ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

1812.5

9/12/83

SUBJ: SYSTEM REQUIREMENTS STATEMENT FOR AUTOMATED WEATHER OBSERVING SYSTEMS

1. PURPOSE. This order establishes the system requirements for automated weather observing systems (AWOS) which are consistent with the National Airspace System Plan.

2. DISTRIBUTION. This order is distributed to the division level in the Air Traffic, Acquisition and Materiel, Program Engineering and Maintenance, and Systems Engineering Services; to the Advanced Automation Program Office and the Offices of Flight Operations, Airport Planning and Programming, Airport Standards, Budget, Airworthiness, Aviation Safety, Aviation Policy and Plans, Environmental and Energy, and International Aviation; to the division level in the regional Flight Standards, Airway Facilities, and Logistics Divisions; and to the division level at the FAA Technical Center and the Aviation Standards National Field Office.

3. DEFINITIONS.

a. Automated Weather Observation System (AWOS). The automated weather observing system is an automated system which, as a minimum, routinely detects and reports cloud cover and height, visibility, precipitation occurrence, windspeed and direction, altimeter setting, temperature, dewpoint temperature, and density altitude information to aviation users via various means, including computer-generated voice. Systems which have this capability, even though observers are used to verify and/or validate certain weather parameters, are classifed as AWOS. This description is the basic AWOS. Other parameters, such as thunderstorm activity and freezing rain detection, may be added when available and justified.

b. Density Altitude. The pressure altitude corrected for temperature deviations from the standard atmosphere.

c. Root Mean Square Error (RMSE). Statistical method for computing an average error of many data points.

4. STATEMENT OF THE PROBLEM. Accurate and reliable weather information must be provided at sufficient locations to meet the needs of pilots, operators, and air traffic control (ATC) facilities without incurring the high costs of using the current labor-intensive manual surface weather observation system to provide this service.

a. Airport surface weather observations currently provide the primary means of obtaining information concerning weather conditions for airports within the National Airspace System (NAS). However, the current observation system is limited primarily to major airports where the observations are taken by the National

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Weather Service (NWS) and to airports co-located with FAA-operated control towers or Flight Service Stations (FSS). The acquisition and dissemination of these observations consume a significant portion of time away from the controller's primary job responsibility. The reduction of secondary functions being performed by the controller is a part of the overall ATC automation concept. If weather observations are available at other airports, they are usually provided by the users themselves for their operations which require this information. These observations are taken, by NWS designated Supplemental Aviation Weather Reporting Stations (SAWRS), using observers and equipment provided by the operators. SAWRS observations are generally taken only when needed by the operator providing the service, and are not routinely available to other users.

b. Although hourly surface weather observations are taken at approximately 595 airports within the United States by the Departments of Commerce (DOC) and Transportation (DOT) and at 207 additional airports by the users themselves, operations under instrument flight rules (IFR) are restricted for commercial operators at over 1,200 airports with instrument approaches because they do not have a local weather reporting capability. However, IFR operations conducted under Federal Aviation Regulations (FAR) Part 91 are authorized at locations without this capability. IFR operations by commercial operators are also restricted due to part-time operation of the facility at approximately 376 of the 802 airports with a weather reporting capability. Additionally, IFR approaches by Part 91 operators at 1,307 of the 1,733 airports with approved instrument approach procedures are currently conducted with altitude information based on a remote altimeter setting source. The minimum altitude for the approach is increased in relation to the distance from the remote source to account for potential differences in barometric pressure at the two locations. Full-time remote altimeter setting penalties are required at approximately 931 airports due to the absence of a local weather observation.

c. The continuing growth of aviation has increased the demand for weather reports and forecasts at additional locations. The increasing cost of fuel has also increased the demand for improvements in the efficiency of NAS which depends, to a degree, on the accuracy and reliability of the weather information. Conversely, the escalating costs related to manually obtained weather reports have increased the demands to consolidate FAA FSS's and to develop new techniques for obtaining weather information. Additionally, the cost of manual weather observations prohibits the expansion of this system to provide weather information at most airports which have instrument approaches, but lack a weather reporting capability. Weather information, as currently supplied, is highly labor-intensive. Therefore, it is expensive and marginally adequate, due to the slow response time of manual observation techniques, in those cases where weather events are rapidly changing. Also, in certain areas of the United States, surface weather and weather radar reporting locations are widely separated. Since current forecasting techniques depend heavily on the availability of weather reports, the accuracy and reliability of forecasts are affected within these areas.

d. The resolution of these conflicting factors requires a means of providing weather observations at additional locations and, at the same time, significantly reducing the current labor-intensive manual observation system.

5. STATEMENT OF MISSION NEEDS AND OPERATIONAL REQUIREMENTS. There is a need to regulate flight operations in navigable airspace in the interest of safety and efficiency. Accurate and reliable weather information is essential to accomplish this mission.

a. Weather information is needed for operations en route and in terminal areas to determine the conditions likely to be encountered during a particular flight or a series of flights. Information concerning hazardous weather is especially needed due to the potentially serious impact these conditions may have on aircraft performance or aircraft structural integrity. Because of these limitations, each operator needs to be familiar with all weather information relative to each flight to ensure that the flight is properly planned and safely conducted.

b. Since the ATC system is affected by weather conditions, ATC facilities need en route and terminal weather information to ensure the safe and efficient utilization of the airspace and airports within their area of responsibility.

c. It is essential to maintain an overall system for obtaining accurate and reliable weather information at locations currently providing weather reports. It is also highly desirable to expand the system, to the extent possible, to meet user needs by providing this information at other locations for the conduct of IFR operations by commercial operators. Due to the escalating costs related to the labor-intensive nature of manual surface weather observations, it is also essential to use a system which significantly reduces these costs.

d. As a minimum, this overall system and its associated equipment must meet the following FAA requirements:

(1) Detect and report weather conditions that are representative of the actual conditions encountered at that location.

(2) Detect and report any significant variations in the actual weather conditions that occur in the local environment in a timely manner.

(3) Detect and report potentially hazardous weather conditions.

(4) Detect and inhibit the reporting of erroneous information.

(5) Detect and report sufficient information for the conduct of IFR operations at that airport.

(6) Provide weather information of sufficient accuracy and reliability to ensure safe and efficient air navigation.

(7) Provide weather information equivalent or superior to the reports currently obtained at that location.

(8) Provide for the storage and retrieval of weather information for accident investigation purposes.

(9) Provide weather information to the users inflight and for planning purposes prior to flight.

(10) Present the weather information to the users in a timely manner utilizing a self-evident, plain language format.

(11) Have no characteristic which could adversely affect the safety of flight.

(12) Have system performance which is acceptable to the users.

(13) Function properly under all normal environmental conditions encountered at that location.

(14) Display present weather observation at the appropriate position(s) within the ATC facilities having weather observation responsibilities.

NOTE: If a particular weather parameter cannot be provided by the automated surface weather reporting system, accurate and reliable information concerning this parameter must be provided by other means (e.g., observers, radar, etc.). Also, the primary need to be satisfied by these systems is to provide the information to the pilot who needs it most (approach and departure operations). Therefore, installation of systems to support the expanding needs of commercial operators should not be delayed even if unforeseen problems should arise in connecting the equipment into the national weather observation, dissemination, and data storage systems.

6. AWOS ACCURACIES. The following list of weather parameters and the required accuracies reflect the parameters to be reported by the basic AWOS. Density altitude will also be reported by the AWOS when it is 1,000 feet or more above the field elevation.

Parameters	Accuracy
a. Temperature	1°F (RMSE) (-50°F to +130°F)
b. Dewpoint Temperature	2°F (RMSE) (30°F to 90°F, 80% to 100% RH)
	3°F (RMSE) (30°F to 90°F, 15% to 75% RH)
	4°F (RMSE) (-30°F to 30°F, 25% to 95% RH)
c. Altimeter Setting	.02 in. Hg (RMSE) (28 in. to 32 in. Hg)
d. Wind Direction	5° (RMSE) (2-min. average)

e. Windspeed	2 kns. (RMSE) (calm to 20 kns.), 2-min. average 10% (RMSE) (20 kns. to 100 kns.), 2-min. average
f. Wind Gust	Same as Windspeed with 5-sec. average
g. Visibility	Measure in the following increments (mi.): < 1/4, 1/4, 1/2, 3/4, 1, 1 1/4, 1 1/2, 1 3/4, 2, 2 1/2, 3, 3 1/2, 4, 5, > 5 ± 1 increment
h. Cloud Height	Measure up to 5,000 ft. (Vsby. 3 mi., no precip.) ± 100 ft. to 2,000 ft. ± 10% accuracy, 2,000 ft. to 5,000 ft.
i. Precipitation Occurrence	± .005 in.

7. <u>ALTERNATIVES CONSIDERED AND PROGRAM MILESTONES</u>.

a. <u>Alternative Selected and Major Reasons for this Selection</u>. The progressive alternative for the automation of surface weather observations has been selected as the concept of providing an accurate and reliable surface weather observation capability when and where it is needed for flight operations within the NAS into the 1990 time period and beyond. These systems provide a practical means of expanding the weather observing and reporting systems to include hundreds of IFR airports that do not now have, and probably never will have, a manual weather observation capability. The progressive alternative will permit automation of all surface weather parameters, except present weather and obstructions to vision, in the very near future. The results of recent FAA and industry automated weather development programs indicate that the current state of technology will permit the design and early implementation of the automated systems which will have a significant, positive effect on safe and efficient flight operations at locations currently without a weather observation capability. These development programs also indicate that the state of technology is approaching a level which will permit automated systems to be used as the primary means of detecting and reporting most surface weather information. The majority of the technology to accomplish this goal currently exists, and ongoing programs are expected to develop the necessary new technology in the future.

b. At Air Traffic Control Towers (ATCT), this alternative provides the mechanism for acquiring most of the required weather information and automatically disseminating it to aircraft and weather network communications. At locations where there will be no NWS observer, the parameters not automatically observed may be input manually by the controller or contract observer. If the tower is only open part-time, the automatic observation will be disseminated without the manual inputs when the tower is closed.

c. Although some unforeseen difficulties could possibly be encountered in the development of the AWOS advanced sensors to detect present weather and obstructions to vision, the progressive automation alternative provides flexibility to account for this possibility. This alternative permits the early automation of these tasks and reduces or eliminates the high costs of maintaining the obsolete equipment currently in use. Additionally, in this interim period, the time which must be devoted to manual observations would be reduced and observers could be assigned additional duties and controllers would have additional time to accomplish their primary duties.

d. The capabilities of AWOS can be augmented, as engineering development proceeds, with additional ground sensors and equipment to support a fully automated surface weather observation capability. The observer's role in surface observations will be phased out as the advanced sensors are added to complete the system. This approach permits the early elimination of the most labor-intensive tasks without degrading the accuracy and reliability of surface weather observations.

e. The progressive automation alternative will provide standardized weather information which is available full time and updated each 60 seconds. This alternative will permit the expansion of the surface observation system to meet the needs of the users without incurring the high long-term costs of using the current labor-intensive system to provide this service.

f. Rejected Alternatives.

(1) Do-nothing Alternative. Although this is a simple alternative, this approach will not meet the needs of FAR Parts 121 and 135 operators, particularly the requirements for IFR operations at locations currently without weather reports, or meet the need for improved safety and efficiency in the NAS. Additionally, this concept does not adequately address the escalating cost of the highly labor-intensive manual observation network.

(2) Expansion of the Manual Observation Network Alternative. Although this concept could meet user needs, a significant expansion of the manual observation network would be required. This could be accomplished by increased FAA and NWS staffing and equipment purchases, by contracting the observations, by increased use of SAWRS from industry sources, or by a combination of these options. However, this approach would be very costly due to the labor-intensive nature of manual observations and is not considered a practical alternative.

(3) Full Automation of Complete Surface Weather Observation. Since this concept would provide high quality 24-hour weather service at airports served by instrument approaches, it would be ideal from the users point of view. This concept would also permit significant reductions in the manual observation network and would assist the consolidation of FSS. However, an enhanced AWOS is very expensive (375K to 425K each) and would require approximately $146 to $166 million to implement these systems at existing FAA reporting locations, $438 to $496 million to implement these systems at all existing reporting locations, and a

total of $507 to $574 million to expand the system to meet user needs. This concept is frequently called the "gold-plated" approach due to these high costs. Additionally, the technology for some of the AWOS advanced sensors is still under development which could delay the implementation of this alternative until 1990 or beyond.

g. Program Milestones. The program milestones of AWOS are:

(1)	Demonstration Contracts Awarded	12/82
(2)	Specification Final Draft Completed	3/83
(3)	Program Master Plan	3/83
(4)	Install Demonstration Units	8/83
(5)	First Results from Demonstration Analyzed	11/83
(6)	TSARC Key Decision #4	2/84
(7)	RFP for Production Units	3/84
(8)	Award Contract(s)	5/85
(9)	Install First Production Unit	3/86

8. POTENTIAL RULEMAKING ACTIONS. Rulemaking action is not required for the procurement and implementation of automatic surface weather systems. The Federal Aviation Act of 1958 as amended authorizes FAA to acquire, establish, install, operate, and maintain apparatus or equipment for the dissemination of weather information. However, since FAR Part 121 operators must use weather information from sources approved by NWS, rulemaking action may be required if NWS does not approve these systems for aviation use. For non-Federal installations, rulemaking action is required to revise FAR Part 171 to include AWOS.

9. RELATED FACTORS.

a. Potential Benefits Assessment. The principal benefits to be realized from the implementation of AWOS are the increased safety and capability for IFR flight operations at airports within the United States. This alternative also encourages and supports industry development of systems which can qualify for Government support for sponsor installation. The implementation of these systems will also reduce the costs related to the highly labor-intensive nature of manual weather observations. Both of these factors are significant due to the rapid expansion of FAR Part 135 operations and the increasing demands for improved weather service in the interest of safety and efficiency in the NAS. These systems are expected to provide the users with high quality "real-time" weather information and have the capability to provide this information directly to the users by various means, including the use of computer-generated voice outputs. These methods are expected to provide current weather information when and where it is needed by the users. In doing so, these systems provide increased safety and efficiency in the conduct of IFR operations by improving the accuracy and reliability of weather information and by permitting IFR operations by commercial operators at additional airports as well as reducing or eliminating restrictions at others.

b. The safety implications of providing accurate and reliable weather information at additional airports can be related to the fact that weather conditions were cited as a factor in 48 percent of the general aviation accidents which occurred during a recent 7-year period. Although it is difficult at this time to determine exactly what part weather plays in an accident, the circumstances indicate that the pilots involved in these accidents may have had difficulty effectively gathering and interpreting sufficient weather information to make sound operational decisions.

c. The economic benefits of automated systems result from the high cost of providing manual observations and the difficulties associated with individual users acquiring their own observations. Additionally, operators are required to accept a minimum approach altitude penalty for safety reasons if an altimeter setting must be extrapolated from a distant source. This reduces the capacity of the airport and reduces the viability of using this airport for destination or alternate purposes in poor weather conditions. Also, there are additional factors, such as fuel consumption and man-hours expended, which could be reduced as a result of more effective operational decisions based on accurate and reliable weather information at additional airports. More specific information is addressed in Report No. FAA-APO-83-6, Establishment and Discontinuance Criteria for Automated Weather Observing Systems (AWOS), May 1983.

d. Expected Public and User Impact. It is anticipated that implementation of AWOS to supplement the current observation network will produce no adverse public or user impact. Instead, these systems should significantly benefit the public and the user.

e. Previous Congressional Attention or Mandates. Congressional interest in improving the accuracy and reliability of aviation weather services has historically been, and remains, high. The primary focus of this interest has been weather factors, such as thunderstorms, wind shear, and other hazardous phenomena, related to aircraft accidents. This interest has also included the weather services provided by FSS. Congressional constraints restrict the closure or part-timing of FSS's without providing weather information relating to temperature, dewpoint, barometric pressure, ceiling, visibility, and wind direction and speed which is as good or better than the service provided by either mechanical device or contract with another party. A crosscut analysis study dated October 13, 1979, prepared for the Office of Management and Budget (OMB) by the Federal Coordinator, recommended common actions by the Department of Commerce (DOC), Department of Defense (DOD), and Department of Transportation (DOT) for weather observations and equipment to provide the necessary weather services.

f. Environmental Assessment. The implementation of AWOS will produce no adverse environmental impact.

10. COST.

a. Research, Engineering, and Development Appropriation. Approximately $2.2M has been expended on the development and feasibility test of AWOS and AWOS sensors between 1978 and 1982. It is estimated that continuing development and evaluation of sensors and software for AWOS enhancements will require:

FY-83	$50,000
FY-84	$510,000
FY-85	$750,000
FY-86	$400,000
FY-87	$140,000

b. Acquisition Costs. Estimated acquisition costs for the procurement, installation, and support of AWOS are as follows:

Each location (FY-82 dollars)

Hardware/software	$91,000	(This amount will be reduced with full production)
Installation/spares	$67,000	
Amortized start up cost	$12,000	
Total Cost	$170,000	

c. Life Cycle Cost Estimates. A preliminary comparison of the costs of the existing manual weather observation system with those costs estimated for an AWOS installed either at an airport with a manned or unmanned ATCT has been conducted. These costs were based upon 1982 dollars and included the categories of "Development," "Investment," and "Annual Operating Costs." The automated system is subject to development and investment costs, but the existing manual system is fully developed and replacement sensors and other equipment are treated as an annual recurring cost. Equipment replacement for the manual system is assumed to occur for only 8 years, since, at a replacement rate of 12 1/2 percent annually, the total system should be replaced in 8 years. Also, as new equipment replaces old, the amount of maintenance manpower required for the manual system also decreases.

(1) The above factors were used in the calculation of life cycle costs for the existing manual system and the automated system. They are shown in paragraph 10c(3) as "Present Value Cost." This quantity reflects each year's expected cost multiplied by that year's discount factor and then summed over the 15-year planning (life cycle) period. The discount rate was 10 percent per year.

(2) The acceptable manual observing system options at an airport with an active ATCT are the existing system either with FAA or NWS personnel taking the observation, or with full-time weather service contract meteorological observatory (WSCMO) personnel taking the observation. The use of SAWRS observations at an active ATCT is not considered an alternative, since their weather observations are not always available to the general aviation community. In like manner, the reduced cost of the contract basic option is also not an acceptable option, since the weather observer is only paid for taking specifically prescribed, hourly

observations. He/she is not a full-time employee, and these costs do not reflect the capability to relay current weather observations directly to an inbound aircraft via radio.

(3) The costs associated with these estimates are shown in the following figure and were obtained from an AWOS cost analysis by Kentron International developed in May 1982.

System	Agency	Activity	Development Cost ($)	Investment Cost ($)	Annual Operating Cost ($)	Present Value Cost ($)
Existing Manual System	FAA	ATCT Observer			100,655	715,128
		FSS			86,920	610,673
		NWS Observer at an Airport			86,980	611,130
	NWS	Contract Basic			38,781	269,754
		WSCMO			134,580	973,128
	Non-Gov't.	SAWRS			9,670	72,905
Automated System		Manned Airport (ATCT)	2,375	122,490	12,349	207,416
		Unmanned Airport (no ATCT)	2,375	116,860	8,283	171,377

(4) Since the costs used to develop life cycle costs of an automated system are estimates, a logical question is "What would happen to the life cycle costs of the automated system if the investment cost and annual recurring costs were more than anticipated?" To answer this question, a sensitivity analysis was performed on an automated system installed at a manned airport, using the following assumptions:

(a) Development costs did not change.

(b) The cost of the automated system (investment cost) is 50 percent more than estimated ($122,490 x 1.5 = $183,735).

(c) Annual recurring costs were underestimated by a factor of three (the revised costs are $12,349 x 3, or $37,047 annually).

(5) Under these conditions, the 15-year, 10 percent discount life cycle (present value) cost was computed to be $450,916, a value still considerably less than the acceptable options for the collection and dissemination of weather data at an airport with an active ATCT.

(6) Report No. FAA-APO-83-6 has life cycle cost estimates for automated systems with and without precipitation and thunderstorm detection. This report does not include development costs for an automated system while the Kentron study included development costs. The different approaches require emphasis on the fact that the FAA report and the associated planning standards will be used in the establishment criteria.

11. MINIMUM BENEFITS OF ANY PROPOSED SOLUTION. Any proposed solution must satisfy the mission needs and operational requirements as defined in this order.

12. RELIABILITY, MAINTAINABILITY, PRODUCTIVITY, SAFETY, ENERGY, ENVIRONMENTAL, AND STAFFING GUIDELINES GOVERNING SYSTEM ACQUISITION. No deviations from current FAA policies and philosophies should be required by the automation of surface weather observation systems. System reliability and safety should be such that the automation of surface weather observations will not disrupt routine aircraft or ATC operations, and will not degrade the weather services provided.

13. MANAGEMENT DECISION MILESTONES. Program assessment will be conducted jointly by the Associate Administrators for Administration, Aviation Standards, Development and Logistics, and the Director, Air Traffic Service, prior to the key decision points relating to prototype development, full-scale development and field testing, and development to ensure that the program milestones are met, that the system is operationally suitable, and that the program is properly managed.

14. RELATED PUBLICATIONS. The publications related to the development, procurement, and installation of AWOS are listed in Appendix 1, Related Publications.

Helms

J. Lynn Helms
Administrator

APPENDIX 1. RELATED PUBLICATIONS

1. Executive Office of the President, Bureau of the Budget. Circular No. A-62, Policies and Procedures for the Coordination of Federal Meteorological Services.

2. Office of Federal Coordinator. Crosscut Analysis of Agency Proposals for Surface Weather Observation Automation.

3. Government.

a. FAA.

(1) Order 7000.2A, FAA/NOAA Memorandum of Agreement, dated 3/25/77.

(2) ATF-4 - Summary of FAR, Aviation Weather Requirements - (undated).

(3) OSEM - Definition Description and Interface of the FAA's Development Programs, FAA-EM-78-1611 and 17, dated 9/78.

(4) SRDS Development Plan for Aviation Automated Weather Observation System (AVAWOS), dated 7/76.

(5) Lincoln Lab Report, A Concept Plan for the Development of a Weather Support Subsystem for ATC FAA-RD-76-23, dated 4/16/76.

(6) New Engineering & Development Initiatives - Policy and Technology Choices - Consensus Views of User/Aviation Industry Representatives, Contract DOT-FA77WA-4001, Vols. I & II, dated 3/1/79.

(7) Systems Research and Development Service - Aviation Weather System (AWES) Engineering Architecture and Design Concept, dated 3/21/79, Rev. 7/79, (MSI Report dated 10/79, DOT-FA78WAI-881).

(8) Order 7110.65C, Air Traffic Control, dated 1/1/80.

(9) Evaluation of Safety Programs with Respect to the Causes of General Aviation Accidents, Vols. I & II, dated 5/80, DOT/FAA ASP 80-2/80-2A.

(10) Department of Transportation, Federal Aviation Administration: National Airspace System Plan, dated 4/83, as amended.

(11) Order 7031.2B (Latest Edition), dated 9/20/74, Airway Planning Standard Number One - Terminal Air Navigation Facilities and Air Traffic Control Services.

b. National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS).

(1) NWS - Summary of NWS Weather Observing Responsibilities (Start 1812) and Chronological List of Legislative Authority.

(2) NOAA Technical Digest - Optical Propagation through Turbulence, Rain and Fog - Boulder Co., dated 8/9-11/77.

(3) NOAA Measurement of Rain Parameters by Optical Scintillation (Laser) - Applied Optics, dated 8/77.

(4) NOAA - A Feasibility Study of Identifying Weather by Laser Forward Scattering, dated 10/78.

(5) National Weather Service Offices and Stations, dated 1/79.

(6) Federal Meteorological Handbook FMH-1, dated 1/1/79.

(7) Federal Meteorological Handbook FHM-9, dated 1/1/79.

c. DOD/Air Weather Service (AWS).

(1) Air Force Geophysics Laboratory (AFGL) - The development of a Fixed Base Automated Weather Sensing and Display System; AFGL-TR-78-0009, dated 1/6/78.

(2) AFGL - Preliminary Assessment of an Automated System for Detecting Present Weather (Decision Tree); AFGL-TR-79-0137, dated 6/26/79.

(3) Required Operation Capability (ROC) AFCS 601-77 Automated Weather Observing System (AWOS), dated 2/16/77.

d. User/Other.

(1) Criteria for Weather Observations at General Aviation Airports WYATT for AOPA, dated 11/76.

(2) Lightning Detection System for Fire Management - University of Arizona, Reprint No. 396, dated 3/78.

(3) A New Approach to Lightning Position and Tracking - Atlantic Science Corporation, dated 3/79.