ORDER **DEPARTMENT OF TRANSPORTATION**
FEDERAL AVIATION ADMINISTRATION

1811.1

9/6/77

SUBJ: SYSTEM REQUIREMENTS STATEMENT/ACQUISITION AUTHORIZATION FOR SECOND GENERATION VOR/VORTAC SYSTEM

1. SYSTEM REQUIREMENT. Replacement of the electronic portion of existing VORTAC navigation system with improved hardware is certified as a valid System Requirement. This improved hardware shall be based upon a single design concept that will permit a revised remote maintenance monitoring methodology to reduce the total operating and support cost of providing necessary air navigation services to the aviation community through the year 1995. This certification is granted subject to the implementation parameters set forth in Section 8 of this Statement.

2. SYSTEM DESCRIPTION. Air navigation service is provided in the CONUS portion of the National Airspace System (NAS) by the VORTAC System. The very high frequency omnidirectional range (VOR) serves to define the basic route structure for all en route, transition, and terminal airspace. The tactical air navigation system (TACAN) provides bearing and distance information to the military user. Through combining the two systems into VORTAC, there is bearing and distance information provided to civil and military aircraft, thus permitting compatibility between the two distinct users for operation throughout the NAS. There are now over 900 VOR, over 700 TACAN, and approximately 20 Distance Measuring Equipment (DME) facilities commissioned in the NAS.

3. BACKGROUND. The first VOR was commissioned more than 30 years ago; the newest half of the stations has been operating for nearly 15 years. The VOR became an international ICAO standard in the early 1950's. DME was introduced and became a national and international standard in the late 1950's. TACAN became the DOD standard in the late 1950's and was principally deployed throughout the NAS in the early to mid-1960's.

   Operational and performance requirements for the civil VOR/DME are outlined in FAA Advisory Circular 00-31 and ICAO Annex 10. Maintenance requirements are provided in FAA Order 6790.4A. Military operational and performance requirements are compatible with the civil definitions.

   The present VOR/TACAN transmitters, monitors, and auxiliary equipment are primarily of vacuum-tube design. Older equipment has been modified over the years; several equipment buys have been made and changes completed. As a result, equipment configuration lacks standardization. The availability of parts and tubes has declined and, in many instances, they are

obtainable only by special procurement. This is especially applicable to that group of approximately 550 VOR transmitters manufactured in the mid-1940's (procured 1943-1946) and over 400 additional transmitters put into service by the mid-1950's. The necessary reliability and availability of facilities using this equipment continues to be obtained only by substantial maintenance effort at a correspondingly high maintenance and support cost.

4. RELATED FACTORS

a. The Congressional Appropriations Committees have indicated that they do not intend to consider funding a "proliferation" of navigation systems until the Department of Transportation "addresses and justifies the need for these systems within the context of a meaningful national plan for navigation." The Committees consider the VORTAC system among these navigation systems.

b. The United States Government has a commitment to ICAO to operate and maintain the VOR/DME system for civil users until 1985.

c. There is an investment of roughly $1 billion in airborne avionics related to the VOR/DME system. The Federal investment in the ground-based VORTAC system has been estimated at approximately $500 million.

d. There are currently no plans to replace the nationwide VOR/VORTAC system with any other navigation system. Experience has shown that even if a new navigation system were chosen now, it would take from 10 to 15 years to fully implement. This includes time to plan the system, procure and install the equipment, and have aircraft owners install new receivers. The replacement of the VOR/VORTAC system with solid-state equipment would be fully amortized and permit the accrual of additional savings in operation and maintenance prior to full implementation of any new system.

e. Almost all of the current VOR/VORTAC ground systems use vacuum-tube hardware at least 15 years old, much of it 30 or more years old. It is highly manpower intensive, expensive to maintain, and increasingly difficult to support logistically. If this replacement program is not undertaken, a substantial capital investment will be required merely to sustain the existing system in operation, without an opportunity to realize the long-term benefits of manpower and other cost savings available in a solid-state equipment environment.

f. This System Requirement Statement applies to a program for which preliminary implementation decisions have already been made by FAA management. Testimony and background information has been presented to Congressional Appropriations Committees to support the initial funding request included in the agency FY 1978 budget submission.

5. OPTIONS. Four viable alternatives for continuing to provide necessary air navigation services to the aviation community were considered in the light of projected economic growth, operational patterns, and other related factors. Basically, these alternatives are:

   a. Continue operation of the VORTAC system as presently deployed using existing equipment;

   b. Retain essentially the current VORTAC system with partial replacement of older equipment with solid-state equipment of current designs;

   c. Replace the entire VORTAC system with solid-state equipment having increased reliability and maintainability, and implement a remote maintenance monitoring system; or

   d. Phase in a new navigation system.

6. COST/PAYOFF ANALYSIS. Since no plans or decisions have been made yet to replace the VOR/VORTAC system and because complete implementation of any new system would be 10 to 15 years in the future, no economic analysis was made of Option 5d.

   An investment analysis did compare partial and complete replacement of the VORTAC system with continuation of the present system. This analysis, which considered total investment cost and projected operations and maintenance (O&M) savings, showed that complete replacement with solid-state equipment incorporating a remote maintenance monitoring system is the most viable of the three remaining options.

   Based upon the figures contained in the March 21, 1977, AAF-410 letter, Second Generation VORTAC Cost/Benefit Study, complete replacement over four years would require an F&E investment of $104 million and $4.5 million in retraining expense; this investment in new VOR/VORTAC systems would save 58% of current Operations and Maintenance costs. This combination of investment and cost savings generates a rate of return of 11.1% if the useful life of the system is 15 years; the rate of return increases to 13.6% if the useful life is extended to 20 years. This is higher than the 10% rate of return used by OMB as a guide for investment decisions.

   This rate of return could fall below 10% as a result of: (a) significant increases in F&E cost of equipment; or (b) significant decreases in projected O&M savings; or (c) a more limited combination of these factors. Appendices A and B of this statement identify specific dollar levels for both investment (F&E and retraining) and O&M saving levels at which the rate of return drops below 10%. These levels are shown for anticipated useful equipment lives of 15 and 20 years.

7. CONCLUSIONS

a. There is a serious congressional concern about the apparent "proliferation" of navigation systems. This concern should be satisfied by the Department of Transportation with a new meaningful National Plan for Navigation (NPN), which will address long-term roles of the various candidate systems in fulfilling the navigation needs of all modes of transportation, the national defense, and providing related communications capabilities. Thus, a phase-in decision for a new navigation system for the post-1985 time frame cannot be made until after the new, revised National Plan for Navigation is promulgated.

b. Based upon the commitment to ICAO for VOR/DME, the substantial investment in the various components of the VORTAC system, and the length of time that would be needed to phase in a new navigation system, it is very unlikely that the VORTAC system could be phased out of the NAS before approximately 1995 regardless of its long-term role.

c. The best available cost/payoff analysis clearly shows that complete replacement of the VORTAC system with solid-state equipment and implementation of a remote maintenance monitoring system will produce the best return on investment of the three viable alternatives for continued operation of the VORTAC system through 1995. Remote maintenance monitoring for certification is a proven technology presently being utilized at selected Remote Control Air-Ground (RCAG) sites.

d. The cost/payoff analysis indicates that a higher rate of return on investment will be produced by a shorter implementation period of 3 years than for a long implementation period of 4 or 5 years.

e. There are no potential rulemaking actions as a result of implementing this program, since there will be no change in the navigation service provided to the user.

f. Implementation of this program will have no distinguishable impact upon NAS users, because the radio navigation signals provided will be unchanged. Thus, present avionics can continue to be used.

g. There will be no environmental impact as a result of implementing this program, since all new equipment will be housed in existing structures.

8. IMPLEMENTATION PARAMETERS. This System Requirement for replacement of the VORTAC system is certified subject to the implementation parameters noted below. In the event that any of these parameters cannot be met during the implementation of this program, the program sponsor will provide the System Requirements Group (SRG) with an assessment of the impact of the deviation on the continued validity of this System Requirement.

a. The solid-state equipment must meet the present system performance standards of FAA Advisory Circular 00-31 and ICAO Annex 10.

b. The rate of return on the investment shall continue to meet or exceed the OMB 10% guideline. The combinations of the amount invested over a 4-year period and the level of O&M savings that must be achieved in order to meet or exceed this 10% rate of return standard are shown in Appendixes 1 and 2. Two points on 20-year project life curves merit special attention; if the F&E investment for the program is held to $104 million and one-time training cost remains at $4.5 million, the total O&M cost savings cannot fall below 45% and still meet this rate-of-return guideline. On the other hand, if all anticipated O&M cost savings are achieved (58%), then total program investment (both F&E and retraining) can grow to $141 million without having the rate of return fall below 10%.

c. A site-by-site evaluation shall be made to ensure that civil and military requirements for VORTAC service are still valid.

d. Assessments will be conducted by the program sponsor at appropriate milestone points to ensure that the estimated total investment does not exceed the maximum allowable cost for the projected level of O&M savings. As a minimum, these reviews should be made when the Acquisition Paper is submitted to TSARC, at contract award time, and when successive budget-year increments are proposed for addition to the initial program.

e. The program sponsor shall assure that arrangements for providing the necessary logistic support capability, training, etc., shall be made concurrent with acquisition of the prime mission equipment.

f. A cost-savings verification plan shall be included as part of the Implementation Plan for the Second Generation VOR/VORTAC systems. For this savings verification plan, early installations shall be chosen so that all aspects of the new maintenance philosophy can be tested. The target date for completion of this savings verification test shall be 10 to 15 months after the last specified test site is installed.

9. KEY MILESTONE EVENTS. For planning and control purposes, the following dates have been established as program goals. The SRG shall be advised by the program manager/program office of any revisions to these dates.

a.	Acquisition Paper to TSARC	October 1977
b.	Completion of Implementation Plan	December 1977
c.	Contract Award (initial increment)	June 1978

10. REFERENCES. Initial Cost Analysis of the Second Generation VORTAC System, Staff Study by C. J. Combs, ASP-120, September 9, 1975; Economic and Performance Analysis of the Second Generation VORTAC, by A. N. Joglekar, the MITRE Corporation, March 1976; Analyses, dated March 21, 1977, by Chief, Navaids Branch, AAF-410, Subject: Second Generation VORTAC Cost/ Benefits Study; FY-78 Budget Item 4a(3) (Replacement VOR/VORTAC Systems); H. R. Report No. 94-1221, "Department of Transportation and Related Agencies Appropriation Bill, 1977," and related hearings on H. R. 14234; Senate Report No. 95-268, "Department of Transportation and Related Agencies Appropriation Bill, 1978;" and related hearings on H. R. 7557.

11. ACQUISITION AUTHORIZATION. This Acquisition Authorization for the Second Generation VORTAC does not address the question of optimum implementation strategy in depth (except in terms of maximizing return on investments) for the following reasons:

    a. Second Generation VORTAC does not represent any change in service provided to the user.

    b. It does not involve any change in procedures within the NAS.

    c. It does not involve any changes in rulemaking.

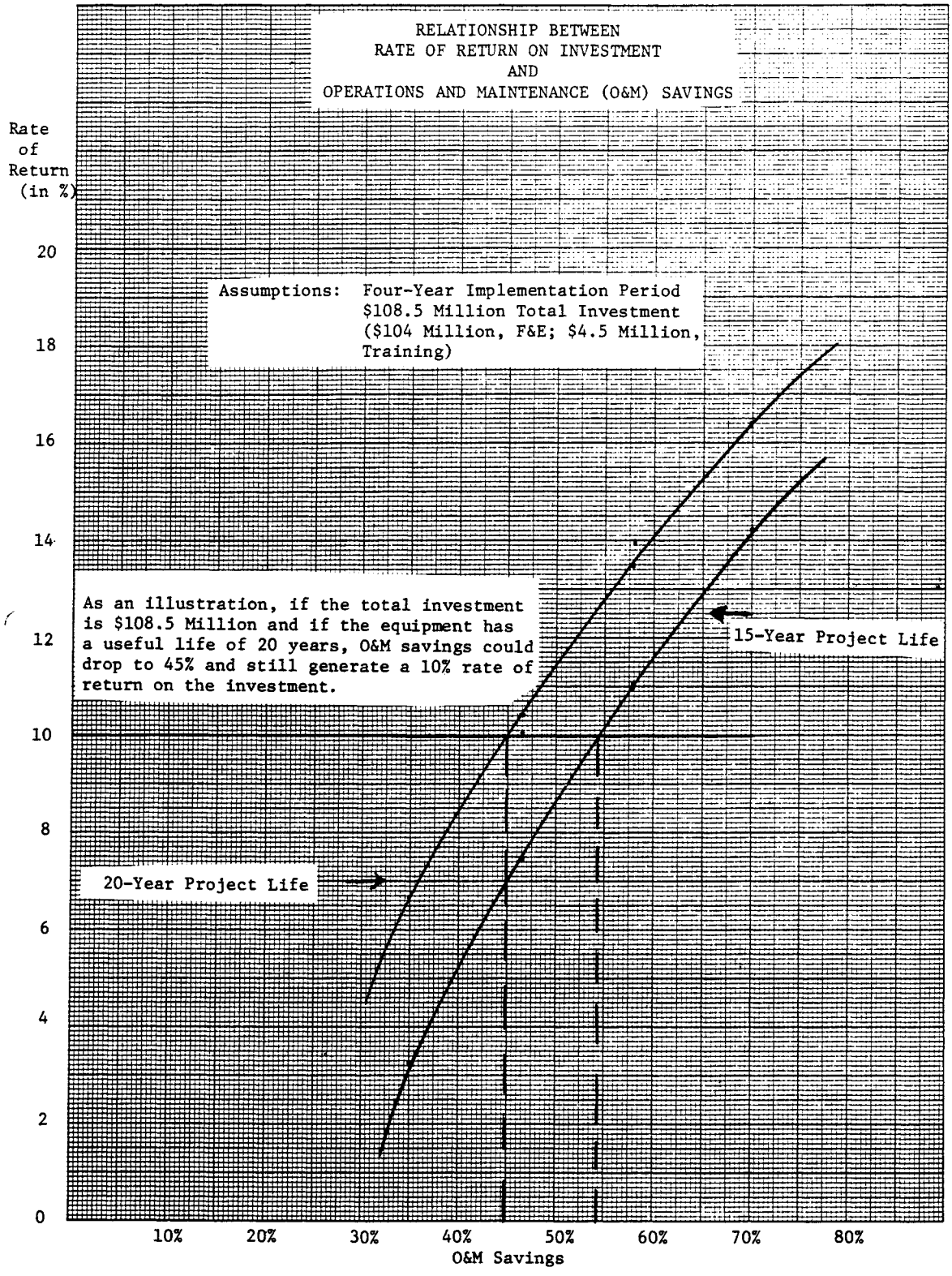
    d. It does not involve any new or changed equipment requirements for the users.

    Accordingly, the details of optimum implementation strategy are to be addressed in the Implementation Plan scheduled for completion in December 1977.

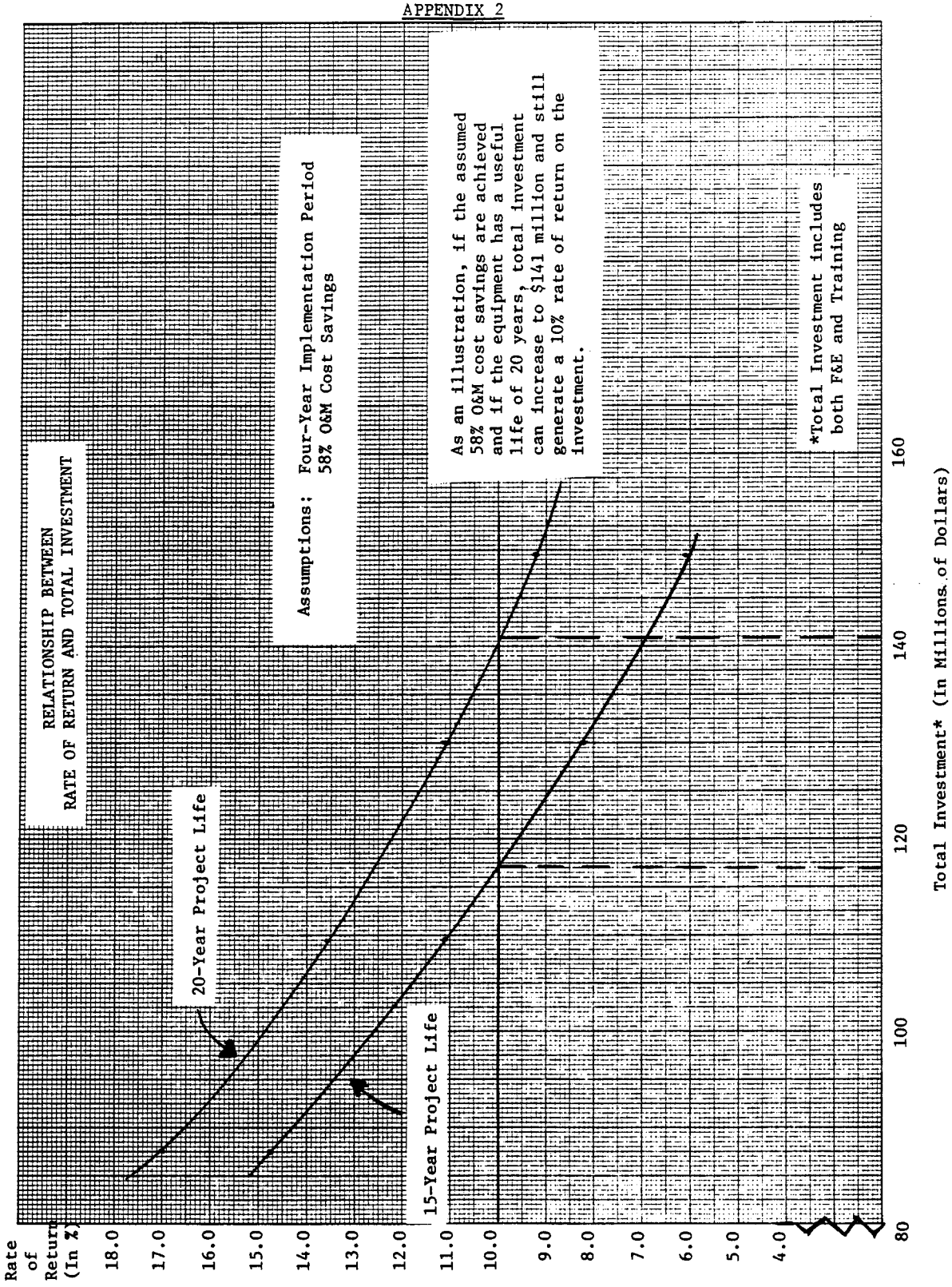
    Authorization is granted for that system and program, as identified herein, to move into an implementation phase as defined in Order 1810.1, "System Acquisition Management."

Quentin S. Taylor
Deputy Administrator

APPENDIX 1


RELATIONSHIP BETWEEN
RATE OF RETURN ON INVESTMENT
AND
OPERATIONS AND MAINTENANCE (O&M) SAVINGS
Rate of Return (in %)
20
18
16
14
12
10
8
6
4
2
0
Assumptions: Four-Year Implementation Period
$108.5 Million Total Investment
($104 Million, F&E; $4.5 Million, Training)
As an illustration, if the total investment is $108.5 Million and if the equipment has a useful life of 20 years, O&M savings could drop to 45% and still generate a 10% rate of return on the investment.
15-Year Project Life
20-Year Project Life
10%
20%
30%
40%
50%
60%
70%
80%
O&M Savings

APPENDIX 2


RELATIONSHIP BETWEEN
RATE OF RETURN AND TOTAL INVESTMENT
Assumptions: Four-Year Implementation Period
58% O&M Cost Savings
As an illustration, if the assumed 58% O&M cost savings are achieved and if the equipment has a useful life of 20 years, total investment can increase to $141 million and still generate a 10% rate of return on the investment.
*Total Investment includes both F&E and Training
20-Year Project Life
15-Year Project Life
Rate of Return (In %)
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
80
100
120
140
160
Total Investment* (In Millions of Dollars)