## AI Summary

***Information System for Management of Maintenance: Development of Repair vs. Replacement Models***

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**Synopsis**

Broadcasting media has developed rapidly since Marconi's trans-Atlantic radio experiments. The evolution of VHF and satellite broadcasting has transformed communication worldwide. Developing countries, particularly All India Radio, face challenges in standardizing equipment and managing repair versus replacement decisions. Outdated technology, regulatory constraints, and limited resources complicate maintenance. The paper proposes models for decision-making in repair vs. replacement, supported by information systems for efficient management.

**Introduction**

Broadcasting in India began in 1927 with private companies. Government involvement followed, leading to the establishment of All India Radio in 1936. Post-independence expansion increased the number of radio stations and transmitters significantly. By 1983, technological advancements had modernized AIR, though standardization issues persisted. Television equipment faced fewer standardization problems since it was introduced later in India.

**Main Body**

- **Repair vs. Replacement Models:** The paper develops mathematical and operational models to evaluate whether equipment should be repaired or replaced.
    - Cost-benefit analysis is central: comparing repair costs, downtime, and reliability against replacement costs and expected lifespan.
    - Models incorporate depreciation, obsolescence, and availability of spares.
- **Information System Design:**
    - A computerized maintenance management system is proposed to track equipment performance, repair history, and costs.
    - Decision support tools help engineers and administrators make rational choices.
    - Emphasis on data standardization across AIR's diverse installations.
- **Case Studies:** Examples from All India Radio highlight situations where repair was uneconomical and replacement was justified, and vice versa.

**Development of Repairs**

Over all these years, All India Radio has developed its system of repairs of the various equipment in use. The repairs are carried out by competent, professional and trained engineers employed by the department. Inventories are maintained for spares. A constant watch is kept for proper inventory control and material management for efficient maintenance. Necessary measuring equipment and tools are provided at every installation. Regular schedules of preventive maintenance are performed to minimise breakdowns.

**Problems Experienced**

All India Radio started facing the problems of uneconomical repairs in the 1960s. A committee was set up in 1963 to examine the replacement needs of equipment in the AIR network which had become obsolete and whose maintenance was uneconomical. The committee, after examining the proposals in detail, recommended the creation of a separate fund called the *Renewal Replacement Fund (RRF)* for financing the replacement. However, the RRF could only be created in March 1969 and, due to financial constraints, equipment costing Rs. 2.2 crores (2.2 million U.S. $) could be replaced only up to 1977.

**Appointment of Inter-Ministerial Committee/Group**

In order to review the whole problem, an Inter-Ministerial Committee was set up in 1977. The committee examined the condition of equipment available in the network and prescribed the norms for replacements. However, it recommended replacements on a very limited scale for the period up to 1982. Replacements costing about Rs. 20 crores (20 million U.S. $) were sanctioned to complete the recommendations of the committee.

The Ministry of Information & Broadcasting set up another Inter-Ministerial Group in 1983 to examine the details about the replacement requirements due to uneconomical repairs. The Group was represented by members from the Ministry of Information and Broadcasting, Department of Electronics, Civil Aviation, Post and Telegraph Department, and All India Radio. The Group is finalising its recommendations.

**Study/Analysis of Problems and Recommendations**

The main points of consideration before the Group are enumerated below:

**Norms for Replacement:** Identification of the cut-off time when repair maintenance becomes uneconomical and replacement is a must. This depends upon:

1. **Reliability of the service required** – In broadcasting service, the reliability of the equipment must be very high.
2. **Standards to be maintained** – Equipment must operate within internationally prescribed tolerances (frequency drift, power drift, spurious emissions, etc.).
3. **Obsolescence/non-availability of spares** – With rapid technological advancement, manufacturers stop supplying spares for equipment still in service. Local fabrication often results in sub-standard quality, leading to frequent breakdowns.

**Development of MIS:** All India Radio, so far, does not have a *Management Information System* for repairs/replacement of equipment in the network. Six steps required for providing management information are: a) Origination b) Collection c) Validation d) Storage e) Processing f) Presentation

Accordingly, “Data Files” were created by the Group. Suitable formats were devised and data regarding performance, expenditure on repairs, and spares problems were collected from various field units.

**Analysis of Data:** The information received was analysed. Expenditure on repairs/maintenance vis-à-vis cost of replacement was plotted against the number of years served by the equipment.

# Information System for Management of Maintenance

## Development of Repair vs. Replacement Models

*H.O. Srivastava**


### Synopsis

In recent past, the broadcasting media has seen an unprecedented proliferation of new technologies. From Marconi's successful experiment of trans-atlantic radio comnnication, the technology has marched to VHF alho satellite broadasting in the contempo age. The devlopment is so rapid and phenomenal that the broadcast equipment become obsolete and out-dated very fast. Broadcasting not coming into "Core Sector" for planning purpose in the developing counvion, the growth of the organisations has been slow. Accordingly, it has not been possible to standardise the equipment in the network. The equipment in use are of various make and type and mostly weed out the unserviceable equipment from the network while it is necessary that these may be maintained to adhere to the various intertnational regulatory standards, viz. tolerdrift limits, wie fremquenccy, iaf these factor have put tremendouy pressure on the broadcasting oradicationi-of this developin Franstiteral Fromuries, –All India Radio excarteines of judicious and forces that proleterpares wan hese field of modis stpurreveted to reconnmes a judicious repair vs replacment models. This paper discusses some of


### Introduction

Broadcasting in India began 56 years ago in the year 1927, when a private company essablished 2 low power Medium Wave trannsmitters in Bombay and Calcutta. The conpany went into liquidation within sshood of cet 8 years and in response to popular demanig, Government assumed direct conerhiose of tnect offer amyd beprabonsirlities in April 1930, In 1934 a radio station was set up at Delhi.

The All India Radio came into being in 1936, At the time of Independence in 1947, All Indie Radio had only 6 radio stations which accounted for coverage of about 9% by population. Since then has been steady expexpion and as on date there are 86 radio stations with 126 Medium Wave transmitters, 33 Short Wave transmitters, 33 Short Wave transmitters, and 4 FM transmitters in 1983 and Television broadcasting has just begun in 1959. Since the broadcasting system is a networked one, it has found itself inprecraious position with standardised equpment not being uniform in the network. The equipment is mostly old compared with TV equipment, due to the fact that the TV started in India much later.

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### Development of Repairs

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### Problems experienced

All India Radio started facing the problems of uneconomical repairs in '60s. A committee was set up in 1963 to examine the replacement needs of equipments in AIR network which had become obsolete and whose maintenance was uneconomical. The committee after examining the proposals in detail, recommended the creation of a separate fund call 'Renewal Replacement Fund' for financing the replacement. However, the RRF could be created in March 1969 and due to financial constraints, equipments costing Rs. 2.2 crores (2.2 Million U.S. $) could only be replaced upto 1977.

### Appointment of Inter-Ministerial Committee/Group

In order to review the whole problem an Inter-Ministerial committee was set up in 1977. The committee examined the condition of equipments available in the network and prescribed the norms for replacements. However, it recommended the replacements on a very limited scale for the period upto 1982. Replacements costing about Rs. 20 crores (20 Million U.S. $) were sanctioned to complete the recommendations of the committee. Ministry of I&B set up another Inter-Ministerial Group in 1983 to examine the details about the replacement requirements due to uneconomical repairs. The Group is represented by members from Ministry of Information and Broadcasting, Department of Electronics, Civil Aviation, Post and Telegraph Department and All India Radio. The Group is finalising its recommendations.

### Study/Analysis of Problems and Recommendations

The main points of consideration before the Group are enumerated below:

*Norms for Replacement:* This means identification of the cut off time when repair maintenance becomes uneconomical and the replacement is a must. This in turn depends upon the following factors:

(i) *Reliability of the service required* – In broadcasting service, the reliability of the equipment is to be very high.

(ii) *Standards to be maintained* – In broadcasting, the equipment have to be maintained to a very high degree of standards so that its operation is within the internationally prescribed tolerances vis. frequency drift, power drift, spurious emissions, etc.

(iii) *Obsolesence of equipment/non-availability of spares* – With the rapid advancement in technology, the manufacturers have stopped supplying the spares of the equipment which are still in service. Due to non-availability of spares from the original manufacturers, these have to be got fabricated from local market. The quality of spares thus becomes sub-standard and this results in frequent breakdowns.

Keeping in view the above considerations, the Group proceeded to decide the time after which an equipment has to be replaced. Following steps were taken:

i) *Development of MIS* – All India Radio, so far, does not have, a 'Management Information System' for repairs/replacement of equipments in the network. Six steps required for providing management information are:

a) Origination
b) Collection
c) Validation
d) Storage
e) Processing
f) Presentation

Accordingly, in order to decide the norms for replacements, "Data Files" were got made by this Group. For this purpose suitable formats were divised anda data regarding its performance, expenditure on repairs, problems of spares etc. collected from various field units, where the equipments are deployed.

(ii) *Analysis of data* – The information received were analysed. The expenditure on repairs/maintenance vis-a-vis cost of replacement of the equipments were plotted against the number of years served by the equipment. The graph for broadcast

transmitter comes as shown in the diagram given at *Annex. I.*

It can be seen that during the initial years, the cost of repairs/maintenance is very less. However, the expenditure goes on increasing with the number of years served by the equipment. The cost of the equipment also increases due to inflation but the increase is not very rapid due to a general tendency of sagging price of electronic equipments. In the diagram, the actual cost vis-a-vis the years has not been shown, as the same would vary for various types of transmitters.

(iii) *Cost Benefit Analysis* – The Cost Benefit Analysis is a practical way of assessing the desirability of a new project. The technique can be applied in developing repair vs. replacement models. The following factors are to be considered:

(i) The recurring expenditure on maintenance of old equipment on the basis of:

a) Direct expenditure on annual repairs.

b) Annual expenditure on power supply consumption. (The efficiency of older equipments say transmitters are of the order of 30%).

c) The annual expenditure on establishment and training of maintenance staff.

(ii) The cost of replacements based on:

a) Capital cost of equipment.

b) Annual expenditure on the Power Supply consumption. (The equipment using latest technology are capable of giving a higher efficiency of the order of 50% and as such the power requirements are much less.)

c) The other recurring expenditure on repairs etc.

d) The annual expenditure on staff.

Using 'Discounted Cash Flow Technique' the 'present value' of maintaining the old equipment vis-a-vis cost of replacement and its maintenance is calculated for next 10 years. It is found that the maintenance of old equipment becomes uneconomical after certain time known as a critical year. The details have been worked out in *Annex. II.*

iv) *Theory propounded* – Having computed the 'Critical year' from the CBA discussed above the exact time when an equipment is to be discarded for replacement can be decided after giving due weightage for a "Reliability Factor". The reliability factor is determined on the basis of outages that may be tolerated. For example a broadcast transmitter has to be 100% reliable and as such the reliability factor would be '1'. However, a tape recording equipment, whose failure may not result in a breakdown due to the availability of standby equipment, the factor could be taken as less than one. Similarly the exact value of this factor can be determined for different type of equipments can be prescribed. The present group is yet taking up this study. The life prescribed by earlier group for various equipments are given in table at *Annexure III.*

**Replacement Policy**

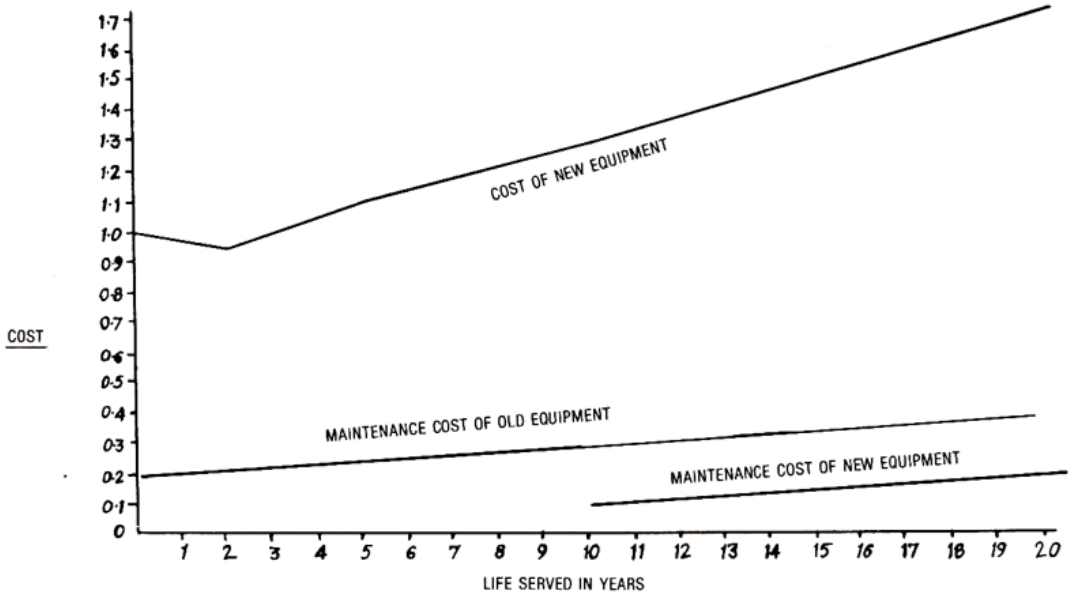
The policy for replacement has been decided by the group on the basis of following considerations:

(i) *Sustenance of service* – A peculiar phenomenon that the broadcast engineer faces is that he designs a transmitter for a specific coverage area. However, after a certain period of time, there is a considerable shrinkage in the service area due to interference from powerful transmitters of other neighbouring countries, noise due to coming up of industries etc. As such, while planning for replacements, it is necessary to up-grade the power of transmitter so as to sustain the coverage area for which the transmitter was initially planned. However, constraints on transmitter power and frequency imposed by various Regulatory Administrations would have to be kept in view.

(ii) *Latest technology* – With the rapid development of technology it is necessary to introduce certain amount of new technology while replacing the equipment. This is essential because of the fact that the equipment introduced at this stage are bound to remain for a considerable time in the network due to financial constraints in the developing countries. In addition, the equipment using the new technology are more efficient leading to saving in the cost of power consumption. The recurring expenditure on maintenance of these equipment is also less.

**ANNEXURE I**

Graph Showing the Cost of Maintenance/Replacement
vs. Life Served by the Broadcast Equipment (Transmitter Only)




NOTE NO. 1 Cost of Maintenance includes:

I. Cost of direct repairs of components from market.
II. Cost of procurement of obsolete spares.
III. Higher inventory carrying cost of obsolete spares.
IV. Salary for larger maintenance staff and the cost of their training.
V. Transmission losses converted into monetary losses due to loss of commercial revenue.

NOTE NO. 2 The increase in cost of broadcast equipment in the international market due to inflation is almost negligible. This is on the basis of budgetory quotations received from manufacturers for various equipments in last 5 years. [The cost of Harris 100 KW transmitters in 77, 79 & 83 were Rs. 24 lakhs, 22 lakhs & 25 lakhs (0.24, 0.22 & 0.25 millions U.S. $). However, an increase in cost @ 3% per annum is assumed.

NOTE NO. 3 The maintenance cost of new equipment is less, even at the start, due to its higher efficiency (lower power consumption) and less maintenance requirements because of compactness and ruggedness.

**ANNEXURE II**

## Cost Benefit Analysis for Maintenance of Old Broadcast Transmitters vis-a-vis Cost of its Replacement and Maintenance after Various Periods of Time

1. Cost of maintaining the old equipment at any stage of time for next 10 years, using Discounted Cash Flow Technique (D.C.F. - Technique) is 6.1446 × RO, where; 6.1446 is Uniform Series Present Worth Factor (USPWF), using 10% interest rate & RO = Average annual recurring expenditure for old equipment.
2. Cost of replacement at any stage of time and thereafter maintaining it for next 10 years, using D.C.F. technique, is C + 6.1446 Rn, where

   C = Capital cost of new equipment

   Rn = Average recurring expenditure for new equipment.
3. Using the graph in Annexure I, the 'CBA' for maintaining old equipment and replaced equipment are tabulated below:

| *No. of years* | *Cost of maintaining old equipment (6.1446 Ro)* | *Cost of maintaining replaced equipment C + 6.1446 Rn* |
|---|---|---|
| 10 | 0.35 × 6.1446 = 2.15061 | 1.30 + 6.1446 × 0.15 = 2.22169 |
| 12 | 0.37 × 6.1446 = 2.273502 | 1.36 + 6.1446 × 0.15 = 2.28169 |
| 15 | 0.40 × 6.1446 = 2.45784 | 1.45 + 6.1446 × 0.15 = 2.37169 |

4. The above table shows that it is economical to replace the transmitters after about 12 years. This becomes the 'critical year'

ANNEXURE III

Table Showing the Life of Various Broadcast Equipment Prescribed by Inter Ministerial Committee 1977

| S. No. | GROUP | HEAD | EFFECTIVE LIFE IN YEARS |
|---|---|---|---|
| I | Site | 1. Site | Permanent |
| II | Building Complete with Services | 2. Buildings including water supply | Pmt. 50 |
| | | Sanitation and Service | Tem. 15 |
| | | 3 (i) Pumps | 10 |
| | | (ii) Motors | |
| | | 4. Fire Fighting Equipments | 10 |
| | | 5. Acoustic Treatment | 10 |
| | | 6. Ventilation Duct Work | 10 |
| III | Plant and Equipment | 7. (i) Mediumwave Transmitters | 10 |
| | | (ii) Shortwave Tranmisttters | |
| | | (iii) F.M. Transmitters | |
| | | (iv) Mobile Transmitters | |
| | | (v) Frequency Synthesizers/VFMO | |
| | | (vi) Console of Transmitter | |
| | | (vii) Automatic Voltage Regulators | |
| | | (viii) Antenna Change over Switches | |
| | | 8. (i) Limiting Amplifiers | 10 |
| | | (ii) Uniselectors Assembly | |
| | | (iii) Announcers Console | |
| | | (iv) Microphone | |
| | | (v) Pre Amplifiers | |
| | | (vi) Programme Amplifiers | |
| | | (vii) Line Amplifiers | |
| | | (viii) Monitoring Amplifiers | |
| | | 9. (i) Console Tape Recorders | 10 |
| | | (ii) Portable Tape Recorders | 5 |
| | | (iii) Heavy Duty Tape Decks | 10 |
| | | (iv) Play Back Decks | 5 |
| | | (v) Ultra Portable Tape Recorders | 3 |
| | | (vi) Turn Tables | 10 |
| | | (vii) High Speed Duplicators | 10 |
| | | a) Masters | |
| | | b) Slaves | |
| | | 10. (i) Diversity Equipments | 10 |
| | | (ii) Communication Receivers | |
| | | 11. (i) Diesel Generators | 25 |
| | | (ii) Petrol Generators | |
| | | 12. (i) Airconditioning Plants except window types | 15 |
| | | (ii) Window Type Airconditioning plants | 3 |
| | | 13. (i) Speech Consoles | 10 |
| | | (ii) Remote Amplifiers | |
| V | Masts Aerials including Feeder Line and Earth Systems | 14. Aerials | 50 |
| | | 15. Feeder Lines including Feeder Poles | 50 |
| VI | Tools Testing Instruments and Workshop Machinery | 16. Tool and Workshop Machinery | 10 |
| | | 17. Machinery and Testing Instruments | 10 |
| VII | Vehicles Technical Furniture and Camp Equippage | 18. Technical Furniture, Camp Equippage | 10 |
| | | 19. O.B. Vans | 10 |

(iii) *Standardisation of equipment* – At present, there are varieties of equipment in the network. Variety reduction results in considerable savings due to lower inventory carrying cost etc. In this connection USSR, has adopted some 'Empirical Formula' for estimating savings due to variety reduction. According to this formula, the variety reduction of 4.73 results in a saving of about 37% in the cost of maintenance of equipment.

### Recommendation

In view of the above considerations it is considered desirable to:-

(i) Use latest technology as far as possible.

(ii) That the power of transmitters to be upgraded in order to achieve the original coverage area, keeping in view the constraints on transmitter power and frequency, imposed by Regulatory Administrations.

(iii) Standardisation of equipment as far as possible.

### Replacements Required

So far the group has considered the replacement of about 65 Medium Wave and Short Wave transmitters of various powers by similar or higher power AM/FM Transmitters. A number of diesel generators, air-conditioning plants and other discrete equipment also need replacement. In addition to this, it is also essential that the complete system in Broadcasting House of cosmopolitan towns are replaced so that the whole system could be modernised keeping in view the latest technology. The studios at few of the centres have been in use for 20 to 40 years and the complete wirings require replacement. Some of the studios require complete refurbishing and modernisation. It is estimated that AIR would require about Rs 1000 million (US$100m) during 1985-90 plan for replacements, renewal and modernisation.

### Conclusion

With the complexities involved in replacement of varied equipments in the broadcasting network, it is essential to evolve a "Management Information System" preferably using computers. The computer can be programmed to perform a 'Cost Benefit Analysis' after feeding to it necessary data, as described in the main text. Thus repair vs. replacement models could be developed. This could help the management in planning its replacements in phased manner. The time and money spent on these activities would pay back enormous dividends by providing a high standard of broadcast service which is used as an effective communication media for socio economic development of masses by most of the developing countries.

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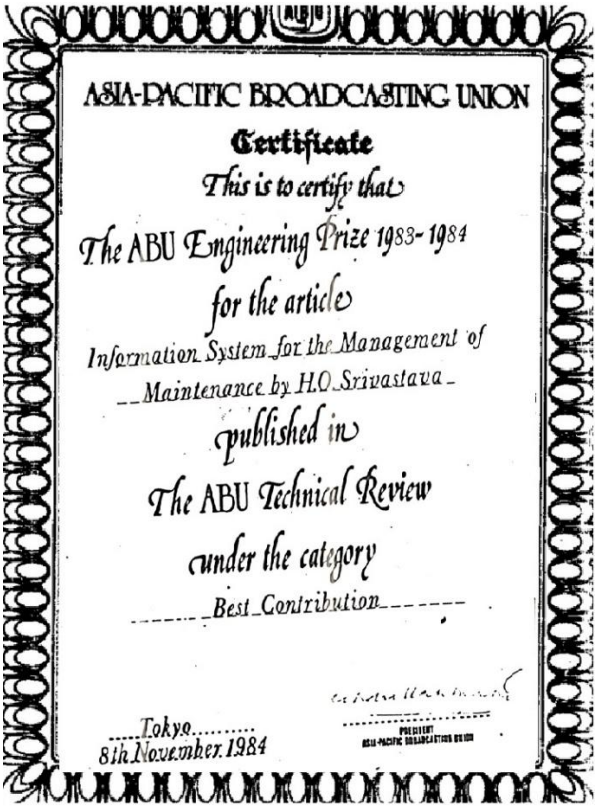

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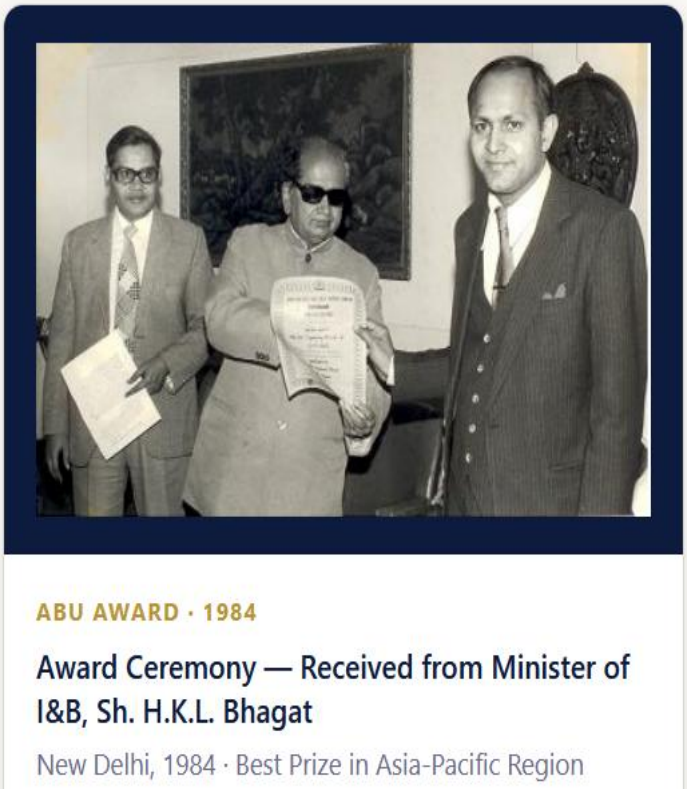

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## Also published in:

1. **Report of the Inter-Ministerial Group, 1983 for Replacement of Equipment in AIR during 1985–1990, Government of India, July 1984.**
2. **Management Information System for Maintenance of Equipment in India** — *Combroad*, No. 64, Commonwealth Broadcasting Association, UK, pp. 40–42, September 1984.
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