ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6650.7

2/3/88

SUBJ: AIRPORT COMMUNICATIONS MEDIA/EQUIPMENT SELECTION CRITERIA

1. PURPOSE. This order establishes guidance for the selection of media/equipment for airport interfacility signal, control, and data communication transmissions. These selection criteria should be applied by regional Airway Facilities personnel when planning new communication installations or the upgrading of existing communication systems at airports.

2. DISTRIBUTION. This order is distributed to branch level in the Program Engineering, Systems Engineering, Air Traffic Plans and Requirements, and Systems Maintenance Services and the Office of Airport Standards and to division level in the Office of Flight Standards in Washington headquarters; to branch level in regional Airway Facilities, Air Traffic, and Airports divisions; to division level in the FAA Depot at the Mike Monroney Aeronautical Center; to division level in the Test and Evaluation, Aircraft and Airport Systems Technology, and Facilities Divisions and the FAA Technical Center (Facilities Divisions); and to all Airway Facilities sectors, sector field offices, sector field units, and sector field office units.

3. BACKGROUND. The FAA within the purview of the National Airspace System (NAS) Plan currently has projects underway to upgrade and expand existing communication systems.

a. Project 5, Chapter V, Airport Telecommunications.

b. Project 5, Chapter VI, Large Airport Cable Loop Systems.

The selection criteria provide assistance in the choice of the most operationally efficient and cost effective media/equipment for airport interfacility transmissions.

4. SCOPE. These guideline criteria are limited to the selection of optimum transmission media/equipment for airport interfacility communications. Media under consideration include optical fiber, copper, and free space. Decision factors which affect the media selection are both economic and technological. Cost assessments required by this order are restricted to initial expenditures and annual operating costs. Technological factors are restricted to system design and implementation/installation. Requests for frequency allocations required for radio/microwave communications are in accordance with normal regional procedures.

5. APPLICATION. The selection of transmission media/equipment is a key element in airport communications design. Application of this order ensures that airport communication designs will be based on common technological principles. This order applies to situations in which:

a. The need for additional interfacility communication capacity or capability has been clearly established.

b. A determination has been made that the cost to maintain the existing interfacility communications is sufficiently high to warrant consideration of new systems implementations.

c. A determination has been made that signal transmission problems exist which limit system performance and reliability.

6. DEFINITIONS AND REFERENCES. The following definitions and references are applicable to this order.

a. Definitions.

(1) UHF Communications. Signal transmissions restricted to the 300 MHz to 3 GHz band.

(2) SHF Communications. Signal transmissions restricted to the 3 to 30 Hz band.

(3) Media Selection Factors. Specific factors which affect the choice of transmission medium which relate to system implementation and reliability/maintainability.

b. References.

(1) FAA Order 6540.4, Criteria and Procedure for Determining Whether to Purchase Radio Link Equipment or Lease Telecommunication Services, March 1983.

(2) FAA Order 2500.24T, Call for Estimates - Facilities and Equipment, January 1985.

(3) CCIR (International Consultive Committee for Radio) Report 338-4, "Propagation Data Required for Line-of-Sight Radio Relay Systems," Vol. 5, 1982.

7. GROUND RULES FOR APPLICATION OF SELECTION GUIDELINES. Application of the selection guidelines must be in accordance with the following ground rules:

a. Candidate media should include optical fiber, copper, and free space in each guideline decision.

b. Equivalent media/equipment redundancies should be considered for each of the candidate systems.

8. SELECTION GUIDELINES PROCEDURE SUMMARY. Application of the guideline selection criteria is primarily the responsibility of the regional Airway Facilities division, and should occur during the budgetary/initial system design stage. A guideline selection procedure diagram illustrating the successive steps in the media/equipment decision process is shown in figure 1. The process includes a master plan review, system design summary, media selection factors review, comparative cost assessment, and a final media/equipment decision. Five sample formats are supplied to assist the user in documenting the necessary information. A detailed description of the methodology used in the media/equipment selection is given in appendix 1. The following subparagraphs summarize the main elements in the guideline selection criteria:

a. Master Plan Review. Airport master plans or FAA approved airport layout plan should be reviewed to establish that the proposed system application is consistent with the five-year program plans and objectives.

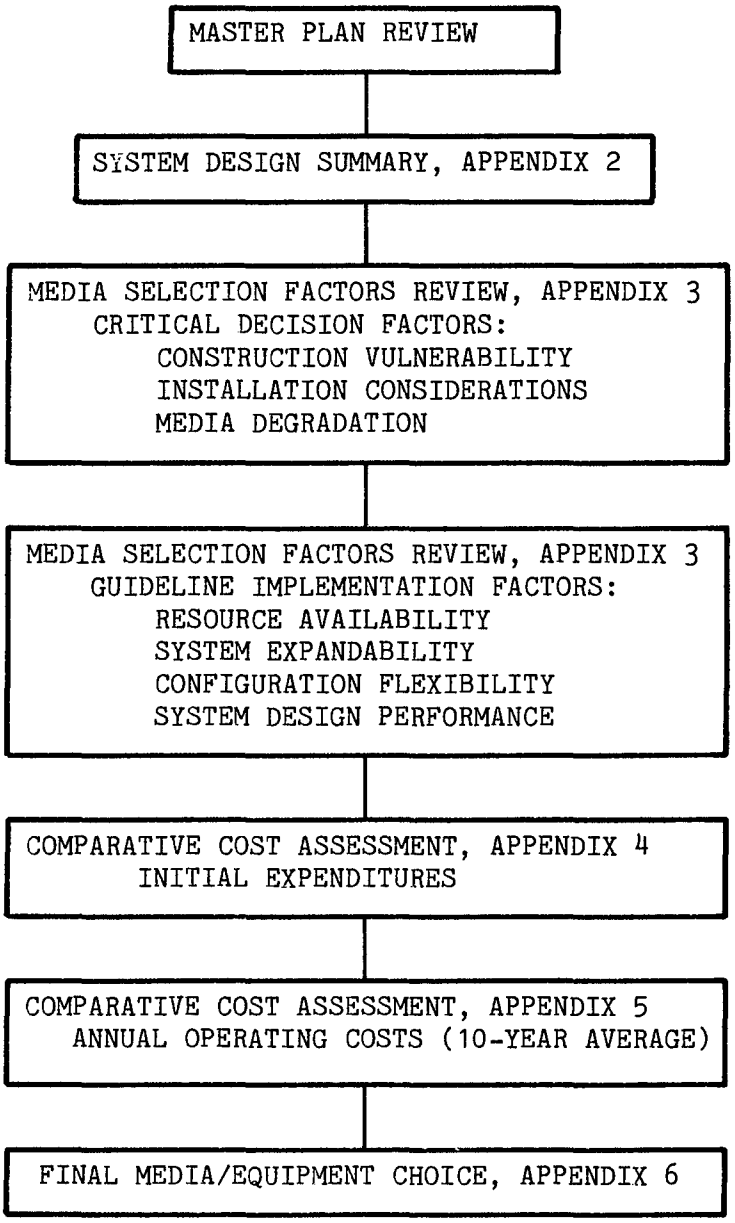
b. System Design Summary. The significant design parameters should be summarized using the instructions set forth in appendix 2 and the sample format shown in figure 2. The inclusion of a plan layout with the system design summary is advised to document the location of the terminal communication facilities and the interfacility signal transmissions.

c. Media Selection Factors Review. The review of media selection factors is critical in establishing any installation or operational constraints involved in the media/equipment decision. The selection factors include critical decision factors which have a major impact on media decision as well as guideline implementation factors which primarily affect only system design and installation economics. Results of the media selection factor review should be summarized in accordance with instructions given in appendix 3, using data from figure 3 as well as the sample format shown in figure 4.

(1) Critical decision factors include airport construction vulnerability, media performance degradation, and cable installation siting considerations. Identification of one or more of these critical decision factors during the system planning and design stage may effectively remove direct earth burial (DEB) media from further consideration. The decision to use a critical decision factor as a basis for excluding DEB media from implementation/planning should be supported by an appropriate summary justification statement as described in appendix 3.

(2) Guideline implementation factors include resource availability, media/equipment installation, system expandability, configuration flexibility, and system design performance. A review of these factors provides the system designer with an assessment of their impact on system design and installation economics. A decision guideline checklist is provided in appendix 3 as a convenience in conducting the implementation factors review.

FIGURE 1. GUIDELINE SELECTION PROCEDURE



d. Comparative Cost Assessment. The media/equipment selection criteria require a comparative cost assessment of the candidate media systems. The assessment includes estimates of initial expenditures and the annual operating costs averaged over a ten-year period for both FAA and sponsor incurred expenses should the sponsor or FAA encounter costs such as real estate acquisition, equipment modifications, personnel, or training required as a consequence of the FAA implementing the new transmission system. An equipment guideline summary is provided in appendix 4 to assist in identifying the types of terminal equipment to use in estimating the initial expenditures. The results of the cost assessment should be documented in accordance with the instructions supplied in appendices 4 and 5. Figures 5 and 6 provide sample worksheet formats for use in preparing cost estimates for initial and annual expenditures, respectively. Appendix 7 contains a summary of current FAA specifications for communication equipment components.

e. Final Media/Equipment Decision. Final design decision should be based on the results of the media selection factors review and the comparative cost assessment (items c and d above). During the last stage of the media decision process, a final media/equipment design decision should be formally prepared. A sample design decision format and instructions are given in figure 7 and appendix 6.

9. PROCEDURES AND INSTRUCTIONS. The procedures and instructions for completing the sample data forms for media/equipment selection are included in appendices 2-6.

a. Appendix 2 - Instructions for preparation of a sample System Design Summary, Airport Layout Plan.

b. Appendix 3 - Instructions for completion of a sample Decision Guideline Checklist.

c. Appendix 4 - Instructions for preparation of a sample Cost Estimate Worksheet (Initial Expenditures).

d. Appendix 5 - Instructions for completion of a sample Cost Estimate Worksheet (Annual Operating Costs).

e. Appendix 6 - Instructions for preparation of a sample Final Media/Equipment Design Choice.

Robert E Brown

for James R. Etgen
Director, Program Engineering Service

APPENDIX 1. OVERVIEW OF SELECTION GUIDELINES

1. PURPOSE. This appendix describes the procedure for selecting media equipment for airport interfacility communications. All applications of the guidelines should include fiber, copper, and free space as media alternatives.

2. SELECTION GUIDELINE PROCEDURE. The media selection guidelines require the execution of the following steps:

a. Step 1. Master Plan Review. Airport master plans should be reviewed to establish that the proposal is consistent with the five-year plan objectives. The proposed system should avoid any duplication of functions addressed under the FAA cable loop program as described in the NAS plan, Project 5, Chapter VI.

b. Step 2. System Design Summary. A summary of the design parameters is necessary to describe the planned system configuration. Instructions for supplying the required data are given in appendix 2. Appendix 2 also includes a plan layout showing the location of the terminal communication facilities and interfacility transmissions.

c. Step 3. Media Selection Factor Review. Implementation and reliability/maintainability factors which affect system installation should be reviewed. Instructions for conducting the media selection factor review are provided in appendix 3. There are eight selection factors. The first three are critical decision factors which have a vital impact on media choice. The remaining five are guideline implementation factors which affect system and installation economics:

(1) Construction Vulnerability. Airports with a history of cable digups or with planned constructions involving extensive earth-moving in the vicinity of cable installations can experience significant problems with DEB media.

(2) Media Degradation. Copper cables are more susceptible than fiber optic cables to deterioration with time in some environments.

(3) Installation Siting Considerations. Extended transmission distance and/or irregular terrain can affect the viability of DEB media communications.

(4) Availability and Condition of Existing Resources. Availability and state of condition of existing communication resources can affect the comparative economics of candidate media systems.

(5) Media/Equipment Installation. Media/equipment installation should conform to standards designed to ensure operational integrity under adverse environmental conditions.

(6) System Expandability. System design should include equipments which provide for future communication expandability.

(7) Configuration Flexibility. System adaptability to changes in network configuration must be considered. DEB networks are less adaptable than free space systems to changes in network configuration.

(8) System Design Performance. Transmission systems require path loss analyses to ensure adequate communication margin for signal transmission.

d. Step 4. Comparative Cost Assessment. A comparative cost assessment based on initial expenditures and annual operating expenditures averaged over ten years is required for each candidate media/equipment system. Appendices 4 and 5 provide instructions for assessing initial expenditures and annual operating expenditures. Table 1 summarizes the approximate costs of communication transmission equipments (excluding cables and antenna towers) for different system applications, based on 1986 prices. The following ground rules apply in conducting the cost assessment:

(1) Initial expenditures should include equipment costs for initial system implementation and for replacement components required for a ten-year operational period. Cost of equipment resources already available at facilities should not be included in the cost assessment.

(2) Assessment of communication equipment costs should be based on system components which have the least aggregate cost subject to system specifications requirements. The exception is for terminal equipments which exhibit a clear technological advantage over alternative components.

(3) Cost data regarding the use of leased lines must be based on the criteria given in FAA Order 6540.4, Criteria and Procedures for Determining Whether to Purchase Radio Link Equipment or Lease Telecommunication Services.

(4) Cost assessment should be restricted to communication components or subsystems, including environmental supports necessary for installation and operation of the media/equipment being assessed.

(5) Comparative costs of candidate media/equipment installations should be based on systems which have equivalent redundancies and comparable performances and capabilities.

e. Step 5. Final Media/Equipment Decision. Final media/equipment choice should be based on the media selection factor review (step 3 above) and the comparative cost assessment (step 4 below). Selection factors which have a critical impact on system reliability/maintainability should take precedence over comparative economics. In other instances, final media choice should be based on least cost as determined by the comparative cost assessment. Instructions for formulating the final media decision are supplied in appendix 6.

TABLE 1. SYSTEM EQUIPMENT COSTS

System Application	Media	Equipment Cost ($ in 000)	Comment
Radar-Video; e.g.,ATCT-ASR	Fiber	30/50	video(6-f)nonred./red.
	Fiber	125/145	video(2-f,w/MUX)nonred./red.
	Microwave	195/218	8 GHz,nonred./red.
	Microwave	35/59	23 GHz,nonred./red.
	Copper	60	line drivers,if required
Voiceband Analog Communications; e.g., ATCT-RTR	Fiber	50-80	48 ch.
	Microwave	30	24 ch.
	Microwave	60/114	48ch;nonred./red.
	Copper	12	line amplifiers,if required
Voiceband Digital Communications; e.g., RMM	UHF Radio	8+3N	9600bps;928/952 MHz
	UHF Radio	3+3N	2400bps;420 MHz
	Copper	3+3N	

N denotes the number of remote sites in RMM multipoint system.

NOTE: Data in table 1 describe sample costs of selected terminal equipment and shall not be used for cost planning purposes. Actual equipment costs may vary substantially from the data given in table 1.

APPENDIX 2. INSTRUCTIONS FOR PREPARATION OF SYSTEM DESIGN SUMMARY

1. SYSTEM APPLICATION. State the type of communication application; e.g., ATCT-ASR-8, Point-to-Point, RMM, Multipoint, etc., at top of each page.

2. CABLE SYSTEM DESIGN PARAMETERS. Guidelines describing the basic procedures for designing an airport fiber optic communication loop are currently being prepared.

a. Cable Distance Summary. List the cable sectional distances, including subrunway boring distances, and sections of conduit encased in concrete, in feet. Supply additional information as required under comment heading; i.e., conduit, DEB, etc.

b. Cable System Redundancy. Describe provisions for system redundancy.

3. FREE SPACE SYSTEM DESIGN PARAMETERS.

a. Terminal Site Locations. Give the location of communication terminal sites in latitude and longitude. Identify the type of terminal facility under comment heading; i.e., ATCT, ASR, GS, etc.

b. Line-of-Sight Distance. Indicate the line-of-sight distances in feet for each transmission section.

c. Notable Path Obstructions. Identify the locations of possible path obstructions for communication systems.

d. System Design Frequency. Give the radio/microwave transmission frequency. Refer to appendix 3, Radio Communication Frequency Selection. Indicate status of frequency allocation if applicable.

e. System Redundancy. Describe provisions for system redundancy.

4. AIRPORT LAYOUT PLAN. Complete an airport layout plan showing runways and location of planned communication installation. Indicate the length of each transmission section in feet. Show any existing conduit installations on the layout plan. Identify major obstructions or access impediments to signal transmissions.

FIGURE 2. SAMPLE SYSTEM DESIGN SUMMARY FORMAT

1. System Application. ATCT-ASR-8, Point-to-Point

2. Cable System Design Parameters.

   a. Cable Distance Summary.

Section No.	Section Length	Comment
1	4190 ft	
2	2350 ft	
3	4270 ft	
		SAMPLE FORMAT

   b. System Redundancy.

3. Free Space System Design Parameters.

   a. Terminal Site Locations.

Site No.	Latitude	Longitude	Comment
1	42°13'18"	83°21'00"	ATCT
2	42°13'51"	83°21'47"	ASR8

FIGURE 2. SAMPLE SYSTEM DESIGN SUMMARY FORMAT (CONT.)

System Application. ATCT-ASR-8, Point-to-Point

b. Line-of-Sight Distance.

Section	LOS Distance
1-2	4853 ft

c. Notable Path Obstructions.

No path obstructions to LOS transmission. Airport hangers present no obstruction problem.

SAMPLE FORMAT

d. System Design Frequency. 8 GHz (nominal)

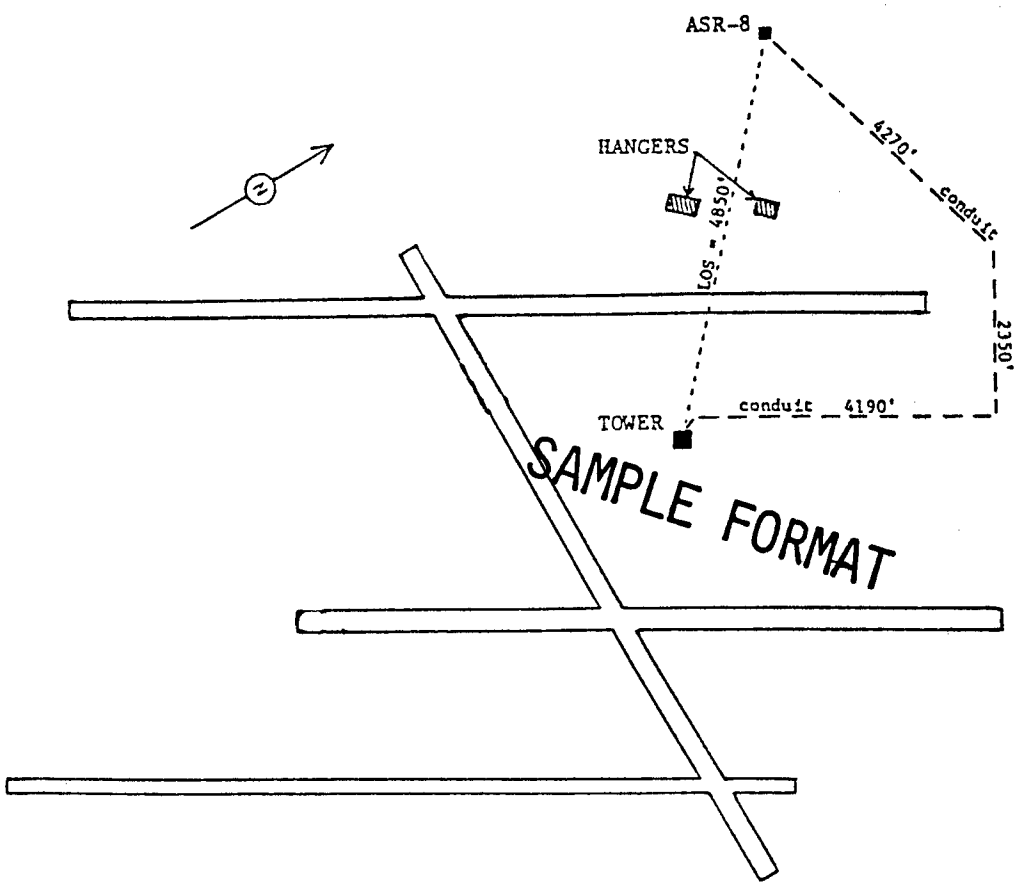
Frequency Allocation Status.

e. System Redundancy.

FIGURE 2. SAMPLE SYSTEM DESIGN SUMMARY FORMAT (CONT.)

System Application ATCT-ASR-8, Point-to-Point

4. Airport Layout Plan.



APPENDIX 3. PREPARATION OF DECISION GUIDELINE CHECKLIST

1. GENERAL. The decision guideline checklist reviews factors other than cost which affect the selection of optimum transmission media/equipment.

2. INSTRUCTIONS FOR COMPLETING THE DECISION GUIDELINE CHECKLIST. The decision guideline checklist reviews eight factors which affect system implementation. These include three critical decision factors which involve media selection and five guideline implementation factors which affect primarily the system design and installation economics. A check mark should be applied at the appropriate space under column "checklist review" upon review of the respective factor.

3. CRITICAL DECISION FACTORS.

a. Construction Vulnerability. Construction vulnerability describes the potential hazard to cable installations resulting from airport construction and related earth-moving activities. Installed ductwork reduces the hazard to cables but does not entirely eliminate it. The installation of cable at airports where extensive construction work is anticipated or where a history of digups exists should be carefully reviewed. The design engineer should make a judgment on potential hazards based on past maintenance history and planned airport construction. The decision to exclude cable installations from design considerations should be supported by a statement of justification in the selection guideline summary below.

b. Media Degradation. Copper cables tend to deteriorate in time due to electrochemical corrosion. Water seepage between cable conductors can cause electrical shorts and require cable replacement. Use of copper cables at airports where environmental conditions have caused significant reliability/maintainability problems should be carefully assessed. The decision to exclude copper cable for signal transmission should be supported by a statement of justification in the selection guideline summary below.

c. Installation Siting Considerations. Transmission distance, terrain conditions, and right of accessibility are important factors affecting cable communication systems. Cable transmission may be precluded from the media selection where transmission distance and terrain pose obvious impediments. The decision to exclude land lines due to adverse siting conditions should be supported by a statement of justification in the selection guideline summary below.

4. GUIDELINE IMPLEMENTATION FACTORS.

a. Availability and Performance Capability of Existing Resources. Availability and performance capability of existing communication resources can affect the media/equipment decision. Acquisition of new communication equipment must be consistent with existing facility resources. Components consistent with FAA goals for equipment modernization should be used.

(1) Conduit Resource. In-place conduit is a major resource accommodating the installation of cable links.

(2) FAA Cable Loop Program. The airport cable loop program includes plans for the installation of fiber optic signal and control cables at selected airports. Airports anticipating additional interfacility communications installations should conduct a review of their eligibility for cable loop installation to avoid any duplication of communication functions.

(3) FAA Integrated Communication Switching System (ICSS). The FAA program to replace leased TELCO equipment with ICSS includes the installation of ATCT-RTR transmission lines for air-ground communications. ATCT-RTR signal transmission equipment should be compatible with equipment planned or already installed under the ICSS program.

(4) FAA Terminal Radar Program. FAA plans include the digitizing of radar data signals at selected airports using common digitizers. Design of future ATCT-ASR systems should be consistent with the use of common digitizers where the installation of such equipment is planned.

b. Media Installation Factor. Media equipment must be installed to provide maximum operational protection.

(1) Lightning. Communication systems should be installed in accordance with FAA Order 6950.19, Practices and Procedures for Lightning Protection, Grounding, Bonding and Shielding Implementation, July 28, 1978, to minimize problems caused by lightning.

(2) Electromagnetic Interference (EMI). Fiber optic lines are immune to EMI. Copper cables are susceptible to induced hum interference when exposed. Lightning presents no significant EMI problem for free space communications. Background EMI noise measurements should be conducted at site locations where background noise levels are likely to pose a problem.

c. System Expandability Factor. Preference should be given to use of components which allow expansion of system communication capability.

d. Configuration Flexibility Factor. DEB cables are fixed communication networks and do not easily accommodate changes in network configuration. The decision to install them should be carefully assessed where future relocation of facilities is likely.

e. System Design Performance. Radio equipments must meet the technical standards outlined in the National Telecommunications and Information Administration (NTIA) "Manual of Regulations and Procedures for Federal Radio Frequency Management," Chapter 5. System design should include sufficient fade margin to ensure reliability under worst case conditions. Frequency allocation is critical to free space media installations.

(1) Radio Communication Frequency. Radio frequency selection is determined by the availability of desired frequency allocation, system economics, and communication performance requirements. Requests for frequency allocations should follow normal regional procedures in accordance with the NTIA "Manual of Regulations and Procedures for Federal Radio Frequency Management."

(2) Rainfall Attenuation. System design requires estimates of rainfall attenuation for microwave transmissions, particularly above 18 GHz. Path distance and system availability decrease with increased rainfall precipitation. System design must provide adequate fade margin to accommodate rainfall attenuation at required signal transmission distance. Figure 3 shows the five rainfall regions in the United States and the rainfall rates which are exceeded for given percentages of a year. The procedure for estimating rainfall attenuation based on the CCIR rain fading model involves five steps. (Ref. Matz, John, "Microwave Reference Guice," Motorola Publication R39-0013, Shaumburg, IL, 1987.)

Step 1. Determine the rain rate, R(mm/hr), associated with the particular rainfall zone from figure 1 for which the rain rate is exceeded 0.01% of the year.

Step 2. Compute the specific rainfall attenuation, s, in dB/km: $s = aR^b$. At 23 GHz, a=0.1, b=1.09; 15 GHz, a=0.036, b=1.12; 8 GHz, a=0.006, b=1.22.

Step 3. Calculate the path length reduction ratio: $r = 90/(90+4D)$ where D is the path length in kilometers.

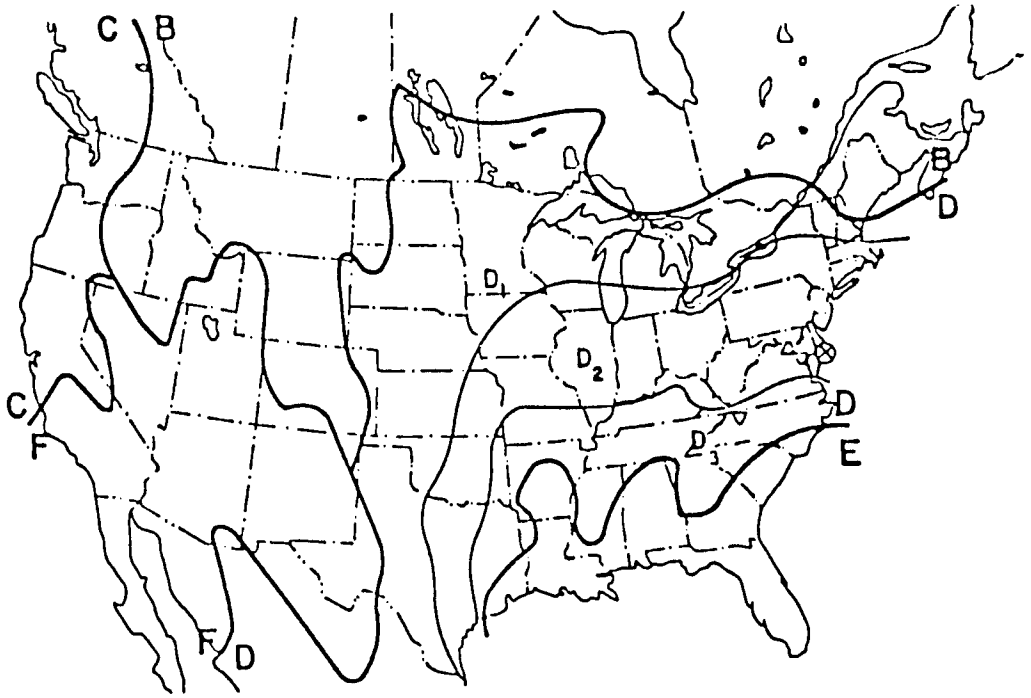
Step 4. Calculate L_o, the rain loss exceeded 0.01% of the time: $L_o = s \cdot r \cdot D$

Step 5. Compute the system unavailability, U, for other rain losses: $U = (.0001)(L_o/\text{Fade Margin})^q$ where $q = 3.00$ for $0.001\% < U < 0.01\%$ and $q = 2.44$ for $0.01\% < U < 0.1\%$.

Fade Margin = Transmitter Power(dBm) - Receiver Sensitivity(dBm) + Transmitter Antenna Gain + Receiver Antenna Gain - 92.4 - 20logF - 20logD, where F is transmission frequency in GHz and D is path length in km.

f. Selection Guideline Summary. Write summary justification statements to support the use of critical decision factors (see paragraph 3 of this appendix) to restrict media selection. Written statements should be included for other factors which impact the decision process; i.e., no in-place conduit installations, planned future facility location changes, etc.

FIGURE 3. RAINFALL ZONE REGIONS IN UNITED STATES AND PERCENT TIME RAINFALL RATES ARE EXCEEDED



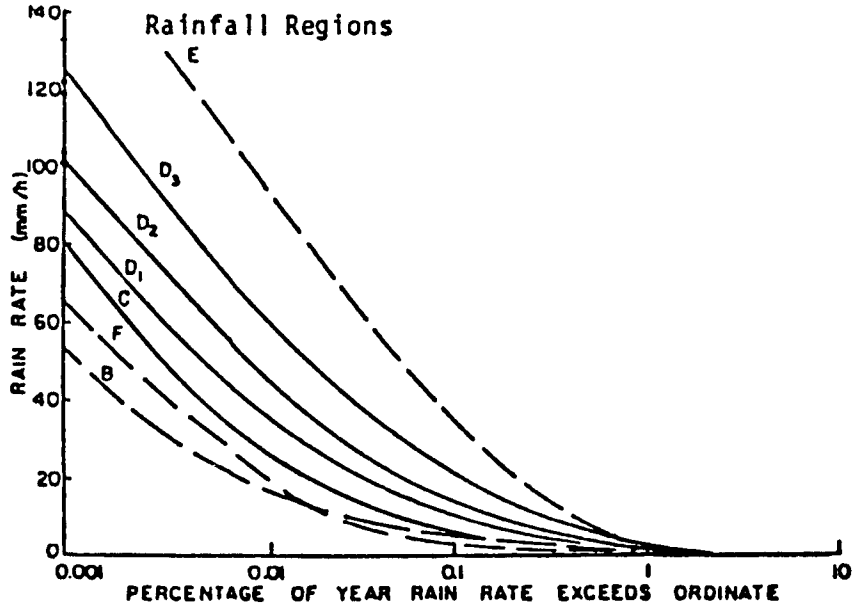


FIGURE 4. SAMPLE DECISION GUIDELINE CHECKLIST FORMAT

MEDIA GUIDELINE FACTORS	CHECKLIST REVIEW
CRITICAL DECISION FACTORS	
1. Critical Decision Factor, Construction Vulnerability	X
2. Critical Decision Factor, Media Deterioration	X
3. Critical Decision Factor, Installation Siting	X
GUIDELINE IMPLEMENTATION FACTORS	
4. Availability and Performance Capability of Existing Resources	X
5. Media Installation	X
6. System Expandability	X
7. Configuration Flexibility	X
8. System Design Performance	X

SAMPLE FORMAT

9. Selection Guideline Statement:

(2) Copper cable unacceptable for new system installation. Frequent maintenance problems with copper cable is primary reason for undertaking new system installation.

(4) Ductwork exists between ASR and tower.

APPENDIX 4. PREPARATION OF COST ESTIMATE WORKSHEET: INITIAL EXPENDITURES

Provide cost data for fiber, copper, and free space transmissions as requested unless medium application has been restricted by critical decision factors given in appendix 3. Express all cost data in kilo-dollars.

1. TERMINAL EQUIPMENT COST. Itemize the cost of terminal equipment to be procured for fiber, copper, and radio/microwave system transmissions. Terminal equipment should include but not be limited to components in the equipment summary listed below. Enter the total equipment procurement cost, including spare parts, on line 1.

Equipment Summary			
Application Type	Fiber	Free Space	Copper
Radar-Video; e.g., ATCT-ASR with control, readback	F/O Cable F/O TX,RX MUX Test Equipment	TX,RX(8 GHz) MUX Antenna Test Equipment	Coax Cable Multipair Cable Line Compensator Line Driver Test Equipment
Voiceband Analog Link; e.g., ATCT-RTR	F/O Cable F/O TX,RX Test Equipment	TX,RX(8 GHz,23 GHz) T1 MUX FDM MUX Antenna Test Equipment	Multipair Cable Line Driver Test Equipment
Voiceband Digital Link; e.g., RMM	F/O TX,RX(Modem) Test Equipment	TX,RX(420 MHz) Modem Test Equipment Antenna	Multipair Cable Line Amplifier Test Equipment Modem

2. MEDIA COSTS. Enter the procurement cost for copper and fiber cables.

3. CONSTRUCTION COSTS. Enter the following construction costs using data obtained from Means Construction Cost Data published annually by R. S. Means, Co., Inc.:

a. Trenching. Include conduit cost if required as well as the cost of encasing the conduit in concrete if necessary.

b. Runway Boring. Specific boring cost is nominally $100/ft. Assume boring distance extends a minimum of 25-50 feet beyond runway edge.

c. Manhole Construction. Typical cost is $2500 per manhole. Separation distance between manholes is nominally 600 feet.

d. Construction Setup Charge. Setup charge is nominally taken to be 5 percent of total construction cost.

e. Tower Construction. Include tower construction cost where new tower construction is required.

4. ENGINEERING COSTS. Estimate the engineering design cost for the system application.

5. TRAINING COST. Enter the training cost required for system installation; e.g., cable splicing, and maintenance operations.

6. OTHER. Enter any additional costs not included in above costs such as any initial expenditures incurred by a sponsor.

7. TOTAL COST. Enter sum of items 1 through 6.

FIGURE 5. SAMPLE COST ESTIMATE WORKSHEET FORMAT: INITIAL EXPENDITURES

All estimates on this sheet shall be based on total costs of end-to-end system equipment costs.

		Fiber	Copper*	Free Space
1.	TERMINAL EQUIPMENT & INSTALLATION	$ 27.5K	$	$ 113K
2.	MEDIA	10.0K		-0-
3.	CONSTRUCTION	-0-		-0-
4.	ENGINEERING	-0-		-0-
5.	TRAINING	4.0K		-0-
6.	OTHER	2.5K		15K
7.	TOTAL INITIAL EXPENDITURE . .	$ 44K	$	$ 146K

SAMPLE FORMAT

*Note copper cable is eliminated as viable option.

APPENDIX 5. COMPLETION OF COST ESTIMATE WORKSHEET: ANNUAL OPERATING EXPENDITURES

Provide cost data for fiber, copper, and free space system transmissions as requested unless medium application has been restricted by critical decision factors given in appendix 3. Express all cost data in kilo-dollars.

1. OPERATING EXPENDITURES.

a. Personnel. Annual cost of personnel per location.

b. Maintenance Costs. Annual cost of planned and non-scheduled maintenance (such as cable repair), including cost for the logistics replenishment of spares over 10-year period.

c. Utilities. Cost of electricity, gasoline, water, etc.

d. Other Facility Costs. Cost of all items in budget item known as "Other Objects."

e. Training. Cost of training required for system installation, operating, or maintenance/repair.

f. Miscellaneous. Include any costs not estimated elsewhere and itemize on reverse side of form.

g. Sponsor. Include expenses incurred by the sponsor, such as any real estate acquisitions, equipment modifications, personnel, or training costs, which are the result of the FAA implementing the new transmission system.

h. Total Expenditures. Enter the sum of the operating expenditures items 1 through 6.

FIGURE 6. SAMPLE COST ESTIMATE WORKSHEET FORMAT: ANNUAL OPERATING EXPENDITURES

ANNUAL OPERATING EXPENDITURES	Fiber	Copper*	Free Space
1. PERSONNEL COSTS	$ 15.0K		$ 15.0K
2. PLANNED MAINTENANCE COSTS	1.0K		1.5K
3. UTILITIES	1.0K		1.0K
4. OTHER FACILITY COSTS	0.5K		-0-
5. TRAINING	1.6K		-0-
6. MISCELLANEOUS	-0-		-0-
7. TOTAL ANNUAL OPERATING EXPENDITURES	$ 19.1K		$ 17.5K

*Note copper cable is eliminated as viable option.

APPENDIX 6. INSTRUCTIONS FOR FINAL MEDIA/EQUIPMENT DESIGN CHOICE

1. GUIDELINE SELECTION SUMMARY. Enter the guideline selection statement(s) from figure 4, item 9.

2. COST COMPARISON ASSESSMENT

a. Enter the total initial expenditures from figure 5, item 7, for alternative communication systems.

b. Enter the total operating and maintenance expenditures from figure 6, item 7, based on 10-year average, for the alternative communication systems.

c. Enter the sum of lines 2 and 3.

3. FINAL MEDIA CHOICE. Enter the final media choice (based on least cost, subject to the restrictions below) in accordance with the following selection criteria:

a. Media selection should be restricted in accordance with guideline selection statement(s), item 1.

b. Media selection should be consistent with the installation of equipments which provide high performance, communication expandability, and long-term reliability/maintainability. When equipment decisions involve tradeoffs between equipment performance and cost, the equipment performance should generally be the deciding factor.

FIGURE 7. SAMPLE FINAL MEDIA/EQUIPMENT DESIGN CHOICE FORMAT

GUIDELINE SELECTION SUMMARY

1. GUIDELINE SELECTION STATEMENT:

(2) Copper medium unacceptable for new system installation. Frequent maintenance problems with copper cable is primary reason for undertaking new communication installation.

(4) Ductwork exists between ASR and tower.

SAMPLE FORMAT

COST COMPARISON ASSESSMENT

	Fiber	Copper	Free Space
2. INITIAL EXPENDITURES	$ 44.0K	$	$ 146.0K
3. OPERATING EXPENDITURES*	$ 19.1K	$	$ 17.5K
4. TOTAL COST	$ 63.1K	$	$ 163.5K

*Annual operating expenditures based on 10-year average

FINAL MEDIA/EQUIPMENT CHOICE

5. CHOICE: Fiber Optic System

No conduit costs involved. Labor costs for fiber installation charged against other funding.

APPENDIX 7. EQUIPMENT SPECIFICATIONS SUMMARY

SYSTEM APPLICATION	MEDIUM	EQUIPMENT SPECIFICATION	
RADAR, ASR4-8	Fiber	ASR Transmission System, Video, Fiber Optic	FAA-E-2790
		Airport Facility, Fiber Optic, Interface	FAA-E-2809
		RS-232 Transceiver, Fiber Optic	FAA-E-2788
		Controller,Programmable, Monitor and Control System	FAA-E-2789
		Modem, Fiber Optic, Multiplexing, Drop and Insert	FAA-E-2820
	Free Space	Airport Surveillance Radar Solid State Communication Equipment for ARTS III Interface	FAA-E-2467
		Airport Surveillance Radar (ASR) Transmitter/Receiver Subsystem	FAA-E-2506
		ASR-4B,-5,-6 Radar Improvements	FAA-E-2581
		ASR-7 Radar Improvements	FAA-E-2582
		Microwave Antenna System	FAA-E-2478
	Copper	Line Compensator, Distribution Amplifier	FAA-E-2484
		Cable, Coaxial Armored, M17/6-RG-11	FAA-E-2171c
		Cable, Electrical Control, Exterior	FAA-E-2042b
RADAR, ASR-9	Fiber	Modem, Fiber Optic, Multiplexing, Drop and Insert	FAA-E-2820
	Copper	Modem	FAA-E-xxxx
RML	Free Space	Radar Microwave Link	FAA-E-2390
		Microwave Antenna System	FAA-E-2478

EQUIPMENT SPECIFICATIONS SUMMARY (CONT.)

SYSTEM APPLICATION	MEDIUM	EQUIPMENT SPECIFICATION	
TML	Free Space	Television Microwave Link (TML)	FAA-E-2446
		Microwave Antenna System	FAA-E-2478
RTR	Fiber	T-Carrier with Drop and Insert, Fiber Optic	FAA-E-2810
	Copper	Multiplex System, Voice/Data, Commercial Type	FAA-E-2376
		Carrier System, Voice/Data Multichannel Commercial Type	FAA-E-2346
		Communication System,VHF/UHF, with Automatic Control(Transc.)	FAA-E-2389
		Radio Link Terminal Sets, UHF	FAA-E-2222
GS/LOC	Fiber	RS-232 Transceiver Fiber Optic	FAA-E-2788
		Controller, Programmable, Monitor and Control System	FAA-E-2789
		Airport Facility, Fiber Optic Interface	FAA-E-2809
		Modem, Fiber Optic, Multiplexing, Drop and Insert	FAA-E-2820
	Free Space	Radio Data Link Transceiver,UHF	FAA-E-2823
		Radio Data Link Antenna	FAA-E-2824
LLWAS	Free Space	Low Level Wind Shear Alert System	FAA-E-2697
AWOS	Free Space Fiber Copper	Automated Weather Observing System	FAA-E-2732a
RVR	Fiber	RS-232 Transceiver Fiber Optic	FAA-E-2788
		Controller, Programmable, Monitor and Control System	FAA-E-2789
		Airport Facility, Fiber Optic Interface	FAA-E-2809

EQUIPMENT SPECIFICATIONS SUMMARY (CONT.)

SYSTEM APPLICATION	MEDIUM	EQUIPMENT SPECIFICATION	
		Modem, Fiber Optic, Multiplexing, Drop and Insert	FAA-E-2820
RVR	Free Space	Radio Data Link Transceiver	FAA-E-2823
		Radio Data Link Antenna	FAA-E-2824
MALSR	Fiber	RS-232 Transceiver Fiber Optic	FAA-E-2788
		Controller, Programmable, Monitor and Control System	FAA-E-2789
RMM	Fiber	Modem, Fiber Optic, Multiplexing, Drop and Insert	FAA-E-2820
	Free Space	Radio Data Link Transceiver	FAA-E-2823
		Radio Data Link Antenna	FAA-E-2824
Model 1 & M1FC	Copper	Flight Service Automation Service	FAA-E-2683

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