

Cjn to Mr. S. Raja

9.5.14

August 5, 1970

My dear Kale:

I am writing this letter in connection with the assignment of specific tasks to GE with ISRO/MIT study. The following points are relevant in this regard:

1. Objectives and scope of the study: (These have been defined in Dr. Sarabhai's letter to Professor Jerome B. Wiesner, dated January 6, 1970 and my letter dated July 22, 1970 to Dr. Sarles).
2. The ground rules according to which the study is to be conducted.
3. Composition of the ISRO team:
 - Mr. S.V. Deshmukh
 - Mr. R.M. Vasagam
 - Mr. H.J. Shenoy
 - Mr. Y. Sundararajan
 - Mr. T.V. Srirangan, TRC
 - Mr. Pramod Kale
4. Composition of the MIT team:
(Kindly furnish this as soon as possible).
5. The work statement provided by GE.
The points which are relevant are:
 - Dr. Sarabhai's discussion with Mr. Fink and others at GE on May 2.
 - Our subsequent meeting with Dr. Sarles and GE representatives.

I think the inputs required from GE to ISRO team should be determined in consultation with the members of ISRO team. These inputs would obviously depend upon the factors 1, 2, 3 and 4 outlined above. It should be our endeavour to assign tasks to GE in areas where GE has competence and members of our team feel that they do not have adequate information, experience or knowledge. It may be possible that MIT or NASA would be able to contribute information in these areas. If this is so, then GE members may not be asked to work on these specific

areas and their efforts should be devoted to other more fruitful areas. On certain occasions, you may like to get facts and figures checked out independently by GE to ascertain if there are any discrepancies.

We have received release of foreign exchange amounting to \$ 44,129 for the GE study. Under no circumstance, this amount should be exceeded. Since the composition of MIT team is not known to us, it is difficult to state specific areas on which you should seek GE help. However, you can discuss this with members of the ISRO team and also with MIT and GE. You could then jointly finalise the precise areas and tasks in which GE can be of assistance to us.

I am enclosing a copy of cable that we have sent to Mr. Carter and also a draft of an offer (Contract) which could form the basis for the formal agreement between GE and ISRO. Kindly show this to Mr. Carter and explain to him that this brief document outlines the basic purpose and method of payment and that since the amount involved is very small, it would be better if only this document could be the basis of agreement rather than a detailed and lengthy contract. This will make easier the task of approval and formal signing of the agreement. However, if GE feels that the formal contract in detail is necessary, then we can finalise this and sign it as soon as possible and in any case within 45 days as stated in my cable to Mr. Carter.

Dr. Sarabhai has indicated that he wants you to work full time on the study and that you should shift your headquarters to Boston. If necessary, you could visit Washington over the week-end. Also this will minimise the travel cost and the daily expenses. It will particularly be useful considering the scarce foreign exchange available.

Kindly inform us what areas and tasks in which you want GE to participate. Also please inform us of the progress of the study through fortnightly reports. We will send you a brief on our discussions with the NASA team shortly.

With kind regards,

Yours sincerely,

SA

E. V. Chitnis

Mr. Pramod Kale
Code 460
GSFC, Greenbelt
Maryland 20771, USA.

Encl:

TELEGRAM "RESEARCH"
TELEX : 012-261

PHYSICAL RESEARCH LABORATORY
NAVRANGPURA
AHMEDABAD-9
(INDIA)

TELEPHONES
77076, 79271,
79272, 77642.

9.6.5

August 4, 1970

MEMORANDUM

Mr. Y. Sundararajan, Electronics Engineer, Space Science and Technology Centre (SSTC) is deputed to Massachusetts Institute of Technology (MIT), USA for a joint ISRO-MIT/Lincoln Lab. study. The period of deputation will be three months from August 7, 1970. The living expenses and cost of air travel will be borne by ISRO.

V. K. Sarabhai
for (Vikram A. Sarabhai)
DIRECTOR

Mr. Y. Sundararajan
Electronics Engineer
Space Science & Technology Centre

M. I. T., 11th Nov. 70

To
Prof. E. V. Chitnis,
Secretary, I. S. R. O.
C/o Physical Research Lab.,
Ahmedabad - 9 (INDIA)

Dear Prof. Chitnis:

Initial drafting of most part of the report is over. Some corrections ~~are~~ and editing are being done. The report is divided into three volume. Vol. I - Summary. Vol. II - Detailed technical specifications and realisation. ~~is~~

Vol. III - Cost. Vol. III is intended to be internal document, to be distributed as ISRO wishes. First, I will briefly describe the technical summary and later will go to some general aspects.

Technical Summary:

(1) Essential channel requirements are as in Preliminary sent before.

Uplink receive frequency:

Down link transmit frequency:-

UHF:- TV : 790 to 950 MHz (4 channels each 40 MHz wide)

AIR : 950 to 955 MHz.

~~FE~~

(2)

~~FE~~ C-Band :-

- (i) Beacon - telemetry : 3705 - 3710 MHz.
Centre 3707.5. PCM-PSK.
- (ii) Telecomm :
6 channels 40 MHz wide
- (iii) Multiple access :
2 channels 40 MHz wide.
- (iv) TV redistribution :
4 channels 40 MHz wide.
(Can be switched from UHF TV when they are not used)

C-Band Command up link receive :-

MHz. PCM-FSK.

#

(2) Realisation: The uplink 6 GHz signals are downconverted to telecomm frequency with _____ MHz, L.O. in a single mixer of balanced type. [As balanced or ring type mixer has 4 diode units redundancy is not required. It is to be noted that no mixer failure has been reported in any flights.] Command signal is filtered from this downconverted signal. Also the redundant command channel is permanently connected to earth coverage horn to ease acquisition problems due to its wider

② ③

beamwidth. The 12 channels of the telecomm are multiplexed from this downconverted signals and ^{power} amplified by a single TWT per each channel. # (An individual channel amplification like this keeps intermod down). Multiple access channel has two TWT's in parallel to allow for back off required to accomodate multiple carriers. TWT's are provided with 50% redundancy. Output multiplexing is done by a waveguide directional ~~coupler~~ filter.

Coming now to TV Channel, one more mixing with an LO of _____ MHz gives TV signals which are multiplexed to separate channels; each channel is amplified by solid state PA chain. (58% efficiency) Output channel combining is to be done by stripline directional filters or waveguides.

After all losses EIRP =

(3) Antenna: 25' to 27' dish with tapered illumination. Optimum design to be fixed by scale model studies.

(4) Size of Earth Viewing Module (EVM):

46" x 46" x 66".

46" x 46" square faces earth.
66" is height.

(4)

5) With the same basic design weight reduction due to decreased channels was also looked into.

Decreased channel capability ~~was~~ was:-

1 TV + (1 standby for redundancy)

2 Telecomm

1 Multiple access.

No distribution of TV or AIR. Calling this MINI and our original one as MAXI, I list the weight breakdown of both. (All in lbs)

Item	MAXI	MINI
Structure	135	117
Solar Array System	235	152
Power System	90.5	51
Ordnance & deployment	3.6	3.6
Antenna & feed	100.2	78.7
Telemetry	15.0	15.0
Command	11.2	11.2
Altitude control electronics	36.0	29.5
Momentum wheel	52.0	23.5
Sensors	11.1	11.1
Electric Thrusters	51.0	—
Thermal control	34.1	16.1
UHF TV transponder	98.0	35.1
C-Band))	60.0	17.8
Telemetry (C-Band)	16.4	16.4
Frequency std		

	(5) MAXI	MINI
Electrical Harness (14%)	142.1	90.2
Contingency	115.7	73.4
	<hr/> 1272.8	<hr/> 807.5

This indicates for the reduced capacity two Thor-delta is not feasible. Of course in the ^{asin} GE report we had sent if we forsake 3.3 ft C-Band dish and go for reduced EIRP for UHF TV, it may be possible.

Pitfalls are :- Without C-Band dish ground transmitting power and dishes are to be large and hence costlier.

Reduced EIRP will require higher (10-ft) TV antennas. Or else we have to cut-down bandwidth. Reducing of TV bandwidth, especially with 14 languages is yet to be decided. That involves major decisions on your part.

General Managerial Aspects:

(1) A setting up of Contract Management office for INSAT satellite has been recommended by Dr. Sarles. It should be made up of experienced Indians and Americans who would decide about awarding of contracts, writing down specifications, identify long lead items etc. He feels that it cannot be

(6)

a place of training.

(2) Hughes Co. had come to us and explained about their earlier programs too. They take some people on their payroll; but then these people have to work as Hughes wishes. (If a person is not on payroll, the company may not care much about training, perhaps!)

(3) Dr. Greg Andrews was saying that ISRO should be ready with overall system study, cost etc (including software) as such questions are bound to arise.

(4) In ~~the~~ our report, MIT would be putting a special disclaimer that its participation in satellite study should not be construed as its siding for satellite versus comparative system such air-plane-broadcasting etc, as they had not done such trade off studies. This I am pointing out specially to have adequate preparations on our side.

(5) In general, people are first concentrating on requirement portions, rather than technical aspects.

(6) For technology transfer, Dr. Sarles feels that at a time maximum number should not be more than fifty people. For

(7)

during a particular test phase a group of people may come and go. Thus the overall ~~peo~~ number involved may be more, but at a time in an industry 50 or less would be there. Of course, this is an involved problem, depending on various parameters such as our goals, facilities set up in India for people who return in the middle (otherwise their training may be diverted to other fields).

INDIAN SPACE RESEARCH ORGANISATION
ISRO

TELEPHONE : 77076, 79271-2, 77641-2
TELEGRAM : ISRO
T E L E X : 012-261

C/O PHYSICAL RESEARCH LABORATORY
NAVRANGPURA, AHMEDABAD-9, INDIA

9.5.14

January 27, 1971

Dear Mr. Sundararajan:

Kale, Karnik and myself have discussed with Dr. Sarabhai the problems regarding continuation of your stay in USA. In view of the fact that you were not intimated, prior to your departure, that you will have to stay for a period of two years beyond ISRO-MIT study, you will be permitted, if you desire, to return to India for a short while to settle the outstanding family matters. You can, then, be sent to USA on a regular deputation which will be processed on the lines similar to that of Mr. Kale.

From the end of ISRO-MIT study (December 11) to the time of your return (if you decide to return immediately) you will be paid daily allowances at normal PRL rates. The difference between \$ 450 p.m. and the amount due to you on the basis of daily allowance, will be paid to you through NASA. The exact amount will be worked out by Mr. Parikh and will be intimated to you for confirmation.

You will have three options for working in the USA.

1. to continue to work at GSFC
2. to work at Fairchild Hiller
3. to work for INSAT in the Project Management Office.

We have not yet received a proposal from Fairchild Hiller. We do not therefore, at this stage, know the exact nature of the assignment we could provide you at Fairchild Hiller. The work which will be done in the INSAT project would be outlined by Mr. Kale to you. You can also exercise the option of returning to India and rejoin your respective divisions. If you desire to continue at GSFC, you will be posted there for a period of two years. Fairchild Hiller assignment may be of similar duration. The INSAT commitment would be a long-term commitment and since all the three assignments are INSAT-oriented, there must be a definite commitment from you to work for INSAT project either in USA

....2

or in India. The fabrication of INSAT will be taken up in USA. You will be given opportunity to work on the hardware or management side depending upon your inclination and the project requirements. Later, when the setting up of satellite facilities and fabrication of the satellite (to be ready in 1977 for launch) is undertaken, you will work in India at SSTC. Since we have discussed the matter in detail with Mr. Kale, please do not hesitate to ask him any clarification. You may, if you wish, write to me for any information which you think would help you in coming to a decision.

Dr. Sarabhai had indicated that Kale, on his return to USA, should prepare a plan giving broad indications of the following items for the development of INSAT:

- i) Man-power requirements,
- ii) Personnel profile,
- iii) Total expenditure and budget,
- iv) Expenditure profile,
- v) Space requirements,
- vi) Environmental testing requirements.

To prepare the plan, Kale stated that he would need about 4-6 weeks time and would require your assistance for a period of two weeks. Dr. Sarabhai agreed that you should work with Kale for a period of two weeks and he will make appropriate arrangements with Mr. Sabelhaus for you to work on this assignment. If you decide to return to India, you can do so after completing this two weeks' assignment. Please let me know, as soon as possible, your decision so that appropriate arrangements could be made for you.

With kind regards,

Yours sincerely,


E. V. Chitnis

Mr. Y. Sundararajan
Code 460
ATS Project Office
NASA/GSFC
Greeneblt, Maryland 20771
USA

Professor E. V. Chitnis
Secretary, I.S.R.O.
% Physical Research Lab
Ahmedabad -9 (India)

1/29/71

Dear Prof. Chitnis:

Briefly given below is the work I have been doing for the past few days. This period was busy with finalization of Specification of ATS F&G spacecraft and sub-systems. The contract has been signed yesterday (1/28/71). I have also enclosed herewith a copy of the name and field of work of the persons who attended the INSAT review.

1. Some corrections - typographic, etc. - were done to the INSAT report.

2. Have updated calculations for protection ratios and have sent to you in an earlier mail. Regarding field strength limits, I have written to the FCC for correct interpretations. (See Annexure para A-2 for details)

3. Am going through many CC/R, & CCITT documents and other related literature to relate many interference phenomena: TV on voice links, the interpretation of power in 4 KHz band, etc. (See Annexure A-3 for details)

4. Regarding the specifications of the ATS, I have been mainly following the Telemetry (Transponder, Feeds & Reflector). We had to finalize specs and test plans before the signing of contract. Test procedures will be finalized in the course of 3 or 4 months from now. Some areas on which I have put an in-depth work (for finalizing some parameters or plans) are: multipactor tests, FSK/AM detection mechanism, short-term stability, incidental FM group delay measurements, etc. (See Annexure para A-4 for details)

TELEX

DRAFT

FROM CHITNIS TO DR SARABHAI

June 15, 1971 1015 hrs

RECEIVED YOUR MSG AT 9.30. HAVE HAD DISCUSSIONS HERE AND WE FEEL THE FOLLOWING POINTS ARE RELEVANT:

1. OUR DELEGATION SHOULD YET PRESS FOR THE 845 TO 935 MHz BAND. IF THIS IS NOT POSSIBLE, THEN THEY SHOULD TRY FOR THE 700 TO 800 MHz BAND.
2. IN THE 700 TO 800 MHz BAND WE MAY BE SLIGHTLY WORSE OFF FROM THE SCINTILLATION POINT OF VIEW. THE DEGRADATION MAY BE ABOUT 0.5 DB MORE THAN THE 800 - 900 MHz BAND. HOWEVER NO EXPERIMENTAL DATA ON THIS EXISTS.
3. THE SHIFT TO 700 TO 800 MHz BAND WILL MEAN A MARGINAL INCREASE IN THE SIZE OF THE SPACECRAFT ANTENNA. OUR CALCULATIONS SHOW THAT AN ANTENNA 31 FEET IN DIAMETER WILL BE NEEDED (AGAINST 30 FEET ON ATS-F).
4. NO EXPERIMENTAL DATA EXISTS ON INTERFERENCE DUE TO SATELLITE BROADCASTING. OUR DELEGATION SHOULD EMPHASISE THIS POINT STRONGLY AND SAY THAT WARC SHOULD NOT MAKE DECISIONS ON UNPROVEN GROUNDS LIKE POSSIBLE INTERFERENCE. ACTUAL DATA WILL BE AVAILABLE ONLY AFTER ATS-F EXPERIMENT.
5. FROM THE MSG IT SEEMS THAT RAO HAS PRESUMABLY AGREED TO THE SHIFT TO THE 700 - 800 MHz BAND.
6. FROM OUR POINT OF VIEW THEREFORE THE 700 TO 800 MHz BAND IS SUITABLE THOUGH WE WOULD YET PREFER THE 845 TO 935 MHz BAND.

✓
Copy to Mr. Pramod Kale

9.5.14

July 22, 1970

Dear Dr. Sarles:

We are delighted to learn from Prof. Wiesner that Ford Foundation has agreed to support MIT for a joint study with ISRO. We are planning to send four engineers from India for the study. Two of them - Mr. S.V. Deshmukh and Mr. R.M. Vasagam - have already been selected and, in fact, they will be reaching Boston on July 23. Two more engineers, including one from the P & T, will be arriving in Boston shortly. As you know, we had intended that the study start on July 20 and we are sorry for the delay. I have already cabled to Mr. Kale about the arrival of our team and that the study should commence on July 24. I hope this is convenient to you.

Dr. Sarabhai, Dr. B.S. Rao, Mr. K.S. Karnik and I have discussed the objectives and the areas that the study should cover. I am summarising below some of the salient points that emerged from our discussion.

1. The ground rules for the study have already been discussed and specified during our discussions at Boston and include the following:-
 - 1.1 The diversity of the spacecraft mission will be limited and the study will not go into such aspects as the inclusion of remote sensing equipment, etc. on the spacecraft.
 - 1.2 The study will, in essence, be mainly a spacecraft study.
 - 1.3 Designs will be made compatible for operation with CCIR International Systems.
 - 1.4 The satellite all up-weight will be in the 1200-1500 pound range and will be compatible with launch vehicles that are likely to be available in the 1974-75 time-frame.
 - 1.5 The reports of the joint ISRO-GE and ISRO-Hughes studies will be used as a starting point for the ISRO-MIT study.

cont'd.

- 2.1 There are a great many problems to be studied which include such things as optimization of the satellite location from the point of view of spill-over, antenna coverage pattern, drift of the satellite, etc. Parametric studies will have to be conducted in order to optimize the location from our point of view.
- 2.2 The final report of the study should bring out clearly a detailed description of the satellite with specifications including tolerance levels, launch vehicle, satellite location, possible contractors, estimated costs, control command and telemetry system details, facilities required for manufacture of a similar satellite in India, test facilities required, etc.
- 2.3 Considering that the output of this study will be the input for the next phase, which will involve actual fabrication of the satellite, and considering the large number of possible trade-offs involved, it seems that 12 weeks (i.e. 48 man-weeks) from our side may be too short a time.
3. The total tasks can be divided as follows and the responsibilities of ISRO engineers are also shown below:

Tasks -----	ISRO Engineer <u>primarily responsible</u>
3.1 <u>Satellite</u>	
3.1.1 Structure	Mr. Shenoi
3.1.2 Antenna	"
3.1.3 Heat balance	"
3.1.4 Spacecraft stabilisation	Mr. Vasagam/Shenoi
3.2 <u>Launch Vehicle & facilities</u>	Mr. Kale/Shenoi
3.2.1 Launch vehicle availability/ cost, etc.	Mr. Kale
3.2.2 Manufacturing facilities required in USA and in India	All

cont'd..

3.2.3	Test facilities required	All
3.3	<u>Electronics</u>	
3.3.1	Transponders (Telecommunication & TV)	Mr. Srirangan/Sundarajan ^{re}
3.3.2	Telemetry, tracking and command system	Mr. Vasagam
3.3.3	Other electronics	Mr. Vasagam / Mr. Sundarajan ^{RAJ}
3.4	<u>Trade-off studies and General Planning</u>	
3.4.1	Trade-off studies	Mr. Deshmukh
3.4.2	Planning	"
3.4.3	Scheduling	" "
3.4.4	Cost analysis	"
3.4.5	Man-power requirements	"

Leaves filled. You will notice some blanks in the responsibility allocation. We expect that the two engineers who are yet to be selected will fill in these blanks.

- 4.1 A person from the P & T would be useful, particularly to feed in information about the present and future plans of the P & T with regard to the terrestrial system so that this information could be considered while designing the telecommunications payload on the spacecraft.

We have approached our Government to provide funds for participation of General Electric in this study. We have already received a clearance and the necessary foreign exchange has been released. We have communicated this to GE and are now awaiting reply from them. I trust you will arrange to have the briefing sessions on specific aspects of the study by experts from companies such as Hughes, Philco-Ford, TRW, CSC, etc. We would expect weekly reports from members of our team and we will give you our comments on these as soon as possible.

I trust the outcome of the study would be very useful for Phase-2 as defined in Dr. Sarabhai's letter dated January 6 to Professor Wiesner. I am reproducing below the two phases which are relevant to the planned study.

Phase 1

Joint ISRO-MIT/Lincoln Lab. study to indicate optimum configurations of satellite launch vehicle, satellite weight, satellite power and mission diversity. Also indicate the approximate cost of development as well as identify sources of existing systems or sub-systems, which would be used either through sub-contracting or through acquisition of know-how and design data.

Phase 2

Study of the report and consideration of financing and bilateral collaboration between the United States and India for undertaking the project. Conclusion of all arrangements including those related to financing and signing of agreement.

With kind regards,

Yours sincerely,

Sd/-

(E V Chitnis)
Secretary

Dr. Sarles
Lincoln Laboratory
Massachusetts Institute of Technology
Cambridge, Mass.
U S A

INDIAN SPACE RESEARCH ORGANISATION
ISRO

TELEPHONE : 77076 79271-2 77641-2
TELEGRAM : ISRO
TELEX : 012-261

C/O PHYSICAL RESEARCH LABORATORY
NAVRANGPURA, AHMEDABAD-9, INDIA

2.43

November 2, 1971

My dear Sundararajan:

Dr. Sarabhai has set up a Group to evolve a comprehensive plan for Space Research for the decade 1970-80. This will be done in three phases:

1. Planning Session: In this Session the programme will be discussed in broad terms and a draft plan which will be the basis for a further detailed study. The study will be conducted by Study Groups.
2. Study Groups: Study groups set up in the Planning Session will go into details of their subjects and come up with a comprehensive plan. The Study Groups are being formed in the following areas: (i) Communications, (ii) Meteorological Programmes, (iii) Earth Resources Survey, (iv) Geodesy, (v) Navigation, (vi) Scientific Programmes for (a) Aeronomy & (b) Astronomy, Fields and Particles, (vii) Requirements of Industry and (viii) Needs of Defence (to be approved).
3. Dissemination and discussion: A National Conference will be held in February 1972 where all interested organisations will be represented. The comprehensive plan prepared by the Study Groups will be discussed.

As a first step, we had meetings of the Planning Session during the period October 29 to November 1, 1971.

I shall be thankful if you could kindly send latest literature/information in the following areas:

1. Communications
2. Earth Resources
3. Navigation

I have, for example, a document entitled "Views on the Practical Use of Space Telecommunications Technology for the National Program for Aeronautical Telecommunication Services via Satellite" prepared for the Executive Office of the President, Office of Telecommunications Policy, Washington DC,

(October 19, 1970) by the General Electric Co. Similar documents in other areas will be most useful. I shall appreciate it very much if you could kindly send me by Air Mail immediately any such documents that you can collect.

With kind regards,

Yours sincerely,



E. V. Chitnis

Mr. Y.S. Sundararajan
Code 460, ATS Project Office
GSFC, Greenbelt, Maryland 20771
U. S. A.

Encl:

Suggested Approach for each Study Group

1. Review the present development in the respective field both Scientific and Technological state of the art.
2. Define scope
 - 2.1 Identify potential applications of Space Technology
 - 2.2 Identify user agencies
 - 2.3 Identify research (action) agencies
 - 2.4 Identify training institutions (national and international)
3. Prepare a draft plan
 - 3.1 Define the targets and missions to be achieved in this decade and their time schedules.
 - 3.2 Existing facilities
 - (a) Research facilities and manpower
 - (b) Technical, Industrial and Production facilities including components and systems.
 - 3.3 Compute resources required to achieve the targets.
 - (a) Facilities
 - (b) Financial outlays involved.
 - 3.4 Man-power requirements
 - (a) Identify categories
 - (b) Training, its phasing, magnitude, possible institutions, etc.
 - 3.5 Ground segments and required space techniques; also total system for further followup to derive benefits of data.
 - 3.6 Views on management.
4. Assign priorities to different targets.
5. Relate the implications of 3.1 to broad national objectives and plans and identify the benefits accruing from these programmes, quantitatively wherever possible and also indicate choices wherever open.
6. Recommend action plan.

Y Sundararajan to Prof. Chitnis

1/29/71

-2-

5. I had contacted few people to get data on failure (or success) of synchronous missions in terms of various phases (i.e., first stage boost, second stage firing, transfer phase, etc.) and time (few days, months, and year). Probably we may get a histogram. It looks one company has made a study of this and shall send details to you when I get it from the person, who is now busy with ATS finalization. (See Annexure, para A-5 for details)

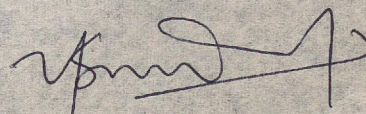
6. Another interesting thing for us is that the actually bread boarded test of UHF solid state amplifier at the Philco-Ford gives an efficiency greater than 60%. (See Annexure para A-6 for details) Direction for 860 MHz has been given. Also, power back off capability is being included in the UHF PA.

7. I am keeping abreast with many literature that are relevant to the communication satellite work: the effects of transmission media on FM with particular reference to FDM FM telephony and TV; performance at difference carrier-to-interference levels; theoretical and measurement aspects of group delay; effect of echoes on transmission quality; short term stability requirements, measurements, and the state-of-the-art; transmission spectrum engineering; noise considerations; scintillation phenomena; measurement accuracies; etc. After much of the systems analysis I would be gathering hardware details to have some preferred approaches in terms of various trade offs. Shall be keeping you informed regarding details from time to time.

Today Mr. Kale has arrived and informed briefly about the options regarding our work here and also about allowances. Shall discuss in detail on Monday. I have sent the contingency account. Hope arrangements are being made to send money for us, as the fresh installment is due now.

With kind regards,

Yours Sincerely,



Y. Sundararajan

(1)

ANNEXURE

A-2: Protection Ratios. Maximum allowed signal strength from the satellite for a particular protection ratio R, defined as in E. Miller's work (Ref my earlier letter) would depend on the definition of field strength: (i) Peak Sync average or (ii) Average AM-VSB. I have written a detailed letter to the FCC requesting for correct interpretation.

A-3: Miller's work (op cit) gives interference of TV on TV. If the FM spectrum were energy dispersed then we can assume equal power (or field) in all 4 KHz slots. For other cases (such as the normal FM-TV r-f spectrum ref Ed Miller) I am investigating effects on 4 KHz voice links. Alternatively, also investigating the complexity needed for energy dispersal of TV or FDM FM telephony.

A-4: Certain contradictions in the sensitivity of command receivers, certain environmental checks due to upsetting of launch phase VSWR, multipactor test for high r-f power handling components, etc., were some details I worked out.

Also for ITV, John E. Miller has given a revised incidental FM Spec, which is needed to send separate audio r-f carriers along with video 4-f carrier. Incidental FM gives the innate phase or frequency stability of the system in a short period of time. In other words, it gives the inherent noise output of the repeater when no input is present. The importance of this can best be understood, because after all, our audio and video signal outputs have to be above this. I have analysed the spec in detail and investigated comparison with the state-of-the-art. I am giving a detailed report on this--analysis, feasibility, & measurement techniques--to A. Sabelhaus on Monday. This has relevance even to our ground system.

The group delay has to be worked out for the communication system as a whole (antenna to antenna). As details of test (cost, time testability, etc.) interact with this, analytical details regarding effects of VSWR of antennas, etc., are being looked into.

(11)

A-5: This is in connection with the failure probability of any synchronous missions. Through intuition and general talks, we know the launch and transfer phase are more critical, empirical data and histograms can be worked out, as we now have information regarding sufficiently large number of missions to be of statistical relevance. You can appreciate that this cannot be worked out by one or two individuals as it is a full contract study. On inquiry, I am told that the Planning Research Corporation has done some work and when I get the details, I will send relevant information.

A-6: The earlier inefficiency was due to lower voltage operation, excessive losses in the hybrids, and many hybrids used. Now they have eliminated 2 hybrids by arranging the individual amplifiers in a different way and also they have achieved a hybrid loss of 0.1db. This has eliminated excessive power losses and hence higher efficiency. This clearly shows that assumption of 58% efficiency for the INSAT is quite realistic. If you need any further information on this, I would send you.

INSAT REVIEW

Attendees

H. Gerwin	Management (Project Manager)	GSFC
R. Rochelle	T&C (Project Scientist)	GSFC
J. Miller	Communications	GSFC
G. Hinshelwood	Structure	GSFC
A. Whalen	Communication	GSFC
A. Kampinsky	Communication	GSFC
A. Kampinsky	Communication	GSFC
A. Merollini	Management (Project Coordinator)	GSFC
B. Trudell	T&C	GSFC
Gary Banks	Controls & Structure	GSFC
T. LaVigna	Power	GSFC
M. Coyle	Thermal	GSFC
J. Webb	Structure	GSFC
H. Doyle	R&QA	GSFC
J. Greenwell	R&QA	GSFC
R. Mattson	Launch Vehicle	GSFC
E. Curtis	Propulsion	GSFC
R. Freeman	Controls	GSFC
C. Johnson	?	GSFC
R. Ratliff	Communication	GSFC
A. Blum	T&C	GSFC
E. Metzger	Ground Stations	GSFC
L. Nicholson	Communications	GSFC
J. Yudd	Ground Stations	
F. Wainscott	Experiment Integration	GSFC
A. Sabelhaus	Management (S/C Manager)	GSFC
A. Rudman	Structure	GSFC
E. Stepandic	Thermal	GSFC
R. Burke		NASA Hq
G. Andrus		NASA Hq
A. Frutkin		NASA Hq
R. Barnes		NASA Hq
B. Goetz		NASA Hq
W. Sarles		Mit Lin Labs
R. Nickelson		Mit Lin Labs
J. Kurtand		Centre for Space Research

Attendees

Prof. C. V. Chitnis
Dr. B. S. Rao
K. Karnik
P. Kale
M. Vasagam
Shenoy
Y. Sundararajan
Mr. Gill
Mr. Bhallacharya
Mr. Gogte

ISRO
ISRO
ISRO
ISRO
ISRO
ISRO I
ISRO
Ministry of I&B
Ministry of I&B
Ministry of Comm WPC

INDIAN SPACE RESEARCH ORGANISATION
ISRO

TELEPHONE : 77076 79271-2 77641-2
TELEGRAM : ISRO
T E L E X : 012-261

C/O PHYSICAL RESEARCH LABORATORY
NAVRANGPURA, AHMEDABAD-9. INDIA

February 3rd, 1972.

Dear Rajan:

afw
Writing to you a long time, I have already written to you informally about the dynamics of the situation over here. Recently Prof. Chitnis has discussed the FI program with Prof. MGK Menon. The new chairman has been quite dynamic (though it is said that he is not permanent Chairman). Most of the decisions have been cleared quickly by him.

I am enclosing along with this letter an internal memorandum that I have prepared which is an attempt to review the INSAT Program as of today in the light of recent developments. Next six months would be very crucial from the point of view of getting ultimate decisions on the INSAT program. Every day there are statements from both the Prime Minister as well as the Finance Minister emphasising over and over the need to become self reliant and to minimize the foreign aid. Under these conditions I really wonder whether we will be able to even open up INSAT program issue at this stage. Besides, since the present set up of ISRO is not permanent the higher authorities are not inclined to take decisions that would have long term repercussions. I enclose a copy of my last letter to Pramod for your information. I hope most of my enclosures you would keep restricted. *only*

for Pramod
On FI program, candidate for Control and Guidance has been now selected. I am enclosing his bio-data along with this letter. I am also enclosing a copy of my internal memorandum for Pramod. As you would appreciate I do not consider it safe enough to send this copy to him either on GSFC address or at his residence (I wonder whether his mail is 'clean') I would, therefore, request you to kindly pass on the copies marked *to him name* and also explain my reasons to send *them* through you.

The foreign exchange for FI program is ready. I have suggested to Pramod that he should explore any possibility of further cost reduction by deploying only 7 engineers on FI program that includes 5 engineers to be sent from India and 2 who are already there - Narayan and Shenoy. I am of the view that you and Vasagam should be kept out of this program for a more productive use to the INSAT program at a later stage. The situation in India, however, being rather fluid, one is not sure whether and how the INSAT program will come through. The decision making may be further delayed because of current situation such as ISRO set up is not yet permanent. Dr. Dhavan is likely to come to India by late April. In between there are State elections, so all the politicians are busy with consolidating their grounds and are not really interested in such Technology program at least

not-

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immediately. If this is correct, then I would expect any concrete action on INSAT program - I mean getting fund on significant scale from Govt. of India and to initiate some efforts in USA in this direction - for at least another 6 to 8 months. I ~~feel~~^{fully} agree with your view that you should continue to be at GSFC. In fact in our last Session where Mr. RL Nickelson, Wg.Cdr.Rao, Prof.Chitnis were present to listern to the presentation of the FI team over here I did emphasise the utility of your being at GSFC. As you know at this end we do not discuss many things freely, as a result I am not feeling aware of the difficulties in allowing you and in general ISRO engineers to be at GSFC. As I understand from my experience of past few days, there are some difficulties to keep our engineers at NASA. For this reason ~~we~~^{you} might have to participate in FI program till the time we find out another suitable opening in USA.

The reporting system has yet to be discussed. Hopefully to-day we will have discussion on the FI program in its totality (Prof.Chitnis, Vasagam, KS Karnik and myself). At that time your issue will figure. At this end there is no formality left in FI program. We are all waiting for the clearance of State Department to FI.

I ~~feel~~^{fully} understand your concerned about the present set up of FI program. However, I only hope that you are able to appreciate the difficulties at this end and can bear ~~at~~ with us for some more time. Please do not allow you to loose the sight of our ultimate goal despite the uncomfortable circumstances such as Reporting System, etc. Be sure that people at this end do appreciate your problems.

The work of our Study Group on Communication as well as Study Group on INSAT communication is not moving at a desirable pace. This will continue for another few weeks. I am personally very keen to see the FI team leaves India soon as possible.

I want you to keep writing about the developments at that end. Do let me know if you have heard anything about the Satellite Television Plans of Brazil. One of the enclosures to your letter includes the Expanded Guide lines for our engineers at FI. They cover only a few disciplines covered by the engineers in India. We would like it to be completed by your writings similar details on communication and structures. ✓

With cheers,

Yours sincerely,

Sanjeev

(S V Deshmukh)

Enc. 6 ^{pages}

Mr.Y.Sundararajan
 9861, Good Luck Road,
 Apt.4 LANHAM,
 Maryland 20801
 USA.

only for use of

for Sunderarajan only

(Don't show this to anybody)

FHC

24 January 1972

Dear Promod:

Today is the first day after the engineers who were hanging around for over a month busy with their technical briefings and discussions etc. have left Ahmedabad - in particular my room! Perhaps you would be aware that for the present, Mr. H.N. Sethna has taken over as the Chairman, Atomic Energy Commission and Prof. M.G.K. Menon as Chairman, ISRO. As I understand from "informed sources" this arrangements may be interim and primarily ISRO at present has three fold functions - (a) not to allow present activities to die down, (b) to evolve a new structure and (c) to think of a mechanism to arrange a smooth transfer from the present structure to the new structure by the time a new and permanent set up to be finalised. This would easily take up another 2-3 months.

I hope, to our engineers in USA you would keep informed of all the developments at this end, because I am sure that they, too, will be anxious to know about the developments in ISRO and in particular of INSAT. Please do share all your information with them.

Coming back to F.I., program, the technical briefings and discussions that were going on for over a month are now over. The team had extremely useful time spent in Ahmedabad. They have been reading the material that we could collect for our study group on Communication. This included some of the latest literature on the space programs of both in USA and elsewhere. The presence of Vasagam has been extremely useful to all of us in conducting valuable technical discussions. The team that heavily interacted with Mr. Nickelson, Vasagam, Wg. Cdr. Rao, Prof. Chitnis and myself.

I am enclosing two copies of the 'Guidelines to ISRO engineers working on Communication Satellite Program' for your reference. The engineers who are available here have been indicated their individual assignments. They have given further thought and have expanded their disciplines into further details. As you would notice, these documents depart significantly from what you had earlier sent as 'training manual'. This is so, because at this end, we have had a lot of useful discussions on it and we decided to have a fresh look at it and have now evolved what could be called as 'program manual'. We have explained our approach here to the engineers that these should be treated as guidelines. They should further apply their own mind to these discipline and follow the guidelines so as to not to miss anything. Their reporting will be based on these tasks.

...2...

On coming Thursday the 27th Prof. Menon is coming to PRL and we will be discussing with him F.I. program. Particularly immediate decisions regarding whether the F.I. program should continue as on the present scale etc. I would now like to refer to a letter by Mr. Singer of F.I. written to Prof. Chitnis on May 6th, 1971. In his letter Mr. Singer indicated that the cost for 6 trainees would be \$60,000. I would suggest that you should explore likelihood of such reduction in the contract cost (F.I. charges) in place of as earlier proposed \$100,000 for 10 engineers. Please find out F.I. charges for seven ISRO engineers. As you would be aware 4 engineers have been already finalised. They are Sandlas, Sarveson, Madhavan and Ramamurthy. Another engineer for control and guidance will be shortly finalised. (one of the likely candidate has already gone through the technical briefings etc. along with these engineers at Ahmedabad for over a month). In addition to these, of course, there exists Narayanan and Shenoy over there. I am sure, Prof. Chitnis would write to you about this soon after the final decision emerges from his meeting with Prof. Menon.

We would very much like to send all these engineers to USA as soon as possible, in fact, if the decision to 'go ahead' comes from the Chairman, Prof. Menon, say, around 28th or 29th January, we would be very keen to ship these engineers by 4th of February. Recently Prof. Chitnis had spoken to you and I understand that there would be two weeks delay on F.I. side. I am not clear as why there would be this delay and from which date. Also, in your earlier communication you have indicated that after signing up contract F.I. would need about 3 weeks to prepare. I feel that these 3 weeks can be now cut to the minimum and they should be in a position to receive our engineers by 4th February by their (F.I) completing the preliminary preparation by then.

One of the decisions that we would like to have from Prof. Menon is about setting up a follow team here in India as a counter part to the team that would be working on this program in USA. Such a follow-up team would ensure proper information dissemination and a reasonably good follow-up work - that is required at this end.

At present there has been increasing talk of self-reliance and practically every day our Prime Minister is giving stronger and stronger statements regarding reducing the dependence on Foreign Aid etc. In this atmosphere, it is imperative for all the government departments to reorganise their plans accordingly. About INSAT, I feel, that we should now talk in more realistic terms. We should strictly talk with a view to ultimately maximise the indigenous contents and to devise a plan to expedite this process. While doing this it is likely that we might have to take a fresh look at the INSAT design and the approach in its entirety. I would therefore like to know your reaction to INSAT

...3...

program in relation to the recent developments and your ideas regarding how this project could be now re-oriented. May be, we will have to study the space program of other countries who were till recently in the similar phase of development in Space Research such as Japan, Italy, Netherlands etc. in more details now. One thing is clear that we have to be very clear about our national objectives and also to find out our place (satellites programs etc.) in relation to these national objectives. It is necessary to point out the realisable goals for the applications program in India for this decade.

I recently got a letter from ITLU regarding a book "Innovations by 'Oxford Press'. I am trying to procure it as suggested by you. The book that I had earlier mentioned to you - the publications of N.A.S. have been delivered here by Dr. Bhavsar and are being used by our study group. Our Study Group on (INSAT) Communication (SGIC) is not active for quite sometime. I do not know when we would be able to conclude anything on the INSAT capacity utilisation and its economic evaluation.

Please do keep writing about the development at that end. As you would have noticed I would now prefer to write to you at ITLU address rather than at GSFC!

With cheers,

Yours sincerely,

S.V. Deshmukh

- Encl: 1. 'Guideline to ISRO engineers ...'
2. Details of a few disciplines mentioned in the guidelines.

Mr. P. P. Kale
ISRO Technical Liaison Unit
P.O. Box 306, Lanham
Maryland 20801
USA

Copy for Inf. to YS

SMA
0328

March 28, 1972.

Dear Pramod,

Writing to you after long time. Thank you so much for sending me a copy of the Satellite Broadcast System study report conducted by Computer Science Corporation for NASA. I do not know exactly when I will be able to go through it as there are quite pressing commitments for the next month or so. A cursory glance at the book reveals that it has been conducted with a view of country like India in mind. The overall cost of total systems cost curves, however, assumes satellite life for two years. I have not yet got the logic behind the choosing the life of two years.

Recently, I had been to New Delhi for a week along with Vasagam. Our briefing to the Defence people was very well received and there were about 35 officers present including some very senior officers. This was primarily to be used as a feeder group to another group set up by their Ministry at the initiation of Scientific Adviser to consider the utilization of satellite for 'their needs'. On behalf of ISRO Wg.Cdr.K.R. Rao is representing. I feel that a good dialogue has started now with that Ministry and should continue in more active cooperation in terms of taking up research projects such as developing a small earth terminal, working out a multiple access type of system suitable to their needs, etc.

In Delhi I had also discussion with Srirangan mainly on multiple access Study Group (SGIC). As you would be knowing last few months, mainly after the demise of Dr. Sarabhai, the progress has been really slackened. I prefer to have an informal meeting with Ministry of Communication mainly because whatever is discussed in the formal meeting is minuted. I could find out from the present analysis of the data collected for SGIC, the ^{case} gains for multiple access transponder is very shabby if based only on the economics alone. Of course, as you would notice since 'other' Ministry may also be interested in hiring a multiple access

transponder exclusively for their use leave ⁱⁿ only one transponder to the Ministry of Communication for experimentation. It may not be difficult to sell this idea to the decision makers if justify ^{ied} on the grounds other than economics such as remote area communication, emergency communication, etc.

Apart from the discussion on multiple access I have had a chance to review their views on INSAT program as a whole. At present there is a strong feeling in the Ministry of Communication that they would support the idea of communication satellite if it is to be of redistribution type, again preferably in the higher frequency bands that is S-band or 12 GHz or both. For satellite, again, we should not try to rub on the wrong side ~~side~~ that is in revenue, if we are to justify satellite on other grounds such as technology, national objective, etc., their ministry (Ministry of Communication) is sure to be with us all through. I only wish that our people try to appreciate this approach of Ministry of Communication.

Now let me tell you a little bit about developments in INSAT within ISRO. In one word I could summarise that 'nothing' is happening on this project. It is rather unfortunate that I find more interested about INSAT project in other Ministries while people within ISRO do not take sufficient interest in this project. Another sad thing is to find not enough seriousness and no realism when people talk about INSAT. It is about two months that I circulated my 'Internal Memorandum' which attempted reassessment of the INSAT program and I had invited comments from all those ^{to} ^{it} ~~whom~~ had been circulated ~~this memorandum~~. I must say the response that I have got only reflects the commitment of the people involved. Only Kiran Karnik could find time to go through it and give comments/suggestions. I am yet to hear from many other individuals about INSAT program. As a result I think we are practically becoming dead office of INSAT program. All that we have been doing since past two years are a few Studies, meetings, etc. and of course lot of public relations. I do not think that is very productive to the ultimate program. The person who had the total commitments to this program is no more with us and I personally feel the loss in every bit of my work. In the present slackness and total inactive period for the INSAT program I am finding it extremely to ~~continue~~ ^{difficult} to

continue to work. May be I should review this once a permanent set up of ISRO evolves.

There are several things that could have started much earlier to quote a few such as follows. At one stage before Dr. Sarabhai we had committed that Techno-Economic Studies (you know our obsession for using big words) about frequency and that final decision about INSAT Frequency are to be taken by 1st October 1971. I have minuted that meeting of 7th March 1971. Nothing has been done so far. To my understanding we have not even opened the frequency issue of INSAT with WPC. May be people concerned are too busy with pressing problems of SITE. But the fact remains that very little attention is being paid to INSAT. On the ground system, of course, as one would guess nobody has started any work not even planning. If one tries to assess the total system cost all that I face is non-cooperation from the people concerned. I would like to get cost estimates of front-end for S-band and 12 GHz. Similarly cost estimate of small earth station for multiple access network. The people concerned just flatly refuse to give any estimates. It is really a very sad state of affairs to not being able to do anything concrete. I only hope that this stage ^{does} has not last longer, at least in my case it will not and I will see to it by opting for other alternatives. On 21st and 22nd We have had a meeting of Communication Study Group - you remember the group that is supposed to be planning for the Space research for the next decade. My comments mainly about not being realistic are also valid for this Study Group. I am only hoping that we do not end up a thick study report - another glorious addition to our already conducted N studies about INSAT and Schemes like that. Before I go on the long leave, say around 13th of May, we would have finished with this Study report. The final seminar is scheduled to be in the mid July though personally I doubt whether it could take place ^{around} for that time and that too in Ahmedabad. But again as you would appreciate, people over here do not like to be realistic. So far even in the past as you would have noticed I refrained from commenting on SITE and I think I will continue to do so. As a fence watcher I am only amused to see the delays in SITE since its inception. Even in the recent past initially we were

told by March 15 some decision regarding ATS-F would come. Now the review itself is delayed by another month! At the end of which a realistic estimate of delay will be known. FI program has become a big joke just like INST is becoming. ISRO is losing credibility as far as I can see with other Ministries as well as ^{with} our own engineers and I think SITE will catch fast. *just like NASA*

I am enclosing a copy of proposed program of Prof. Menon which you would have got by cable. I hope you would note the places and persons involved and would talk to Prof. Chitnis about it. Everybody here is anxiously waiting for the new set up which would involve the shifting and restructuring of headquarters. At least I am too anxious.

More in the next.

With cheers,

Yours sincerely,

Enc : Tour program of Pfof.
Menon.

S.V. Deshmukh

Pramod P Kale
Code 460
ATS F Project Office
Goddard Space Flight Center
Greenbelt, Maryland 20771

Copy to Y S Rajan for inf with all the circulars

October 13, 1972.

Dear Pramod,

For long time there is no news about any development on the INSAT Program either from USA or at this end. Even the revised budget which is upto 1973 March that I have submitted for INSAT Program, I don't know whether it has approved or not. Sometime back I addressed a note to the Chairman, Dr. S. Dhawan, requesting him to arrange for full scale discussion (internally) on the INSAT Program. Since then the Chairman has been abroad for quite sometime and may be due to that there is no response as of today.

There has been some reorganisation going on in ISRO. I think you might not have heard about it officially. There still exist a chance that there may not be a formal channel to inform you. Hence I thought it is appropriate to send you copies of few circulars that I ~~am~~ managed to receive. This will give you some idea of the things to come in Ahmedabad.

I have distributed the S-band Study reports to the persons who participated in the INSAT Program Meeting. The summary record of which I have already sent to you. (I don't know whether you got it or not). We are yet to meet to discuss it. Informally I have talked to Wg.Cdr. Rao and Dick. ^{Wg.Cdr.} feels that there will be a serious problem in trying to ~~feed~~ physically 9 horns for various beams in the focal planes of an 18 foot ~~time~~ reflector. These beams are - 4 for television communication and 5 for T.V. According to him if one takes a view of minimizing the maximum off-set (In other words to equalise the off-set of the beams). The available area turns out to be a ~~corn~~ of 2 degrees. He very strongly feels that unless this idea has been technically evaluated one cannot take it for granted that such an arrangement will be feasible. I would therefore request you to send the engineering details (of whatever level are worked out with you) regarding the feed systems on the proposed S-band spot beam satellite.

Wg.Cdr. has done quite a good deal of work of optimization ~~of~~ on the locations of these spot beams. He has carried out this exercise with the help of a computer and has managed to cover India by adopting certain logic, such as in one beam linguistically closer States are covered. All the capitals are covered within 3 dB contour of some beam or the other, etc.

There is no action yet initiated regarding frequency registration. As you are aware the applicable recommendations/rules are going to change in coming January. Mr. Basu as repeatedly expressed the desire that the INSAT frequency registration should be processed before January. Yet nothing apparently has been done regarding this.

Certain comments have been received from various participants on Communication Study report. Dr. Bhavasar hopefully will consolidate these and will modify the report as well as the recommendations accordingly. I do not know the time-table regarding this action.

Vasagam has apparently now gone to Thumba. I think he is going to conduct another study of spot beam type satellite with a vehicle that may not be procured from U.S.A. I personally feel that such a study will be very essential considering the non-technical and yet more important for decision making the political climate prevailing at present. I have sent him all the technical material - the huge collection that he had collected during his stay in Ahmedabad.

I think sometime back I have written to you about making ^{graded} the capability that you have said regarding updated thor-delta which had actually promised by the Delta office. Sometime ago there was a news item in the Aviation Week & Space Technology which need not quite agree with the projected capability that you have assumed in your study. I would therefore very strongly suggest that we obtain a written document regarding the projected capabilities from the ~~Data~~ ^{Delta} office which we can then use as a reliable projection.

While you were here you said that the STS is handling ^{ed} by Department of Transportation in Canada. I wonder whether it is true or not since some material that we had requested has come from Department of Communication of Canada.

Recently Nickelson has gone to Tehran to attend a briefing given by Asian Broadcasting Union - mainly by Japan. He felt that technically it was not of much use as most of the participants as well as the presentation was mainly pertaining to the broadcasting aspects and there was hardly any technical presentation regarding the Space segment.

The progress of INSAT Program within India has been quite poor but for the little activity that it has seen during Seminar. The follow up of the Seminar too has been extremely poor. I wonder what these sort of delays in decision-making, failures in arranging detailed discussions, what type of schedule we will be aiming at. Certainly for the kind of Program that we envisaged during Seminar the first launch 1976 now seems to be too optimistic. Even to think of it. The recommendations are yet to be approved by the Department of Space. ~~The officials~~ ^{are} yet to be considered by the Secretaries' Committee, which is still remains very much the same ^{Secretary} ~~to~~ to Communication, I & B, and DAE. Frequency is yet to be registered. ^{W. What} ~~What~~ all these, I don't know how we are going to launch and how soon ?

I would appreciate to hear your reactions about the points that I have raised in this letter as well as my earlier letter which would also help in clarifying doubts raised by other people at this end).

With cheers.

Yours sincerely,

Sujeer
(S.V. DESHMUKH)

Enc: as above.

SPACE APPLICATIONS CENTRE

TELEPHONE : 83715-19-26-29
TELEGRAM : ANTARIX. TELEX : 012-261

SATELLITE INSTRUCTIONAL
TELEVISION EXPERIMENT (SITE)
AHMEDABAD 380 015 INDIA

5.6.7


February 18, 1974

My dear Rajan:

I thank you for your participation in the test and evaluation of ESCES developed equipment for SITE. I wish to express my satisfaction at the successful completion of the test and evaluation for which you put in a tremendous amount of work. I appreciate very much that the tests were conducted in spirit of cooperation and complete understanding. The outcome of this has certainly boosted our confidence and I am looking forward to a complete report on the evaluation.

With kind regards,

Yours sincerely,



E. V. Chitnis

Mr. Y.S. Rajan
Indian Scientific Satellite Project
A 3-6 Peenya Industrial Estate
Bangalore 560022.