Circuits of NAT Plan likely to require reconsideration

That the following circuits should be reviewed at an appropriate time after the implementation of a VHF Forward Scatter/Cable or VHF Forward Scatter System to assess the need for retention:

GANDER - LONDON	GANDER - REYKJAVIK
GANDER - SHANNON	LONDON - REYKJAVIK
NARSSARSSUAQ - REYKJAVIK	PRESTWICK - REYKJAVIK
PRESTWICK - STAVANGER	REYKJAVIK - THULE

REYKJAVIK - NORD

Note 1: This list excludes the circuits referred to this Meeting by the Joint Finance Conference (Geneva, 1956). (See Recommendations 23, 24 and 25.)

Recommendation No.20: Removal of redundant circuits from service

That at such time as a State operating a terminal of any of the circuits noted under Recommendation 19 regards the circuit as no longer being justifiable, it should initiate a proposal to that effect through the Regional office to afford an opportunity to all other States concerned to comment.

Recommendation No.21: Prestwick-Stavanger Circuit

That, in view of the fact that the need for this circuit in the NAT Region, i.e., a standby for the London-Reykjavik HF RTTY circuit, will no longer exist when the VHF forward scatter or cable circuit to Reykjavik is introduced, the question of its retention be referred to the 4th EUM RAN Meeting.

Recommendation No.22: Use of Error Correction Equipment

That States, noting:

(a) the increased reliability achievable by the use of error correction equipment;

(b) the comparative low cost of such equipment and the compensating saving in personnel;

(c) the incorporation of multiplex facilities in most varieties of error correction equipment;

(d) the recent standardization of characteristics of such equipment by the CCIR (Warsaw) Meeting,

give early consideration to the deployment of error correction to radiotele-typewriter circuits in the North Atlantic Region as a specific technique capable of improving reliability.

Recommendation No. 23:* Essential Improvement to London-Reykjavik Circuit

That, taking into account:

(1) the improved performance data at page II-23 resulting solely from the installation of a highly selective receiver at the London terminal on 1st June, 1956;

(2) the dependence of flights through United Kingdom and Iceland on this facility;

(3) the short period required for implementation;

the Meeting recommends the immediate implementation of the installation of a highly selective receiver and associated antenna at the Reykjavik terminal of the London-Reykjavik RTT circuit.

Recommendation No. 24* Additional Improvement to the London-Reykjavik Circuit

That recognizing:

(1) the possible need for standby facilities to the cable or VHF Forward Scatter link between Shanwick and Reykjavik;

(2) that no further improvements to the Reykjavik-London leg are possible except by improved transmitting facilities at Reykjavik;

* See statements of Iceland and United Kingdom in Appendix A.

States should be circulated as soon as possible after 1st May, 1957, when the method of linkage between Shanwick and Reykjavik and the performance of the Reykjavik-London circuit during the poor propagation to be anticipated in Spring, 1957 will be known in order to determine the date and extent to which the remainder of the improvements should be effected.

Recommendation No. 25* Manual W/T-Godhavn-Goose and Prins Christians Sund-Reykjavik

That, taking into account that:

(1) the manual W/T circuits between Goose Bay and Godhavn and Prins Christians Sund and Reykjavik could be implemented earlier and at a very much lower cost than the corresponding RTT circuits;

(2) the RRT circuits could be expected to be installed only one year before VHF Forward Scatter;

(3) adequate standby to the VHF Forward Scatter circuits Gander-Narssaq, Narssaq-Reykjavik is available via Shanwick, utilizing cable or VHF Forward Scatter and HF RTT between Reykjavik and Shanwick and HF RTT between Shanwick and Gander;

the Meeting recommends that the manual W/T circuits Godhavn - Goose and Prins Christians Sund - Reykjavik be implemented forthwith but that the installation of RTT be reviewed should it become apparent that VHF Forward Scatter between these two locations cannot be implemented by Spring, 1959.

Note: The administrations concerned drew attention to the fact that existing commercial services are available for use between Shanwick and Gander to exchange urgent traffic during temporary failure of HF RTT circuits.

2.1 Performance data on London - Reykjavik RTT circuits for period October 1955 - September 1956 * Relevant to Recommendation No. 23

London - Reykjavik (Transmitting Power 40 KW)		Reykjavik - London (Transmitting Power 3 KW)	
% Availability	Outages exceeding 30 minutes	% Availability	No. of Outages exceeding 30 Mins.
Oct.1955 93.6	23	84.0	46
Nov. 95.9	17	82.5	50
Dec. 94.5	22	78.5	56
Jan.1956 92.0	29	78.2	64
Feb. 90.3	23	75.8	42
Mar. 91.0	31	77.3	64
Apr. 92.6	26	81.8	43
May 94.0	38	90.9	25
June 94.5	21	97.7	7
July 97.3	12	98.9	4
Aug. 95.1	19	97.8	10
Sept. 96.6	13	96.5	13

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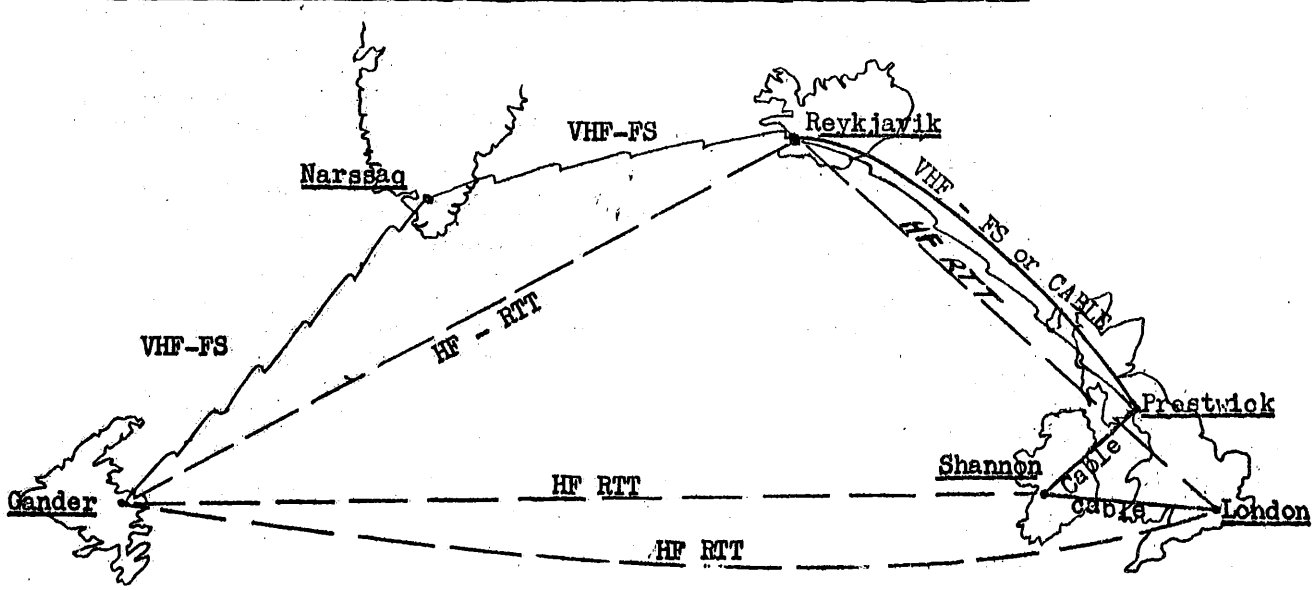
2.2 Circuitry anticipated at the time the proposed VHF Forward Scatter/Cable or VHF Forward Scatter System is implemented (some time in 1959). Only circuits subject to review to determine whether retention is justified after the VHF Forward Scatter/Cable or VHF Forward Scatter System is installed, are included in this diagram (See Recommendation 19).



Note: This diagram is for illustration only.

* See statements of Iceland and United Kingdom in Appendix A.

Recommendation No.26: Integration of Mobile with Fixed Services

That the following services or facilities be provided and integrated with the VHF Forward Scatter System.

(a) In Iceland

Landline connections and facilities as follows between the VHF Forward Scatter Station and the centres indicated:

Centre	VHF Forward Scatter/Cable System Landline Circuits	VHF Forward Scatter System Landline Circuits
ATC (Reykjavik)	one (two wire) telephone	two (two wire) telephone
"	one (two wire) teletypewriter	two (two wire) teletypewriter
COM centre (Gufunes)	one (two wire) teletypewriter (A/G)	two (two wire) teletypewriter (A/G)
"	two (four wire) teletypewriter (AFTN)	four (four wire) teletypewriter (AFTN)

(b) In Greenland

Prins Christians Sund: (A/G Station) One HF radio circuit to Narssaq providing two duplex teletypewriter channels (one A/G and one AFTN).

Narssaq: (VHF Scatter Station) One HF radio circuit to Prins Christians Sund providing two duplex teletypewriter channels (one A/G and one AFTN).

Narssaq: (VHF Scatter Station) One VHF circuit to Narssarssuaq providing one telephone and four duplex teletypewriter circuits (one ATS, two AFTN and one A/G).

Narssarssuaq: (ATC centre) One VHF circuit to Narssaq providing one telephone and four duplex teletypewriter circuits (one ATS, two AFTN and one A/G).

Note 1: Services indicated in brackets are shown to indicate the functions to be provided for. Specific association of these functions with a particular channel is shown for illustration only.

Note 2: The requirements for the circuits between Narssaq and Narssarssuaq are based upon the existing NAT Regional Plan which specifies an air traffic control centre and air/ground communication service at Narssarssuaq.

Circuit Description

2.3 The foregoing is based on the following types of communications facilities.

2.3.1 The circuit between Narssaq and Prins Christians Sund: Provision for three-frequency operation, using HF single side-band or frequency shift keying together with diversity reception using transmitters of 5 kW.

2.3.2 The circuit between Narssaq and Narssarssuaq: A VHF system with 50 watt transmitters and providing two telephone channels of which one is used to provide four teletypewriter channels.

Note: In the system contemplated, an additional telephone channel can be provided without additional cost. Such provision would be desirable to provide for order wire and standby facilities.

Problem of circuit provision between Narssaq and Prins Christians Sund

2.4 In general, the short links from communication and control centres to scatter transmitting and receiving terminals should be engineered well enough that they contribute no significant degradation of the main scatter system. This is feasible where links are short, by use of land line or VHF or microwave facilities. These possibilities are practicable in Iceland and between Narssaq and Narssarssuaq.

2.5 A special problem arises, however, in the instance of the link from Prins Christians Sund to Narssaq. The path length is approximately 100 miles, and much of the path is over irregular mountainous terrain, and extremities of the Greenland Ice Cap.

2.6 A short-distance VHF or microwave relay links would be impractical to maintain along the path; tropospheric scatter suggests itself as being the most promising means of reliable communication. Special terrain problems at both terminals, however, require very careful evaluation, and in all probability propagation measurements on the path, before the engineering requirement for power and antennae for the tropospheric scatter link could be established. As there is, therefore, no adequate basis at hand for the Meeting to establish costs for a tropospheric scatter link between Narssaq and Prins Christians Sund, other alternatives were considered.

2.7 Ground-wave propagation across an area of such poor conductivity as the Greenland Ice Cap, even at low frequencies, is likely to be ineffective with reasonable transmitter powers and antenna installation. At MF and HF, the ground-wave would be effectively totally absorbed. High-frequency sky-wave propagation seemed to the Meeting to offer the only possibility as a propagation medium for which a service could be proposed with a reasonably firm estimate of cost. It is considered that 3-frequency operation, using SSB or FSK techniques can provide a largely effective circuit. 5 kW power and diversity reception is contemplated.

Recommendation No.27: Tropospheric Scatter Link, Narssaq-Prins Christians Sund

That further engineering consideration be given to the feasibility and requirement for a tropospheric scatter link between Narssaq and Prins Christians

Sund to satisfy ultimately the operational requirement for a highly reliable circuit.

Comment: While an HF circuit of the type described in 2.3.1 above can be expected to provide a reasonably satisfactory service it will be subject to blackout during ionospheric disturbances and occasional outages will occur.

SECTION III - RECOMMENDATIONS ON IMPLEMENTATION

Organization for implementation

1. In considering the Technical Coordination required for Implementation, the Meeting reached the following conclusions on the principles.

2. The actual implementation should be undertaken by the States upon whose territories facilities would be physically located.

3. In order to assure system integration, to be in a position to assign responsibility to a single agent, and to broaden the field of sub-contracting, the principle of using a Prime Contractor should be applied.

4. A time schedule should be established and periodic coordinated progress reports should be issued and communicated to ICAO for circulation among the interested States.

Recommendation No. 28: Creation of Coordinating Group to Execute Plan

That, at the earliest convenience, and if possible within two months after the close of this Meeting, there be created a Coordinating Group of Representatives of States upon whose territory VHF Forward Scatter or undersea cable facilities would be located, and that this Group be empowered to take such actions on behalf of the implementing States as will be necessary to execute the plan adopted by this Meeting for the improvement of the NAT fixed services.

Recommendation No. 29: Organization of Coordinating Group

That the organization for technical coordination should be established so that subsequent to an agreement to implement, further reference to ICAO is unnecessary except for Joint Finance matters.

Recommendation No. 30:* Joint Invitation to Bid for Prime Contract

That the States concerned should issue joint invitations to bid for the VHF Forward Scatter System and should select a single Prime Contractor to take overall responsibility for the technical planning and implementation of the Plan.

Recommendation No. 31: Basis of Bid for Prime Contract

That the States concerned shall ensure that the Prime Contract is based upon the system characteristics established by this Meeting. Adequate performance and cost guarantees should be incorporated in the Contract.

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* See statement of Denmark in Appendix A.

Recommendation No. 32: Placing of Sub-contracts by Prime Contractor

That the invitation to tender, as a result of which the Prime Contractor will be appointed, should specify that in obtaining equipment and materials, the Prime Contractor would be expected to seek tenders in the international market, having regard to the suitability of equipment and materials available and having regard to any currency problems.

Estimated Time Schedule for Implementation

5. In determining a realistic date for putting the system into operation, the most difficult location, from an installation standpoint based on climatic conditions, is Narssaq. It is most desirable, therefore, that an award to a single Prime Contractor be made not later than Fall of 1957. Assuming that 1 October 1957 is a practical date for making the award, an estimate of the time schedule for the Narssaq station has been prepared (page III-3).

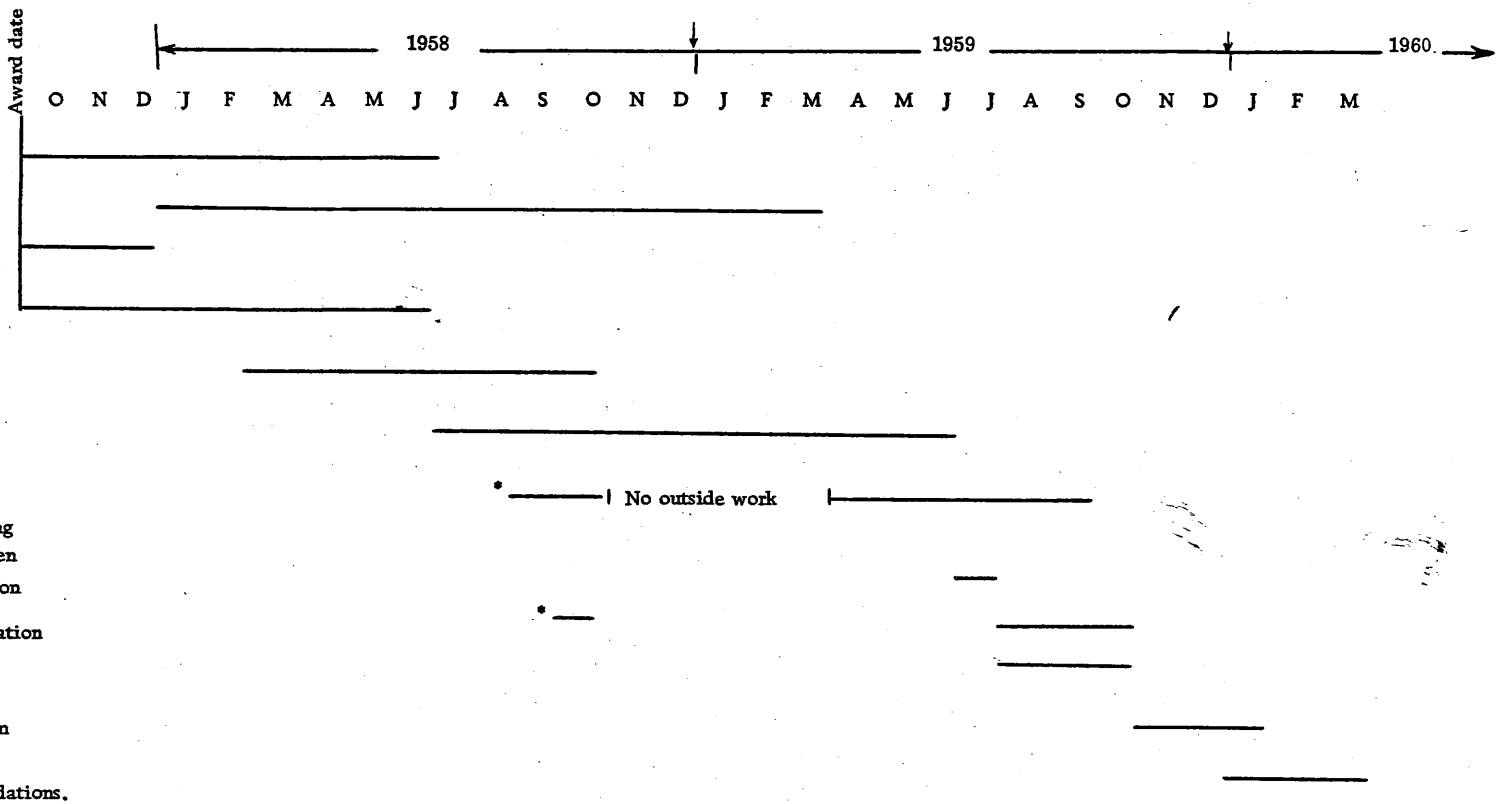
6. Before an award can be made by 1 October 1957, a number of preliminary steps must be taken by the implementing States. Shortly after the end of this Meeting, the implementing States should meet in order than an invitation for bid can be issued by 1 June 1957. On the basis that 60 days will be allowed for preparation of bids and 60 days for the implementing States to evaluate proposals, an award date of 1 October 1957 appears to be practicable.

7. In addition to the above, simultaneous action can be taken by ICAO on obtaining an agreement of the North Atlantic States as to provision of Joint Support funds. Obviously, Joint Support agreement must be obtained before the award date of 1 October 1957. Selection of frequencies should also be initiated at an early date so that these frequencies can be specified, insofar as practicable, in the invitation for bid.

8. It is recognized that the Narssaq time schedule will not permit system operation until early 1960. If suitable assurances could be given by 1 March 1957 to the Danish Government that Joint Support funds would be made available at a later date for the Narssaq facility, it is possible that the time schedule could be advanced several months or as much as a year.

9. The time schedule for implementation on page III-3 is based on the foregoing assumptions. This schedule does not take into account the possibility mentioned in paragraph 8 which, if realized, would permit work on several important parts of the programme to be begun earlier.

ESTIMATED TIME SCHEDULE FOR NARSSAQ



NOTE: It is not possible for ships to land at Narssaq between approximately 15 April to 1 July.

SECTION IV.- RECOMMENDATIONS ON JOINT FINANCING

Recommendation No. 34: Joint Financing of Greenland and Icelandic portions of the system

1. That, for the purpose of jointly financing the Greenland and Icelandic portions of the Services recommended by this Meeting, States participating in the 1956 Danish and Icelandic Joint Financing Agreements should consent, pursuant to Article VI thereof, to an increase in the limit prescribed by Article V; in the case of the 1956 Danish Agreement the amount of this increase to be 385,574 United States dollars, in the case of the 1956 Icelandic Agreement the amount of 434,591 United States dollars.

2. That the Council, upon receipt of 90% consents pursuant to Article VI of the 1956 Agreements, should increase the limit prescribed by Article V in the amounts indicated in paragraph 1 of this Recommendation; and should take steps, pursuant to paragraph 3 of Article XXVI, to amend appropriately the Annexes to these Agreements, utilizing as necessary the data set forth in Appendices 1 - 12, Supplement B of the Report of this Meeting.

Recommendation No. 35: Implementation schedule for obtaining the necessary financial assurances

1. That, preferably by 1 April 1957 but not later than 1 May 1957,

(a) States in whose territories services are to be provided without Joint Financing should advise the Organization whether they are definitely prepared to proceed with their installations provided the entire system will be installed, and whether they are prepared to bear their share of the costs of the installation requiring Joint Financing on the basis determined by the Meeting; and

(b) the other interested States should advise the Organization whether they are prepared to bear their responsible share of the costs of installations requiring Joint Financing.

2. That the Council, upon receipt of 90% consents pursuant to Article VI of the 1956 Danish and Icelandic Joint Financing Agreements, should notify the States in whose territories installations are to be made that the necessary contracts can be let.

Measures to expedite realization of VHF Forward Scatter/Cable or VHF Forward Scatter Systems

Having regard to:

(a) the acute and serious air traffic control problem existing in the North Atlantic at the present time;

(b) the expected increase in the volume and density of traffic;

(c) the introduction of turbo-jet aircraft expected in 1959, and;

(d) the imperative need to resort to any measure reasonably necessary to assure implementation of the VHF Forward Scatter System;

the Meeting made the following recommendations:

Recommendation No. 36:

That States concerned exert every possible effort to provide the necessary notice of intentions to implement and to provide for joint financing called for in other recommendations of this meeting.

Recommendation No. 37:

That, in the event consents to Joint Financing of the system are not received by 1 May 1957 from States responsible in the aggregate for 90% of the total assessments made under the provisions of Article VII of the 1956 Agreements, the Council of ICAO should forthwith give consideration to the initiation of whatever steps appear appropriate to assure the implementation of the VHF Forward Scatter System or the VHF Forward Scatter/Cable System with a minimum of delay.

Note: For proposals respecting action that might be taken, see Chairman's Report, paragraphs 4.10 and 4.11.

SUPPLEMENT A

SUPPLEMENTARY MATERIAL FOR INFORMATION

1.- THE ADVANTAGES FROM UTILISATION AND FLEXIBILITY POINTS OF VIEW OF USING A GROUP OF COOPERATIVE CHANNELS

Presented by the United Kingdom

1.1 We are of the opinion that States, when considering Recommendations 16 and 17 should also take into account the mass of information available on the advantages to be derived from the operation of groups of circuits in co-operation rather than as discrete circuits alloted on a functional basis.

2.- USE OF COOPERATIVE CHANNELS

2.1 It should be noted that the guidance material on circuit utilization developed at fourth Session of COM Division (Doc 7171 para. 5.12) and included in Air Navigation Circular No. 28 has hitherto been applied only to single channels, and that the presently proposed VHF Forward Scatter System provides four circuits in parallel rather than individual North Atlantic circuits.

2.2. Experience in other fields, for instance, telephony, has shown that parallel circuits are most efficient when operated as cooperative channels, that is when each is available to every subscriber rather than being limited to separate functions. As a measure of the efficiency which may be gained, the sub-joined tables show that cooperative operation produces considerable reductions in:

(i) the proportion of messages delayed;
(ii) the average delay of the delayed messages;
(iii) the delay exceeded by a specific proportion of messages.

From this consideration, there could be no doubt but that the best use would be to allow access to all channels to all the groups of users rather than to restrict each of the four channels to the carriage of traffic generated by individual users such as Air Traffic Services, AFTN centres, Air/Ground stations and so on.

2.3 The proportion of messages delayed is given by the following table:

Occupancy	Proportion of messages delayed		
	Use of discrete channels	Use of 3 co-operative channels	Use of 4 co-operative channels
0.1	10%	0.38%	0.1 %
0.2	20%	2.5 %	0.95%
0.3	30%	7.0 %	3.7 %
0.4	40%	14.0 %	9.0 %
0.5	50%	23.5 %	17.5 %
0.6	60%	36.0 %	29.0 %
0.7	70%	50.0 %	43.0 %
etc			

The average delay of the delayed messages is given by the following table:

Occupancy	Average delay of delayed messages		
	Use of discrete channels	Use of 3 co-operative channels	Use of 4 co-operative channels
0.1	68 secs.	21 secs.	17 secs.
0.2	80	24	18.5
0.3	92	28	21
0.4	105	32.5	25
0.5	120	38	30
0.6	158	47	37.5
0.7	204	65	48

The delay exceeded only by 5% of the messages is given by the following table:

Occupancy	Delay exceeded by only 5% of the messages		
	Use of discrete channels	Use of 3 co-operative channels	Use of 4 co-operative channels
0.1	45 secs.	--	--
0.2	96	--	--
0.3	150	7 secs.	--
0.4	207	27	12 secs.
0.5	270	55	35
0.6	360	90	63
0.7	480	150	102

The foregoing tables have been calculated from the formulae established in:

"Probability and its engineering uses"

by

Thornton C. Fry (Bell Telephone Laboratories).

Without going into considerable detail the mathematics requires that the traffic satisfies certain conditions which may be expressed in general terms as follows:

a) that the traffic flow has reached a state of statistical equilibrium,

b) that the arrival of messages is random,

c) that messages are handled in the order in which they arrive,

d) that the distribution of message lengths approximates an exponential distribution of the following pattern,

$$Pt = \frac{1}{T} \cdot e^{-t/T},$$ t being the mean transmission time.

Statistical analysis over a representative field of traffic has shown that general air/ground, AFTN, and aeronautical MET messages satisfy these conditions sufficiently closely as not to invalidate the mathematics. Additionally, although the above tables have been derived in respect of a homogeneous field of non-priority traffic, the theory can be extended to cover the case of the traffic field divided into priority categories; in the latter case condition (c) above would read:

(c) that messages are handled in the order in which they arrive within their priority category.

2.4 A further consideration is that so far as A/G and ATS traffic is concerned the circuits tend to peak over a period of 10 hours of the day. In the discrete channel case the two channels allotted to this traffic are virtually unused during the remaining 14 hours. With cooperative operation virtually double capacity exists for the steady flow of AFTN traffic.

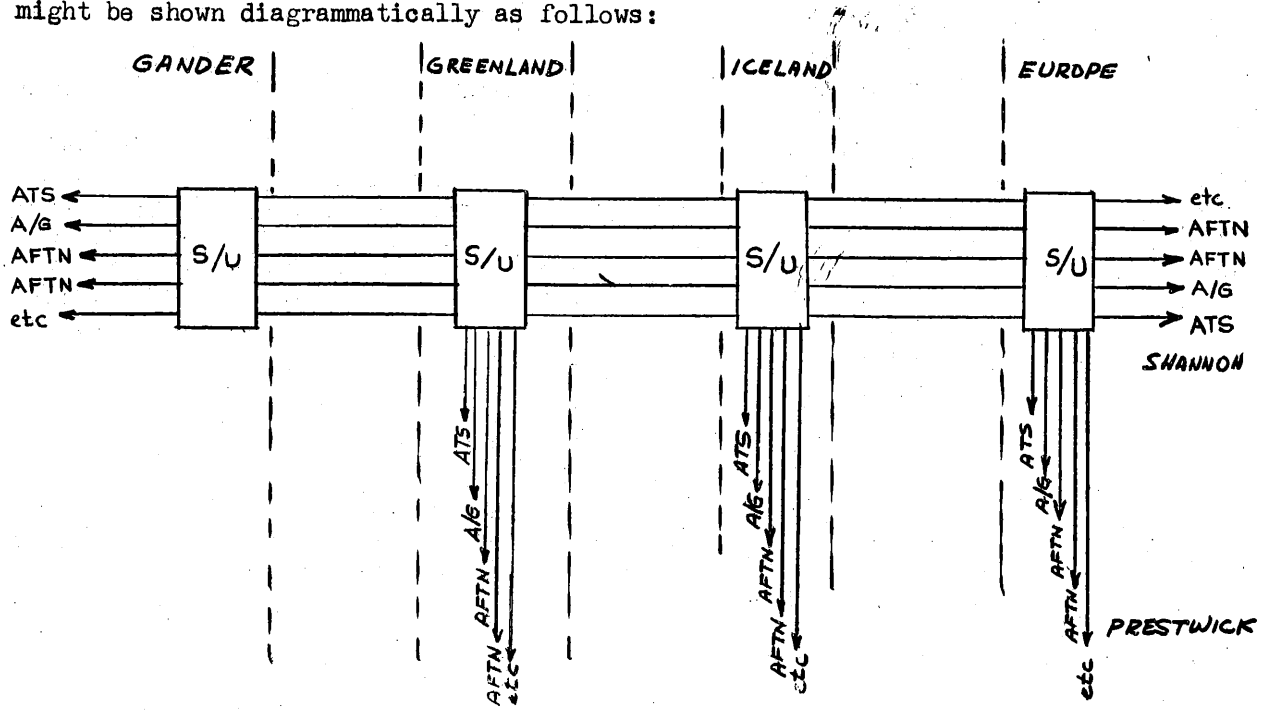
3. In consideration of the facts derived from the foregoing paragraph, we have concluded that the best method of use of the four teletypewriter channels would be obtained from the use of automatic message storage devices to terminate the four circuits. Such devices which are readily available from various commercial sources perform the following functions:

(i) to receive messages from the operating tails and direct them into an available free outlet;

(ii) to receive and store messages in the event of non-availability of a free outlet, and thereafter to direct them to the first outlet to become free;

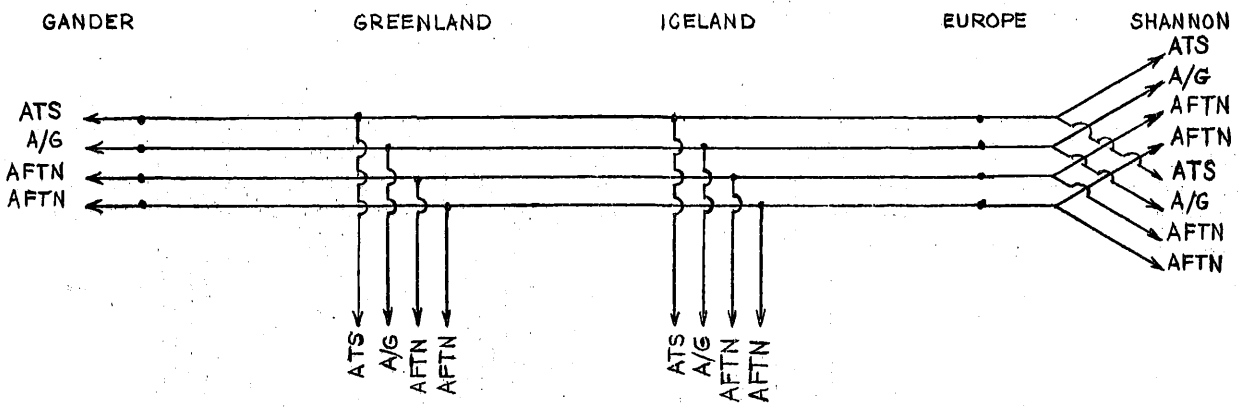
(iii) to perform the functions (i) and (ii) in respect of such priority categories as are considered necessary.

The location of units in a NAT VHF Forward Scatter System might be shown diagrammatically as follows:



Although 5 "tails" have been shown at each location, any number may be connected, and this number would be one of the factors determining the capacity of the storage unit. With such an arrangement any tail would obtain the most rapid connexion with any other tail using any of the three sectors of the four channels which happened to be available.

3.1 For comparison a diagram is given of the 4 channel system using discrete channelling.



The disadvantages are apparent; there is no interconnexion between authorities, and on any circuit operation over the whole length may be interminably delayed by an operation over part of its length. It should further be noted that the number of authorities is limited to four.

4.- THE ADVANTAGES OF USING COOPERATIVE CHANNELS

4.1 Maximum flexibility is provided.

4.2 Maximum capacity is provided for a given grade of service.

4.3 Maximum opportunity is provided for rendering existing circuits redundant on traffic grounds.

4.4 For a given occupancy delays are reduced to a minimum.

4.5 The average delay of delayed traffic is reduced to a minimum.

4.6 Should the number of channels or sectors of channels need to be reduced because of radio path loss, there would be no invidious choice as to which authority should lose its channel; the remaining channels would still be available between all authorities.

4.7 Greater capacity can be reached before additional channels need to be provided by time division multiplex.

4.8 The system does not limit the number of authorities which may be connected.

5.- CONSIDERATION OF PARTICULAR CIRCUMSTANCES

5.1 It had been considered that the introduction of a NAT ATS voice channel with the consequent variations in ATS procedures might be initially assisted by isolating one teletype channel from the group of four and providing this as a private "party line" linking the ATS centres. It would then operate in the manner described in para. 3.1 above.

5.2 It is recognized that such a circuit would have low capacity, would not be integrated with the other authorities, and would in general be subject to the usual disadvantages of non-availability, etc.

5.3 However, if one recognized that the circuit would not be used for normal ATS messages, which would continue to use the AFTN, but would rather act as a back-up to the voice channel and be used on a less formal basis than an AFTN circuit, then it might fairly be reasoned that its occupancy would be fairly low and this would to some extent mitigate the others disadvantages.

5.4 It must be pointed out that the requirement to pass traffic from, say, an air/ground station at one location to ATS at another location cannot be met without the addition of an additional two teleprinters at each location.

5.5 Nevertheless we had proposed that initially the system be organized as 1 ATS party line teletypewriter circuit and a cooperative group of three teletypewriter circuits to serve other authorities, A/G stations, AFTN, etc. It is for this reason that in the tables of para. 2.3, figures are given for three channels.

5.6 It has been our experience that when a satisfactory speech circuit is provided between ATS centres, the need for a direct teletypewriter connexion between the Air Traffic Controllers disappears and the normal AFTN provides satisfactory service for ATS messages. In the same way, we would

expect that when the initial problems associated with the provision of a satisfactory speech channel had been overcome, that the private ATS teletypewriter circuit would not be required. This teletypewriter channel could then be grouped with the other three to provide the ideal usage as a group of four co-operative channels.

Desirable Characteristics of VHF Forward Scatter System

(Associated with Recommendations Nos. 4 and 5)

Presented by the United States

The following material is general background information which may be useful as guidance for implementing States.

1. The system should be designed to operate in the 30 to 60 megacycle frequency band. The equipment should be designed so that two frequency operation will be provided with one of the frequencies in the 30-45 megacycle band and the other frequency in the 45-60 megacycle band. Provision should be made to change frequencies without serious disruption to operation and without completely shutting down any circuit segments of the system.

2. Equipment to be used should be of advanced design specifically manufactured for continuous duty in VHF Forward Scatter service. Reliability of the equipment must be a prime design goal in order that over-all circuit reliability is not significantly reduced. Automatic changeover from a defective unit of the system to a spare unit would be advantageous. All equipment must be readily accessible for maintenance purposes.

3. To achieve improved system reliability at reduced cost, system design should provide for dual transmitters on each circuit capable of feeding, additively, a single antenna. Failure of one transmitter should permit continuation of the circuit on the remaining transmitter with no appreciable loss of transmission time in disconnecting the defective transmitter.

In the interest of minimizing the probability of interference as well as improving operating economy, the transmitters should be capable of efficient operation over a wide range of power output levels so that during periods of low propagation loss the transmitter power may be reduced.

To provide the expected circuit availability the peak transmitted power required of any terminal is of the order of 100 kW.

4. Receivers should be specifically designed to be optimum for use on the VHF Forward Scatter System, and should be employed in diversity arrangements employing optimum combining to the extent practicable. The receivers should be designed for minimum noise figure practicable.

5. The antenna system should provide for space-diversity reception on at least two antennae. The minimum separation between centres of receiving antennae should be a minimum of 10 wavelengths perpendicular to the transmission path. In order to minimize cost, use is contemplated of a common antenna structure for transmitting and receiving. The design and construction of antennae must be such

that any antenna noise introduced does not measurably degrade the service. Receiving antennae must be designed for maximum freedom from precipitation noise. Antennae must be designed to withstand maximum ice and wind loads likely to be encountered at the locations involved and to minimize the effect of icing on performance of the system. To minimize cost, use is contemplated of common antenna structures for dual-frequency operation. Such an arrangement must be designed for minimum compromise of system performance.

Desirable antenna characteristics for scatter propagation have been published in technical journals.

To minimize interference to and from other services and the harmful multipath distortion arising from distant back-scatter, back and side-lobe radiation should be suppressed to the maximum extent consistent with the state of the art.

There is a basic requirement for use of a high gain antenna. A standard minimum figure of 18 db relative to a dipole is recommended. Its radiation efficiency should be high; the loss associated with terminations of rhombics or other long-wire antennae (apart from undesirable minor lobe radiation from such antenna) cannot be tolerated.

Note: The realized gain of the antennae should be as high as practicable, consistent with economic and other factors. Antennae having gains of the order of 18 decibels (plane wave) relative to a dipole have been found suitable in existing VHF ionospheric scatter circuits. If antennae having plane wave gains lower than 18 decibels should be proposed, it should be demonstrated that such antennae have compensating advantages from the standpoint of realized gain, reduction of multipath effects or other advantages which would outweigh the lower value of plane wave gain.

It is essential that antenna design for any given link be standardized in order that the vertical and horizontal polar diagrams of transmitting and receiving antennae use a common scattering volume in the ionosphere. For purposes of aiming the vertical lobe at the scattering volume at the path midpoint, an ionospheric height of 85 kilometres should be assumed.

Sites must be selected so as to be free from man-made noise; as a practical matter the ambient noise levels should not exceed minimum levels of background galactic noise level, so that the limiting circuit noise is essentially galactic in origin under normal conditions.

Besides being free from man-made noise and obstructions in the direction of transmission, the sites must be selected with due regard to providing the large, relatively flat reflecting surface required for effective radiation in well defined patterns at the low angles of elevation involved in directing transmission

at an 85 km ionospheric midpoint height. A good flat reflecting surface should be available over the area of the first Fresnel zone for ground reflection. Within the reflection zone, it is desirable that the area not depart from flatness by more than plus or minus 1/8th of the antenna height. Beyond the first Fresnel zone, the horizon should not be obstructed above the desired elevation of the main lobe.

Observance of these principles, and other factors affecting siting, being quite complex, must be dealt with on a terminal by terminal basis without attempting to resolve by generalities all the detailed considerations. Logistics, access, and, convenience are also major considerations.

6. Primary power and standby power equipment must be provided to assure that there is no significant interruption of service due to power failure.

7. The teletype modulation system used should be specifically designed for use on ionospheric scatter circuits and should afford freedom from Doppler shifts associated with meteor trail reflections.

Note: It is not considered necessary to specify the particular type of teletype system that should be employed. It will be advisable, however, to select one system which can be agreed by all of the implementing States prior to finalization of contracts. The United States proposal has been based on use of Frequency Shift Keying using predetection matched filter techniques.

8. From the point of view of system performance it is not necessary for this Meeting to standadardize as to type of telephone modulation. It will be necessary for the implementing States involved, to agree on a single system such as single-sideband suppressed carrier or narrow band FM prior to acceptance of final bids in order to preserve the system concept. From the point of view of conservation of spectrum space and minimizing the possibilities of interference to other services it may be desirable to use single-sideband.

9. The specific frequencies assigned to particular stations to be selected by the Licensing Administrations in accordance with all applicable provisions of the Convention and Radio Regulations of the International Telecommunications Union. Until suitable allocation provisions can be made, full coordination with any affected Administration should be accomplished, as an interim measure, to accommodate specific ionospheric scatter operations in any given area.

It is strongly recommended that in order to minimize the possibility of interference the interested Administrations select the frequencies for the operation of the ionospheric scatter circuits in such a manner that the actual frequency in use at any given time be one which is at least 20% above the monthly median hourly F2-4000 MUF as predicted by Central Radio Propagation Laboratory (CRPL) Series D Bulleting or other comparable data.

SUPPLEMENT B

DATA ON JOINT FINANCING OF VHF FOREWARD SCATTER

CABLE AND VHF FOREWARD SCATTER SYSTEMS

INDEX TO APPENDICES

Appendices		Description
1 - 5		Capital and Annual Costs for Scatter Stations and Connecting Links:
	1	3 hop Greenland
	2	2 hop Greenland
	3	3 hop Iceland, 2 locations
	4	3 hop Iceland, 1 location
	5	2 hop Iceland and Cable to U.K.
6 - 10		Inventory Annexes for Scatter Stations and Connecting Links:
	6	3 hop Greenland
	7	2 hop Greenland
	8	3 hop Iceland, 2 locations
	9	3 hop Iceland, 1 location
	10	2 hop Iceland and Cable to U.K.
11		Amendments of Technical Annexes
12		Amendments of Financial Annexes

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SUMMARY OF ANNUAL AND ADDITIONAL MAXIMUM PROJECT COST

		(1) Annual Costs Scatter Station	(2) Annual Costs Connecting Links	(3) Additional Maximum project Cost 110% (1 + 2)
1)	3 hop Greenland	$311,833	$ 33,199	$ 379,535
2)	2 hop Greenland	317,323	33,199	385,574
3)	3 hop Iceland — 2 locations	468,790	30,683	549,420
4)	3 hop Iceland — 1 location	364,400	30,683	434,591
5)	2 hop Iceland/cable*	240,187	143,666*	422,238

* Including $127,008 representing 50% of the U.K./Iceland cable rental plus 5% administration.

APPENDIX 1

Three-Hop System at Narssaq

I - CAPITAL COSTS OF THE STATION

1.	Radio equipment, without standby, auxiliary equipment, one year's quantity spare parts, and test equipment. (a)	$564,000
2.	Four cylindrical parabolic antennas, capable of 2-frequency operation, including installation and provision for a small stand-by antenna.	166,000
3.	Radio equipment building (30 ft. by 64 ft.).	60,000
4.	Two 250 KVA Diesel-electric generators (with auto-start facilities), spare parts and accessories, including installation (primary power source municipal mains).	81,000
5.	Building for primary and standby power generating equipment (22 ft. by 26 ft.).	20,000
6.	Fuel oil storage facilities requiring one refueling per year.	15,000
7.	Building for living quarters.	70,000
8.	Site preparation, water, fencing, sewage, access roadway.	35,000
9.	Radio equipment installation and system test assuming availability of assistance from five technicians who will operate and maintain the station when contractor work is completed.	31,280
10.	System and station design, shipping costs, travel and miscellaneous.	88,000
11.	Additional cost for standby electronic equipment.	98,000
12.	Land acquisition	NIL
	TOTAL CAPITAL COSTS OF STATION	$1,228,280

(a) Including $40,000 for possible error correcting devices.

APPENDIX 1 (Cont'd)

Three-Hop System at Narssaq

NARSSAQ

II - CAPITAL COSTS OF CONNECTING LINKS

Prins Christians Sund circuit

1.	Radio equipment, without standby, auxiliary equipment One year's quantity spare parts and test equipment Automatic channel selection device	19,000
2.	Antennae providing for three frequency operation and diversity reception	25,000
3.	Building and appurtenances	NIL
4.	Standby electronic equipment	13,000

Narssarssuaq circuit

5.	Radio equipment, without standby, auxiliary equipment, one year's quantity spare parts and test equipment	6,000
6.	Antennae	1,000
7.	Building	NIL
8.	Standby electronic equipment	5,000
	TOTAL CAPITAL COSTS OF CONNECTING LINKS (NARSSAQ)	69,000
	TOTAL CAPITAL COSTS (NARSSAQ)	$1,297,280

NARSSARSSUAQ

II - CAPITAL COSTS OF CONNECTING LINKS

Narssaq circuit

1.	Radio equipment, without standby, auxiliary equipment, one year's quantity spare parts and test equipment	$6,000
	Selective calling device	1,000
2.	Antennae	1,000
3.	Building	NIL
4.	Standby electronic equipment	5,000
	TOTAL CAPITAL COSTS (NARSSARSSUAQ)	$13,000

APPENDIX 1 (Cont'd)

Three-Hop System at Narssaq

PRINS CHRISTIANS SUND

II - CAPITAL COSTS OF CONNECTING LINKS

Narssaq circuit

1.	Radio equipment, without standby, auxiliary equipment One year's quantity spare parts and test equipment	$25,000
2.	Antennae providing for three frequency operation and diversity reception	25,000
3.	Building and appurtenances	10,000
4.	Standby electronic equipment	13,000
	TOTAL CAPITAL COSTS (PRINS CHRISTIANS SUND)	$73,000
	TOTAL CAPITAL COSTS FOR CONNECTING LINKS	$155,000
	GRAND TOTAL OF CAPITAL COSTS FOR A THREE-HOP SYSTEM WITH CONNECTING LINKS (Narssaq, Narssarssuaq and Prins Christians Sund)	$1,383,280

III - ANNUAL EXPENSES OF THE STATION

A. Operating Expenses

1.	Salaries of regular operating personnel Six men at $5,000/year	$30,000
2.	Working expendables (Average commercial power load assumed: 350 kw at $0.02 per kw hr.)	60,000
3.	General operating expenses	1,100
4.	Transportation	2,500
5.	Miscellaneous additional necessary operating expenses	NIL

B. Maintenance Expenses

1.	Salaries of regular maintenance personnel (covered in A-1)	
2.	Special labor employed in maintenance	6,500
3.	Material used for maintenance	18,000
4.	Miscellaneous additional necessary maintenance expenses	1,500
	TOTAL DIRECT EXPENSES	$119,600

APPENDIX 1 (Cont'd)

Three-Hop System at Narssaq

III - ANNUAL EXPENSES OF THE STATION

C.	Indirect Expenses	
1.	10% for Administration	$11,960
2.	Depreciation	
	2.1 Building at 6.6%	12,210
	2.2 Equipment (excluding storage tanks) at 10%	102,828
	2.3 Storage tanks at 5%	750
3.	Interest at 4.5%	55,273
4.	Insurance at 0.75%	9,212
	TOTAL INDIRECT EXPENSES	$192,233
	GRAND TOTAL A + B + C	$311,833

IV - ANNUAL EXPENSES OF THE CONNECTING LINKS

		NARSSAQ	NARSSARSSUAQ	PRINS CHRISTIANSUND	TOTAL
A.	Operating Expenses				
2.	Working expendables	$3,000	$500	$3,000	$6,500
B.	Maintenance Expenses				
3.	National used for maintenance	1,000	500	1,000	2,500
	TOTAL DIRECT EXPENSES	4,000	1,000	4,000	9,000
C.	Indirect Expenses				
1.	10% for Administration	400	100	400	900
2.	Depreciation				
	2.1 Buildings at 6.6%	-	-	660	660
	2.2 Equipment at 10%	6,900	1,300	6,300	14,500
3.	Interest at 4.5%	3,105	585	3,285	6,975
4.	Insurance at 0.75%	518	98	548	1,164
	TOTAL INDIRECT EXPENSES	$10,923	2,083	11,193	$24,199
	GRAND TOTAL A + B + C	$14,923	$3,083	$15,193	$33,199

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APPENDIX 2

Two-Hop System at Narssaq

I - CAPITAL COSTS OF THE STATION

1.	Radio equipment, without standby, auxiliary equipment, one year's quantity spare parts, and test equipment. (a)	$582,000
2.	Four cylindrical parabolic antennae, capable of 2-frequency operation, including installation and provision of a small transmitting antenna.	170,000
3.	Radio equipment building (30 ft. by 64 ft.)	60,000
4.	Two 250 KVA Diesel-electric generators (with auto-start facilities), spare parts and accessories, including installation (primary power source municipal mains).	81,000
5.	Building for primary and standby power generating equipment (22 ft. by 26 ft.).	20,000
6.	Fuel oil storage facilities requiring one refueling per year.	15,000
7.	Building for living quarters	70,000
8.	Site preparation, water, fencing, sewage, access roadway.	35,000
9.	Radio equipment installation and system test assuming availability of assistance from five technicians who will operate and maintain the station when contractor work is completed.	31,280
10.	System and station design, shipping costs, travel and miscellaneous.	102,000
11.	Additional cost for standby electronic equipment.	98,000
12.	Cost of land acquisition.	NIL

Note (a) Including $40,000 for possible error correcting devices

TOTAL CAPITAL COSTS OF STATION $ 1,264,280

APPENDIX 2 (Cont'd)

Two-Hop System at Narssaq

II - CAPITAL COSTS OF CONNECTING LINKS	
NARSSAQ	
Prins Christians Sund circuit	
13. Radio equipment, without standby, auxiliary equipment One year's quantity spare parts and test equipment Automatic channel selection device	19,000
14. Antennae providing for three frequency operation and diversity reception	25,000
15. Building and appurtenances	NIL
16. Standby electronic equipment	13,000
Narssarssuaq circuit	
17. Radio equipment, without standby, auxiliary equipment One year's quantity spare parts and test equipment	6,000
18. Antennae	1,000
19. Building	NIL
20. Standby electronic equipment	5,000
CAPITAL COSTS OF CONNECTING LINKS (NARSSAQ)	$ 69,000
TOTAL CAPITAL COSTS (NARSSAQ)	$ 1,333,280

NARSSARSSUAQ

II - CAPITAL COSTS OF CONNECTING LINKS	
Narssaq circuit	
1. Radio equipment, without standby, auxiliary equipment, One year's quantity spare parts and test equipment	6,000
Selective calling device	1,000
2. Antennae	1,000
3. Building	NIL
4. Standby electronic equipment	5,000
TOTAL CAPITAL COSTS (NARSSARSSUAQ)	$ 13,000

APPENDIX 2 (Cont.)

Two-Hop System at Narssaq

PRINS CHRISTIANS SUND

II - CAPITAL COSTS OF CONNECTING LINKS

Narssaq circuit

1.	Radio equipment, without standby, auxiliary equipment One year's quantity spare parts and test equipment	$ 25,000
2.	Antennae providing for three frequency operation and diversity reception	25,000
3.	Building and appurtenances	10,000
4.	Standby electronic equipment	13,000
	TOTAL CAPITAL COSTS (PRINS CHRISTIANS SUND)	$ 73,000
	TOTAL CAPITAL COSTS FOR CONNECTING LINKS	$ 155,000
	GRAND TOTAL OF CAPITAL COSTS FOR A TWO-HOP SYSTEM WITH CONNECTING LINKS (Narssaq, Narssarssuaq and Prins Christians Sund)	$ 1,419,280

III - ANNUAL EXPENSES OF THE STATION

A - Operating Expenses

1.	Salaries of regular operating personnel Six men at $5,000/year	$ 30,000
2.	Working expendables (Average commercial power load assumed: 350 kw at $0.02 per kw hr.)	60,000
3.	General operating expenses	1,100
4.	Transportation	2,500
5.	Miscellaneous additional necessary operating expenses	NIL

B - Maintenance Expenses

1.	Salaries of regular maintenance personnel (covered in A-1)	
2.	Special labor employed in maintenance	6,500
3.	Material used for maintenance	18,000
4.	Miscellaneous additional necessary maintenance expenses	1,500
	TOTAL DIRECT EXPENSES	$ 119,600

APPENDIX 2 (Cont.)

Two-Hop System at Narssaq

C - Indirect Expenses

1.	10% for Administration	$ 11,960
2.	Depreciation	12,210
	2.1 Buildings at 6.6%	
	2.2 Equipment (excl. storage tank) at 10%	106,428
	2.3 Storage tank at 5%	750
3.	Interest at 4.5%	56,893
4.	Insurance at 0.75%	9,482
	TOTAL INDIRECT EXPENSES	197,723
	GRAND TOTAL A + B + C	$ 317,323

IV - ANNUAL COSTS OF CONNECTING LINKS

Costs are identical with those for connecting links in a three-hop system (cf. Appendix 1, IV)

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APPENDIX 3

Three-hop system with two Stations at different locations in Iceland

I — CAPITAL COSTS OF THE STATIONS

1.	Radio equipment, without standby, auxiliary equipment, one year's quantity of spare parts, and test equipment. (See Note 1).	$564,000
2.	Four cylindrical parabolic antennae, capable of 2-frequency operation, including installation and provision of a small transmitting antenna for standby purposes.	166,000
3.	Radio equipment buildings, including garages for two vehicles (26 ft x 60 ft).	100,000
4.	Six 250 KVA Diesel-electric generators (with auto-start facilities), spare parts and accessories including installation (for both primary and standby power). (Cost figure based on assumption that commercial power is not available). (See Note 2)	201,000
5.	Buildings for primary and standby power generating equipment (28 ft. x 34 ft.). (See note 2).	68,000
6.	Fuel oil storage facilities requiring one refueling per year. (See note 2).	30,000
7.	Site preparation, water, fencing, sewage, and access roadway. (See note 2).	50,000
8.	Radio equipment installation and system testing assuming availability of assistance from five technicians who will operate and maintain the station when contractor work is completed.	35,000
9.	System and station design, shipping costs, travel, and misc.	75,000
10.	Additional cost for standby electronic equipment. (See Note 2)	98,000
11.	Buildings for living quarters. (See Notes 2 and 3)	200,000
12.	Vehicles (two for each station). (See Note 4)	7,400
	TOTAL	$ 1,594,400

Note 1: Include $40,000 for possible error correction devices.

Note 2: This item represents twice the cost of a single station.

Note 3: Iceland pointed out that since personnel would number the same at each of the two stations, a duplicate requirement results. It was also pointed out that these sites would be remote from Reykjavik and that there was no possibility for obtaining other housing accommodations.

Note 4: To provide transportation for station personnel, food, supplies, etc.

APPENDIX 3 (cont'd)

Three-hop system with two Stations at different locations in Iceland

II - CAPITAL COSTS OF CONNECTING LINKS

At Gufunes:

1.	Selective Calling device	$1,000
2.	Automatic Circuit Selection device	5,000
	TOTAL	$6,000

III- ANNUAL EXPENSES OF THE STATIONS:

A. Operating Expenses

1.	Salaries of regular operating personnel 14 men (7 per station) at $4,850/year based on the mean salaries of similar personnel at Gufunes	$68,000
2.	Working expendables Average power load assumed: 188 kw at each of the two locations	66,000
3.	General operating expenses Including $10,000 line rental, $1,000 land rent and $2,000 cleaning at each location	26,000
4.	Transportation Twice the amount of single station	4,000

B. Maintenance Expenses

1.	Salaries of regular maintenance personnel (covered in A-1)	
2.	Special labor employed in maintenance including painting and maintenance of antennae, fuel tanks, housing and communications equipment. Twice the amount for one station.	12,000
3.	Material used for maintenance Twice the amount for single station	19,000
4.	Miscellaneous additional necessary maintenance expenses Twice the amount for single station	2,000
	TOTAL - DIRECT EXPENSES	$197,000

APPENDIX 3 (cont'd)

Three-hop system with two Stations at different locations in Iceland

C. Indirect Expenses

1.	10% for Administration	$19,700
2.	Depreciation	
2.1	Buildings at 6.6%	27,588
2.2	Equipment at 10%	113,900
2.3	Storage tank at 5%	1,500
2.4	Vehicles at 20%	1,480
3.	Interest at 6%	95,664
4.	Insurance at 0.75%	11,958
	TOTAL - INDIRECT EXPENSES	$271,790
	GRAND TOTAL A + B + C	$468,790

IV - ANNUAL EXPENSES OF CONNECTING LINKS

A. Operating Expenses

A3 General Operating Expenses

Rental of Landlines	$25,500
Rental of Teletypewriters	1,480
B. Maintenance Expenses	NIL
TOTAL - DIRECT EXPENSES	$26,980

C. Indirect Expenses

C1	10% for Administration	2,698
C2	Depreciation of equipment	600
C3	Interest at 6%	360
C4	Insurance at 0.75%	45
	TOTAL A + B + C	$30,683

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APPENDIX 4

Three-Hop System, two Stations at one location in Iceland

I - CAPITAL COSTS OF THE STATIONS:

1.	Radio equipment, without standby, auxiliary equipment, one year's quantity of spare parts, and test equipment. (See Note 1)	$ 564,000
2.	Four cylindrical parabolic antennae, capable of 2-frequency operation, including installation and provision of a small transmitting antenna for standby purposes.	166,000
3.	Radio equipment building including garages for 2 vehicles (26 ft. by 60 ft.)	60,000
4.	Three 250 KVA Diesel-electric generators (with auto-start facilities), spare parts and accessories including installation (for both primary and standby power). Cost figure based on assumption that commercial power is not available.	100,580
5.	Building for primary and standby power generating equipment (28 ft. by 34 ft.)	34,000
6.	Fuel oil storage facilities requiring one refueling per year.	20,000
7.	Site preparation, water, fencing, sewage, and access roadway.	25,000
8.	Radio equipment installation and system test assuming availability of assistance from five technicians who will operate and maintain the station when contractor work is completed.	28,500
9.	System and station design, shipping costs, travel, and miscellaneous.	75,000
10.	Additional cost for standby electronic equipment.	98,000
11.	Buildings for living quarters. (See Note 2)	100,000
12.	Vehicles (2) (See Note 3)	3,700
	TOTAL	$1,274,780

APPENDIX 4 (Cont'd)

Note 1: Include $ 40,000 for possible error correction devices.

Note 2: It was pointed out that the site would be remote from Reykjavik and that there was no possibility for obtaining other housing accommodation.

Note 3: To provide transportation for station personnel, food, supplies, etc.

III - ANNUAL EXPENSES OF THE STATION

A. Operating Expenses

1.	Salaries of regular operating personnel Seven men at $4,850 per annum based on the mean salaries of similar personnel at Gufunes	$ 34,000
2.	Working expendables Average power load assumed: 350 kw. per hr. at 2 cents per kw. per hr. Assuming commercial power not available	56,000
3.	General operating expenses Including line rental, land rent and cleaning	24,000
4.	Transportation Including fuel, snow chains, lubrication and tires	2,000

B. Maintenance Expenses

1.	Salaries of regular maintenance personnel (included in A1)	
2.	Special labor employed in maintenance Including painting and maintenance of antennae, fuel tanks, housing and communication equipment	10,000
3.	Material used for maintenance	17,000
4.	Miscellaneous additional necessary maintenance expenses	1,500
	TOTAL A + B	$ 144,500

APPENDIX 4 (Cont'd)

Three Hop System two Stations at one location in Iceland

C.	Indirect Expenses	
1.	10% for Administration	$ 14,450
2.	Depreciation	
2.1	Building at 6.6%	14,454
2.2	Equipment at 10%	103,208
2.3	Storage tanks at 5%	1,000
2.4	Vehicles at 20%	740
3.	Interest at 6%	76,487
4.	Insurance at 0.75%	9,561
	TOTAL - INDIRECT EXPENSES	$ 219,900
	GRAND TOTAL	$ 364,400

IV - ANNUAL EXPENSES OF CONNECTING LINES

A.	Operating Expenses	
A3	General Operating Expenses	
	Rental of Landlines	25,500
	Rental of Teletypewriters	1,480
B.	Maintenance Expenses	NIL
	TOTAL - DIRECT EXPENSES	26,980
C.	Indirect Expenses	
1.	10% for Administration	2,698
2.	Depreciation of equipment	600
3.	Interest at 6%	360
4.	Insurance at 0.75%	45
	TOTAL A + B + C	$ 30,683

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APPENDIX 5

Two-Hop and Cable System with One Station

I - CAPITAL COST OF THE STATION:

1.	Radio equipment, without standby, auxiliary equipment. One year's quantity of spare parts, and test equipment. (See Note 1)	$ 291,000
2.	Two cylindrical parabolic antennae, capable of 2-frequency operation, including installation and provision for a small transmitting antenna.	87,000
3.	Radio equipment building including garage for 2 vehicles (26 ft. by 60 ft.).	50,000
4.	Three 250 KVA Diesel-electric generators (with auto-start facilities) spare parts and accessories including installation (for both primary and standby power). Cost figure based on assumption that commercial power is not available.	100,580
5.	Building for primary and standby power generating equipment (28 ft. by 34 ft.).	34,000
6.	Fuel oil storage facilities requiring one refueling per year.	15,000
7.	Site preparation, water, fencing, sewage, and access roadway.	25,000
8.	Radio equipment installation and system test assuming availability of assistance from five technicians who will operate and maintain the station when contractor work is completed.	21,500
9.	System and station design, shipping costs, travel and miscellaneous.	55,000
10.	Additional cost for standby electronic equipment.	49,000
11.	Building for living quarters (See Note 2).	100,000
12.	Vehicles (2) (See Note 3).	3,700
		$ 831,780

Note 1: Include $ 20,000 for possible error correction devices.

Note 2: It was pointed out that the site would be remote from Reykjavik and that there was no possibility for obtaining other housing accommodation.

Note 3: To provide transportation for station personnel, food, supplies, etc.

APPENDIX 5 (Cont'd)

Two-Hop and Cable System with One Station

II - CAPITAL COST OF CONNECTING LINKS

At Gufunes

1. Selective calling devices	$ 1,000
2. Automatic circuit Selection devices	5,000
TOTAL	6,000

III - ANNUAL EXPENSES OF THE STATION

A.- Operating Expenses

1. Salaries of regular operating personnel Seven men at $4,850/year based on the mean salaries of similar personnel at Gufunes	34,000
2. Working expendables Average power load assumed: 188 kW, no commercial power available	33,000
3. General operating expenses Line rental $10,000, land lease $1,000 and cleaning $2,000	13,000
4. Transportation Operating expenses of 2 vehicles, fuel, tires, etc.	2,000

B.- Maintenance Expenses

1. Salaries of regular maintenance personnel (covered in A-1)	
2. Special labor employed in maintenance including painting, maintenance of antennae, fuel tanks, housing, etc.	6,000
3. Material used for maintenance	9,500
4. Miscellaneous additional necessary maintenance expenses	1,000
TOTAL - DIRECT EXPENSES	$ 98,500

APPENDIX 5 (Cont'd)

Two-Hop and Cable System with One Station

C - Indirect Expenses

1.	10% for Administration	$ 9,850
2.	Depreciation	
	2.1 Buildings at 6.6%	13,794
	2.2 Equipment at 10%	60,408
	2.3 Storage tanks at 5%	750
	2.4 Vehicles at 20%	740
3.	Interest at 6%	49,907
4.	Insurance at 0.75%	6,238
	TOTAL - INDIRECT EXPENSES	$ 141,687
	GRAND TOTAL (A + B + C)	$ 240,187

IV - ANNUAL EXPENSES AT CONNECTING LINKS

a - At Gufunes

A3	General operating Expenses	
	Rental of Landlines	12,750
	Rental of Teletypewriters	1,480
C1	10% for Administration	1,423
C2	Depreciation of equipment at 10%	600
C3	Interest at 6%	360
C4	Insurance at 0.75%	45
	TOTAL	$ 16,658

b - Cable UK - Iceland

A3	General operating Expenses	
	50% of the rental	120,960
C1	5% for Administration	6,048
		$ 127,008
	TOTAL OF a + b	$ 143,666

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APPENDIX 6

Amendments required to Inventory Annex for three-hop System

Station: NARSSAQ (a) - Station proper

Calculated in Danish Kroner
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	1,277,821 ($185,000)				
2. Antenna towers and counter-poises		1,146,585 ($166,000)			
3. Machinery and tools		559,478 ($81,000)			
4. Storage tanks		103,607 ($15,000)			
5. Communications equipment		5,396,410 ($781,280)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL	1,277,821 ($185,000)	7,206,080 ($1,043,280)			

APPENDIX 6 Cont'd

Amendments required to Inventory Annex for three-hop System

Station: NARSSAQ (b) Connecting links

Calculated in Danish Kroner except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises		179,586 ($26,000)			
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		297,007 ($43,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		476,593 ($69,000)			

APPENDIX 6 Cont'd

Amendments required to Inventory Annex for three-hop System

Station: NARSSARSSUAQ - Connecting links

Calculated in Danish Kroner
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises		6,907 ($1,000)			
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		82,886 ($12,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		89,793 ($13,000)			

APPENDIX 6 Cont'd

Amendments required to Inventory Annex for three-hop System

Station: PRINS CHRISTIANS SUND - Connecting links

Calculated in Danish Kroner except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	69,071 ($10,000)				
2. Antenna towers and counter-poises		172,679 ($25,000)			
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		248,657 ($36,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL	69,071 ($10,000)	421,336 ($61,000)			

APPENDIX 7

Amendments required to Inventory Annex for two-hop System

Station: NARSSAQ (a) Station proper

Calculated in Danish Kroner
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	1,277,821 ($185,000)				
2. Antenna towers and counter-poises		1,174,214 ($170,000)			
3. Machinery and tools		559,478 ($ 81,000)			
4. Storage tanks		103,607 ($ 15,000)			
5. Communications equipment		5,617,439 ($813,280)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL	1,277,821 ($185,000)	7,454,738 ($1,079,280)			

APPENDIX 7 Cont'd

Amendments required to Inventory Annex for two-hop System

Station: NARSSAQ (b) Connecting links

Calculated in Danish Kroner except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises		179,586 ($26,000)			
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		297,007 ($43,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		476,593 ($69,000)			

APPENDIX 7 Cont'd

Amendments required to Inventory Annex for two-hop System

Station: NARSSARSSUAQ - Connecting links

Calculated in Danish Kroner except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises		6,907 ($1,000)			
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		82,886 ($12,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		89,793 ($13,000)			

APPENDIX 7 Cont'd

Amendments required to Inventory Annex for two-hop System

Station: PRINS CHRISTIANS SUND - Connecting links

Calculated in Danish Kroner
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	69,071 ($10,000)				
2. Antenna towers and counter-poises		172,679 ($25,000)			
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		262,471 ($38,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL	69,071 ($10,000)	435,150 ($63,000)			

APPENDIX 8

Amendments required to Inventory Annex for three-hop System

Station "1" (a) Station proper

(One of two stations at different locations in Iceland)
Calculated in Icelandic Kronur
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	3,403,711 ($209,000)				
2. Antenna towers and counter-poises		1,351,713 ($ 83,000)			
3. Machinery and tools		1,636,713 ($100,500)			
4. Storage tanks		244,286 ($ 15,000)			
5. Communications equipment		6,286,280 ($386,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles		60,257 ($ 3,700)			
9. Boats					
10. Office and housing equipment					
TOTAL	3,403,711 ($209,000)	19,579,249 ($588,200)			

APPENDIX 8 Cont'd

Amendments required to Inventory Annex for three-hop System

Station "2" (a) Station proper

(One of two stations at different locations in Iceland)
Calculated in Icelandic Kronur
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	3,403,711 ($209,000)				
2. Antenna towers and counter-poises		1,351,713 ($ 83,000)			
3. Machinery and tools		1,636,713 ($100,500)			
4. Storage tanks		244,286 ($ 15,000)			
5. Communications equipment		6,286,280 ($386,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles		60,257 ($ 3,700)			
9. Boats					
10. Office and housing equipment					
TOTAL	3,403,711 ($209,000)	9,579,249 ($588,200)			

APPENDIX 8 Cont'd

Amendments required to Inventory Annex for three-hop System

Station: Gufunes - Connecting links

Calculated in Icelandic Kronur
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises					
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		97,714 ($ 6,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		97,714 ($ 6,000)			

APPENDIX 9

Amendments required to Inventory Annex for three-hop System

Station: Station proper

(Cost for two stations at same location in Iceland)
Calculated in Icelandic Kronur,
except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	3,566,568 ($219,000)				
2. Antenna towers and counter-poises		2,703,426 ($166,000)			
3. Machinery and tools		1,638,016 ($100,580)			
4. Storage tanks		325,714 ($ 20,000)			
5. Communications equipment		12,466,703 ($765,300)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles		60,257 ($ 3,700)			
9. Boats					
10. Office and housing equipment					
TOTAL	3,566,568 ($219,000)	17,194,116 ($1,055,780)			

APPENDIX 9 Cont'd

Amendments required to Inventory Annex for three-hop System

Station: Gufunes - Connecting links

Calculated in Icelandic Kronur except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises					
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		97,714 ($ 6,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		97,714 ($ 6,000)			

APPENDIX 10

Amendments required to Inventory Annex for two-hop and cable System

(One Station in Iceland)

Calculated in Icelandic Kronur except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto	3,403,711 ($209,000)				
2. Antenna towers and counter-poises		1,416,856 ($ 87,000)			
3. Machinery and tools		1,638,016 ($100,580)			
4. Storage tanks		244,286 ($ 15,000)			
5. Communications equipment		6,782,994 ($416,500)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles		60,257 ($ 3,700)			
9. Boats					
10. Office and housing equipment					
TOTAL	3,403,711 ($209,000)	10,142,409 ($622,780)			

APPENDIX 10 (Cont'd)

Amendments required to Inventory Annex for two-hop and cable System

Station: Gufunes - Connecting links

Calculated in Icelandic Kronur except as otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)
Items	Agreed initial value for purposes of annual depreciation		Depreciation and insurance received by less reinvestments for renewals	Agreed Residual value as of	Date of commencement of depreciation
	Buildings and appurtenances thereto	Equipment			
1. Buildings and appurtenances thereto					
2. Antenna towers and counter-poises					
3. Machinery and tools					
4. Storage tanks					
5. Communications equipment		97,714 ($ 6,000)			
6. Cables - armoured ordinary					
7. Meteorological Equipment					
8. Vehicles					
9. Boats					
10. Office and housing equipment					
TOTAL		97,714 ($ 6,000)			

APPENDIX 11

AMENDMENT OF TECHNICAL ANNEXES (ANNEX I) TO THE EXISTING AGREEMENTS

1. For either the 3-hop or 2-hop VHF Forward Scatter/Cable System the Services in Annex I, Part III-Aeronautical Telecommunications Services would need to be amended as follows:

Danish Agreement

2. For the inclusion of the Scatter Station at Narssaq, insert:-

"E. Narssaq-1. VHF Forward Scatter Relay Station with the following specifications:

The station is to provide, in association with stations at Gander, Reykjavik, and Shannon-Prestwick, a point to point communications system across the North Atlantic, with voice and teletype circuits linking air-ground stations and air-traffic services centres in the Gander OAC, Narssarssuaq FIR, Iceland OAC and Shannon-Prestwick OAC. The station is to be equipped and maintained for the provision of this service with a minimum of interruption due to failure of its component parts."

3. For the inclusion of the connecting links insert:-

3.1 "B. Prins Christians Sund

5 Circuit between Narssaq and Prins Christians Sund: Provision for three-frequency operation, using HF single side band or Frequency shift keying together with diversity reception using transmitters of 5 kW." and,

3.2 "E. Narssaq-2.

Circuit between Narssaq and Narssarssuaq: A VHF system with 50 watt transmitters and providing two telephone channels of which one is used to provide four teletypewriter channels."

3.3 "F. Narssarssuaq -1. VHF communications with Narssaq as in E.2 above."

Icelandic Agreement

4. For either the 3-hop Scatter system (2 stations at 2 locations or at 1 location) or 2-hop Scatter with cable between U.K. and Iceland, the Services in Annex I, Part III - Aeronautical Telecommunications Services would need to be amended as follows:

4.1 For inclusion of the Scatter Station or Stations at a place remote from Reykjavik in Iceland, insert:-

"D. Place Name(s) - VHF Forward Scatter Station(s) with the following specifications:

"The station is to provide, in association with stations at Gander, Reykjavik, and Shannon-Prestwick, a point to point communications system across the North Atlantic, with voice and teletype circuits linking air-ground stations and air-traffic services centres in the Gander OAC, Narssarssuaq FIR, Iceland OAC and Shannon-Prestwick OAC. The station is to be equipped and maintained for the provision of this service with a minimum of interruption due to failure of its component parts."

4.2 For inclusion of the cable between U.K. and Iceland, insert:-

"E. _____ an undersea cable between U.K. and Iceland with 1 voice and 4 teletype circuits linking air-ground stations and air traffic services centres in the Iceland OAC and Shannon/Prestwick OAC.

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APPENDIX 12

AMENDMENT OF FINANCIAL ANNEXES (ANNEX III) TO THE EXISTING AGREEMENTS

1. For either the 3-hop or 2-hop VHF Forward Scatter/Cable System the Services in Annex III - Financial would need to be amended as follows:-

Danish Agreement

2. For the inclusion of the Scatter Station at Narssaq, insert:-

2.1 in Section I, para. 4; III Aeronautical and Meteorological Communications Services (either 3 or 2 hop system):-

	Technical	Other	Total
"5 Narssaq	6	0	6"

2.2 in Section II, para. 2.1, Depreciation of Buildings and Appurtenance thereto at (either 3 or 2 hop system):-

"Narssaq 6.6%"

3. For the inclusion of the connecting links, insert in Section I, para. 4, III, Aeronautical and Meteorological Communications Services (either 3 or 2 hop system):-

	Technical	Other	Total
"6 Narssarssuaq	0	0	0"

Icelandic Agreement

4. For the inclusion of the 3-hop Scatter System (2 Stations at 2 locations or at 1 location) or 2-hop Scatter with cable between U.K. and Iceland, insert:-

4.1 in Section I, para. 4, III Aeronautical and Meteorological Communications Services:-

a) (for 3-hop system with 2 stations at 2 locations)

	Technical	Other	Total
"/Station A/	7	0	7
/Station B/	7	0	7"

b) (for 3-hop system with 2 stations at 1 location or 2-hop scatter/cable system)

"/Station/	7	0	7"

4.2 in Section II, Part C, 2.2 Depreciation for Buildings and Appurtenances thereto at (either 3 or 2 hop system):-

"/Stations A & B/ 6.6%"

4.3 in Section II, Part C, 2.3 Depreciation for Equipment, except (either 3 or 2 hop system):-

"Storage tanks 5%"

5. For the inclusion of the connecting links to Scatter Stations, insert:-

5.1 in Section I, para. 5, (for 2-hop Scatter/Cable):-

"5.4 UK-Iceland Cable - 50% of the rental between UK and Icelandic air traffic centers."

5.2 in Section II, Part C, 1 Miscellaneous Overhead including Administrations, add at the end (for 2-hop scatter/cable):-

"except that for the rental of the U.K. Iceland Cable specified in Section I, para. 5.4 herein only 5% may be charged."

APPENDIX 'A'

STATEMENTS BY DELEGATIONS

ICELAND AND THE UNITED KINGDOM

Improvement in London-Reykjavik HF-RTT Circuit

1. Until 1st June 1956, the Reykjavik and London terminals of the London-Reykjavik HF RTTY circuit both employed receivers of the conventional general purpose variety. Since that time the London terminal of the Reykjavik-London leg has employed a highly selective double diversity receiver. Throughout transmitting power has been 3 kW from Reykjavik and 40 kW from London.

2. The main features of this receiver are:

Basic oscillator stability	-	Variable first oscillator	5 in 10^6 per° C
		Crystal first oscillator	1 in 10^6 per° C
		Second oscillator	5 in 10^6 per° C
		The setting accuracy of the variable first oscillator is within ± 1 kc/s.	
Sensitivity	-	15% disturbance at 100 bauds.	
Selectivity	-	First IF	15 kc/s wide at 3 db attenuation 70 kc/s wide at 70 db attenuation
		Second IF	1 kc/s filter - 1 kc/s wide at 3 db attenuation, 2 kc/s wide at 80 db attenuation
			2 kc/s filter - 2 kc/s wide at 3 db attenuation, 3.8 kc/s wide at 80 db attenuation.
		Image protection better than 65 db at any frequency.	
Diversity switching	-	Operates a minimum signal difference of 1.5 db.	
		Initiating time	500 μs max.
		Transit time	50 μs max.
Noise factor	-	3 db at 3 Mc/s 6 db at 27.5 Mc/s.	

3. The effect of this substitution is shown on page II-23 from which it may be seen that a marked improvement to performance of the Reykjavik leg has occurred to the extent of more than compensating for the difference in transmitting power.

4. A receiver of the same type was installed on the receive leg of the Gander-London leg at the same time with similar improvements.

5. However, the figures since June 1956 still involve too many periods of significant outage taking into account (a) the deployment of faster aircraft on a comparatively short haul route, (b) an increase in air traffic - even above the high NAT average - because of the development of polar route flying, and (c) the lack of appropriate alternative communication routes.

6. It is contemplated that the installation of a receiver with similar performance at Reykjavik (approved at Recommendation No. 23) will increase reliability in the London-Reykjavik leg to 98-100% with periods of outage exceeding 30 mins. varying from 1 to 2 in months when good propagation pertains and 4 to 5 under bad propagation conditions.

7. Despite this improvement, nothing further can be done at the London terminal to improve performance of the Reykjavik-London leg and the outage figures given on page II-23 are not regarded as satisfactory. The attention of all States concerned is, therefore, directed to Recommendation No. 24 for it is believed that a transmitter with a power rating of not less than 20 kW should be installed at Reykjavik as soon as possible both to cater for the pre-VHF Forward Scatter/Cable installation period and for standby purposes for the Forward Scatter/Cable link after that date.

UNITED KINGDOM

Integration of Mobile with Fixed Services in Greenland

The United Kingdom reserves its right to withhold its contributions towards the joint financing of a VHF circuit (providing one telephone and four duplex teletypewriter circuits) between the VHF forward scatter terminal at Narssaq and the ATC centre at Narssarssuaq, until such time as it is firmly decided by the Danish Government that an ATC centre will be established at Narssarssuaq.

The VHF Forward Scatter System

Whilst in general agreement with the recommendations of this Meeting, and conscious of the urgent need to meet the increasing operational requirements, the United Kingdom wishes to place on record its views on certain features of the system.

It is considered that the assignment of frequencies to a scatter terminal whether located in Ireland or in the United Kingdom poses a problem of some magnitude and difficulty which is not capable of simple solution at short notice, and which will require detailed evaluation in the light of all relevant factors.

The United Kingdom has expressed the opinion that insufficient operational experience of the performance of such circuits exists, particularly in regard to multihop speech. It is considered, therefore, that strict performance specifications will have to be met by the Prime Contractor, as regards this requirement.

Bearing in mind these doubts; the contractual and radio frequency problems associated with this project and that the paramount need is to ensure direct speech of adequate reliability and intelligibility between the ATCC's concerned at the earliest possible date, the United Kingdom still believes that the phased plan it proposed, involving, initially, the use of the Trans-Atlantic telephone cable for communications between Gander and Shanwick until data on the performance of the Gander/Greenland VHF Forward Scatter link was known, would have been a better solution.

Iceland-Shanwick Cable Link

1. The United Kingdom notes that at Recommendation No. 1, the meeting recommends that if the Iceland-Shanwick link is provided by cable, one voice and four teletypewriter circuits be provided from that cable.

2. The United Kingdom agrees that:

(a) a cable will provide the highest quality speech between Iceland and Shanwick and make an important contribution towards improving the reliability and quality of speech between Gander and Shanwick;

(b) to provide equivalent capacity over the entire system the same number of teletypewriter channels must be made available over the Iceland-Shanwick link as are provided by VHF Forward Scatter over the Iceland-Greenland and Greenland-Gander links.

3. Nevertheless, taking into account the possibility of cable interruptions and relative costs, the United Kingdom considers that the requirement can be better met by leasing one telephone circuit in the cable, multiplexing and error correcting the existing HF RTTY and leasing one telegraph circuit in the cable as a standby to cover outages on the radio circuits.

4. Consequently, the United Kingdom reserves its right, in the event that a cable and not VHF Forward Scatter is employed for the Iceland/Shanwick link, to fulfil its responsibilities in the most economic fashion until such time as it can be demonstrated that any operational advantage is to be derived from adopting the more expensive solution. In formulating a final conclusion, the United Kingdom would take into account the factors at 2(a) and its view that voice is the primary requirement.

Paragraph 1.3, page II leading to Recommendation No. 2

With regard to the end of paragraph 1.3 leading to Recommendation No. 2, the United Kingdom strongly disagrees with the reference to sub-paragraph (b) mentioned therein, and believes that this was not the intent of the Meeting.

The United Kingdom believes that due to a drafting error, the reference should have been to sub-paragraph (c), but that this error was subsequently overlooked when considered by the Meeting.

It was the United Kingdom understanding that the States proposing Recommendation No. 2 did express the view that there were operational advantages in locating the European terminal in the United Kingdom, but that there was a slight technical advantage in locating the terminal in Ireland as regards frequency difficulties. This is, of course, reflected in Recommendation No. 2.

Unfortunately, owing to procedural objections, the United Kingdom was unable to re-open discussion on this matter in the Final Plenary Meeting. The United Kingdom believes therefore that the reference should be to sub-paragraph (c) rather than to sub-paragraph (b) and that this was the correct interpretation of the Meeting's intent.

CANADA

In the 1956 Joint Financing Agreement with Denmark provision was made for the exchange of meteorological data from Greenland to Canada by the assignment of an exclusive meteorological channel in the Radio Teletypewriter circuit between Prins Christians Sund and Gander. Recommendation No. 16 makes no similar provision in the event that the Forward Scatter System replaces the Radio Teletypewriter System. The Canadian Delegation considers this meteorological traffic to be of extreme importance and that it will be necessary to give consideration at a later date to the assignment of either scheduled periods or an exclusive channel for meteorological traffic in the portion of the system between Prins Christians Sund and Gander. Accordingly the Canadian Delegation must reserve its position in respect to Recommendation No. 16.

DENMARK

The Danish delegation agrees to the technical necessity of using a Prime Contractor (Recommendation No. 30). Our understanding, however, has to be made clear that the Prime Contractor concept relates to the radio equipment with associated antennae and other radio accessories and the installation thereof only and not necessarily to the remainder of the stations such as buildings, roads, primary power supply, etc.

STATEMENT BY THE DELEGATE OF ISRAEL

The Delegate of Israel would like to state that while he has not found it possible to be active in the considerations and discussions of the various Committees or the Plenary Sessions, his Government thought it proper not to be absent from this important Meeting. By its formal participation in this Meeting, the Government of Israel meant to express its feeling that there was a need for improvement in the fixed services of the North Atlantic Region, from the safety as well as from the economic points of view. The attention devoted to technical and financial study of the problem by this Meeting can no doubt serve as a step towards the implementation of such improvements.

However, the view of the Government of Israel is that what has been suggested up to now does not seem the best solution to the problems of communications over the North Atlantic. The Government of Israel would further like to state that it does not find itself in a position to increase its share of the yearly payments in accordance with the Joint Financing Agreements. The Delegate of Israel would, therefore, like to make it clear that whatever the conclusions or recommendations of this Special Meeting, he could not see himself in any way committed, directly or implicitly, to support such conclusions or recommendations if such support would involve any increase in the share of Israel's payments to the Joint Financing Agreements.

STATEMENT BY THE DELEGATE OF SWEDEN

The Delegate of Sweden reserves the position of his Administration with respect to the following decisions:

Agenda Item 3

The recommendation in the case of Greenland to include four duplex teletypewriter circuits between Narssaq and Narssarssuaq for integration of mobile and fixed services.

Agenda Item 4

1. The recommendation in the case of the Icelandic Agreement that the limit prescribed in Article V should be increased by an amount of 434,591 United States dollars, which corresponds to the cost in respect of a one-location station in Iceland of the Three-Hop VHF Forward Scatter System.

2. The decision in the case of the Icelandic Agreement that 5 per cent should be charged for administration of the rented circuits in the United Kingdom/Iceland cable.

INTERNATIONAL AIR TRANSPORT ASSOCIATION

Time Schedule for Implementation of VHF Forward Scatter System

The International Air Transport Association has been pleased to note the general recognition by States of the critical shortcomings of the existing North Atlantic Fixed Communications and their agreement to implement a VHF Forward Scatter/Cable System which promises to introduce a marked improvement in North Atlantic Air Traffic Control and overall air operations efficiency.

However, it is with considerable alarm that IATA notes the Schedule of Implementation devoloped by the meeting which indicates that the new fixed communications facilities will possibly not be operationally available before the Spring of 1960. It is further noted that this would be nearly two years later than the date recommended in the First Report of the ICAO Implementation Panel (Doc 7751, PNL/1).

IATA therefore urges all Implementing States and such Prime Contractors as they may select to do everything possible to improve substantially upon what appears to be a highly pessimistic implementation schedule.

It is IATA's carefully considered opinion that unless such an improvement can be realized, the growing significance of ATC penalties will be such as seriously to reduce the service rendered to States and the travelling public on this important group of North Atlantic Air Routes.

- END -

ICAO TECHNICAL PUBLICATIONS

The following summary gives the status, and also describes in general terms the contents of the various series of technical publications issued by the International Civil Aviation Organization. It does not include specialized publications that do not fall specifically within one of the series, such as the ICAO Aeronautical Chart Catalogue *or the* Meteorological Tables for International Air Navigation.

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES are adopted by the Council in accordance with Articles 54, 37 and 90 of the Convention on International Civil Aviation and are designated, for convenience, as Annexes to the Convention. The uniform application by Contracting States of the specifications comprised in the International Standards is recognized as necessary for the safety or regularity of international air navigation while the uniform application of the specifications in the Recommended Practices is regarded as desirable in the interest of safety, regularity or efficiency of international air navigation. Knowledge of any differences between the national regulations or practices of a State and those established by an International Standard is essential to the safety or regularity of international air navigation. In the event of non-compliance with an International Standard, a State has, in fact, an obligation, under Article 38 of the Convention, to notify the Council of any differences. Knowledge of differences from Recommended Practices may also be important for the safety of air navigation and, although the Convention does not impose any obligation with regard thereto, the Council has invited Contracting States to notify such differences in addition to those relating to International Standards.

PROCEDURES FOR AIR NAVIGATION SERVICES (PANS) are approved by the Council for worldwide application. They comprise, for the most part, operating procedures regarded as not yet having attained a sufficient degree of maturity for adoption as International Standards and Recommended Practices, as well as material of a more permanent character which is considered too detailed for incorporation in an Annex, or is susceptible to frequent amendment, for which the processes of the Convention would be too cumbersome. As in the case of Recommended Practices, the Council has invited Contracting States to notify any differences between their national practices and the PANS when the knowledge of such differences is important for the safety of air navigation.

REGIONAL SUPPLEMENTARY PROCEDURES (SUPPS) have a status similar to that of PANS in that they are approved by the Council, but only for application in the respective regions. They are prepared in consolidated form, since certain of the procedures apply to overlapping regions or are common to two or more regions.

The following publications are prepared by authority of the Secretary General in accordance with the principles and policies approved by the Council.

ICAO FIELD MANUALS have no status in themselves but derive their status from the International Standards, Recommended Practices and PANS from which they are compiled. They are prepared primarily for the use of personnel engaged in operations in the field, as a service to those Contracting States who do not find it practicable, for various reasons, to prepare them for their own use.

TECHNICAL MANUALS provide guidance and information in amplification of the International Standards, Recommended Practices and PANS, the implementation of which they are designed to facilitate.

AIR NAVIGATION PLAN documents detail requirements for facilities and services for international air navigation in the respective ICAO Air Navigation Regions. They are prepared on the authority of the Secretary General on the basis of recommendations of regional air navigation meetings and of the Council action thereon. The plans are amended periodically to reflect changes in requirements and in the status of implementation of the recommended facilities and services.

ICAO CIRCULARS make available specialized information of interest to Contracting States.