

Issued in Washington, D.C. on April 15, 1982.

Alan I. Roberts,

Associate Director for Hazardous Materials Regulation, Materials Transportation Bureau.

[FR Doc. 82-10788 Filed 4-21-82; 8:45 am]

BILLING CODE 4910-60-M

VETERANS ADMINISTRATION

Administration, Maintenance, Chapel Buildings, and Related Site Work, Garrison State Veterans Cemetery, Owings Mills, Maryland; Finding of No Significant Impact

The Veterans Administration has assessed the potential environmental impacts that may occur from the construction of administration, maintenance, and chapel buildings, and related site work for Phase 1 (approximately 20 acres) of the 90 acre Garrison State Veterans Cemetery. It is located in Baltimore County near Owings Mills approximately 35 minutes from downtown Baltimore. This is a state operated veterans cemetery; the Veterans Administration is providing funding for the action from the state cemetery grant-in-aid program.

After evaluating and assessing a wide scope of environmental concerns related to the action, it was concluded that development of approximately 20 acres into a veterans cemetery will not generate significant and/or adverse impacts on the environment.

The significance of the identified impacts has been evaluated relative to

the considerations of both context and intensity, as defined by the Council on Environmental Quality (Title 40 CFR 1508.27).

This Environmental Assessment has been performed in accordance with the requirements of the National Environmental Policy Act Regulations, §§ 1501.3 and 1508.9. A "Finding of No Significant Impact" has been reached based on the information presented in this assessment.

The assessment is being placed for public examination at the Veterans Administration, Washington, D.C. Persons wishing to examine a copy of the document may do so at the following office: Mr. Willard Sitler, P.E., Director, Environmental Affairs Staff (005B), Room A14, Veterans Administration, 810 Vermont Avenue, N.W., Washington, D.C., (202-389-2526). Questions or requests for single copies of the Environmental Assessment may be addressed to: Director, Environmental Affairs Staff (005B), 810 Vermont Avenue, N.W., Washington, D.C. 20420.

Dated: April 15, 1982.

Robert P. Nimmo,

Administrator.

[FR Doc. 82-10988 Filed 4-21-82; 8:45 am]

BILLING CODE 8320-01-M

National Cemetery, Availability of Supplemental Final Environmental Impact Statement; Federal Region IV

Notice is hereby given that a document entitled "Supplemental Final

Environmental Impact Statement for Veterans Administration Federal Region IV National Cemetery," dated April 1982, has been prepared in accordance with § 1502.9(c) of the National Environmental Policy Act Regulations.

Since the decision by the Administrator of Veterans Affairs on July 24, 1981 to develop the Federal Region IV National Cemetery at Fort Mitchell, Alabama, new information regarding land use restrictions on the Fort Mitchell site has been brought to the attention of the Veterans Administration. The Supplemental FEIS documents and makes public these restrictions as well as other conditions which must be satisfied prior to the transfer of Fort Mitchell to the VA.

The document is being placed for public examination at the Veterans Administration in Washington, D.C. Persons wishing to examine a copy of the document may do so at the following office: Mr. Willard Sitler, Director, Office of Environmental Affairs (005B), Room A14, Veterans Administration, 810 Vermont Avenue, N.W., Washington, D.C. 20420, (202-389-2526). Single copies of the Supplemental Final Environmental Impact Statement may be obtained on request to the above office.

Dated: April 15, 1982.

Robert P. Nimmo,

Administrator.

[FR Doc. 82-10989 Filed 4-21-82; 8:45 am]

BILLING CODE 8320-01-M

Sunshine Act Meetings

Federal Register

Vol. 47, No. 78

Thursday, April 22, 1982

This section of the FEDERAL REGISTER contains notices of meetings published under the "Government in the Sunshine Act" (Pub. L. 94-409) 5 U.S.C. 552b(e)(3).

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1

CIVIL AERONAUTICS BOARD

[M-348, April 19, 1982]

Short Notice of Meeting for April 20, 1982

TIME AND DATE: 2 p.m., April 20, 1982.

PLACE: Room 1012, 1825 Connecticut Avenue, NW., Washington, D.C. 20428.

SUBJECT:

1. Docket 40534, Joint application of Braniff Airways, Inc. and Pan American World Airways, Inc. for approval of an agreement and for other relief. (Memo 1232, 1232-A, For Information Memoranda, dated April 12, 1982 and April 14, 1982, BIA.)

STATUS: Closed.

PERSON TO CONTACT: Phyllis T. Kaylor, the Secretary (202) 673-5068.

[S-594-82 Filed 4-20-82; 3:55 pm]

BILLING CODE 6320-01-M

2

CIVIL AERONAUTICS BOARD

[M-347, Amdt. 4, April 15, 1982]

Notice of Addition to the April 15, 1982 Board Meeting

TIME AND DATE: 9 a.m. (closed), 3 p.m. (open), April 15, 1982.

PLACE: Room 1012 (closed), room 1027 (open), 1825 Connecticut Avenue NW., Washington, D.C. 20428.

SUBJECT:

5c. Discussions with Venezuela.

STATUS: Closed.

PERSON TO CONTACT: Phyllis T. Kaylor, the Secretary (202) 673-5068.

[S-595-82 Filed 4-20-82; 3:55 pm]

BILLING CODE 6320-01-M

3

CIVIL AERONAUTICS BOARD

[M-347, Amdt. 5, April 16, 1982]

Notice of Addition to the April 15, 1982 Board Meeting

TIME AND DATE: 9 a.m. (closed), 3 p.m. (open), April 15, 1982.

PLACE: Room 1012 (closed), room 1027 (open), 1825 Connecticut Avenue, NW., Washington, D.C. 20428.

SUBJECT:

4a. Discussions with Japan. (BIA)

STATUS: Closed.

PERSON TO CONTACT: Phyllis T. Kaylor, the Secretary (202) 673-5068.

[S-596-82 Filed 4-20-82; 3:55 pm]

BILLING CODE 6320-01-M

4

COMMODITY FUTURES TRADING COMMISSION

TIME AND DATE: 11 a.m., Friday, April 30, 1982.

PLACE: 2033 K Street, NW., Washington, D.C., eighth floor conference room.

STATUS: Closed.

MATTERS TO BE CONSIDERED: Surveillance Briefing.

* * * * *

TIME AND DATE: 11 a.m., Friday, May 7, 1982.

PLACE: 2033 K Street, NW., Washington, D.C. eighth floor conference room.

STATUS: Closed.

MATTERS TO BE CONSIDERED: Surveillance Briefing.

CONTACT PERSON FOR MORE INFORMATION: Jane Stuckey, 254-6314.

[S-585-82 Filed 4-20-82; 9:59 am]

BILLING CODE 6351-01-M

5

FEDERAL DEPOSIT INSURANCE CORPORATION

Changes in Subject Matter of Agency Meeting

Pursuant to the provisions of subsection (e)(2) of the "Government in the Sunshine Act" (5 U.S.C. 552b(e)(2)),

notice is hereby given that at its closed meeting held at 2:30 p.m. on Monday, April 19, 1982, the Corporation's Board of Directors determined, on motion Chairman William M. Isaac, seconded by Director C. T. Conover (Comptroller of the Currency), that Corporation business required the addition to the agenda for consideration at the meeting, on less than seven days' notice to the public, of the following matters:

Recommendations regarding the liquidation of a bank's assets acquired by the Corporation in its capacity as receiver, liquidator, or liquidating agent of those assets:

Case No. 45,188-SR—The Metro Bank of Huntington, Inc., Huntington, West Virginia Memorandum and Resolution re: Franklin National Bank, New York, New York

The Board further determined, by the same majority vote, that no earlier notice of the changes in the subject matter of the meeting was practicable; that the public interest did not require consideration of the matters in a meeting open to public observation; and that the matters could be considered in a closed meeting by authority of subsection (c)(9)(B) of the "Government in the Sunshine Act" (5 U.S.C. 552b(c)(9)(B)).

Dated: April 19, 1982.

Federal Deposit Insurance Corporation.
Alan J. Kaplan,

Deputy Executive Secretary.

[S-587-82 Filed 4-20-82; 2:06 pm]

BILLING CODE 6714-01-M

6

FEDERAL ELECTION COMMISSION

DATE AND TIME: Tuesday, April 27, 1982 at 10 a.m.

PLACE: 1325 K Street, NW., Washington, D.C.

STATUS: This meeting will be closed to the public.

MATTERS TO BE CONSIDERED: Compliance. Litigation. Audits. Personnel.

* * * * *

DATE AND TIME: Thursday, April 29, 1982 at 2 p.m.

PLACE: 1325 K Street, NW., Washington, D.C. (fifth floor).

STATUS: This meeting will be open to the public.

MATTERS TO BE CONSIDERED:

Setting of dates for future meetings
Correction and approval of minutes
Advisory opinions:
Draft AO 1982-19: Ronald C. Peterson,
Treasurer, Cranston Presidential Advisory
Committee
Draft AO 1982-27: Lee E. Holt, City Attorney,
City of Dallas
Draft AO 1982-29: Janet M. Lashendock,
Treasurer, The United Telecom PAC
Ballot Access Exemptions
Appropriations and budget
Routine administrative matters

PERSON TO CONTACT FOR INFORMATION:

Mr. Fred Eiland, Public Information
Officer; Telephone: 202-523-4065.
Marjorie W. Emmons,
Secretary of the Commission.

[S-592-82 Filed 4-20-82; 3:06 pm]

BILLING CODE 6715-01-M

7

FEDERAL MARITIME COMMISSION**TIME AND DATE:** 9 a.m., April 28, 1982.**PLACE:** Hearing Room One, 1100 L
Street, NW., Washington, D.C. 20573.**STATUS:** Open.**MATTERS TO BE CONSIDERED:**

1. Report on Notation Items disposed of during March 1982.
2. Report of the Secretary on times shortened for submitting comments on section 15 agreements pursuant to delegated authority during March 1982.
3. Report of the Secretary on Applications for Admission to Practice approved during March 1982, pursuant to delegated authority.
4. Agreement No. 9925-3: Extension of the Pacific America Container Express Cooperative Working Arrangement.

CONTACT PERSON FOR MORE

INFORMATION: Francis C. Hurney,
Secretary (202) 523-5725.

[S-593-82 Filed 4-20-82; 3:54 pm]

BILLING CODE 6730-01-M

8

**FEDERAL MINE SAFETY AND HEALTH
REVIEW COMMISSION**

April 14, 1982.

TIME AND DATE: 10:00 a.m., Wednesday,
April 21, 1982.**PLACE:** Room 600, 1730 K Street, NW.,
Washington, D.C.**STATUS:** Open.**MATTERS TO BE CONSIDERED:** The
Commission will consider and act upon
the following:

1. Penn Allegh Coal Company, Docket No. PITT 76X241-P; IBMA 76-60. (In this case, arising under the 1969 Coal Act, the issues include whether the judge properly found a violation of 30 CFR 75.1403 dealing with safe transportation of miners and materials.)
2. Amax Lead Company of Missouri, Docket No. CENT 81-63-M. (In this case, on interlocutory review, the issues include

whether the judge properly rejected the
parties' proposed settlement agreement.)

CONTACT PERSON FOR MORE**INFORMATION:** Jean Ellen (202) 653-5632.

[S-586-82 Filed 4-20-82; 9:59 am]

BILLING CODE 6735-01-M

9

METRIC BOARDAdministrative and Budget Committee
Meeting**TIME AND DATE:** 10:30 to 11:30 a.m.,
Wednesday, May 5, 1982.**PLACE:** 1600 Wilson Blvd., Suite 400,
Arlington, Virginia 22209.**STATUS:** Open to the Public.**MATTERS TO BE CONSIDERED:** Two
Briefings on Administrative and Budget
Matters: (1) Summary Briefing on
appropriation on matters and (2)
Summary Briefing on internal personnel
policies and ongoing personnel actions.**CONTACT PERSON FOR FURTHER****INFORMATION:** Mr. Jerry Manolatos; 703/
235-2918.

Louis F. Polk,

Chairman, Metric Board.

[S-590-82 Filed 4-20-82; 2:06 pm]

BILLING CODE 6260-01-M

10

METRIC BOARD

Bimonthly Board Meeting

TIME AND DATE: 9 a.m. to 5:30 p.m.,
Thursday, May 6, 1982; 9 a.m. to 12
noon, Friday, May 7, 1982.**PLACE:** The Twin Bridge Marriott,
Commonwealth Ballroom, Second Floor,
Convention Center, U.S. 1 and I-395,
Washington, D.C. 20024.**STATUS:** Open to the public.**MATTERS TO BE CONSIDERED:**

- Approval of Agenda—Approval of agenda for
this meeting.
Review/Approval of Minutes of the Board
Meeting held on March 4, 1982 in Arlington,
Virginia.
Committee Reports—Committee Chairmen
who wish to report to the Board will be
recognized.
Operating Plan Status Report—Program by
program review of modified Operating Plan
indicating status of major deliverables and
reporting schedule/completion schedule for
May/July USMB meetings.
Medical Industry Panel—A prototype panel
of industry decisionmakers assembled to
provide the Board insight into the status
and outlook for metric conversion in their
industry.

Report on Metric Education Program—A
report on the status of the metrication
program in the Department of Education.
Metric Use in the Machine Tool Industry—
This study assesses the status of

metrication in the American machine tool
industry. The comprehensive study covers
the entire metalworking sector. The
contractor will present an information
briefing on the study.

Federal Procurement Metrication:

Appropriateness and Methods—A study
designed to provide the USMB with a
clearer understanding of the basic
relationships between the Federal
procurement process and private sector
suppliers. The contractor will present an
information briefing on the study.

**USMB Research Program Overview and
Implications—**A presentation which will
consist of the major findings, conclusions
and implications of all completed USMB
research.

**Recommendations for the Worker Safety
Study—**The third in a series of studies on
the impact of metrication on workers
focused on the potential safety problems
associated with metric conversion.

Agenda Items for the July Board Meeting—
Discussion of agenda items for the
bimonthly meeting of the Board to be held
in Arlington, Virginia on July 8-9, 1982.
State Program Report—The report will
provide the Board with a progress report on
FY-82 activities being pursued to achieve
effective program continuity.

Summary Report—Design and schedule for
printing and distributing of the report.

CONTACT PERSON FOR FURTHER**INFORMATION:** Lu Verne V. Hall; 703/
235-1696.

Louis F. Polk,

Chairman, Metric Board.

[S-591-82 Filed 4-20-82; 2:10 pm]

BILLING CODE 6260-01-M

11

METRIC BOARD—Planning and Coordination Committee
Meeting**TIME AND DATE:** 10 a.m., Wednesday,
May 5, 1982.**PLACE:** 1600 Wilson Blvd., Suite 400,
Arlington, Virginia 22209.**STATUS:** Open to the public.**MATTERS TO BE CONSIDERED:**

- Approval of Minutes
Briefing on Medical Industry Panel
Approval of Staff Reports on Standards
Approval of State Program Status Report
Approval of Federal Program Status Report

CONTACT PERSON FOR FURTHER**INFORMATION:** Mr. Alan Whelihan; 703/
235-2919.

Louis F. Polk,

Chairman, Metric Board.

[S-589-82 Filed 4-20-82 2:08 pm]

BILLING CODE 6260-01-M

12

METRIC BOARD

Research Committee Meeting

TIME AND DATE: 10 a.m. to 1 p.m.,
Wednesday, May 5, 1982.

PLACE: 1600 Wilson Blvd., Suite 400,
Arlington, Virginia 22209.

STATUS: Portions of the meeting will be
open to the public and portions of the
meeting will be closed to the public.

MATTERS TO BE CONSIDERED: Two
Briefings on Research Activities: (1)
General Status Briefing on Research
Projects, Research Overview, and Status
of Metrication in the U.S. Machine Tool
Industry. This is the first agenda item of
the meeting and will be Open to the
Public. (2) Detailed report of two
research projects, The Effects of
Metrication on Safety in the Workplace
and Federal Procurement Metrication.

and their preliminary findings and
recommendations will be made. This
portion of the meeting will be closed
under exemption 5 U.S.C. 552(b)(c)(9)
because premature release of this
information would have significant
adverse impact on the successful
completion of the three projects under
review by the Committee.

**CONTACT PERSON FOR FURTHER
INFORMATION:** Mr. G. Edward McEvoy;
703/235-1697.

Louis F. Polk,
Chairman, Metric Board.

[S-588-82 Filed 4-20-82; 2:07 pm]

BILLING CODE 8260-01-M

13

POSTAL RATE COMMISSION

TIME AND DATE: 10 a.m., Tuesday, April
27, 1982

PLACE: Conference Room 500, 2000 L
Street, NW., Washington, D.C. 20268.

STATUS: Open.

MATTER TO BE CONSIDERED: Election of a
Vice Chairman.

**CONTACT PERSON FOR MORE
INFORMATION:** D. Watson, Information
Officer, Postal Rate Commission, Room
500, 2000 L Street, NW., Washington,
D.C. 20268; telephone (202) 254-5614.

[S-578-82 Filed 4-19-82; 10:24 am]

BILLING CODE 7715-01-M

federal register

**Thursday
April 22, 1982**

Part II

Department of Transportation

Federal Aviation Administration

**United States National Aviation Standard;
Traffic Alert and Collision Avoidance
System II**

DEPARTMENT OF TRANSPORTATION**Federal Aviation Administration****National Aviation Standard; Traffic Alert and Collision Avoidance System II**

AGENCY: Federal Aviation Administration (FAA), Transportation (DOT)

ACTION: Invitation for public comment on the Final U.S. National Aviation Standard for the Traffic Alert and Collision Avoidance System II (TCAS II).

SUMMARY: TCAS is an assembly of airborne equipment that makes use of air-to-air transmissions for the purpose of aircraft separation assurance in all airspace. It is intended to satisfy the operational need for an airborne separation assurance service and to ensure compatibility with all other elements of the National Airspace System. Its operation does not depend upon the existence of any of these other elements except altitude reporting Air Traffic Control Radar Beacon System (ATCRBS) or Mode S transponders in other aircraft. The standard defines the system and the performance characteristics, including technical parameters, of its subsystems. While not regulatory, the standard may provide the basis for later rule making concerning airborne collision avoidance equipment.

FOR FURTHER INFORMATION CONTACT: T. A. Morgan, Separation Systems Branch, ARD-242, Communications and Surveillance Division, Systems Research and Development Service, Federal Aviation Administration, Department of Transportation, 800 Independence Avenue, SW., Washington, D.C. 20591, telephone 202-426-9382. Additional copies of this notice may be obtained from the same address.

Invitation of Public Comments

Interested persons are invited to submit written data and comments on this U.S. National Aviation Standard. Communications should identify the notice number and be submitted in duplicate to: Director, Systems Research and Development Service, Attn: ARD-10, Federal Aviation Administration, Department of Transportation, 800 Independence Avenue, Washington, D.C., 20591, on or before June 15, 1982. Copies of comments received will be available through ARD-10 for examination before and after the closing date for comments.

Description

TCAS II is an important element of the engineering and development program for Aircraft Separation Assurance (ASA) that includes Automatic Traffic Advisory Service (ATAS), Conflict Alert, and Conflict Resolution. It is intended to be a stand-alone development which is independent of the other elements of the ASA program but which will operate compatibly and cooperatively with the other elements should any or all of them be implemented. Use of Mode S signal formats has been selected for TCAS II to provide for high quality system communications and to allow evolutionary transition to the enhanced performance capabilities of that system as it is implemented.

History

The announcement of the selection of the TCAS concept was made on June 23, 1981. This concept includes and expands upon earlier aircraft separation assurance systems development, especially the development of the Beacon Collision Avoidance System (BCAS) concept. The objective of the TCAS program is to provide a range of equipment affording maximum protection throughout either selected or all airborne environments.

Since TCAS II is an improvement of the earlier development of the BCAS concept, it follows that the TCAS II standard is a revision and update of the proposed BCAS National Aviation Standard (see the Federal Register, October 27, 1980). During the process of rewriting and editing, applicable comments regarding the published BCAS standard were reviewed and considered for incorporation. Thus, this TCAS II standard is a product of earlier collision avoidance system development, public response to such development, and improvements creditable to the advent of the TCAS concept.

Definition of U.S. National Aviation Standard

U.S. National Aviation Standards are system standards embodying descriptions of system characteristics. They are issued by the Administrator of the Federal Aviation Administration in accordance with Section 312(c) of the Federal Aviation Act (49 U.S.C. 1353(c)). They describe the performance characteristics (the technical parameters, tolerances and techniques) of major elements of the system to the extent necessary to assure proper operation and interface compatibility among elements of the National

Airspace Systems (NAS). U.S. National Aviation Standards generally are limited to cooperative air-to-ground subsystems involving government owned ground equipment and private airborne equipment. They are neither equipment specifications nor standards pertaining to planning, programming, siting, installation, availability, reliability or maintainability.

Relationship of the U.S. National Aviation Standard to Federal Regulations

U.S. National Aviation Standards issued by the Administrator in agency orders are binding only on FAA organizational elements. They establish the technical basis and description of the NAS and component subsystems. A National Aviation Standard is not a standard of general or particular applicability designed to implement or prescribe law or policy. It does not fall within the definition of "rule" contained in the Administrative Procedures Act (5 U.S.C. 551). There is no requirement that a National Aviation Standard be published as a notice of proposed rule making in the Federal Register. However, U.S. National Aviation Standards may serve as the basis for subsequent rule making actions. Because of the relationship between the standards and possible subsequent regulatory actions, the FAA publishes such standards in the Federal Register and solicits public comment prior to their approval by the Administrator.

The Standard

Accordingly, the Federal Aviation Administration proposes to adopt the following TCAS II Standard.

Issued in Washington, D.C., on April 19, 1982.

Robert W. Wedan,

Director, Systems Research and Development Service, Engineering and Development, Federal Aviation Administration, Department of Transportation.

Traffic Alert and Collision Avoidance System II, National Aviation Standard, April 19, 1982

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- 5.2.3.6 Provisions for Coordination with Mode S Sensors
 - 5.2.3.6.1 Air-Initiated Downlink of TCAS Resolution Advisories
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- 5.3 Interfaces
 - 5.3.1 Aircraft Inputs
 - 5.3.2 Additional Inputs
- 5.4 Airborne Antenna System
 - 5.4.1 Polarization
 - 5.4.2 Radiation Pattern
 - 5.4.3 Antenna Selection
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 - 5.4.3.2 Interrogation

Appendix A—Comprehensive Index of Field
Appendix B—Index of Variables Used in
Collision Avoidance Algorithms

U. S. National Aviation Standard for the Traffic Alert and Collision Avoidance System II

1. General

The Traffic Alert and Collision Avoidance System II (TCAS II) is an assembly of airborne equipment that makes use of air-air beacon transmissions for the purpose of aircraft separation assurance with respect to appropriately equipped aircraft in all airspace. As a minimum, airborne TCAS II equipment is capable of providing aircraft with collision resolution advisories in the vertical dimension without reliance on any ground-based equipment. Enhanced airborne TCAS II equipment will be capable of providing resolution advisories in both the vertical and the horizontal dimensions in all airspace, again without reliance on any ground-based equipment. This standard applies only to the minimum capability TCAS II and, unless otherwise noted, TCAS II will mean the minimum capability TCAS II hereafter in this Standard. A separate standard for the Enhanced TCAS II will be published at a later time.

1.1 System Features

1.1.1 The Functions of TCAS II

The principal functions of a TCAS II unit installed on an aircraft are:

- a. Detect the presence of other aircraft flying in the vicinity and make position measurements. A TCAS II unit is

capable of detecting and tracking in range, bearing, and altitude aircraft that are equipped with Air Traffic Control Radar Beacon System (ATCRBS) transponders with altitude encoders or with Mode S transponders with altitude encoders.

b. Display to the pilot information on the position of detected intruder aircraft.

c. Determine if any of these aircraft represents a collision threat.

d. Determine an appropriate aircraft vertical maneuver to resolve an encounter if a threat is detected.

e. Coordinate the maneuver decision with the threat aircraft if it is equipped with an applicable TCAS capability so that the resulting maneuvers are compatible.

f. Communicate the maneuver decision (resolution advisory) to the pilot.

g. Alter intruder equipped with the appropriate Mode S transponders and associated capabilities (TCAS I) of the presence of own aircraft by crosslinking maneuver and traffic advisory information when TCAS II determines that a collision threat exists.

1.1.2 Rationale for the TCAS II National Aviation Standard

1.1.2.1 Legal Rationale

Under the Federal Aviation Act, the Department of Transportation has the responsibility for the development and operation of a common system of air traffic control and navigation for both military and civil aircraft. Explicitly, Section 312(c) of the Act (49 U.S.C. 1353(c)) requires the Secretary to develop, modify, test and evaluate systems, procedures, facilities, and devices, as well as define the performance characteristics thereof, to meet the needs for safe and efficient navigation and traffic control of all civil and military aviation, except for those needs of military agencies which are peculiar to air warfare and primarily of military concern. The promulgation of a national aviation standard for TCAS II is in keeping with this directive, as it will permit uniformity among aircraft collision avoidance systems, promoting greater efficiency and safety in aviation.

1.1.2.2 Technical Rationale

This U.S. national aviation standard contains a description of a system selected for implementation. This system is the result of development modification, tests, and evaluation efforts which have culminated in required characteristics, including technical parameters, to ensure proper operation and compatibility among

elements of the National Airspace System.

1.2 Compatibility of TCAS II With Other Elements of the National Airspace System

TCAS II is compatible with other existing and proposed elements of the National Airspace System, and the operation of TCAS II may be automatically coordinated with the operation of these other elements.

1.2.1 Compatibility With ATCRBS and Mode S Surveillance Systems

TCAS II is designed for full operational compatibility with ATCRBS and Mode S equipment. TCAS II provides surveillance of both ATCRBS and Mode S transponders and includes safeguards to prevent interference with the operation of ATCRBS and Mode S ground surveillance systems.

1.2.2 Interface With Mode S Ground Sensors

The operation of TCAS II does not require ground equipment. Its airborne operation can, however, be automatically interfaced with a Mode S ground sensor (sensitivity level control and communication of TCAS II resolution advisories) in areas of Mode S coverage. The Mode S transponder onboard the TCAS II aircraft can be used for these purposes in communicating with Mode S ground sensors.

1.2.3 Compatibility With ATCRBS IFF Mark XII System (AIMS)

TCAS II is designed for full operational compatibility with AIMS including Mode 4.

1.2.4 Compatibility With TCAS I

TCAS I is a limited capability Traffic Alert and Collision Avoidance System. It provides traffic advisories to the pilot on nearby ATCRBS and Mode S transponder equipped aircraft. In addition TCAS I can alert the pilot to the presence of a TCAS II equipped collision threat using maneuver and traffic advisory information received over the Mode S air-air crosslink from the TCAS II threat. TCAS II is designed for full operational compatibility with TCAS I.

1.2.5 Compatibility With Enhanced TCAS II

Enhanced TCAS II is an extended capability Traffic Alert and Collision Avoidance System designed to operate in all airspace. It provides the pilot traffic advisories as well as resolution advisories in both the vertical and horizontal dimensions. TCAS II is

designed for full operational compatibility with Enhanced TCAS II.

1.3 Scope of This Standard

This document describes and standardizes those characteristics of TCAS II that must be controlled to provide compatibility among components of the system and to prevent impairment of services to other users of the airspace. Specifically, it:

a. Defines the data link messages, formats, and protocols to be used in transmissions among airborne TCAS equipments, airborne Mode S transponders and Mode S sensors.

b. Provides limits on radiated energy.

c. Standardizes certain aspects of the collision avoidance algorithms.

All applications of TCAS II messages are standardized and no experimental or ad hoc applications should be implemented without prior approval of the Federal Aviation Administration.

1.3.1 Relationship to Other U.S. National Aviation Standards

Since TCAS II interests with other systems and subsystems which are also part of the National Airspace System, the standards governing pertinent other systems are referenced herein (1.6).

1.3.1.1 Relationship Between TCAS II and ATCRBS National Aviation Standard

TCAS II adheres to all of the provisions of the ATCRBS National Aviation Standard (ref. A). In the event of conflict between the ATCRBS Standard and the TCAS II Standard, the TCAS II Standard takes lower precedence.

1.3.1.2 Relationship Between TCAS II and Mode S National Aviation Standard

TCAS II adheres to all of the provisions of the Mode S National Aviation Standard (ref. B). In the event of conflict between the Mode S Standard and the TCAS II Standard, the TCAS II Standard takes lower precedence.

1.3.2 Items Not Covered

This Standard does not prescribe the detailed technical features and capabilities of airborne TCAS II equipment nor the minimum performance standards that must be met for operation in the National Airspace System. Other documentation will prescribe such minimum performance standards for the airborne equipment. This Standard does not define or constrain the media, devices or formats for cockpit display of TCAS II resolution advisories or traffic information.

1.4 Overall System Capability

The TCAS II system is an assembly of airborne equipment. The principal functions of this equipment are described below.

1.4.1 Functional Elements

The principal elements of airborne TCAS II equipment are Mode S and ATCRBS surveillance subsystems, a conflict resolution logic function and a pilot display. Every TCAS II aircraft has a Mode S transponder with a capability to process specified uplink and downlink messages to provide air-air maneuver coordination and to coordinate with Mode S sensors.

1.4.2 TCAS II Operation

1.4.2.1 Coverage

By alternating between Mode S and ATCRBS surveillance modes, the airborne TCAS II equipment performs surveillance of all aircraft equipped with altitude reporting Mode S or ATCRBS transponders within its line-of-sight coverage airspace. Airborne TCAS II equipment can be designed, in accordance with this Standard, to provide serviceable surveillance at air-air ranges of up to 14 nmi. Serviceable surveillance corresponds to a link margin of 6 dB given nominal equipment and antenna parameters.

1.4.2.2 Mode S Surveillance

The Mode S surveillance subsystem detects and tracks Mode S equipped aircraft. TCAS II listens to squitters and replies generated by Mode S transponders in response to ground and air-air interrogations in order to determine the altitudes and Mode S addresses of proximate Mode S equipped aircraft.

After TCAS II has received replies from a new aircraft, it compares the altitude of the aircraft against its own altitude to determine whether the aircraft should be interrogated to determine its range. If the measured range and the reported maximum airspeed capability indicate that it is or could soon be a collision threat, the aircraft is regularly interrogated and the resulting track data are fed to the conflict detection and resolution algorithms.

1.4.2.3 ATCRBS Surveillance

ATCRBS surveillance may be accomplished by the transmission of modified ATCRBS Mode C interrogations at regular intervals. These interrogations elicit replies from ATCRBS transponders but, to minimize interference, Mode S transponders do not reply.

ATCRBS synchronous interference may be controlled by alternating Mode C interrogations and ATCRBS suppression transmissions at varying power levels to reduce the population of ATCRBS transponders replying to each interrogation. Steerable narrow interrogation sectors may also be used in conjunction with the above technique in controlling ATCRBS synchronous interference.

1.4.2.4 Traffic Advisories

TCAS II uses antennas with direction-finding capability for intruder bearing measurements. Intruder bearing data along with other surveillance track data is used in displaying the positions of proximate aircraft. These traffic advisories may include the ranges, range rates, altitudes, altitude rates, and bearings of such aircraft. Traffic advisories may be provided for intruding aircraft, either alone if resolution advisories are unnecessary, or they may be accompanied by resolution advisories if needed.

1.4.2.5 Conflict Resolution

The TCAS II collision avoidance algorithms perform conflict resolution in the vertical dimension only.

Note.—Enhanced TCAS II will provide resolution advisories in both the horizontal and vertical dimensions.

TCAS II generates the following types of vertical resolution advisories:

- Positive advisories.
- Negative advisories.
- Vertical speed limit advisories.
- Vertical speed minimum advisories.

An advisory is generated for each aircraft whose tracked range, range rate, altitude and altitude rate indicate that its projected separation is within predefined bounds. These threat boundaries may vary according to local traffic and airspace conditions. Such variations are either based on external inputs, pilot inputs, or aircraft altitude. If the threat aircraft is equipped with a TCAS capability that generates resolution advisories, a coordination procedure via the air-air Mode S data link is performed before displaying the advisory to the pilot to assure that the aircraft maneuvers are compatible.

1.4.2.6 Display

The display(s) indicate to the pilot the resolution advisories generated by the conflict resolution function and the traffic advisories generated by the traffic advisory function. The display(s) may also provide additional information including equipment failure indication.

1.4.2.7 Maneuver and Traffic Advisory Crosslink

When a Mode S aircraft that is not equipped with a TCAS capable of generating on-board resolution advisories is declared by TCAS II to be a collision threat requiring conflict resolution, TCAS II alerts the threat with crosslink advisories. A maneuver advisory is automatically crosslinked to all such collision threats. In addition, TCAS II crosslinks a traffic advisory if such a threat is requesting crosslink traffic advisory service. The maneuver advisory informs the threat of the projected relative altitude (above or below) of the TCAS II aircraft at the point of closest approach that will result from the conflict resolution maneuver that TCAS II has selected. The traffic advisory informs the threat of the TCAS II aircraft's current position with respect to it with relative range, relative altitude and bearing data. Both of these advisories are crosslinked to the threat using the Mode A air-air data link.

TCAS I requests crosslink traffic advisory service, and TCAS II therefore transmits traffic advisory information to TCAS I equipped threat aircraft. TCAS II aircraft do not request crosslink traffic advisory service. These aircraft rely upon their own capability to generate traffic and resolution advisories in lieu of displaying crosslinked advisories in the cockpit. A Mode S equipped aircraft with no on-board resolution capability automatically receives a maneuver advisory from TCAS II which indicates whether TCAS II intends to pass above or below the Mode S aircraft.

1.5 Acronyms and Abbreviations

1.5.1 Acronyms

ASA: Aircraft Separation Assurance
ATC: Air Traffic Control
ATCRBS: Air Traffic Control Radar Beacon System
TCAS: Traffic Alert and Collision Avoidance System

1.5.2 Abbreviations

ABS(X): absolute value of X
fpm: feet per minute
fps²: feet per second per second
.GE.: is greater than or equal to
.GT.: is greater than
.LE.: is less than or equal to
LSB: least significant bit
.LT.: is less than
MAX(X): the maximum of the elements of the set X
MIN(X): the minimum of the elements of the set X
MSB: most significant bit
.NE.: not equal to
VSL: Vertical Speed Limit

VSM: Vertical Speed Minimum

1.6 References

Reference A: "U.S. National Standard for the IFF Mark X (SIF)/Air Traffic Control Radar Beacon System Characteristics", Attachment 1 to DOT/FAA Order 1010.51A, 8 March 1971.

Reference B: "U.S. National Aviation Standard for the Mode S System", Appendix 1 to FAA Order 6365.1, 9 December 1980.

Note.—In referring to references, paragraph numbers are usually specified. For example, a reference to paragraph 4.1 of reference B would be shown herein as ref. B: 4.1.

2. Signals in Space

2.1 RF Characteristics

The radio frequency characteristics of all signals employed by TCAS II conform to either ref. A or ref. B.

3. Signal Content

TCAS II uses a number of specified Mode S air-air transmissions for surveillance and air-air communications. The communications functions include the means by which resolution advisory decisions are

coordinated with TCAS threat aircraft and the means by which maneuver and traffic advisory information is crosslinked to appropriately equipped intruders (TCAS I). A limited number of transmissions are specified for coordination with ground air traffic control in regions where applicable capabilities are implemented in Mode S sensors.

Note.—Ref. B describes the message format structures and coding that are used in specified Mode S transmissions. This section further defines Mode S formats and information coding used for the transmission of TCAS II messages.

3.1 Data Blocks

The Mode S interrogation and reply data blocks can contain either 56 or 112 bits.

3.2 Format Structure

Mode S transmission formats consist of 56 or 112 bits of which 24 bits are used as the address while the rest are used for information transfer. The interrogation and reply formats that can contain TCAS II information are

presented in Figures 3.2-1 and 3.2-2 respectively.

3.2.1 Bit Numbering and Sequence

In the description of the information fields (3.2.2) contained in Mode S transmissions, bits are numbered consecutively with bit 1 being the first bit transmitted in the Mode S interrogation or reply. Numerical values encoded by groups of bits are encoded with the MSB transmitted first. Bits designated as "not assigned" are transmitted as all zeroes, and are reserved for assignment in future national aviation standards.

3.2.2 Fields

Information is coded in fields which consist of one or more bits. In this document the decimal equivalent of the binary code formed by the bit sequence within a field is used as the designator of the field function.

Note.—As an example, the 5-bit UF field is used to designate the uplink format type. A surveillance interrogation with identity has in its UF field position the bit sequence 00101. Since $00101_2 = 5_{10}$, this format is designated as UF=5.

BILLING CODE 4910-13-M

Format
No.

Format No.	UF	Description
0	(0 0000)---3---(RL:1) (AQ:1) (AV:4)--18--(AP:24)	.Short Special Surveillance
4	(0 0100) (PC:3) (RR:5) (DI:3) (SD:16) (AP:24)	.Surveillance, Altitude Request
5	(0 0101) (PC:3) (RR:5) (DI:3) (SD:16) (AP:24)	.Surveillance, Identity Request
16	(1 0000)---3---(RL:1) (AQ:1) (AV:4)--18--(MU:56) (AP:24)	.Long Special Surveillance
20	(1 0100) (PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24)	.Comm-A, Altitude Request
21	(1 0101) (PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24)	.Comm-A, Identity Request

Note: (1) $\overline{XX:M}$ denotes a field designated "XX" which is assigned M bits.
 (2) ---N--- denotes unassigned coding space, N bits; must be set to all zeroes.
 (3) The format number in the above uplink formats (UF) corresponds to the binary code in the first 5 bits of the interrogation.

Fig. 3.2-1. Mode S Interrogation or Uplink Formats Used for TCAS II Messages.

Format
No.

Format No.	DF	Description
0	(0 0000) (FS:3)---1---(RI:4) (SL:3) (AR:2)---1---(AC:13) (AP:24)	.Short Special Surveillance
4	(0 0100) (FS:3) (DR:5) (UM:6) (AC:13) (AP:24)	.Surveillance, Altitude
5	(0 0101) (FS:3) (DR:5) (UM:6) (ID:13) (AP:24)	.Surveillance, Identity
16	(1 0000) (FS:3)---1---(RI:4) (SL:3) (AR:2)---1---(AC:13) (MV:56) (AP:24)	.Long Special Surveillance
20	(1 0100) (FS:3) (DR:5) (UM:6) (AC:13) (MB:56) (AP:24)	.Comm-B, Altitude
21	(1 0101) (FS:3) (DR:5) (UM:6) (ID:13) (MB:56) (AP:24)	.Comm-B, Identity

Note: (1) $\overline{XX:M}$ denotes a field designated "XX" which is assigned M bits.
 (2) ---N--- denotes unassigned coding space, N bits; must be set to all zeroes.
 (3) The format number in the above downlink formats (DF) corresponds to the binary code in the first 5 bits of the reply.

Fig. 3.2-2. Mode S Reply or Downlink Formats Used for TCAS II Messages.

Codes designated as "not assigned" are reserved for assignment in future national aviation standards. Fields containing numeric data are encoded in positive binary notation unless otherwise noted. The LSB value and the allowed range of values are included for all numeric quantities. Unless otherwise noted, when the value of a numeric quantity is outside the indicated range of values, it will be encoded as equal to the nearest end point of the range. Unless otherwise noted, the coded value of a numeric quantity is the quantized value nearest the actual value of the quantity (i.e., the value of rounded off rather than truncated).

3.2.2.1 Essential Fields.

Each Mode S transmission contains two essential fields. The first essential field is a 5-bit format descriptor which occurs at the beginning of the transmission. This field is designated UF (Uplink Format) for interrogations and DF (Downlink Format) for replies. The UF and DF codes pertinent to this Standard are given in Figs. 3.2-1 and 3.2-2 respectively. The second essential field is a 24-bit field which contains a

Mode S address and carries parity information according to ref. B: 4.1. This field is designated AP (Address/Parity) and is located at the end of the transmission.

Note.—In the air-air transmissions used by TCAS, interrogations transmitted at 1030 MHz are uplink transmissions and contain UF (Uplink Format) codes. Replies transmitted at 1090 MHz are downlink transmissions and contain DF (Downlink Format) codes.

3.2.2.2 Mission Fields

The remaining coding space is used to transmit the mission fields. For specific missions, a specific set of fields is prescribed.

Note.—All mission fields are labeled with two-letter designators in this Standard.

3.2.2.3 Subfields

Subfields may appear within mission fields. The name, length (number of bits) and coding of a defined subfield are the same wherever it appears; however, the location and protocol for use may vary.

Note.—Subfields of mission fields are labeled with three-character alphanumeric designators in this Standard. Subfields of

three-character designator subfields are labeled with four-character alphanumeric designators in this Standard.

3.3 Field Descriptions

For all mission fields and subfields which are processed by the airborne TCAS II equipment, the relevant characteristics (location and coding) are described in this section. In some cases this description duplicates the description found in other national aviation standards; in other cases it introduces new information that is not found elsewhere. Mission fields and subfields used by TCAS II and defined by ref. B are described in 3.3.1. All other mission fields and subfields are described in 3.3.2. Table 3.3-1 provides an index of all described mission fields and the three-character designator subfield groups (if any) within them. Appendix A provides an alphabetically ordered index of all essential fields, mission fields, three-character designator subfields and four-character designator subfields described in this Standard.

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Table 3.3-1

Field Index

Field	Sub Field	Bits		Formats		Reference Paragraph(s)	
		No.	Position	Up	Down	Content	Protocol
AC		13	20-32		X	3.3.1.1	4.2.1;4.2.3
AQ		1	10	X		3.3.1.2	4.2.2.1;4.2.2.2
AR		2	17-18		X	3.3.2.1	4.2.3;4.3.1 4.4
AV		4	11-14	X		3.3.2.2	
	Subfields of AV:						
	VMA	2	11-12			3.3.2.2.1	4.4.1
	HMA	1	13			3.3.2.2.1	4.4.1
	(-n-)	1	14				
<i>Note: The notation (-n-) is used to denote bits that are not assigned.</i>							
DR		5	9-13		X	3.3.1.3	4.5.1
FS		3	6-8		X	3.3.1.4	4.2.1;4.2.3
MA		56	33-88	X		3.3.1.5	
<u>TCAS Sensitivity Level Command</u>							
<u>Message subfields of MA:</u>							
	ADS	8	33-40			3.3.2.3.1	4.5.3
	SLC	3	41-43			3.3.2.3.1	
	(-n-)	45	44-88				
MB		56	33-88		X	3.3.1.6	
<u>Extended Capability Report</u>							
<u>subfields of MB:</u>							
	(-n-)	2	42-43				4.5.2
	ACS	16	45-60			3.3.1.6.2	
	(-n-)	7	61-67				
	CRS	1	68			3.3.2.4.2	
	ORC	2	69-70			3.3.2.4.2	
	ECS	16	71-86			3.3.1.6.2	
<u>Resolution Advisories</u>							
<u>Message subfields of MB:</u>							
	BDS	8	33-40			3.3.2.4.1	4.5.1
	ARA	14	41-54			3.3.2.4.1	
	RAC	4	55-58			3.3.2.4.1	
	CLS	1	59			3.3.2.4.1	
	(-n-)	29	60-88				

Table 3.3-1 (cont'd)

Field Index

Field	Sub Field	Bits		Formats		Reference Paragraph(s)	
		No.	Position	Up	Down	Content	Protocol
MU		56	33-88	X		3.3.1.7	
	<u>TCAS Resolution Advisories</u>						
	<u>Request and TCAS Resolution</u>						
	<u>Message subfields of MU:</u>						
	UDS	8	33-40			3.3.2.5.1	4.3.1;4.3.1.1; 4.3.1.2
	LCK	1	41			3.3.2.5.1	
	MTB	1	42			3.3.2.5.1	
	CVC	2	43-44			3.3.2.5.1	
	VRC	2	45-46			3.3.2.5.1	
	CHC	2	47-48			3.3.2.5.1	
	HRC	2	49-50			3.3.2.5.1	
	(-n-)	14	51-64				
	MID	24	65-88			3.3.2.5.1	
	<u>TCAS Crosslink Traffic</u>						
	<u>Advisory Message</u>						
	<u>subfields of MU:</u>						
	UDS	8	33-40			3.3.2.5.2	4.4;4.4.2
	RRG	6	41-46			3.3.2.5.2	
	RAL	6	47-52			3.3.2.5.2	
	BTI	2	53-54			3.3.2.5.2	
	BRG	6	55-60			3.3.2.5.2	
	(-n-)	4	61-64				
	MID	24	65-88			3.3.2.5.2	
MV		56	33-88		X	3.3.1.8	
	<u>Coordination Reply Message</u>						
	<u>subfields of MV:</u>						
	VDS	8	33-40			3.3.2.6.1	4.3.2
	ARA	14	41-54			3.3.2.6.1	
	RAC	4	55-58			3.3.2.6.1	
	CLI	1	59			3.3.2.6.1	
	(-n-)	29	60-88				

Table 3.3-1 (concluded)

Field Index

Field	Sub Field	Bits		Formats		Reference Paragraph(s)	
		No.	Position	Up	Down	Content	Protocol
RI		4	10-13		X	3.3.1.9	4.2.3.1; 4.2.3.2
RL		1	9	X		3.3.1.10	4.2.2.1; 4.2.2.2; 4.2.3.1; 4.2.3.2
RR		5	9-13	X		3.3.1.11	4.5.1
SD		16	17-32	X		3.3.1.12	
	Subfield of SD: IIS	4	17-20			3.3.1.12.1	4.5.3
SL		3	14-16		X	3.3.2.7	4.2.3

Note.—Duplicate mission filed subfield descriptions aid in identifying those areas in which the various national aviation standards must be coordinated with respect to future modifications or additions.

3.3.1 Fields and Subfields Defined by Ref. B

Location and coding of mission fields and subfields that are required for transmission of TCAS II information and that are specified by ref. B are described in alphabetical order in the following paragraphs.

Note.—Certain codes in the mission fields described below that are designated "not assigned" in ref. B are assigned for TCAS use and are specified in this section.

3.3.1.1 AC Altitude Code

Downlink, 13 bits, 20 through 32. Appears in special surveillance, surveillance and Comm-B formats DF=0, 4, 16, 20. This field contains the altitude code. If bit 26 (M bit) is zero, the pattern of ref. A: 2.7.13.2.5 is used in the remaining bits in the sequence C1, A1, C2, A2, C4, A4, M=0, B1, D1=0, B2, D2, B4, D4. Zero is transmitted in each of the 13 bits if altitude information is not available. Metric altitude is contained in this field if bit 26 (M bit) is set to '1'.

Note 1.—Metric altitude codes are not included in this Standard.

Note 2.—Bit 28 contains the D1 bit which is zero in all altitude codes.

3.3.1.2 AQ Acquisition, Special

Uplink, 1 bit, 10. Appears in special surveillance formats UF=0, 16. This field is used to designate the UF=0 or 16 interrogation as an acquisition transmission (4.2.2).

Coding:

- 0=Non-acquisition interrogation
- 1=Acquisition interrogation

3.3.1.3 DR Downlink Request

Downlink, 5 bits, 9 through 13. Appears in surveillance and Comm-B formats DF=4,5,20,21. This field is used to request extraction of downlink messages from the transponder by the interrogator.

Coding:

- 0=No downlink request
- 1=B bit set
- 2=TCAS bit set
- 3=TCAS bit set and B bit set
- 4-15=Not assigned
- 16-31=Comm-D protocol (ref. B; 4.11.2)

Note.—The B bit is explained in ref. B: 4.11.2.

Whenever either a TCAS resolution advisory or a TCAS resolution advisory complement (received from other TCAS aircraft) or both exist, code DR=2 or 3 is set as appropriate (4.5.1). Requests

associated with codes 1-15 take priority over requests associated with codes 16-31.

3.3.1.4 FS Flight Status

Downlink, 3 bits, 6 through 8. Appears in downlink special surveillance, surveillance and Comm-B formats DF=0,4,5,16,20,21. This field reports the flight status of the aircraft.

Coding:

- 0=Airborne and no ALERT and no SPI
- 1=Airborne and no ALERT and no SPI and TCAS unit interrogating
- 2=ALERT
- 3=Not assigned
- 4=SPI
- 5=Not assigned
- 6=ALERT and SPI
- 7=On the ground and no ALERT and no SPI

Whenever the TCAS II unit is airborne and is operating at sensitivity levels 2 through 7 and no ALERT and no SPI conditions exist, code FS=1 is set.

Notes.—The meaning of ALERT and SPI are explained in ref. B: 4.5.

3.3.1.5 MA Message, Comm-A

Uplink, 56 bits, 33 through 88. Appears in Comm-A formats UF=20,21. This field is used by a Mode S sensor to transmit a TCAS Sensitivity Level Command Message to airborne TCAS II equipment. Contains 8-bit ADS (Comm-A Definition) subfield.

3.3.1.5.1 Subfield in MA: ADS, A—Definition Subfield

Uplink, 8 bits, 33 through 40, subfield in MA. This subfield defines the data contained in the remainder of MA. For convenience in coding, ADS is expressed in two groups of 4 bits each, ADS1, 33 through 36, and ADS2, 37 through 40. A TCAS Sensitivity Level Command Message uses ADS1=3 and ADS2=0.

3.3.1.6 MB Message, Comm-B

Downlink, 56 bits, 33 through 88. Appears in Comm-B formats DF=20,21. This field is used by airborne TCAS II equipment to transmit TCAS resolution advisories and extended capability information (ref. B: 4.6.3) to Mode S sensors. Contains 8-bit BDS (Comm-B Definition) subfield.

3.3.1.6.1 Subfield in MB: BDS, B—Definition Subfield

Downlink, 8 bits, 33 through 40, subfield in MB. This subfield defines the data contained in the remainder of MB. For convenience in coding, BDS is expressed in two groups of 4 bits each, BDS1, 33 through 36, and BDS2, 37 through 40. Comm-B messages

originating from airborne TCAS II equipment use BDS1=3.

3.3.1.6.2 Subfields in MB for an Extended Capability Report

The following subfields defined by ref. B appear in MB for an Extended Capability Report and are related to TCAS II.

ACS: A-Capability, 16 bits, 45 through 60. This subfield contains the identity (ADS1 values) of all on-board operative A-sinks (Comm-A destinations).

Coding:

To report the presence of the A-sink with ADS1 = x, bit 45 + x is set to '1'.

Note.—The airborne TCAS II equipment is a destination for Comm-A messages containing the ADS1 = 3 code in MA. Hence, operative airborne TCAS II equipment sets bit 48 in ACS to '1'.

ECS: Extended Capability, 16 bits, 71 through 86. This subfield contains the identity (BDS1 values) of all on-board operative B-sources (Comm-B sources).

Coding:

To report the presence of the B-source with BDS1 = x, bit 71 + x is set to '1'.

Note.—The airborne TCAS II equipment is a source of Comm-B messages containing the BDS1 = 3 code in MB. Hence, operative airborne TCAS II equipment sets bit 74 in ECS to '1'.

Note.—The following table provides a complete summary of the structure of MB for an Extended Capability Report as defined by ref. B and this Standard.

STRUCTURE OF MB FOR AN EXTENDED CAPABILITY REPORT

Position	No. of Bits	Subfield	Remarks
33-36	4	BDS1	= 1.
37-40	4	BDS2	= 0.
41	1	CBS	—
42-43	2	—	Not assigned.
44	1	FDS	—
45-60	16	ACS	—
61-67	7	—	Not assigned.
68	1	CRS	—
69-70	2	ORC	—
71-86	16	ECS	—
87-88	2	EDS	—

The BDS1, BDS2, CBS, FDS and EDS subfields are defined in ref. B: 4.6.3.1 and are not related to TCAS II. The CRS and ORC subfields are defined by this Standard in 3.3.2.4.2.

3.3.1.7 MU Message, Comm-U

Uplink, 56 bits, 33 through 88. Appears in long special surveillance format UF=16. This field is used by airborne TCAS II equipment to transmit air-air maneuver coordination information and

to crosslink traffic advisory information to aircraft requesting crosslink traffic advisory service. This message field does not use the Comm-A protocol (ref. B: 4.10).

3.3.1.8 MV Message, Comm-V

Downlink, 56 bits, 33 through 88. Appears in long special surveillance format DF=16. This field is used by airborne TCAS II equipment to transmit air-air maneuver coordination information to requesting TCAS equipped aircraft. This message field does not use the Comm-B protocol (ref. B: 4.11).

3.3.1.9 RI Air-Air Reply Information

Downlink, 4 bits, 10 through 13. Appears in special surveillance formats DF=0, 16. This field contains information pertaining to replying aircraft. Where airspeed is reported (4.2.3.1), the maximum true airspeed flown in normal operations is given using the coding shown below.

- Coding:
- 0=No on-board Enhanced TCAS II capability and no request for crosslink traffic advisory service
 - 1=No on-board Enhanced TCAS II capability and requesting crosslink traffic advisory service with magnetic bearing contained in the traffic advisory
 - 2=No on-board Enhanced TCAS II capability and requesting crosslink traffic advisory service with track bearing contained in the traffic advisory
 - 3=On-board Enhanced TCAS II capability
 - 4-7=Not assigned
 - 8=No maximum airspeed data available
 - 9=Airspeed is up to 75 knots
 - 10=Airspeed is between 75 knots and 150 knots
 - 11=Airspeed is between 150 knots and 300 knots
 - 12=Airspeed is between 300 knots and 600 knots
 - 13=Airspeed is between 600 knots and 1200 knots
 - 14=Airspeed is more than 1200 knots
 - 15=Not assigned

Note.—Crosslink maneuver and traffic advisories are not provided to aircraft with an on-board resolution capability (AR.GT.0), see 1.4.2.7. Therefore, codes RI=1 or RI=2 are not set by these aircraft.

3.3.1.10 RL Reply Length

Uplink, 1 bit, 9. Appears in special surveillance formats UF=0, 16. This field commands a specific air-air reply format (short or long).

- Coding:
- 0=Reply with short special surveillance format DF=0
 - 1=Reply with long special surveillance format DF=16

3.3.1.11 RR Reply Request

Uplink, 5 bits, 9 through 13. Appears in surveillance and Comm-A formats

UF=4,5,20,21. This field contains length and content of the reply requested by the interrogator. The RR code that airborne TCAS II equipment responds to is RR=19. This RR code elicits a Comm-B reply whose entire MB field content is provided by the TCAS II equipment.

Coding:

RR code	Requested MB content
19	Resolution Advisories Message (3.3.2.4.1)

Note.—If the first bit of the RR code is one, the last four bits of the 5-bit RR code, if transformed into their decimal equivalent, designate the number (BDS1) of the requested source. BDS2 is assumed to be zero if not specified (ref. B: 4.11.1.1).

3.3.1.12 SD Special Designator

Uplink, 16 bits, 17 through 32. Appears in surveillance and Comm-A formats UF=4,5,20,21. This field can contain control codes affecting transponder protocol. The content of this field is specified by the DI field (ref. B: 3.3.8).

Airborne TCAS II equipment examines the contents of SD for interrogator identification information.

3.3.1.12.1 Subfield in SD

The following subfield defined by ref. B appears in all SD fields regardless of DI code and is related to TCAS II.

IIS: Interrogator Identifier, 4 bits, 17 through 20. This subfield contains the self-identification code of the interrogator and is numerically identical to the II code (ref. B: 3.3.13) transmitted by the same interrogator in the Mode S Only All-Call (ref. B: 4.2.1.3).

Coding:

An interrogator is assigned an IIS code which may take on a value of 1 through 15. IIS=0 is not a valid interrogator identifier code.

3.3.2 TCAS II Fields and Subfields

The following paragraphs describe the location and coding of those mission fields and subfields required for the transmission of TCAS II information and that are not defined in ref. B.

3.3.2.1 AR ASA Capability Report

Downlink, 2 bits, 17 through 18. Appears in special surveillance formats DF=0, 16. This field reports the ASA capability of the aircraft.

Coding:

- 0=No on-board resolution capability
- 1=On-board resolution capability, range .LE. 4 nmi
- 2=On-board resolution capability, 4 nmi .LT. range .LE. 10 nmi
- 3=On-board resolution capability, 10 nmi .LT. range .LE. 14 nmi

Note.—The TCAS II threat detection and resolution logic distinguishes between intruders that are equipped to generate on-board resolution advisories and those that are not (5.2). An airborne Enhanced TCAS I equipment may have the ability to generate resolution advisories but have a surveillance range limited to 4 nmi. Such a unit could generate timely resolution advisories in many of the low speed encounters pertinent to general aviation applications. However, in high speed encounters that can occur between TCAS II aircraft and such an Enhanced TCAS I aircraft above 10,000 feet, the TCAS I aircraft lacks sufficient surveillance range to participate in timely conflict resolution. Similarly, the surveillance range of TCAS II equipment may be reduced dynamically because of interference limiting or surveillance overload in high density airspace. A TCAS II with reduced surveillance range is effectively unequipped if involved in an encounter with another aircraft whose TCAS range has not been reduced by a comparable amount. When the intruder's AR code indicates that his TCAS surveillance range is currently less than own TCAS surveillance range, the intruder is treated as if it were unequipped. (See 5.2.1 and 5.2.2.1).

3.3.2.2 AV TCAS Maneuver Advisory

Uplink, 4 bits, 11 through 14. Appears in special surveillance formats UF=0, 16. This field provides a conflict resolution maneuver advisory to the interrogated threat aircraft.

3.3.2.2.1 Subfields in AV

The following subfields appear in AV.

VMA: Vertical Maneuver Advisory, 2 bits, 11 through 12. This subfield indicates the projected relative altitude of the TCAS II aircraft with respect to the interrogated threat at the point of closest approach that will result from the vertical conflict resolution maneuver that TCAS II has selected.

Coding:

- 0=No vertical resolution has been selected
- 1=Above
- 2=Below
- 3=Not assigned

HMA: Horizontal Maneuver Advisory, 1 bit, 13. This subfield indicates whether horizontal resolution has been selected by Enhanced TCAS II with respect to the interrogated threat aircraft.

Coding:

- 0=No horizontal resolution has been selected
- 1=Enhanced TCAS II has selected horizontal resolution

Note.—Structure of AV.

Position	No. of bits	Subfield	Remarks
11-12	2	VMA.....	
13	1	HMA.....	(1)

Position	No. of bits	Subfield	Remarks
14	1		

¹ Not assigned.

3.3.2.3 MA Fields Used by TCAS II

Mode S sensors may use the MA field of Comm-A interrogations (3.3.1.5) to transmit a TCAS Sensitivity Level Command Message to airborne TCAS II equipment.

3.3.2.3.1 Subfields in MA for a TCAS Sensitivity Level Command Message

ADS: A-Definition Subfield, 8 bits, 33 through 40 (3.3.1.5.1). A TCAS Sensitivity Level Command Message is identified by ADS1=3 and ADS2=0, the combination of which is equivalent to ADS=48.

SLC: TCAS II Sensitivity Level Command, 3 bits, 41 through 43. This subfield contains a sensitivity level command for the TCAS II aircraft.

Coding

- 0=No command issued
- 1=Set TCAS II sensitivity level to 1
- 2=Set TCAS II sensitivity level to 2
- 3=Set TCAS II sensitivity level to 2
- 4=Set TCAS II sensitivity level to 4
- 5=Set TCAS II sensitivity level to 5
- 6=Set TCAS II sensitivity level to 6
- 7=Set TCAS II sensitivity level to 7

Note.—Structures of MA for a TCAS Sensitivity Level Command Message.

Position	No. of bits	Subfield	Remarks
33-36	4	ADS1	=3
37-40	4	ADS2	=0
41-43	3	SLC	
44-88	45		(¹)

¹ Not assigned.

3.3.2.4 MB Fields Used by TCAS II

Airborne TCAS II equipment uses the MB field (3.3.1.6) of the Comm-B replies to transmit a Resolution Advisories Message and an Extended Capability Report to Mode S sensors.

3.3.2.4.1 Subfields in MB for a Resolution Advisories Message

BDS: B-Definition Subfield, 8 bits, 33 through 40 (3.3.1.6.1). A Resolution Advisories Message is identified by BDS1=3 and BDS2=0, the combination of which is equivalent to BDS=48.

ARA: Active Resolution Advisories, 14 bits, 41 through 54. This field contains the currently active resolution advisories (if any) generated by own on-board TCAS II unit against one or more threat aircraft.

Coding

Each bit in the ARA subfield is a dedicated bit representing a specific resolution advisory.

The bits in ARA have the following meaning:

Bit	Resolution advisory
41	Climb.
42	Don't descend.
43	Don't descend faster than 500 fpm.
44	Don't descend faster than 1000 fpm.
45	Don't descend faster than 2000 fpm.
46	Descend.
47	Don't climb.
48	Don't climb faster than 500 fpm.
49	Don't climb faster than 1000 fpm.
50	Don't climb faster than 2000 fpm.
51	Turn left.
52	Turn right.
53	Don't turn left.
54	Don't turn right.

A bit set to '1' indicates that the associated resolution advisory is active. A bit set '0' indicates that the associated resolution advisory is inactive.

Note.—When CLS=1, the ARA subfield has no meaning.

RAC: Resolution Advisory Complements, 4 bits, 55 through 58. This subfield contains the currently active resolution advisory complements (if any) received from all other TCAS aircraft equipped with an on-board resolution capability.

Coding

Each bit in the RAC subfield is a dedicated bit representing a specific resolution advisory complement.

The bits in RAC have the following meaning:

Bit	Resolution advisory complement
55	Don't climb.
56	Don't descend.
57	Don't turn left.
58	Don't turn right.

A bit set to '1' indicates that the associated resolution advisory complement is active. A bit set to '0' indicates that the associated resolution advisory complement is inactive.

Note.—When CLS=1, the RAC subfield has no meaning.

CLS: Coordination Lock State Bit, 1 bit, 59. This subfield indicates current coordination lock state (5.2.3.1) of own TCAS aircraft.

Coding

- 0=Own TCAS aircraft is not currently in a coordination lock state
- 1=Own TCAS aircraft is currently in a coordination lock state

Note.—Structure of MB for a Resolution Advisories Message.

Position	No. of bits	Subfield	Remarks
33-36	4	BDS1	=3
37-40	4	BDS2	=0
41-54	14	ARA	
55-58	4	RAC	
59	1	CLS	
60-88	29		(¹)

Not assigned.

3.3.2.4.2 Subfields in MB for an Extended Capability Report

The following subfields appear in MB for an Extended Capability Report.

Note.—A summary of the complete MB subfield structure for an Extended Capability Report is given in 3.3.1.6.2.

CRS: Crosslink Request Status Bit, 1 bit, 68. This subfield indicates whether or not aircraft is requesting crosslink traffic advisory service.

Coding

- 0=Aircraft is not requesting crosslink traffic advisory service
- 1=Aircraft is requesting crosslink traffic advisory service

ORC: On-Board Resolution Capability Bit, 2 bits, 69 through 70. This subfield indicates aircraft's on-board resolution advisory generation capability.

Coding

- 0=No on-board resolution advisory generation capability
- 1=An on-board vertical-only resolution advisory generation capability exists
- 2=An on-board vertical and horizontal resolution advisory generation capability exists
- 3=Not assigned

3.3.2.5 MU Fields Used by TCAS II

TCAS II uses the MU field (3.3.1.7) of a long special surveillance interrogation to transmit both a TCAS Resolution Advisories Request Message and a TCAS Resolution Message for air-air maneuver coordination. The MU field is also used by TCAS II to transmit a TCAS Crosslink Traffic Advisory Message to aircraft requesting crosslink traffic advisory service.

3.3.2.5.1 Subfields in MU for a TCAS Resolution Advisories Request Message and TCAS Resolution Message

The TCAS Resolution Advisories Request Message and the TCAS Resolution Message share a common MU message format and are distinguished by the setting of the LCK subfield.

UDS: U-Definition Subfield, 8 bits, 33 through 40. This subfield defines the data content and coding in the remainder of MU. For convenience in coding, UDS is expressed in two groups of 4 bits each, UDS1, 33 through 36, and

UDS2, 37 through 40. TCAS Resolution Advisories Request Messages and TCAS Resolution Messages are identified by UDS1=3 and UDS2=0, the combination of which is equivalent to UDS=48.

LCK: Coordination Lock Bit, 1 bit, 41. When set to '1', LCK instructs the interrogated equipped threat aircraft to enter the coordination lock state and maintain the lock state until a second coordination interrogation (TCAS Resolution Message) is received.

Coding

- 0=Do not maintain coordination lock state for a second coordination interrogation
- 1=Enter and maintain coordination lock state until a second coordination interrogation is received

Note.—The LCK subfield implicitly distinguishes a TCAS Resolution Advisories Request Message from a TCAS Resolution Message because LCK is always set to '1' in a TCAS Resolution Advisories Request Message while it is always set to '0' in a TCAS Resolution Message.

MTB: Multiple Threat Bit, 1 bit, 42.

Coding

- 0=Interrogating TCAS II has no more than one threat
- 1=Interrogating TCAS II has more than one threat

CVC: Cancel Vertical Resolution Advisory Complement, 2 bits, 43 through 44. This subfield is used by airborne TCAS II equipment to cancel a vertical resolution advisory complement sent to an equipped threat aircraft.

Coding

- 0=No cancellation
- 1=Cancel don't descend
- 2=Cancel don't climb
- 3=Not assigned

VRC: Vertical Resolution Advisory Complement, 2 bits, 45 through 46. This subfield is used by airborne TCAS II equipment to send a vertical resolution advisory complement (don't climb or don't descend) to the equipped threat aircraft.

Coding

- 0=No vertical resolution advisory complement sent
- 1=Don't descend
- 2=Don't climb
- 3=Not assigned

CHC: Cancel Horizontal Resolution Advisory Complement, 2 bits, 47 through 48. This subfield is used by Enhanced TCAS II equipment to cancel a horizontal resolution advisory complement sent to an equipped threat aircraft. In TCAS Resolution Advisories Request Messages and TCAS Resolution Messages transmitted by minimum TCAS II, horizontal resolution is not used and CHC is set to the zero code.

Coding

- 0=No cancellation
- 1=Cancel don't turn left
- 2=Cancel don't turn right
- 3=Not assigned

HRC: Horizontal Resolution Advisory Complement, 2 bits, 49 through 50. This subfield is used by Enhanced TCAS II equipment to send a horizontal resolution maneuver complement (don't turn left or don't turn right) to the equipped threat aircraft. In TCAS Resolution Advisories Request Messages and TCAS Resolution Messages transmitted by minimum TCAS II, horizontal resolution is not used and HRC is set to the zero code.

Coding

- 0=No horizontal resolution advisory complement sent
- 1=Don't turn left
- 2=Don't turn right
- 3=Not assigned

MID: Mode S Address, 24 bits, 65 through 88. This subfield contains the discrete address of the interrogating TCAS aircraft.

Note.—Structure of MU for a TCAS Resolution Advisories Request Message and a TCAS Resolution Message.

Position	No. of bits	Subfield	Remarks
33-36	4	UDS1	=3
37-40	4	UDS2	=0
41	1	LCK	
42	1	MTB	
43-44	2	CVC	
45-48	2	VRC	
47-48	2	CHC	
49-50	2	HRC	
51-64	14		(¹)
65-88	24	MID	

¹ Not assigned.

3.3.2.5.2 Subfields in MU for a TCAS Crosslink Traffic Advisory Message

The following subfields appear in MU for a TCAS Crosslink Traffic Advisory Message.

UDS: U-Definition Subfield, 8 bits, 33 through 40 (3.3.2.5.1). A TCAS Crosslink Traffic Advisory Message is identified by UDS1=3 and UDS2=1, the combination of which is equivalent to UDS=49.

RRG: Relative Range, 6 bits, 41 through 46. This subfield contains the current slant range of the TCAS II aircraft from the interrogated threat.

Coding

Range is expressed as two-way range delay with an LSB of 2 μ sec. The minimum and maximum values are 0 μ sec and 126 μ sec respectively.

Note.—All TCAS II range codes are expressed in terms of two-way range delay. Nominal transponder reply delays are not

included in the range delay. To obtain the one-way range, multiply the two-way range delay by $c/2$, where c is the speed of light. For example, using $c=3 \times 10^8$ m/sec, a 2 μ sec two-way range delay is equivalent to a range of 300 meters.

RAL: Relative Altitude, 6 bits, 47 through 52. This subfield contains the current relative altitude of the TCAS II aircraft with respect to the interrogated threat.

Coding

The relative altitude is transmitted in two's complement notation with an LSB of 100 feet. The minimum and maximum values are -3,300 feet and +3,200 feet respectively. Relative altitude is defined to be positive when the TCAS II aircraft is above the interrogated threat.

BTI: Bearing Type Indicator, 2 bits, 53 through 54. This subfield defines the type of bearing contained in the BRG subfield.

Coding

- 0=No bearing reported
- 1=Magnetic bearing
- 2=Track bearing
- 3=Not assigned

BRG: Bearing, 6 bits, 55 through 60. This subfield contains the current magnetic or track bearing, as determined by the BTI subfield, of the TCAS II aircraft with respect to the interrogated threat aircraft.

Coding

Bearing is transmitted with an LSB=5.625 degrees. The minimum and maximum values are 0 degrees and 354.375 degrees respectively. Magnetic and track bearing are rounded off to the nearest 5.625 degrees. Magnetic bearing is measured positive clockwise from Magnetic North as viewed from above. Track bearing is measured positive clockwise from the threat aircraft flight vector as viewed from above.

Note.—When BTI=0, the BRG subfield has no meaning.

MID: Mode S Address, 24 bits, 65 through 88. This subfield contains the discrete address of the interrogating TCAS aircraft.

Note.—Structure of MU for a TCAS Crosslink Traffic Advisory Message.

Position	No. of bits	Subfield	Remarks
33-36	4	UDS1	-3
37-40	4	UDS2	-1
41-46	6	RRG	
47-52	6	RAL	
53-54	2	BTI	
55-60	6	BRG	
61-64	4		
65-88	24	MID	

Not assigned.

3.3.2.6 MV Fields Used by TCAS II

TCAS II uses the MV field of a long special surveillance reply (3.3.1.10) to transmit a Coordination Reply Message to requesting TCAS aircraft for air-air maneuver coordination.

3.3.2.6.1 Subfields in MV for a Coordination Reply Message

The following subfields appear in MV for a Coordination Reply Message.

VDS: V-Definition Subfield, 8 bits, 33 through 40. This subfield defines the data content and coding in the remainder of MV. For convenience in coding, VDS is expressed in two groups of 4 bits each, VDS1, 33 through 36, and VDS2, 37 through 40. The airborne TCAS II equipment is a source of long special surveillance reply MV messages containing the VDS1=3 code. A Coordination Reply Message is identified by VDS1=3 and VDS2=0, the combination of which is equivalent to VDS=48.

ARA: Active Resolution Advisories, 14 bits, 41 through 54. The content and coding of this subfield is as defined in 3.3.2.4.1.

Note.—When CLI=1, the ARA subfield has no meaning.

RAC: Resolution Advisory Complements, 4 bits, 55 through 58. The content and coding of this subfield is as defined in 3.3.2.4.1.

Note.—When CLI=1, the RAC subfield has no meaning.

CLI: Coordination Lock State Initiator Bit, 1 bit, 59. This subfield indicates if interrogated TCAS aircraft is currently in a coordination lock state initiated by the interrogating TCAS aircraft eliciting this reply or, by own aircraft or a threat TCAS aircraft other than the one eliciting this reply.

Coding

0=Interrogated TCAS aircraft is currently in a coordination lock state initiated by the interrogating aircraft eliciting this reply
1=Interrogated TCAS aircraft is currently in a coordination lock state initiated by an aircraft other than the interrogating aircraft

Note.—Structure of MV for a Coordination Reply Message.

Position	No. of bits	Subfield	Remarks
33-36	4	VDS1	=3
37-40	4	VDS2	=0
41-54	14	ARA	
55-58	4	RAC	
59	1	CLI	
60-68	29		(1)

¹ Not assigned.

3.3.2.7 SL TCAS II Sensitivity Level Report

Downlink, 3 bits, 14 through 16. Appears in special surveillance formats DF=0,16. This field reports the sensitivity level at which the TCAS II unit is currently operating.

Coding

0=No TCAS II sensitivity level reported
1=TCAS II is operating at sensitivity level 1
2=TCAS II is operating at sensitivity level 2
3=TCAS II is operating at sensitivity level 3
4=TCAS II is operating at sensitivity level 4
5=TCAS II is operating at sensitivity level 5
6=TCAS II is operating at sensitivity level 6
7=TCAS II is operating at sensitivity level 7

Note.—The SL field has no meaning for aircraft that set AR=0 (no on-board capability to generate resolution advisories).

3.3.2.8 Unassigned Coding Space

Unassigned coding space as indicated in Figures 3.2-1 and 3.2-2 contains all zeroes as transmitted by interrogators and transponders. Coding space currently unassigned is reserved for possible future use.

Note.—This rule assures that future assignments in this coding space define a "zero-block" as a default code, i.e., no message is sent and/or no capability exists.

4. Protocol

4.1 ATCRBS Surveillance

4.1.1 ATCRBS Interrogation

4.1.1.1 ATCRBS-Only All-Call

For surveillance of aircraft equipped with ATCRBS transponders, the ATCRBS-Only All-Call interrogation may be used (ref. B: 2.3.2).

Note 1.—This interrogation format causes all ATCRBS-only equipped aircraft to reply and all Mode S equipped aircraft to not reply. The absence of replies from Mode S transponders is desirable since such replies

would add to the interference environment. Absence of these replies from the TCAS II synchronous in interference environment is particularly beneficial.

Note 2.—An ATCRBS-Only All-Call can be in Mode A or Mode C. A TCAS II transmits Mode C interrogations to obtain range and altitude surveillance information. Mode A interrogations may also be used.

4.1.1.2 Control of Synchronous Interference by Transmitter Power

To control ATCRBS synchronous interference and facilitate TCAS II operation in airspace with higher traffic densities, a feature called "whisper-shout" may be used. In this feature, a single interrogation is replaced by a sequence of interrogations at different power levels. Each of these interrogations, other than the one at lowest power, is preceded by a suppression pair (a pair of pulses spaced by 2 μ s, with characteristics the same as the 2-pulse SLS control transmission defined in ref. A: 2.4.4). The suppression pair is transmitted at a power level lower than that of the accompanying interrogation. The suppression pair begins at a time typically 4 μ s before the beginning of the interrogation.

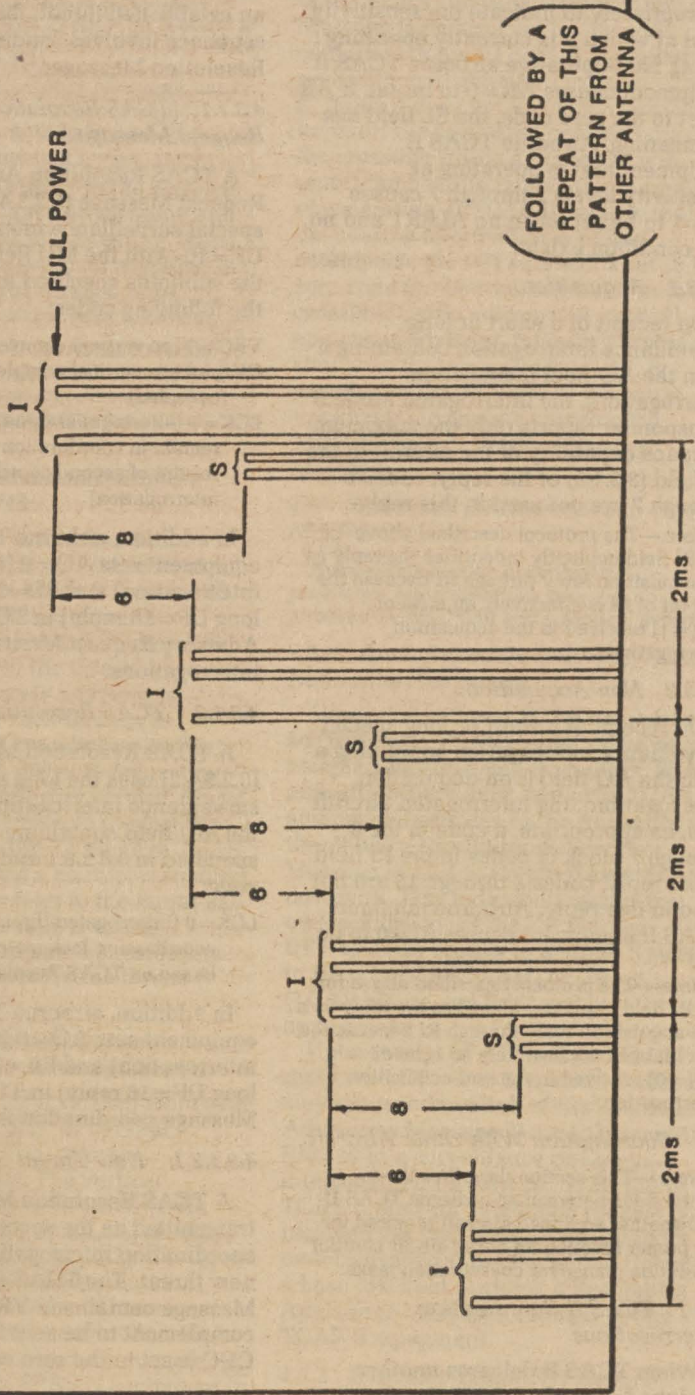
Note.—Figure 4.1-1 shows an example of a whisper-shout sequence with 4 interrogations from the top antenna and 4 interrogations from the bottom antenna. The four power levels are spaced uniformly by 6 dB, and each suppression pair is 8 dB below its accompanying interrogation (other combinations of interrogation and suppression power may be used also). The intended mechanism is that each aircraft replies to one, or at most two, of the four interrogations in a group. Given a situation in which several aircraft are near enough in range to synchronously interfere with each other, it is unlikely they would all reply to the same interrogation (due to variations in link margin) and, as a result, the severity of synchronous interference is reduced. Use of whisper-shout has additional benefits in reducing the severity of the effects of multipath on the interrogation link.

4.2 Mode S Surveillance

Note.—This section describes the interactions between an airborne TCAS II and a Mode S equipped aircraft required for the proper functioning of the TCAS II Mode S surveillance tasks.

BILLING CODE 4910-13-M

NOTES: I DENOTES MODE C FORM OF ATRCBS-ONLY ALL-CALL INTERROGATION
 S DENOTES SUPPRESSION PAIR.
 POWER LEVELS MARKED IN dB.



TRANSMITTED POWER

FIG. 4.1-1. EXAMPLE OF WHISPER-SHOUT SEQUENCE

4.2.1 Detection

TCAS II detects the presence of Mode S equipped by listening at 1090 MHz to Mode S transmissions with DF=4 (surveillance reply with altitude) and DF=0 (short special surveillance). Mode S responder transmissions with DF=4 may occur in response to Mode S sensor discrete interrogations or as squitters. Mode S responder transmissions with

DF=0 may occur in response to UF=0 or 16 interrogations from airborne TCAS interrogators.

TCAS II derives the discrete address and altitude of the Mode S equipped aircraft from the AP and AC fields, respectively. Additionally, TCAS II examines the Flight Status, FS, field in these transmissions to determine if the other aircraft has an interrogating TCAS unit (FS=1) or is on the ground (FS=7).

Note 1.—The fact that the other Mode S aircraft has an interrogating TCAS unit on-board is used for the computation of permissible interrogation rates (5.1.2).
 Note 2.—If the other Mode S aircraft is on the ground, TCAS II does not need to track it.

4.2.2 Surveillance Interrogations

The response to the initial detection of a near-coaltitude Mode S aircraft is a

range acquisition interrogation. When the range, altitude, and maximum speed capabilities of the TCAS II aircraft and the detected Mode S aircraft indicate that the detected aircraft is or could soon become a collision threat, periodic surveillance interrogations (tracking) of the Mode S aircraft are made. Otherwise, interrogations to the Mode S aircraft are temporarily suspended.

4.2.2.1 Acquisition

When a Mode S aircraft is undergoing range acquisition, TCAS II uses the short special surveillance format UF=0 for an acquisition interrogation. TCAS II sets AQ=1 (3.3.1.2) in an acquisition interrogation. This serves as an aid in distinguishing the reply to own interrogation from replies elicited by other TCAS units (4.2.3). In addition, TCAS II sets RL=0 (3.3.1.10) in an acquisition interrogation to command a short acquisition reply DF=0.

4.2.2.2 Tracking

When a track has been established for a Mode S aircraft, TCAS II uses the short special surveillance format UF=0 for a tracking interrogation with the exception given in the next paragraph. TCAS II sets AQ=0 and RL=0 (to command a short reply DF=0) in a tracking interrogation.

If the tracked Mode S aircraft is requesting crosslink traffic advisory service (RI=1 or 2) from own TCAS II and is determined by own TCAS II to be a collision threat requiring the issuance of a resolution advisory, then as long as the resolution advisory remains active, TCAS II performs surveillance of the threat aircraft with a tracking interrogation that uses the long special surveillance format UF=16.

Note.—The use of the long interrogation, UF=16, in the situation described above allows the tracking interrogation to function both as a surveillance interrogation and as a carrier of the TCAS Crosslink Traffic Advisory Message (3.3.2.5.2). When the threat aircraft requesting crosslink traffic advisories is declared a non-threat and the resolution advisory with respect to it is dropped, TCAS II reverts to the use of normal tracking interrogations, UF=0.

4.2.3. Surveillance Replies

On receipt of a short special surveillance interrogation, UF=0, or a long special surveillance interrogation, UF=16, the interrogated Mode S transponder replies with a short special surveillance reply, DF=0, or a long special surveillance reply, DF=16, depending on the code contained in the RL field of the interrogation. In these replies, the altitude, the ASA capability and the flight status of the aircraft are reported in the AC (3.3.1.1), AR (3.3.2.1),

and FS (3.3.1.4) fields respectively. Operative airborne TCAS II equipment sets the AR field to code 1, 2 or 3 as appropriate and sets the SL field (3.3.2.8) appropriately to indicate the sensitivity level at which it is currently operating (5.2.4). Non-operative airborne TCAS II equipment causes AR=0 to be set. If AR is set to the zero code, the SL field has no meaning. Airborne TCAS II equipment that is operating at sensitivity levels 2 through 7 causes FS=1 to be set when no ALERT and no SPI condition exists.

4.2.3.1 Acquisition

On receipt of a short or long surveillance interrogation containing a '1' in the AQ field (acquisition interrogation), the interrogated Mode S transponder reports only the maximum airspace capability of the aircraft in the RI field (3.3.1.9) of the reply; codes 0 through 7 are not used in this reply.

Note.—The protocol described above for the RI field implicitly identifies the reply as an acquisition reply through RI because the first bit of RI is effectively an echo of AQ(=1) received in the acquisition interrogation.

4.2.3.2 Non-Acquisition

On receipt of a short or long special surveillance interrogation containing a '0' in the AQ field (non-acquisition interrogation), the interrogated aircraft sets, as appropriate, a code in the 0 through 7 block of codes in the RI field of the reply; codes 8 through 15 are not used in this reply. Airborne minimum TCAS II equipment causes RI=0 to be set.

Note.—The protocol described above for the RI field implicitly identifies the reply as a non-acquisition reply through RI because the first bit of RI is effectively an echo of AQ(=0) received in the non-acquisition interrogation.

4.3 Coordination With Other Aircraft

Note.—This section describes the interactions between an airborne TCAS II and another equipped aircraft required for the proper functioning of the air-air conflict resolution maneuver coordination tasks.

4.3.1 TCAS II Coordination Interrogations

When TCAS II declares another equipped aircraft (AR.NE.0) to be a collision threat, interrogations to it are transmitted for conflict resolution maneuver coordination (5.2.3.4). Coordination interrogations are periodically made to the other aircraft as long as it remains a collision threat. Two types of TCAS II coordination interrogations are transmitted: a TCAS Resolution Advisories Request Message and a TCAS Resolution Message. For a

newly declared threat, the coordination sequence involves first sending a TCAS Resolution Advisory Request Message and then a TCS Resolution Message. For an established threat, the coordination sequence involves sending only a TCAS Resolution Message.

4.3.1.1 TCAS Resolution Advisories Request Message

A TCAS Resolution Advisories Request Message (5.2.3.4.1) uses the long special surveillance interrogation, UF=16, with the MU field containing the subfields specified in 3.3.2.5.1 and the following codes:

VRC=0 (no vertical complement sent)

CVC=0 (no vertical complement to be canceled)

LCK=1 (interrogated threat to enter and remain in coordination lock state until receipt of second coordination interrogation)

In addition, airborne TCAS II equipment sets AQ=0 (non-acquisition interrogation) and RL=1 (respond with long DF=16 reply) in TCAS Resolution Advisory Request Message coordination interrogations.

4.3.1.2 TCAS Resolution Message

A TCAS Resolution Message (5.2.3.4.2) uses the long special surveillance interrogation, UF=16, with the MU field containing the subfields specified in 3.3.2.5.1 and the following code:

LCK=0 (interrogated threat to end coordination lock state after update based on TCAS Resolution Message)

In addition, airborne TCAS II equipment sets AQ=0 (non-acquisition interrogation) and RL=1 (respond with long DF=16 reply) in TCAS Resolution Message coordination interrogations.

4.3.1.2.1 New Threat

A TCAS Resolution Message is transmitted as the second of a two-coordination interrogation sequence to a new threat. The TCAS Resolution Message contains in VRC the vertical complement to be sent to the threat. CVC is set to the zero code.

4.3.1.2.2 Established Threat

Coordination with established threats and with aircraft that have changed from a threat status to a non-threat status (dropped threats) involves only a single transaction, that is, transmission of a TCAS Resolution Message. The complements (if any) to be added (or continued) and/or canceled are coded in VRC and CVC respectively.

4.3.2 Coordination Reply to TCAS

Upon acceptance of a TCAS coordination interrogation from a threat TCAS aircraft, own Mode S transponder replies with a Coordination Reply Message derived from the own TCAS II equipment (5.2.3.4.3).

A Coordination Reply Message uses the long special surveillance reply, DF=16, with the MV field containing the subfields specified in 3.3.2.6.1. If CLI=1, the remaining subfields in the message (ARA and RAC) have no meaning and are ignored by the interrogating TCAS aircraft. Also, the protocol specified in 4.2.3 and 4.2.3.2 governing a non-acquisition DF=16 reply is followed.

Note.—Although a Coordination Reply Message is sent in response to receipt of a TCAS Resolution Message, the resolution advisories information in the reply is not used.

4.4 TCAS Maneuver and Traffic Advisory Crosslink

When TCAS II determines that criteria for the issuance of a resolution advisory against a Mode S threat with no on-board resolution capability (AR=0) have been satisfied, crosslink advisory service to the threat is initiated. A maneuver advisory is crosslinked to all such threats. In addition, TCAS II crosslinks a traffic advisory if such a threat is requesting crosslink traffic advisory service. These crosslink advisories serve to alert the threat to the presence of the own TCAS II aircraft executing a conflict resolution maneuver with respect to the threat and are transmitted in each tracking interrogation as long as the resolution advisory with respect to the threat remains active.

4.4.1 Crosslink to a Threat not Requesting Traffic Advisory Service

TCAS II transmits a vertical maneuver advisory to a collision threat that reports AR=0 and RI=0 in its surveillance replies. The vertical maneuver advisory is encoded in the VMA subfield of AV (3.3.2.2.1) of each tracking interrogation (4.2.2.2), UF=0, to the threat as long as the resolution advisory remains active. Otherwise, VMA is set to the zero code. The HMA subfield of AV is set to the zero code by airborne minimum TCAS II equipment in all tracking interrogations.

4.4.2 Crosslink to a Threat Requesting Traffic Advisory Service

TCAS II transmits a maneuver and traffic advisory to a collision threat that reports AR=0 and RI=1 or 2 in its surveillance replies. A TCAS Crosslink Traffic Advisory Message (3.3.2.5.2) is encoded in the MU field of each tracking

interrogation (4.2.2.2), UF=16, to the threat as long as the resolution advisory remains active. The type of bearing information (magnetic or track) reported in the TCAS Crosslink Traffic Advisory Message is determined by the code contained in the RI field of surveillance replies (non-acquisition) from the threat. If TCAS II does not have the capability to report the requested bearing type in the crosslink traffic advisory, it will report the bearing type that it is capable of generating. If TCAS II decides that the bearing information is of low confidence, the BTI subfield is set to the zero code (no bearing reported) in the crosslink traffic advisory. A vertical maneuver advisory, following protocol similar to that described in 4.4.1, is encoded in the AV field of the same tracking interrogation carrying the TCAS Crosslink Traffic Advisory Message.

4.5 Provisions for Coordination With Mode S Sensors

Note.—This section describes the provisions for interactions between an airborne TCAS II unit and a Mode S sensor.

4.5.1 Air-Initiated Downlink of TCAS Resolution Advisories

Whenever either a TCAS resolution advisory or a TCAS resolution advisory complement (received from other TCAS aircraft) or both exist, airborne TCAS II equipment indicates to the transponder that it has a Resolution Advisories Message (3.3.2.4.1) Comm-B awaiting downlink. This indication causes the transponder to set the DR field in DF=4,5,20,21 replies to a Mode S sensor to DR=2 (TCAS bit set) or DR=3 (TCAS bit set and B-bit set) as appropriate.

Upon receipt of a DF=4,5,20 or 21 reply with DR=2 or 3, a Mode S sensor may request downlink of the Resolution Advisories Message (3.3.2.4.1) by setting RR=19 in a surveillance or Comm-A interrogation, UF=4,5,20, or 21, to the TCAS II aircraft. When this request is received via own Mode S transponder, own transponder replies with a Comm-B whose MB field contains a Resolution Advisories Message provided by the TCAS II equipment.

4.5.2 Extended Capability Report

When operating TCAS II equipment is on-board an aircraft, the CA field (ref. B: 3.3.5) in an All-Call reply (DF=11, see ref. B) to a Mode S sensor is set to code 1, 2, or 3, as appropriate, to indicate extended capability. The Mode S sensor learns of the specific extended capabilities on-board the aircraft by using the extended capability report protocol specified in ref. B: 4.6.2.

Operating TCAS II equipment indicates to the Mode S transponder for inclusion in an Extended Capability Report (3.3.1.6.2, 3.3.2.4.2) that it has the appropriate Comm-A message destination and Comm-B message source and ASA capabilities. These indications cause the transponder to set the following codes in an Extended Capability Report:

- (1) CRS=0 (No request for full crosslink advisory service).
- (2) ORC=1 (On-board vertical-only resolution advisory generation capability).
- (3) ACS: bit 48=1.
- (4) ECS: bit 74=1.

4.5.3 TCAS II Sensitivity Level Control

Control of the TCAS II sensitivity level can be accomplished by Mode S sensors through the transmission of a Comm-A interrogation, UF=20,21, containing a TCAS Sensitivity Level Command Message (3.3.2.3.1) to the TCAS II aircraft. The interrogator identification information required to correlate the sensitivity level command with the originating Mode S sensor site is contained in the IIS subfield (3.3.1.12.1) of SD of the same Comm-A. After receipt of a TCAS Sensitivity Level Command Message from a given Mode S sensor, the sensitivity level command associated with that sensor: a) may be modified by a subsequent TCAS Sensitivity Level Command Message from that Mode S sensor, and b) is automatically refreshed if it has not timed out (5.2.3.8) by reception of any UF=4,5,20 or 21 interrogation from that Mode S sensor. TCAS II determines the source of a UF=4,5,20 or 21 ground-air interrogation by the IIS code contained in the SD field of the interrogation.

5. Characteristics of Airborne TCAS II Equipment

5.1 Interference Control

5.1.1 RF Maximum Output Power

The maximum root mean square effective radiated power of each pulse of a TCAS II airborne transmission at any point in space does not exceed 34 dBW.

Note.—A nominal value of 24 dBW is sufficient for effective performance at closing speeds up to 1200 knots. The higher limit given here allows for nonuniformities in airborne antenna patterns and transmitter manufacturing tolerances.

5.1.1.1 Unwanted Output Power

When the airborne TCAS II equipment is not transmitting an interrogation, the RF output effective radiated power at any point in space does not exceed -25 dBm at

frequencies between 1027 MHz and 1033 MHz.

Note.—This constraint assures that aircraft flying near the airborne TCAS II equipment (as close as 0.1 nmi) do not receive interference that would prevent their being tracked by another interrogator. If internal TCAS signals exist that may affect the receiving performance of own aircraft's Mode S transponder, additional provisions may be necessary to ensure that one Mode S transponder performance is not degraded.

5.1.2 Interference Limiting

Each TCAS II airborne interrogator controls its interrogation rate or power or both to minimize interference effects. The interrogator conforms to the following specific inequalities, which are a means for ensuring that all interference effects resulting from these interrogations together with the interrogations from all other TCAS airborne interrogators in the vicinity are kept to a low level. The limits on interrogation rate and power are functions of the local airborne environment. In the process of checking for compliance with the limits, the TCAS II unit counts the number of other TCAS airborne interrogators in the vicinity. This count is obtained by monitoring Mode S transmissions with DF=4 and DF=0. Receptions that contain PS=1 indicate that the transmitting aircraft is equipped with a TCAS interrogator, currently interrogating, and by counting these aircraft the subject TCAS II obtains a value NT. The reception for monitoring Mode S transmissions is omnidirectional, and uses a variable threshold level, MTL, that is adjusted automatically to keep the received ATCRBS fruit rate less than 10,000 replies per sec. At any time, the current value of MTL is used to obtain an adjusted estimate of the number of TCAS II aircraft within 30 nmi range, denoted NTA.

$$NTA = NT \cdot 10^a$$

$$a = \frac{MTL + 74}{10} \quad (\text{for MTL in dBm referred to the antenna})$$

The three inequalities below are associated with the following physical mechanisms: (1) Reduction in reply ratio of transponders installed on other aircraft, (2) reduction in reply ratio of own transponder due to mutual suppression during transmission of

interrogations, and (3) ATCRBS fruit due to TCAS interrogations.

$$\sum_{i=1}^I \frac{P(i)}{250 \text{ watts}} \cdot \text{LE} \cdot \frac{280}{1 + NTA} \quad (1)$$

$$\sum_{i=1}^I M(i) \cdot \text{LE} \cdot 0.01 \text{ second} \quad (2)$$

$$\frac{1}{BS} \cdot \sum_{k=1}^K \frac{PA(k)}{250 \text{ watts}} \cdot \text{LE} \cdot \frac{80}{1 + NTA} \quad (3)$$

The variables, in these inequalities are defined as follows.

I = total number of interrogations transmitted in a 1-second period.

i = index number of the current interrogation; i=1, 2, . . . I.

P(i) = total radiated power from the antenna for the ith interrogation.

M(i) = duration of the mutual suppression interval for own transponder associated with the ith interrogation.

K = total number of ATCRBS interrogations transmitted in a 1-second period.

k = index number of the current ATCRBS interrogation; k=1, 2, . . . K.

PA(k) = total radiated power from the antenna for the kth ATCRBS interrogation.

BS = beam sharpening factor (3 dB beamwidth ÷ effective beamwidth).

For TCAS II interrogators that employ transmit sidelobe suppression (SLS), effective beamwidth is the extent in azimuth angle of the ATCRBS replies from one transponder as limited by SLS, averaged over the transponder population.

When interrogation rate and power vary as functions of time, it is admissible to exceed these bounds, inequalities (1)–(3), briefly, provided the averages over 32-second periods are kept within the bounds.

5.1.3 Suppression of Own Aircraft Transponder

The Mode S transponder on board the aircraft is suppressed during each TCAS II transmission.

Note.—The purpose of this suppression is to assure that the TCAS II does not interrogate its own transponder.

5.2 Collision Avoidance Algorithms

Airborne TCAS II equipment contains algorithms that implement the following functions as illustrated in Figure 5.2-1. The equipment executes these functions in sequence on each cycle of operation. The term "logic cycle" used in this section refers to the sequence of functions represented by c. through e.

- Surveillance
- Tracking
- Threat Detection
- Threat Resolution
- Coordination

Certain of these functions or subfunctions must be standardized to ensure that airborne TCAS II units interface satisfactorily with other TCAS units, with Mode S sensors and with the conventional air traffic control (ATC) system. Parameters used in the algorithms are adjusted automatically to maintain collision avoidance protection with minimal interference to normal ATC operations. Each of the functions or subfunctions which is standardized is discussed in a paragraph below. Appendix B provides an alphabetically ordered index of all variables used in the collision avoidance algorithms described in this section.

5.2.1 Threat Detection

All aircraft tracked by TCAS II are considered intruders and potential collision threats. The characteristics of an intruder that are used to define a threat are:

- Tracked Altitude—ZINT
- Tracked Rate of Change in Altitude—ZDINT
- Tracked Slant Range—R
- Tracked Rate of Change in Slant Range—RD
- TCAS Equipage—BEQ
- Sensitivity Level of TCAS II Operation—SLINT

BEQ is set to the value reported by the intruder in the AR field (3.3.2.1) unless the intruder reports an inhibited resolution function, SL=1 or 2 in a TCAS II sensitivity level report (3.3.2.9). When this condition is reported, BEQ is set to -1. In addition, the following characteristics of own TCAS II aircraft are used in threat definition:

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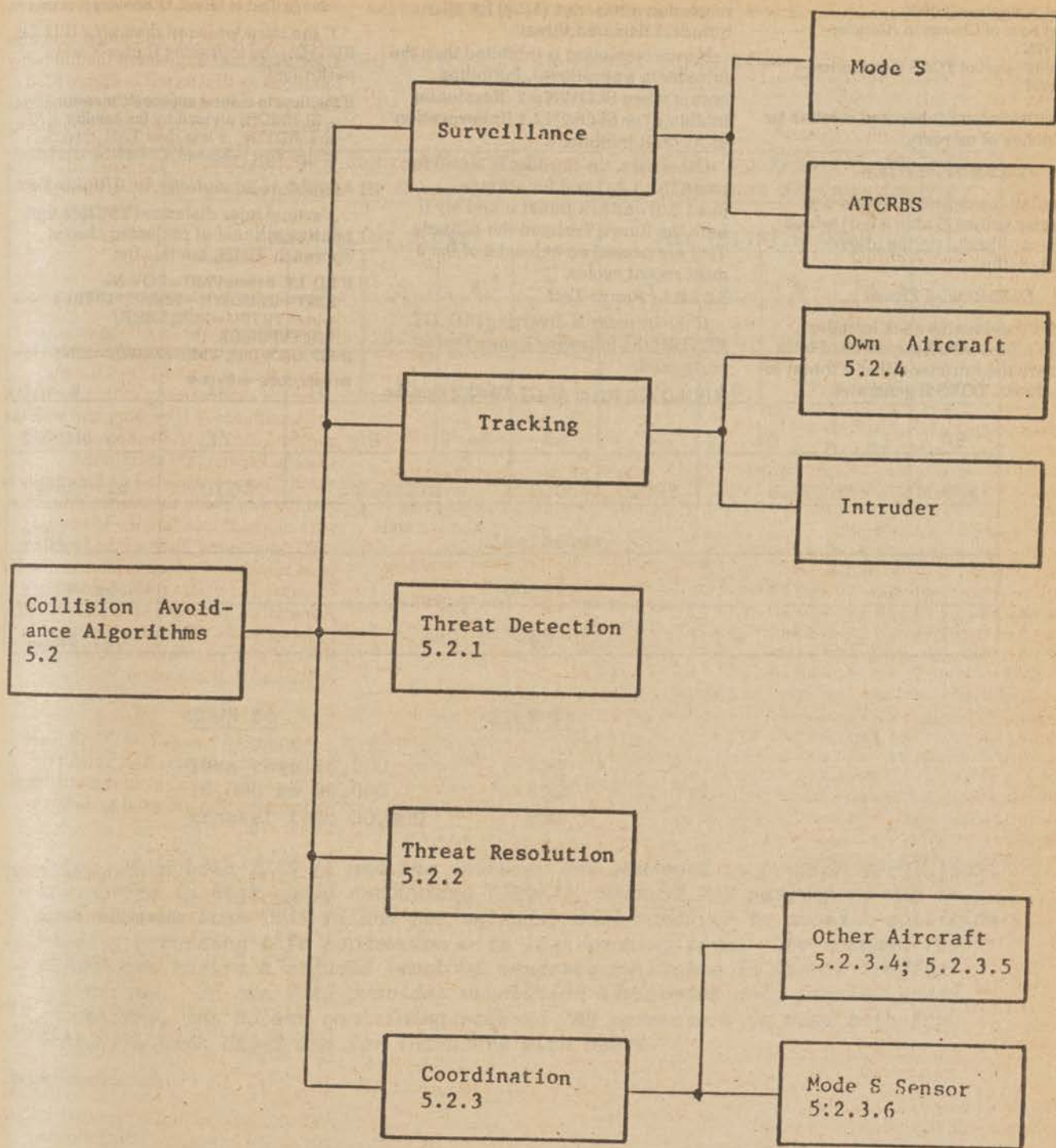


Fig. 5.2-1. Functional Elements of TCAS II Collision Avoidance Algorithms.

Tracked Altitude—ZOWN
 Tracked Rate of Change in Altitude—
 ZDOWN
 Sensitivity Level of TCAS II Operation—
 SLOWN

All altitudes are measured relative to 29.92 inches of mercury.

5.2.1.1 Parameter Selection

Calculations defining threats use parameter values (Table 5.2-1) which are selected based on the above characteristics.

5.2.2.1 Definition of Threat

TCAS II evaluates each intruder through a prescribed sequence of tests to declare the intruder either a threat or a non-threat. TCAS II generates

resolution advisories (5.2.2) for all intruders declared threats.

If own resolution is inhibited then the intruder is a non-threat. Inhibition occurs when SLOWN=2 (Resolution Inhibited) or SLOWN=1 (Interrogation of Aircraft Inhibited).

Otherwise, the intruder is tested for range (5.2.1.2.1) and for altitude (5.2.1.2.3) and is a threat if and only if both the Range Test and the Altitude Test are passed on at least 2 of the 3 most recent cycles.

5.2.1.2.1 Range Test

If the intruder is diverging (RD .GT. RDTHR) the following Range Test is performed:

If (R*RD .GT. H1) or (R .GT. DMOD) then the

Range Test is failed. Otherwise it is passed.

If the intruder is not diverging (RD .LE. RDTHR) the following Range Test is performed:

If the time to closest approach, measured by $-(R-DMOD)$ divided by the smaller of RD and -RDTHR, is less than TAU, then the Range Test is passed. Otherwise it is failed.

5.2.1.2.2 Calculations for Altitude Test

Vertical miss distance (VMD) is the relative altitude at projected closest approach. Calculate this by:

If RD .LT. 0 then $VMD = ZOWN - ZINT + ((ZDOWN - ZDINT) * TRTRU)$
 where $TRTRU = \text{MIN}(\text{ABS}(R / RD), TVPCMD)$

If RD .GE. 0 then $VMD = ZOWN - ZINT$.

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TABLE 5.2-1

PARAMETERS USED BY TCAS II IN THREAT DEFINITION

Parameter	BEQ.GE.Own Reported AR Code (Intruder is Equipped)					BEQ.LT.Own Reported AR Code (Intruder is Unequipped)				
	MAX (SLINT, SLOWN)					MAX (SLINT, SLOWN)				
	3	4	5	6	7	3	4	5	6	7
DMOD nmi	0.075	0.1	0.3	1.0	1.3	0.075	0.1	0.3	1.0	1.3
TAU s	16	18	25	30	35	18	20	25	30	35
TVPCMD s	35	40		45	48	35	40		45	48
H1 nmi ² /s	0.002	0.00278			0.004	0.002	0.00278			0.004
ZTHR	See below									
RDTHR nmi/s	.00167									
ZDTHR fpm	-60									

ZOWN ftZTHR ft

less than 18,000	750
18,000 to 30,000	850
greater than 30,000	950

Note: When both TCAS II and the intruder are equipped to provide resolution advisories in high speed encounters (BEQ=3), reduced TAU parameters may be used because both TCAS II and the intruder will maneuver to avoid a collision thereby providing safe separation with less warning time. The reduced TAU parameters assure a reduced level of unnecessary alarms in normal traffic operations. If own TCAS provides resolution advisories only for low speed encounters, the column containing reduced TAU parameters is used both for intruders with BEQ=3 and for intruders with BEQ=2.

Calculate vertical divergence rate (ADOT) by:

IF ZOWN-ZINT .GE. 0 then
ADOT=ZDOWN=ZDINT.
IF ZOWN-ZINT .LT. 0 then
ADOT=ZDINT-ZDOWN.

Horizontal miss distance (HMD) is the projected range at coalitude. Calculate this by:

IF ADOT .LT. ZDTHR then HMD=R—
(RD*(ABS(ZOWN-ZINT)/ADOT))
IF ADOT .GE. ZDTHR then HMD is undefined.

5.2.1.2.3 Altitude Test

IF ABS(ZOWN-ZINT) .LT. ZTHR (relative altitude is small) then perform the following Altitude Test:

IF ABS(VMD) .LT. ZTHR then the Altitude Test is passed.

Otherwise the Altitude Test is failed.
IF ABS(ZOWN-ZINT) .GE. ZTHR, then perform the following Altitude Test:

IF ADOT .GE. ZDTHR (vertical divergence) then the Altitude Test is failed.

Otherwise, if—ABS(ZOWN-ZINT)/ADOT .GE. TAU (time to coalitude is large) then the Altitude Test is failed.

Otherwise, if HMD .LT. DMOD or ABS(VMD) .LT. ZTHR then the Altitude Test is passed.

Otherwise, the Altitude Test is failed.

5.2.2 Computation of Resolution Advisories

TCAS II considers the resolution advisory options of Table 5.2-2 in resolving collision threats. Each threat is processed individually for selection of a resolution advisory. The sequence of resolution processing is as follows:

- Enter coordination lock state (5.2.4.1)
- Communicate with new threat (5.2.3.2.1)
- Select sense of advisory for new threat (5.2.2.1)
- Select magnitude of advisory (5.2.2.2)
- Evaluate multi-aircraft situation (5.2.2.3)
- Update resolution advisories (5.2.3.2)
- End coordination lock state (5.2.3.1)
- Communicate with threat (5.2.3.4.2)

Note.—Items (a), (f), (g), and (h) of this sequence are also executed once for each newly declared non-threat that was previously a threat.

TABLE 5.2-2. RESOLUTION ADVISORY OPINIONS

Down sense	Up sense
	Positive Advisories
Descend.....	Climb.
	Vertical Speed Minimums
Maintain descent faster than 500 fpm.	Maintain climb faster than 500 fpm.
Maintain descent faster than 1000 fpm.	Maintain climb faster than 1000 fpm.
Maintain descent faster than 2000 fpm.	Maintain climb faster than 2000 fpm.

TABLE 5.2-2. RESOLUTION ADVISORY OPINIONS—Continued

Down sense	Up sense
	Negative Advisories
Don't climb.....	Don't descend.
	Vertical Speed Limits
Don't climb faster than 500 fpm.	Don't descend faster than 500 fpm.
Don't climb faster than 1000 fpm.	Don't descend faster than 1000 fpm.
Don't climb faster than 2000 fpm.	Don't descend faster than 2000 fpm.

5.2.2.1 Selection of Sense

When an intruder is first declared a threat, TCAS II selects the sense (climb or descend) of the maneuver. Following the selection, which is only performed once, this sense remains unchanged throughout the encounter.

TCAS II evaluates maneuver options by modeling the corresponding altitude separations after an escape maneuver, at time of closest approach TESC, where $TESC = \text{MIN}(\text{ABS}(R/RD), \text{TVPESC})$; (Table 5.2-3). Options evaluated are climb and descend unless either is not compatible with active resolution advisories. The resolution advisory complements received from other TCAS aircraft are not used in testing the compatibility of maneuver options. If the climb option is not compatible, a don't descend option is evaluated in its place; if the descend option is not compatible, don't climb is substituted. Climbs and descends are modeled at nominal rates of 1500 fpm unless the magnitude of the current rate exceeds that level in which case the current rate is used. Don't climb and don't descend are modeled as level flight.

TCAS II provisionally selects the sense of the maneuver which is projected to achieve the greater altitude separation. If the threat is unequipped (BEQ .LT. Own AR Code) and the difference in separation resulting from a climb maneuver versus separation resulting from a descend maneuver is small (e.g., 150 ft or less), TCAS II notes that its provisional sense selection is not significant.

5.2.2.1.1 Exception for Threats in a Multi-Aircraft Conflict

If the threat has the capability to generate on-board resolution advisories (BEQ.GE.1) and is in a multi-aircraft conflict, if own TCAS II is not in a multi-aircraft conflict, and if own TCAS II has received a message conveying maneuver sense from the threat (5.2.3.4.3), own TCAS II selects the sense opposite that selected by the threat. Otherwise, TCAS II makes no exception for multi-aircraft conflict conditions in selecting the sense

of the resolution advisory other than that provided in 5.2.2.3.

5.2.2.1.2 Yielding to Prior Sense Selection by Threat

If the threat has already selected and communicated a vertical sense selection to TCAS II which is incompatible with the TCAS II preferred sense, TCAS II selects the sense opposite to (i.e., compatible with) that selected by the threat if the compatible sense is projected to achieve an altitude separation at the time of closest approach (TESC, 5.2.2.1) greater than 400 ft or if it provides at least 66% of the separation provided by own preferred sense.

5.2.2.1.3 Path Prediction

TCAS II models its own and the threat's trajectory based on threat's active resolution advisories and own vertical maneuver options. The model of each aircraft's altitude profile is a projection with one maneuver at constant acceleration to a new altitude rate (equations below).

TABLE 5.2-3.—PARAMETERS USED IN RESOLUTION ADVISORY SELECTION

Parameter	MAX (SLINT, SLOWN)				
	3	4	5	6	7
TVPESC s.....	25	30	30	35	40
ALIM.....	Sep below 1000 fpm				
ILEV.....					
	ZOWN ft				ALIM ft
Less than 10,000.....					340
10,000 to 18,000.....					440
18,000 to 30,000.....					640
Greater than 30,000.....					740

If the threat's current altitude rate (ZDINT) satisfies the active resolution advisories obtained from its Coordination Reply Message (3.3.2.6.1), the threat is modeled as continuing at its current altitude rate. Otherwise, the threat is modeled as accelerating to a rate which satisfies its active resolution advisories with minimum change in vertical rate.

If $TCUR.LT.T.LE.DELAY + TCUR$,
 $Z(T) = Z(TCUR) + (ZD(TCUR) * (T - TCUR))$

If
 $DELAY + TCUR.LT.T.LE.DELAY + TCUR + (ABS(SENSE * ZDGOAL - ZD(TCUR)) / VACCEL)$,
 $Z(T) = Z(TCUR) + (ZD(TCUR) * (T - TCUR)) + (SENSE * .5 * VACCEL * (T - DELAY - TCUR)^2)$

If
 $T.GT.DELAY + TCUR + (ABS((SENSE * ZDGOAL) - ZD(TCUR)) / VACCEL)$,
 $Z(T) = Z + ZD * DELAY + 5 * (ZD + ZDGOAL) * (ABS(ZDGOAL - ZD) / VACCEL) + ZDGOAL * ((T - DELAY - TCUR) - ABS(ZDGOAL - ZD) / VACCEL)$.

TCUR = Current Time
 T = Time of Prediction
 DELAY = Pilot Response Time
 (= 8 Sec for New Advisories)
 (= 1 Sec for Changed Advisories)
 Z(X) = Altitude at Time X
 ZD(X) = Altitude Rate at Time X
 ZDGOAL = Altitude Rate Objective of Resolution Advisory
 (= MAX(1500 fpm, ABS(ZDOWN)) for Positive Advisories)
 (= 0 fpm for Negative Advisories)
 (= -500 fpm; if ABS(VSL) = 500)
 (= -1000 fpm; if ABS(VSL) = 1000)
 (= -2000 fpm; if ABS(VSL) = 2000)
 SENSE = Sense Selection
 (= +1 for 'Up' Sense)
 (= -1 for 'Down' Sense)
 VACCEL = Vertical Acceleration
 (= 8 fps²)

5.2.2.2 Selection of Advisory Magnitude

TCAS II selects a resolution advisory which results in a predicted safe altitude separation at time of closest approach (TESC, 5.2.2.1) with the least impact on the current flight path by following the sequence of tests described below. Certain parameter values used in the prediction of safe altitude separation are selected based on the characteristics of own and threat aircraft.

If the intruder has failed either the Range Test or the Altitude Test (5.2.1.2.1, 5.2.1.2.2) or both but is still a threat, the advisory selected by the previous cycle is maintained and the tests in 5.2.2.2.1 through 5.2.2.2.3 are not performed.

5.2.2.2.1 Selection of Immediate Positive Advisory if Warranted

If the intruder is unequipped (BEQ .LT. Own AR Code) and not level (ABS(ZDINT) .GE. ILEV) or if the current separation is small (ABS(ZOWN - ZINT) .LT. ALIM), a positive advisory of the selected sense is generated depending upon the results of the following test on vertical miss distance (VMD) where $VMD = (ZOWN - ZINT) + ((ZDOWN - ZDINT) * TRTRU)$ and $TRTRU = \text{MIN}(ABS(R/RD), TVPCMD)$.

If the selected sense is climb, a positive advisory is generated if VMD .LT. ALIM. If the selected sense is descend, a positive advisory is generated if VMD .GT. -ALIM. When none of the cases in this paragraph apply, the tests in 5.2.2.2.2 are performed next.

5.2.2.2.2 Extension of Own Vertical Rate

If own vertical rate is compatible with the sense selected and if extending own vertical rate will resolve the encounter, the vertical speed minimum test (5.2.2.2.1) is performed. Otherwise, the vertical speed limit test (5.2.2.2.3) is performed. Extending own vertical rate will resolve the encounter if the predicted vertical separation (5.2.2.1.3) at time TESC (5.2.2.1) is greater in magnitude than ALIM for all rates in the direction of ZDOWN (5.2.1) that are equal to or which exceed the magnitude of ZDOWN.

5.2.2.2.2 Vertical Speed Minimum

TCAS II selects the lowest magnitude Vertical Speed Minimum (VSM) (Table 5.2-2) of the selected sense which provides a vertical rate for own TCAS II resulting in a predicted vertical separation (5.2.2.1.3) at time TESC (5.2.2.1) greater in magnitude than ALIM. If no such Vertical Speed Minimum exists, TCAS II selects a positive advisory of the selected sense (5.2.2.1).

5.2.2.2.3 Vertical Speed Limit

TCAS II selects the highest magnitude

Vertical Speed Limit (VSL) (Table 5.2-2) that provides a vertical rate for own TCAS II resulting in a predicted vertical separation (5.2.2.1.3) at time TESC (5.2.2.1) greater in magnitude than ALIM. If the lowest magnitude Vertical Speed Limit does not result in a predicted vertical separation at time TESC greater in magnitude than ALIM TCAS II selects a negative advisory of the established sense (5.2.2.1).

5.2.2.3 Multi-Aircraft Conflicts

TCAS II converts existing resolution advisories as illustrated in Table 5.2-4 when it determines that own TCAS II has more than one simultaneous threat. Sense selections which were noted to be not significant (5.2.2.1) do not constrain multi-aircraft resolution advisory selection, and may be changed as a result of multi-aircraft resolution. If the sense selected for every threat is not significant, the last one processed is declared significant before performing the conversion. After conversion, the senses of all resolution advisories are declared significant.

TABLE 5.2-4.—CONVERSION OF RESOLUTION ADVISORIES FOR MULTI-AIRCRAFT CONFLICTS

Existing resolution advisory		Converted resolution advisory		
Sense	Magnitude	One or more 'downward' sense selections but no significant 'upward' sense selections	one or more 'upward' sense selections but no significant 'downward' sense selections	Significant 'upward' and 'downward' sense selections
Upward.....	VSM.....	Descend.....	No change.....	Don't descend.
Upward.....	Climb.....	Descend.....	No change.....	Don't descend.
Upward.....	Don't descend.....	Descend.....	Climb.....	No change.
Upward.....	VSL.....	Descend.....	Climb.....	No change.
Downward.....	VSL.....	Descend.....	Climb.....	No change.
Downward.....	Don't climb.....	Descend.....	Climb.....	No change.
Downward.....	Descend.....	No change.....	Climb.....	Don't climb.
Downward.....	VSM.....	No change.....	Climb.....	Don't climb.

Each resolution advisory will be converted from the list on the left hand side to the advisory shown.

5.2.2.4 Sense Significance

On each cycle of equipment operation, all resolution advisories are assigned significant sense at the conclusion of resolution advisory processing.

5.2.3 Coordination

Airborne TCAS II equipment coordinates conflict resolution with other TCAS aircraft having the ability to generate on-board resolution advisories. In addition, airborne TCAS II equipment is capable of coordinating with Mode S aircraft not having the ability to generate on-board resolution advisories with crosslink maneuver and traffic advisories, and with Mode S sensors.

5.2.3.1 Coordination Lock State

If own TCAS II aircraft is not already involved in coordination processing, initiation of resolution processing against a threat aircraft by own TCAS II aircraft or receipt of a coordination interrogation from another TCAS aircraft causes own TCAS II aircraft to enter a coordination lock state for the duration of coordination processing. While own TCAS II aircraft is in a coordination lock state, only the initiator of the lock state (own or another TCAS aircraft) can interrupt the coordination processing except as provided in 5.2.3.4.3. In order to avoid an extended coordination lock state due to a communication failure, the maximum duration of a lock state is 0.1 seconds.

5.2.3.2 Update of Own TCAS II Resolution Advisories for Coordination Messages

All resolution advisories selected by own TCAS II are made available for encoding in the Coordination Reply Message (3.3.2.6.1) and the Resolution Advisories Message (3.3.2.3.1). For these messages, a vertical speed minimum is converted to a positive advisory of the same sense. The advisory data to be encoded in the above messages is updated each time a resolution advisory is added (new threat resolved) or a resolution advisory for an existing threat is modified or deleted. Unchanged data is refreshed each logic cycle. If the current resolution advisory for a threat is to be deleted, TCAS II enters a '0' in the appropriate bit of the ARA subfield (3.3.2.4.1, 3.3.2.6.1) if that advisory is not also posted for another threat. If a resolution advisory is to be added or refreshed for some threat, TCAS II enters a '1' in the appropriate bit of the ARA subfield. If a threat's bit in the ARA subfield has not been refreshed for an interval of 6 seconds, the bit is set to '0' if it has not also been set for another threat.

5.2.3.3 Update of Other TCAS Resolution Advisory Complements for Coordination Messages

The resolution advisory complements (Table 5.2-5) received from all other TCAS aircraft (5.2.3.4.2) are made available for encoding in the Coordination Reply Message and the Resolution Advisories Message. If there is a complement to delete (own TCAS II dropped as a threat), TCAS II enters a '0' in the appropriate bit of the RAC subfield (3.3.2.4.1, 3.3.2.6.1) if that complement is not also posted for another aircraft. If there is a complement to add or to be refreshed, TCAS II enters a '1' in the appropriate bit of the RAC subfield. If a threat's bit in the RAC subfield has not been

refreshed for an interval of 6 seconds, that bit is set to '0' if it has not also been set to '1' for another threat.

Table 5.2-5.—Complements of Resolution Advisories

Resolution advisory	Complement
Maintain climb faster than 500 fpm.	Don't climb.
Maintain climb faster than 1000 fpm.	Don't climb.
Maintain climb faster than 2000 fpm.	Don't climb.
Climb	Don't climb.
Don't descend	Don't climb.
Don't descend faster than 500 fpm.	Don't climb.
Don't descend faster than 1000 fpm.	Don't climb.
Don't descend faster than 2000 fpm.	Don't climb.
Maintain descent faster than 500 fpm.	Don't descend.
Maintain descent faster than 1000 fpm.	Don't descend.
Maintain descent faster than 2000 fpm.	Don't descend.
Descend	Don't descend.
Don't climb	Don't descend.
Don't climb faster than 500 fpm.	Don't descend.
Don't climb faster than 1000 fpm.	Don't descend.
Don't climb faster than 2000 fpm.	Don't descend.

5.2.3.4 Coordination of Conflict Resolution With Other Aircraft

TCAS II coordinates conflict resolution with other appropriately equipped aircraft, indicated by BEQ.NE.0. The sequence of message is illustrated in Figure 5.2-4.

5.2.3.4.1 Transmission of TCAS Resolution Advisories Request Message

TCAS II enters the coordination lock state and transmits the TCAS Resolution Advisories Request Message (4.3.1) to an appropriately equipped newly declared threat and waits for a reply (4.3.2). If TCAS II receives a Coordination Reply Message with CLI=1, TCAS II retransmits the TCAS Resolution Advisories Request Message.

5.2.3.4.2 Transmission of TCAS Resolution Message

After receiving a Coordination Reply Message with CLI=0 from a new threat

and after selecting a resolution advisory for either a new or established threat, TCAS II updates own resolution advisories, ends own coordination lock state and then transmits the TCAS Resolution Message (4.3.1.2) to the threat. The TCAS Resolution Message includes a resolution advisory complement selected in accordance with the resolution advisory TCAS II has selected for the threat and Table 5.2-5. If TCAS II receives a Coordination Reply Message with CLI=1, TCAS II retransmits the TCAS Resolution Message.

5.2.3.4.3 Coordination Reply to TCAS

If own transponder receives a TCAS Resolution Advisories Request Message (4.3.1.1) from a TCAS aircraft and own TCAS is not in a coordination lock state, TCAS II enters the coordination lock state reserving access only to the interrogating TCAS aircraft and replies with a Coordination Reply Message (4.3.2.1) with CLI=0. If own transponder receives a TCAS Resolution Advisories Request Message (4.3.1.1) while own TCAS is in a coordination lock state due to own TCAS processing the interrogating aircraft as a threat, and the Mode S address code of the interrogating aircraft is less than the Mode S address code of own TCAS II, then own TCAS II maintains the coordination lock state, reassigns the locking source to be the interrogating aircraft and replies with a Coordination Reply Message with CLI=0 (4.3.2). In all other situations when own TCAS II is in a coordination lock state when a TCAS Resolution Advisories Request Message is received, own transponder replies with a Coordination Reply Message with CLI=1.

Note.—If TCAS II relinquishes access to the coordination lock state in favor of an interrogating aircraft, TCAS II reacquires access when the interrogating aircraft ends the coordination lock state.

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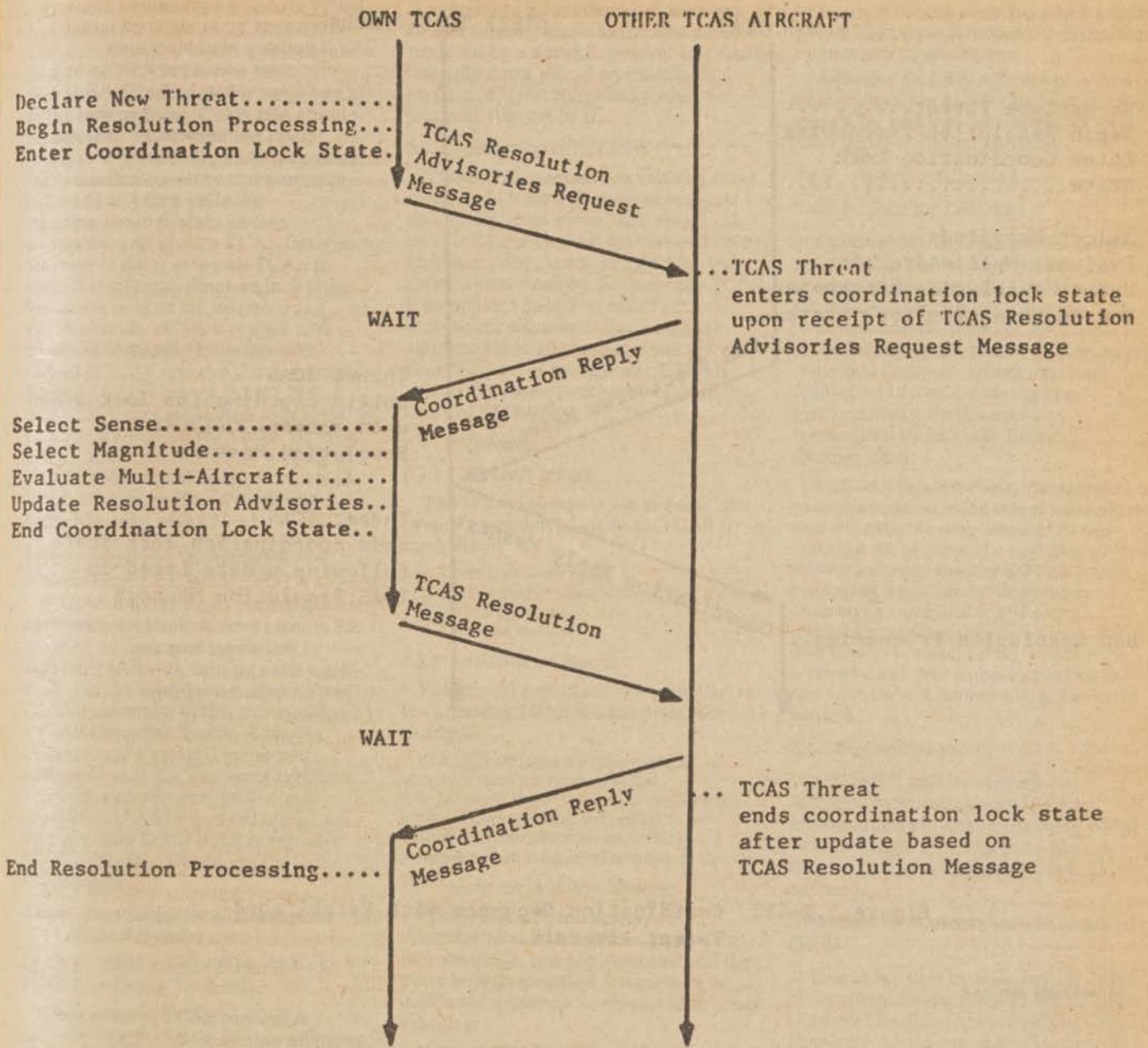


Figure 5.2-4a. Coordination Sequence With New Threat Aircraft.

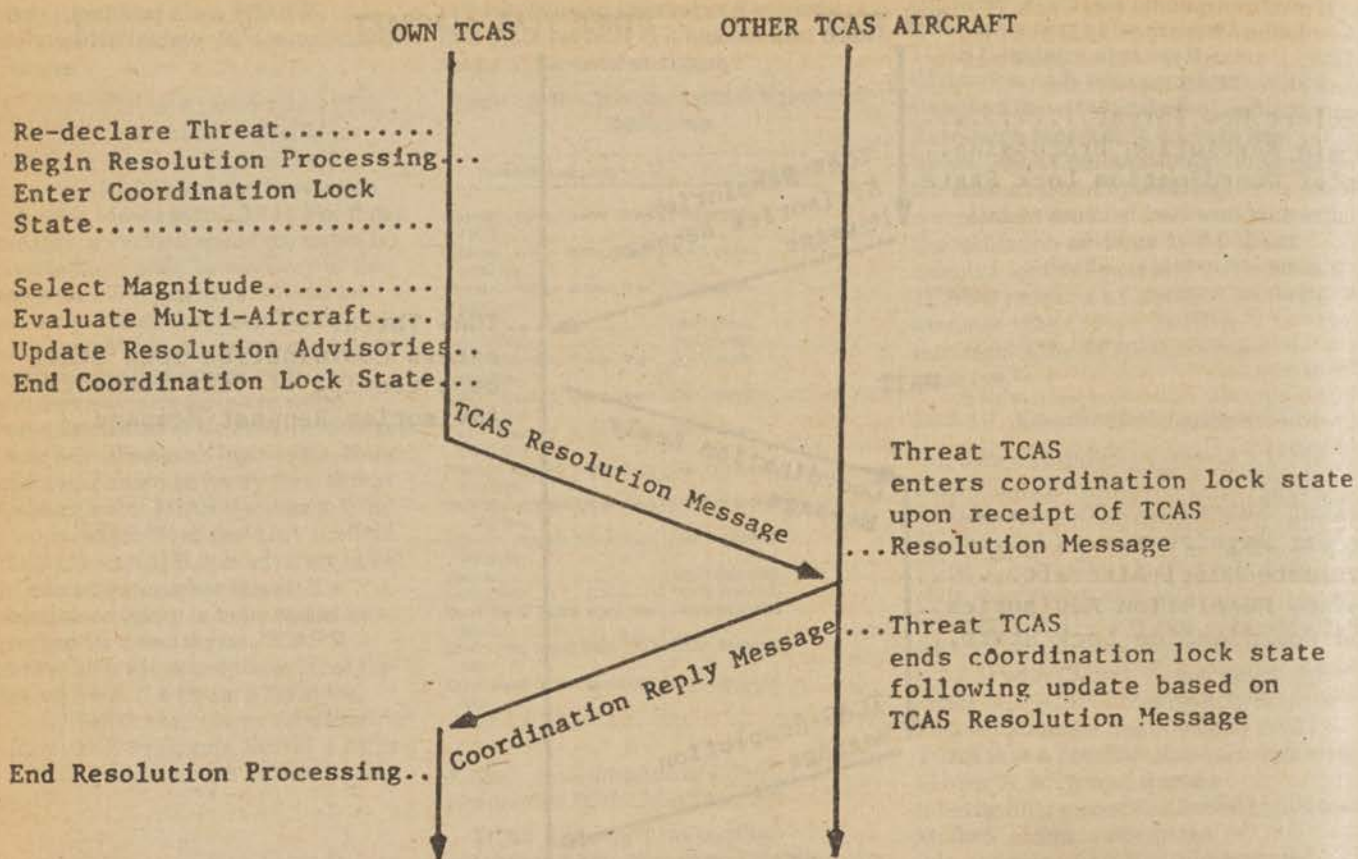


Figure 5.2-4b. Coordination Sequence with Established Threat Aircraft.

If own transponder receives a TCAS Resolution Message (4.3.1.2) and own TCAS II aircraft is not in a coordination lock state, TCAS II enters the coordination lock state for access only to the interrogating TCAS aircraft, replies with a Coordination Reply Message with CLI=0 (4.3.2.1), updates the resolution advisory complements (5.2.3.1.2) and then ends the coordination lock state. If own transponder receives a TCAS Resolution Message (4.3.1.2) and own TCAS II aircraft is in a coordination lock state for access only to the interrogating TCAS aircraft, TCAS II replies with a Coordination Reply Message with CLI=0 (4.3.2.1), updates the resolution advisory complements (5.2.3.1.2) and then ends the coordination lock state. In all other situations when own TCAS is in a coordination lock state when a TCAS Resolution Message is received, TCAS II replies with a Coordination Reply Message with CLI=1.

5.2.3.5 Crosslink of Maneuver and Traffic Advisory Information

If TCAS II generates a resolution advisory for a Mode S threat which has reported no on-board resolution capability (AR=0), then on each logic cycle that the intruder remains a threat, TCAS II transmits to this threat either a) a TCAS Crosslink Traffic Advisory Message and a vertical maneuver advisory (4.4.2) if it has reported RI=1 or 2 in its surveillance replies (non-acquisition), or b) a vertical maneuver advisory only (4.4.1) if it has reported RI=0 in its surveillance replies (non-acquisition).

5.2.3.8 Provisions for Coordination With Mode S Sensors

5.2.3.8.1 Air-Initiated Downlink of TCAS Resolution Advisories

When either a TCAS resolution advisory or a TCAS resolution advisory complement or both exist, TCAS II provides an indication to the transponder to initiate the downlink of a Comm-B containing a Resolution Advisories Message to the Mode S sensor (4.5.1).

5.2.3.8.2 Command of Sensitivity Level

TCAS II can accept a sensitivity level command from a Mode S-sensor (4.5.3).

A sensitivity level command received from a sensor remains effective until replaced by a sensitivity level command from the same site. If an existing command is not refreshed within 14 seconds, it is set to '0'.

5.2.4 Selection of SLOWN

TCAS II may receive sensitivity level commands from a number of sources. Sensitivity level commands may be received from Mode S sensors (5.2.3.6.2) and from pilot inputs. In addition, they may be generated by the airborne TCAS II equipment based on radar altitude, barometric altitude or flap and gear settings. From all these individual sensitivity level commands, TCAS II selects the lowest nonzero value as the value of SLOWN.

5.3 Interfaces

5.3.1 Aircraft Inputs

The following inputs are required for proper operation of airborne TCAS II equipment:

- Mode S address code.
- Own maximum operating airspeed code.
- Pressure altitude.
- Magnetic heading.

5.3.2 Additional Inputs

Additional inputs may be provided to the airborne TCAS II equipment. For example:

- A manual input for generating a sensitivity level command (5.2.4).
- An input signal from a radar altimeter which allows descend advisories to be inhibited at low altitudes and which generates sensitivity level commands (5.2.4).

5.4 Airborne Antenna System

A TCAS II unit transmits interrogations and receives replies via two antennas, one top mounted and the other bottom mounted. These may be dedicated antennas or shared with other avionics.

Note.—A TCAS II unit and Mode S transponder may share a single pair of antennas.

5.4.1 Polarization

The antennas are vertically polarized.

5.4.2 Radiation Pattern

The radiation pattern in elevation of each antenna when installed on an aircraft is nominally equivalent to that

of a quarter-wave monopole on a ground plane. This gives a nominal 3 dB vertical beamwidth of 30 degrees.

Airborne TCAS II equipment uses one or more antennas with direction finding capability and may use antennas with directional radiation patterns.

5.4.3 Antenna Selection

5.4.3.1 Squitter Listening

Airborne TCAS II equipment receives squitters via the top and bottom antennas. This can take the form of simultaneous reception using multiple receivers and decoders or switched reception using one receiver. If reception is switched, the switching times are controlled to avoid undesirable synchronism with the squitters transmitted by Mode S diversity transponders.

Note.—A Mode S diversity transponder transmits squitters at the rate of nominally 1 each second alternating between its two antennas. An example of a switching pattern by which an omnidirectional TCAS II unit can listen for squitters while avoiding undesirable synchronism is to switch receiving antennas once every 2 seconds; then in each 4-second period, squitters are received via all four antenna pairs (top-to-top, top-to-bottom, bottom-to-top, bottom-to-bottom).

5.4.3.2 Interrogation

A TCAS II unit transmits each ATCRBS interrogation and Mode S interrogation via one or the other of the two antennas. Interrogations are not transmitted simultaneously via both antennas.

Appendix A—Comprehensive Index of Fields

This index lists in alphabetical order all essential fields, mission fields, three-character designator subfields and four-character designator subfields for which coding is given in this Standard. The "Location" column indicates the mission field or three-character designator subfield in which the three-character or four-character designator subfield listed under the "Designator" column appears. Content of all four-character designator subfields can be found by referring to the three-character subfields in which they appear.

Designator	Downlink/uplink	Name	Location	References	
				Content	Protocol
AC	D	Altitude Code		3.3.1.1	4.2.1 and 4.2.3
ACS	D	A—Capability	MB	3.3.1.6.2	4.5.2
ADS	U	A—Definition Subfield	MA	3.3.1.5.1	
ADS1	U	A—Definition Subfield 1	ADS		
ADS2	U	A—Definition Subfield 2	ADS		
AP	U/D	Address/Parity		3.2.2.1	

Designator	Downlink/uplink	Name	Location	References	
				Content	Protocol
AQ	U	Acquisition, Special		3.3.1.2	4.2.2.1 and 4.2.2.2
AR	D	ASA Capability Report		3.3.2.1	4.2.3, 4.3.1, and 4.4
ARA	D	Active Resolution Advisories	MB and MV	3.3.2.4.1	
AV	U	TCAS Maneuver Advisory		3.3.2.2	4.4.1
BDS	D	B—Definition Subfield	MB	3.3.1.8	
BDS1	D	B—Definition Subfield 1	BDS		
BDS2	D	B—Definition Subfield 2	BDS		
BRG	U	Bearing	MU	3.3.2.5.2	4.4.2
BTI	U	Bearing Type Indicator	MU	3.3.2.5.2	4.4.2
CA	D	Capability			4.5.2
CHC	U	Cancel Horizontal Resolution Advisory Complement	MU	3.3.2.5.1	
CLI	D	Coordination Lock State Initiator Bit	MV	3.3.2.6.1	4.3.2
CLS	D	Coordination Lock State Bit	MB	3.3.2.4.1	
CRS	D	Crosslink Request Status Bit	MB	3.3.2.4.2	4.5.1
CVC	U	Cancel Vertical Resolution Advisory Complement	MU	3.3.2.5.1	4.3.1
DF	D	Downlink Format		3.2.2.1	
DR	D	Downlink Request		3.3.1.3	4.5.1
ECS	D	Extended Capability	MB	3.3.1.6.2	4.5.2
FS	D	Flight Status		3.3.1.4	4.2.1
HMA	U	Horizontal Maneuver Advisory	AV	3.3.2.2.1	4.4.1
HRC	U	Horizontal Maneuver Advisory Complement	MU	3.3.2.5.1	
IIS	U	Interrogator Identifier	SD	3.3.1.10.1	4.5.3
LCK	U	Coordination Lock Bit	MU	3.3.2.5.1	4.3.1.1 and 4.3.1.2
MA	U	Message, Comm-A		3.3.1.5 and 3.3.2.3	
MB	D	Message, Comm-B		3.3.1.6 and 3.3.2.4	
MID	U	Mode S Address	MU	3.3.2.5.1 and 3.3.2.5.2	
MTB	U	Multiple Threat Bit	MU	3.3.2.5.1	
MU	U	Message, Comm-U		3.3.1.7 and 3.3.2.5	
MV	D	Message, Comm-V		3.3.1.8 and 3.3.2.6	
ORC	D	On-board Resolution Capability Bit	MB	3.3.2.4.2	4.5.2
RAC	D	Resolution Advisory Complements	MB and MV	3.3.2.4.1	
RAL	U	Relative Altitude	MU	3.3.2.5.2	
RI	D	Air-Air Reply Information		3.3.1.9	4.2.3.1 and 4.2.3.2
RL	U	Reply Length		3.1.1.10	4.2.2.1 and 4.2.2.2
RR	U	Reply Request		3.3.1.11	4.5.1
RRG	U	Relative Range	MU	3.3.2.5.2	
SD	U	Special Designator		3.3.1.12	4.5.3
SL	D	TCAS II Sensitivity Level Report		3.3.2.7	4.2.3
SLC	U	TCAS II Sensitivity Level Command	MA	3.3.2.3.1	4.5.3
UDS	U	U—Definition Subfield	MU	3.3.2.5.1	
UDS1	U	U—Definition Subfield 1	UDS		
UDS2	U	U—Definition Subfield 2	UDS		
UF	U	Uplink Format		3.2.2.1	
VDS	D	V—Definition Subfield	MV	3.3.2.6.1	
VDS1	D	V—Definition Subfield 1	VDS		
VDS2	D	V—Definition Subfield 2	VDS		
VMA	U	Vertical Maneuver Advisory	AV	3.3.2.2.1	4.4.1
VRC	U	Vertical Resolution Advisory Complement	MU	3.3.2.5.1	4.3.1

Appendix B.—Index of Variables Used in Collision Avoidance Algorithms

This index lists in alphabetical order all variables used in the collision avoidance algorithms described in this Standard.

Variable	Reference
ADOT	5.2.1.2.2
ALIM	Table 5.2-3.
BEQ	5.2.1.

Variable	Reference
DMOD	Table 5.2-1.
HMD	5.2.1.2.2
H1	Table 5.2-1
ILEV	Table 5.2-3.
R	5.2.1.
RD	5.2.1.
RDTHR	Table 5.2-1.
SENSE	5.2.2.1.3.
SLINT	5.2.1.
SLOWN	5.2.1, 5.2.4.
T	5.2.2.1.3.
TAU	Table 5.2-1.
TCUR	5.2.2.1.3.
TESC	5.2.2.1.
TRTRU	5.2.1.2.2

Variable	Reference
TVPAMD	Table 5.2-1.
TVPESC	Table 5.2-3.
VACCEL	5.2.2.1.3.
VMD	5.2.1.2.2
Z	5.2.2.1.3.
ZD	5.2.2.1.3.
ZDGOAL	5.2.2.1.3.
ZDINT	5.2.1.
ZDOWN	5.2.1.
ZDTHR	Table 5.2.1.
ZINT	5.2.1.
ZOWN	5.2.1.
ZTHR	Table 5.2-1.

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federal register

Thursday
April 22, 1982

Part III

Department of Education

**Consolidated Grant Applications for
Insular Areas; Regulations and Request
for Comments**

DEPARTMENT OF EDUCATION

34 CFR Part 76

Consolidated Grant Applications for Insular Areas

AGENCY: Department of Education.

ACTION: Final regulations.

SUMMARY: The Secretary issues new final regulations for Consolidated Grant Applications for Insular Areas. These new regulations are required because the Education Consolidation and Improvement Act of 1981 modifies the Federal education programs that an Insular Area may consolidate under Title V of Pub. L. 95-134. The Consolidated Grant Applications for Insular Areas permit the Insular Areas to consolidate two or more educational programs listed in these regulations. Consolidated applications are intended to simplify application and reporting procedures and to give the Insular Areas greater flexibility in the use of Federal education funds.

EFFECTIVE DATE: Unless the Congress takes certain adjournments, these regulations will take effect 45 days after publication in the *Federal Register*. If you want to know if there has been a change in the effective date of these regulations, call or write the Department of Education contact person. At a future date, the Secretary will publish a notice in the *Federal Register* stating the effective date of these regulations.

FOR FURTHER INFORMATION CONTACT: Mrs. Shirley A. Jackson, Director, Office of State and Local Educational Programs, U.S. Department of Education, Room 2079, 400 Maryland Avenue, S.W., Washington, D.C., 20202; Telephone: (202) 245-8094.

SUPPLEMENTARY INFORMATION: Under Chapter 2 of the Education Consolidation and Improvement Act of 1981 (Pub. L. 97-35) (ECIA) several programs Insular Areas are authorized to consolidate under the Consolidated Grant Applications for Insular Areas, (Pub. L. 95-134), are folded into a block grant. Therefore, an amended list of programs an Insular Area may consolidate is presented in these regulations. Through these regulations, the Secretary also waives all requirements for matching funds for Insular Areas participating in the Consolidated Grant Applications Program.

In addition, these regulations clarify the eligibility of an Insular Area to consolidate grant funds; the disposition of carryover of funds from previous fiscal years; and those Federal

education programs under which consolidated grant funds may be spent.

Background

Title V of Pub. L. 95-134 allows Federal agencies to consolidate grants to the Insular Areas—Virgin Islands, Guam, American Samoa, Trust Territory of the Pacific Islands, and the Commonwealth of the Northern Mariana Islands. This consolidation is intended to reduce the administrative and financial burdens associated with the Federal assistance programs.

Overview of These Regulations

These regulations differ from the regulations for the Consolidated Grant Applications Program, which were published in the *Federal Register* on April 3, 1980, (45 FR 22648) in the following respects:

- Section 76.125 of these regulations includes a revised list of the programs that an Insular Area may consolidate.
- Section 76.130(d) clarifies that the eligibility of an Insular Area to receive grant funds under a Federal education program is determined under the specific statute and regulations for that program.
- Section 76.135 waives all requirements for matching funds for programs that an Insular Area consolidates.
- Section 76.136 indicates that an Insular Area may only use and administer funds under programs listed in § 76.125(c) for which funds have been appropriated by the Congress.
- Section 76.137 provides guidance regarding the expenditures of carryover funds.
- Many of the section headings have been modified, the term Secretary has been substituted for Commissioner; section numbers have been changed; and references to programs that have been changed by Pub. L. 97-35 (ECIA) have been revised.

Waiver of Proposed Rulemaking

In accordance with Section 431(b)(2)(A) of the General Education Provisions Act (20 U.S.C. 1232(b)(2)(A)), it is the practice of the Department of Education to publish regulations in proposed form and to offer interested parties the opportunity to comment on those proposed rules. However, these new regulations for the Consolidated Grant Applications for Insular Areas are published as final regulations because they do not differ substantially from the final regulations published on April 3, 1980, with the exception of the change in the list of Federal education programs an Insular Area may consolidate and the waiver of requirements for matching funds.

These regulations are being published at this time so that regulations reflecting the changes made by Pub. L. 97-35 and the Secretary's decision to waive requirements for matching funds will be in effect in time to avoid delays in soliciting and approving consolidated grant applications for funding prior to the beginning of fiscal year 1983.

For the reasons discussed above, the publication of these new regulations for the Consolidated Grant Applications for Insular Areas as a notice of proposed regulations would be impractical and contrary to the public interest, under 5 U.S.C. 553(b), if consolidated grants are to be made in a timely manner. Therefore, these regulations—which differ substantially from the April 3, 1980 regulations in only a few respects—are published as final regulations.

To assist the Department in complying with the specific requirements of Executive Order 12291 and its overall requirement of reducing regulatory burden, public comment is invited on whether there may be further opportunities to reduce any regulatory burdens found in these regulations. The Department is also interested in receiving suggestions from interested persons concerning how these regulations may be improved.

Comments or suggestions concerning the regulations should be sent to Dr. O. Ray Warner at the address given at the beginning of the preamble.

Executive Order 12291

These regulations have been reviewed by the Department in accordance with Executive Order 12291. They are classified as non-major regulations because they do not meet the criteria for major regulations established in the order.

Regulatory Flexibility Act Certification

The Secretary certifies that these regulations will not have a significant economic impact on a substantial number of small entities. These regulations concern only consolidated grant applications for Insular Areas. None of the Insular Areas is classified as a small entity.

Citations of Legal Authority:

A citation of statutory authority or other legal authority is placed in parentheses on the line following each substantive provision of these regulations.

List of Subjects in 34 CFR Part 76

Education, Grant programs—
education, Grants administration.

Intergovernmental relations, State—
administered programs.(Catalog of Federal Domestic Assistance
Number not applicable.)

Dated: April 15, 1982.

T. H. Bell,
Secretary of Education.**PART 76—STATE ADMINISTERED
PROGRAMS**

The Secretary revises §§ 76.125 through 76.137 of Part 76 of Title 34 of the Code of Federal Regulations to read as follows:

* * * * *

Consolidated Grant Applications for Insular Areas

Sec.

- 76.125 What is the purpose of these regulations?
- 76.126 What regulations apply to the consolidated grant applications for insular areas?
- 76.127 What are the purposes of a consolidated grant?
- 76.128 What is a consolidated grant?
- 76.129 How does a consolidated grant work?
- 76.130 How are consolidated grants made?
- 76.131 How does an insular area apply for a consolidated grant?
- 76.132 What assurances must be in a consolidated grant application?
- 76.133 What is the reallocation authority?
- 76.134 What is the relationship between consolidated and non-consolidated grants?
- 76.135 Are there any requirements for matching funds?
- 76.136 Under what programs may consolidated grant funds be spent?
- 76.137 How may carryover funds be used under the consolidated grant application?

Authority: Title V, Pub. L. 95-134, 91 Stat. 1159 (48 U.S.C. 1469a).

Consolidated Grant Applications for Insular Areas**§ 76.125 What is the purpose of these regulations?**

(a) Sections 76.125 through 76.137 of this part contain requirements for the submission of an application by an Insular Area for the consolidation of two or more grants under the programs listed in paragraph (c) of this section.

(b) For the purpose of §§ 76.125-76.137 of this part the term "Insular Area" means the Virgin Islands, Guam, American Samoa, the Trust Territory of the Pacific Islands, or the Commonwealth of the Northern Mariana Islands.

(c) The Secretary may make an annual consolidated grant to assist an Insular Area in carrying out one or more of the following programs—

CFDA No. and name of program	Authorizing legislation	Implementing regulations, Title 34 CFR (Part)
Library Programs		
84.034 Public Library Services State Grant Program...	Title I, Library Services and Construction Act (20 U.S.C. 351-354).	770
84.035 Interlibrary Cooperation	Title III, Library Services and Construction Act (20 U.S.C. 355e-355e-2).	770
Postsecondary Education Programs		
84.001 Grants for Construction, Reconstruction, and of Undergraduate Academic Facilities.	Title VII, Part E of the Higher Education Act (20 U.S.C. 1132b-1132b-2).	617
84.046 Education Outreach Programs.....	Title I, Part B of the Higher Education Act (20 U.S.C. 1011-1019).	610
84.135 Aid to Land-Grant Colleges	Second Morrill Act of 1890 (7 U.S.C. 322 and 323).....	621
Vocational and Adult Education Programs		
84.002 Adult Education—State-administered Programs.	Adult Education Act (except) Sections 309, 316 and 318) (20 U.S.C. 1201 et seq.).	426
84.048 Vocational Education—Basic Grants to States.	Title I, Part A of the Vocational Education Act (20 U.S.C. 2301-2380).	400
84.049 Vocational Education—Consumer and Homemaking Education.	Title I, Part A, Section 150 of the Vocational Education Act (20 U.S.C. 2380).	400
84.050 Vocational Education—Program Improvement and Services.	Title I, Part A, Section 130-136 of the Vocational Education Act (20 U.S.C. 2350-2356).	400
84.052 Vocational Education—Special Programs for the Disadvantaged.	Title I, Part A, Section 140 of the Vocational Education Act (20 U.S.C. 2370).	400
84.053 Vocational Education—State Advisory Council.	Title I, Part A, Section 105 of the Vocational Education Act (20 U.S.C. 2305).	400
84.121 Vocational Education—State Planning and Evaluation.	Title I, Part A, Sections 102 and 111 of the Vocational Education Act (20 U.S.C. 2302 and 2311).	400
Education for the Handicapped Programs		
84.009 Program for Education of Handicapped Children in State Operated or Supported Schools.	Section 554(a)(2)(B), of Chapter 1 of the Education Consolidation & Improvement Act of 1981 (20 U.S.C. 3803 and 20 U.S.C. 2771-2772).	302
84.027 Handicapped Preschool and School Programs—State Grant Programs.	Education of Handicapped Act Part B (except Section 619) (20 U.S.C. 1411-1418; 1420).	300
84.027 Handicapped Preschool and School Program—Incentive Grants.	Section 619 of the Education of the Handicapped Act (20 U.S.C. 1419).	301
Other Elementary and Secondary Programs		
84.010 Educationally Deprived Children—Local Educational Agencies.	Chapter 1 of the Education Consolidation and Improvement Act of 1981 (20 U.S.C. 3801-3807).	200
84.011 Migrant Education Programs State Formula Grant Program.	Section 554(a)(2)(A) of Chapter 1 of the Education Consolidation and Improvement Act of 1981 (20 U.S.C. 3803 and 20 U.S.C. 2781).	204
84.012 Educationally Deprived Children—State Administration.	Chapter 1 of the Education Consolidation and Improvement Act of 1981 (20 U.S.C. 3801-3807).	200
84.013 Educationally Deprived Children in State Administered Institutions Serving Neglected and Delinquent Children.	Section 554(a)(2)(C) of Chapter 1 of the Education Consolidation and Improvement Act of 1981 (20 U.S.C. 3803 and 20 U.S.C. 2781).	203
84.068 Indochinese Refugee Children Assistance Act.	Subpart C of the Consolidated Refugee Assistance Act (8 U.S.C. 1522).	537
84.150 Chapter 2—Consolidation of Federal Programs for Elementary and Secondary Education.	Chapter 2 of the Education Consolidation and Improvement Act of 1981 (20 U.S.C. 2811-3862).	298

§ 76.126 What regulations apply to the consolidated grant applications for insular areas?

The following regulations apply to those programs included in a consolidated grant:

- (a) The regulations in §§ 76.125 through 76.137; and
- (b) The regulations that apply to each specific program included in a consolidated grant for which funds are used.

(48 U.S.C. 1469a)

§ 76.127 What is the purpose of a consolidated grant?

An Insular Area may apply for a consolidated grant for two or more of the programs listed in § 76.125(c). This procedure is intended to—

(a) Simplify the application and reporting procedures that would otherwise apply for each of the programs included in the consolidated grant; and

(b) Provide the Insular Area with flexibility in allocating the funds under the consolidated grant to achieve any of the purposes to be served by the programs that are consolidated.

(48 U.S.C. 1469a)

§ 76.128 What is a consolidated grant?

A consolidated grant is a grant to an Insular Area for any two or more of the programs listed in § 76.125(c). The amount of the consolidated grant is the sum of the allocations the Insular Area receives under each of the programs

included in the consolidated grant if there had been no consolidation.

Example. Assume the Virgin Islands applies for a consolidated grant that includes programs under the Adult Education Act, Vocational Education Act, and Chapter 1 of the Education Consolidation and Improvement Act. If the Virgin Islands' allocation under the formula for each of these three programs is \$150,000; the total consolidated grant to the Virgin Islands would be \$450,000.

(48 U.S.C. 1469a)

§ 76.129 How does a consolidated grant work?

(a) An Insular Area shall use the funds it receives under a consolidated grant to carry out, in its jurisdiction, one or more of the programs included in the grant.

Example. Assume that Guam applies for a consolidated grant under the Vocational Education Act, the Handicapped Preschool and School Programs-Incentive Grants, and the Adult Education Act and that the sum of the allocations under these programs is \$700,000. Guam may choose to allocate this \$700,000 among all of the programs authorized under the three programs. Alternatively, it may choose to allocate the entire \$700,000 to one or two of the programs; for example, the Adult Education Act Program.

(b) An Insular Area shall comply with the statutory and regulatory requirements that apply to each program under which funds from the consolidated grant are expended.

Example. Assume that American Samoa uses part of the funds under a consolidated grant for the State program under the Adult Education Act. American Samoa need not submit to the Secretary a State plan that requires policies and procedures to assure all students equal access to adult education programs. However, in carrying out the program, American Samoa must meet and be able to demonstrate compliance with this equal access requirement.

(48 U.S.C. 1469a)

§ 76.130 How are consolidated grants made?

(a) The Secretary annually makes a single consolidated grant to each Insular Area that meets the requirements of §§ 76.125 through 76.137 and each program under which the grant funds are to be used and administered.

(b) The Secretary may decide that one or more programs cannot be included in the consolidated grant if the Secretary determines that the Insular Area failed to meet the program objectives stated in its plan for the previous fiscal year in which it carried out the programs.

(c) Under a consolidated grant, an Insular Area may use a single advisory council for any or all of the programs that require an advisory council.

(d) Although Pub. L. 95-134 authorizes the Secretary to consolidate grant funds that the Department awards to an Insular Area, it does not confer eligibility for any grant funds. The eligibility of a particular Insular Area to receive grant funds under a Federal education program is determined under the statute and regulations for that program.

(48 U.S.C. 1469a)

§ 76.131 How does an Insular Area apply for a consolidated grant?

(a) An Insular Area that desires to apply for a grant consolidating two or more programs listed in § 76.125(c) shall submit to the Secretary an application that—

(1) Contains the assurances in § 76.132; and

(2) Meets the application requirements in paragraph (c) of this section.

(b) The submission of an application that contains these requirements and assurances takes the place of a separate State plan or other similar document required by this part or by the authorizing statutes and regulations for programs included in the consolidated grant.

(c) An Insular Area shall include in its consolidated grant application a program plan that—

(1) Contains a list of the programs in § 76.125(c) to be included in the consolidated grant;

(2) Describes the program or programs in § 76.125(c) under which the consolidated grant funds will be used and administered;

(3) Describes the goals, objectives, activities, and the means of evaluating program outcomes for the programs for which the Insular Area will use the funds received under the consolidated grant during the fiscal year for which it submits the application, including needs of the population that will be met by the consolidation of funds; and

(4) Contains a budget that includes a description of the allocation of funds—including any anticipated carryover funds of the program in the consolidated grant from the preceding year—among the programs to be included in the consolidated grant.

(48 U.S.C. 1469a)

§ 76.132 What assurances must be in a consolidated grant application?

(a) An Insular Area shall include in its consolidated grant application assurances to the Secretary that it will—

(1) Follow policies and use administrative practices that will insure that non-Federal funds will not be supplanted by Federal funds made

available under the authority of the programs in the consolidated grant;

(2) Comply with the requirements (except those relating to the submission of State plans or similar documents) in the authorizing statutes and implementing regulations for the programs under which funds are to be used and administered, (except requirements for matching funds);

(3) Provide for proper and efficient administration of funds in accordance with the authorizing statutes and implementing regulations for those programs under which funds are to be used and administered;

(4) Provide for fiscal control and fund accounting procedures to assure proper disbursement of, and accounting for, Federal funds received under the consolidated grant;

(5) Submit an annual report to the Secretary containing information covering the program(s) for which the grant is used and administered, including financial and program performance information required under 34 CFR Part 74, Subparts I and J;

(6) Provide that funds received under the consolidated grant will be under control of, and that title to property acquired with these funds will be in, a public agency, institution, or organization. The public agency shall administer these funds and property;

(7) Keep records, including a copy of the State Plan or application document under which funds are to be spent, which show how the funds received under the consolidated grant have been spent.

(8) Adopt and use methods of monitoring and providing technical assistance to any agencies, organizations, or institutions that carry out the programs under the consolidated grant and enforce any obligations imposed on them under the applicable statutes and regulations.

(9) Evaluate the effectiveness of these programs in meeting the purposes and objectives in the authorizing statutes under which program funds are used and administered;

(10) Conduct evaluations of these programs at intervals and in accordance with procedures the Secretary may prescribe; and

(11) Provide appropriate opportunities for participation by local agencies, representatives of the groups affected by the programs, and other interested institutions, organizations, and individuals in planning and operating the programs.

(b) These assurances remain in effect for the duration of the programs they cover.

(48 U.S.C. 1469a)

§ 76.133 What is the reallocation authority?

(a) After an Insular Area receives a consolidated grant, it may reallocate the funds in a manner different from the allocation described in its consolidated grant application. However, the funds cannot be used for purposes that are not authorized under the programs in the consolidated grant under which funds are to be used and administered.

(b) If an Insular Area decides to reallocate the funds it receives under a consolidated grant, it shall notify the Secretary by amending its original application to include an update of the information required under § 76.131.

(48 U.S.C. 1469a)

§ 76.134 What is the relationship between consolidated and non-consolidated grants?

(a) An Insular Area may request that any number of programs in § 76.125(c)

be included in its consolidated grant and may apply separately for assistance under any other programs listed in § 76.125(c) for which it is eligible.

(b) Those programs that an Insular Area decides to exclude from consolidation—for which it must submit separate plans or applications—are implemented in accordance with the applicable program statutes and regulations. The excluded programs are not subject to the provisions for allocation of funds among programs in a consolidated grant.

(48 U.S.C. 1469a)

§ 76.135 Are there any requirements for matching funds?

The Secretary waives all requirements for matching funds for those programs that are consolidated by an Insular Area in a consolidated grant application.

(48 U.S.C. 1469a)

§ 76.136 Under what programs may consolidated grant funds be spent?

Insular Areas may only use and administer funds under programs listed in § 76.125(c)(1) during a fiscal year for which the Insular Area is entitled to receive funds under an appropriation for that program.

(48 U.S.C. 1469a)

§ 76.137 How may carryover funds be used under the consolidated grant application?

Any funds under any applicable program which are available for obligation and expenditure in the year succeeding the fiscal year for which they are appropriated must be obligated and expended in accordance with the consolidated grant application submitted by the Insular Area for that program for the succeeding fiscal year.

(20 U.S.C. 1225(b); 48 U.S.C. 1469a)

[FR Doc. 82-10929 Filed 4-21-82; 8:45 am]

BILLING CODE 4000-01-M

DEPARTMENT OF EDUCATION**34 CFR Part 76****Consolidated Grant Applications for Insular Areas; Request for Comments****AGENCY:** Department of Education.**ACTION:** Notice of proposed rulemaking; Cross-reference.**SUMMARY:** The Secretary proposes regulations for the Consolidated Grant Applications for Insular Areas. The regulations on which the Secretary invites comments are published in the

Rules and Regulations section of this issue of the **Federal Register**. They have been adopted as final regulations and will govern this program until the Secretary issues new regulations based on public comment.

DATES: All comments, suggestions, or objections must be received on or before June 7, 1982.**ADDRESSES:** Comments should be addressed to Dr. O. Ray Warner, U.S. Department of Education, Room 2079, 400 Maryland Avenue, SW., Washington, D.C. 20202-6263.**FOR FURTHER INFORMATION CONTACT:**

Dr. O. Ray Warner, Telephone: (202) 245-7793.

For additional details on how to comment, see the Preamble of the final regulations published in this issue of the **Federal Register**.

(Catalog of Federal Domestic Assistance Number not applicable.)

Dated: April 15, 1982.

T. H. Bell,*Secretary of Education.*

[FR Doc. 82-10930 Filed 4-21-82; 8:45 am]

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federal register

Thursday
April 22, 1982

Part IV

Environmental Protection Agency

**Polychlorinated Biphenyls (PCBs); Use in
Electrical Equipment; Proposed Rules**

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 761

[OPTS-62015B; TSH-FRL-2095-5]

Polychlorinated Biphenyls (PCBs); Use in Electrical Equipment

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: On February 12, 1981, the U.S. Court of Appeals for the District of Columbia Circuit issued an order requiring EPA to conduct a rulemaking concerning the use of Polychlorinated Biphenyl (PCBs) in electrical equipment. In response to the court's order, EPA proposes to amend the existing PCB rule to authorize the use of PCBs in capacitors and the use and servicing of PCBs in electromagnets, circuit breakers, voltage regulators, reclosers, cables, switches/sectionalizers, and transformers other than railroad transformers. EPA also proposes to amend other parts of the PCB rule to provide for the disposal and distribution in commerce of this electrical equipment.

DATES: An informal hearing, if requested, will be held on June 7, 1982 in Washington, D.C. The exact time and location of the hearing will be available by calling the Industry Assistance Office toll free at 800-424-9065 or, in Washington, D.C., by calling 554-1404. Comments on this proposed rule and requests to participate in the informal hearing must be submitted by May 24, 1982. This comment period is being limited to thirty days because EPA is under court order to promulgate a final rule by August 19, 1982.

ADDRESS: Comments should be sent to: Document Control Officer (TS-793), Office of Toxic Substances, Environmental Protection Agency, Room E-401, 401 M St., SW., Washington, D.C. 20460.

EPA requests that comments be submitted in triplicate. Comments should include the docket number, OPTS 62023. Comments received on this proposed rule will be available for review from 8:00 a.m. to 4:00 p.m., Monday through Friday, excluding holidays, in Room E-107, Environmental Protection Agency, 401 M St. SW., Washington, D.C.

Requests to participate in the informal hearing should be made in writing to the Industry Assistance Office (see address listed under "FOR FURTHER INFORMATION CONTACT"). All requests for participation must include at least an

outline of the topics to be addressed in the opening statement(s), the amount of time requested for the statement(s), and the names of the participants. Statements should not repeat information already presented in written comments, but should address additional information or issues. All hearings will be conducted in accordance with EPA's "Procedures For Rulemaking Under Section 6 of the Toxic Substances Control Act" (40 CFR Part 750).

FOR FURTHER INFORMATION CONTACT: Douglas G. Bannerman, Acting Director, Industry Assistance Office (TS-799), Office of Toxic Substances, Environmental Protection Agency, Rm. E-509, 401 M St., SW., Washington, D.C. 20460, Toll free: (800-424-9065), In Washington, D.C. (554-1404), Outside the USA: (Operator-202-554-1404).

SUPPLEMENTARY INFORMATION:

I. Background

Section 6(e) of the Toxic Substances Control Act (TSCA) generally prohibits the use of PCBs after January 1, 1978. The statute sets forth two exceptions under which EPA may, by rule, allow a particular use of PCBs to continue. Under section 6(e)(2) of TSCA, EPA may allow PCBs to be used in a "totally enclosed manner." A "totally enclosed manner" is defined, by TSCA to be "a manner which will ensure that any exposure of human beings or the environment to a polychlorinated biphenyl will be insignificant, as determined by the Administrator by rule." TSCA also allows EPA to authorize the use of PCBs in a manner other than a "totally enclosed manner" if the Agency finds that the use "will not present an unreasonable risk of injury to health or the environment."

EPA promulgated a rule, which was published in the *Federal Register* of May 31, 1979 (44 FR 31514), to implement sections 6(e) (2) and (3) of TSCA. This rule is listed in the Code of Federal Regulations under 40 CFR Part 761. The rule designated all intact, nonleaking electrical capacitors, electromagnets, and transformers other than railroad transformers as "totally enclosed," thus permitting their use without specific authorization or conditions. The Environmental Defense Fund (EDF) petitioned the U.S. Court of Appeals for the District of Columbia Circuit to review that portion of the PCB rule that designated the use of intact, nonleaking capacitors, electromagnets and transformers other than railroad transformers as "totally enclosed". (*Environmental Defense Fund, Inc. v. Environmental Protection Agency*, 636

F.2d 1267). On October 30, 1980, the court decided that there was no substantial evidence in the record to support the Agency's classification of transformers, capacitors, and electromagnets as totally enclosed. The court invalidated this portion of the rule and remanded it to EPA for further action. The effect of this decision would have been to make the use of capacitors, electromagnets, and transformers other than railroad transformers, containing any concentration of PCBs a violation of section 6(e) of TSCA. An immediate ban of these uses would not only disrupt electric service, but also cause severe economic hardship for the public and U.S. industry. EPA believed, and still believes, that it is completely impractical to take no action and allow a total ban on the use of this equipment to go into effect immediately.

On January 21, 1981, EPA, EDF, and certain industry intervenors in *EDF v. EPA* filed a joint motion with the court. The motion asked for an eighteen-month stay of the court's mandate setting aside the classification of transformers, capacitors, and electromagnets as totally enclosed. During the period of the stay, EPA agreed to conduct a rulemaking on the use of PCBs in electrical equipment beginning with an Advance Notice of Proposed Rulemaking (ANPR). In addition, the Edison Electric Institute (EEI) through the Utility Solid Waste Activities Group (USWAG) agreed to develop some of the factual material necessary for the rulemaking. The parties also agreed on interim risk-reduction measures (the Interim Measures Program) for transformers containing PCBs at 50 ppm or greater. They suggested that the court make these measures a condition of the eighteen-month stay. On February 12, 1981, the court granted the requests of the joint motion and entered an order. The text of the court's order was published in the *Federal Register* of March 10, 1981, along with EPA's ANPR on the use of PCBs in electrical equipment (46 FR 16090 and 46 FR 16096, respectively). The court's order allows the totally enclosed classification (40 CFR 761.30), to remain in effect for the duration of the stay. Therefore, persons who use PCB-containing transformers, capacitors, and electromagnets may use this electrical equipment during the stay, providing that they comply with the PCB rule and the Interim Measures Program which is detailed in the court's order.

The court's order requires EPA to promulgate a final rule within six months of receipt of the study from EEI/USWAG. Since the final report of the EEI/USWAG study was received on

February 19, 1982, EPA must promulgate a final rule on the use of PCBs in electrical equipment by August 19, 1982.

II. Electrical Equipment Containing PCBs

The rulemaking was initiated to deal with those uses of PCBs which EPA had formerly classified as totally enclosed (transformers other than railroad transformers, capacitors, and electromagnets). For the remainder of this notice any reference to transformers does not include transformers used on locomotives and self-propelled cars. While administering the existing PCB rule and while gathering information for this rulemaking, EPA has identified five additional types of oil-filled electrical equipment that contain PCBs. These are: voltage regulators, switches/sectionalizers, circuit breakers, reclosers, and cable. These uses were not addressed in the May 1979 PCB rule because EPA was not aware of their existence.

It is important to note that any use of PCBs not in a totally enclosed manner or specifically authorized by EPA is prohibited. EPA needs to identify all electrical equipment that contains PCBs and consider whether such uses should be allowed. Therefore, EPA requests comments regarding the exposures and benefits of all types of electrical equipment which contain PCBs, including any equipment types not covered by this proposed rule. The final rule may address additional uses of PCBs in electrical equipment that are brought to the Agency's attention.

While existing regulations technically do not permit the use of PCBs in voltage regulators, switches/sectionalizers, circuit breakers, reclosers and cables in concentrations greater than 50 ppm, EPA will not pursue enforcement action against persons who have used and are using such equipment while this rulemaking is pending, provided that such persons fully comply with the existing PCB rule and the requirements of the Interim Measures Program. If EPA were to prosecute such persons, a substantial portion of the electric service in the U.S. would be seriously affected. Furthermore, EPA does not believe that the current use of this oil-

filled electrical equipment while the rulemaking is pending presents a serious problem for four reasons. First, the length of time until there will be rules covering the use of these electrical equipment types is short; EPA expects to promulgate these final rules by August 19 of this year. Second, the total number of pieces of equipment and the total quantity of PCBs in use in these electrical equipment types is comparatively small. The EEI/USWAG study estimates that utility-owned voltage regulators, switches/sectionalizers, circuit breakers, cables, and reclosers contain a total of approximately 20,000 pounds of PCBs. This constitutes approximately 0.01 percent of the total number of pounds of PCBs used by utility companies. Third, based on the EEI/USWAG study, the concentration of PCBs in these electrical equipment types, the rates of leakage from them, and, consequently, the risks that may be presented appear to be no greater than the PCB concentration, leakage rate, and risks of oil-filled transformers which are permitted to be used under the current rule. Fourth, although the existing regulations do not allow the use of PCBs in these electrical equipment types, disposal of any item of electrical equipment containing PCBs in concentrations of 50 ppm or more is covered by existing PCB rules. Disposal of the liquid PCBs is covered under 40 CFR 761.10(a)(1) and disposal of the equipment is covered under 40 CFR 761.10(b)(4) in the existing rule. However, since the mineral oil contained in oil-filled electrical equipment is the same type of oil as that found in oil-filled transformers, this oil may also be disposed of in accordance with the provisions for mineral oil dielectric fluid from PCB-Contaminated Transformers (40 CFR 761.10(a)(2)) while this rule is pending.

III. The EEI/USWAG Study

The EEI/USWAG study gathered information on electrical equipment used in the electric utility industry, and did not gather information on nonutility equipment. Because the utility industry uses most of the types of equipment that contain PCBs and because EPA has no information indicating that utility and

nonutility equipment is significantly different, EPA is using this study as a major source of data for this proposed rule. Persons who believe that their experience with this equipment is different, or who have information on any types of equipment not covered by the EEI/USWAG study should submit relevant data to EPA. Useful data would include: Identification of other types of equipment, the number of units, the distribution of PCB concentrations, the propensity of the equipment to leak, and measures that could be taken to reduce the exposures associated with the use of the equipment. All data should be sent to the Document Control Officer listed under "ADDRESS" at the beginning of this notice.

The EEI/USWAG study provides information on the usage of PCBs in equipment in the electric utility industry, the propensity of the electrical equipment to lead or rupture, and an analysis of the feasibility of various measures to reduce or eliminate the risk of exposure to PCBs from the use of the electrical equipment. Because this study represents a major portion of the data base for this rulemaking, EPA solicits comments concerning all data contained in the study. Copies of the EEI/USWAG study are available for review in the public record for the rulemaking from 8:00 a.m. to 4:00 p.m., Monday through Friday, excluding holidays, in Rm. 107, East Tower, EPA, 401 M St., SW., Washington, D.C. Copies of the EEI/USWAG study are also available, for a fee, through the Edison Electric Institute which can be reached by calling 202-828-7630.

Data from the EEI/USWAG study concerning the number of electrical equipment types that contain PCBs, the amounts of PCBs contained within these units, and an estimate of the quantity of PCBs released annually through leaks and spills are summarized in the following Table 1.

The distribution of electrical equipment containing PCBs between utility and nonutility industries has been estimated from studies prepared for the May 1979 rule and the EEI/USWAG study. These data are summarized in the following Table 2.

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TABLE 1 SUMMARY OF EEL/USWAG DATA

	NUMBER OF UNITS IN UTILITY INDUSTRY	PERCENTAGE OF UNITS CONTAINING 50 PPM OR GREATER PCBs	PERCENTAGE OF UNITS CONTAINING 500 PPM OR GREATER PCBs	TOTAL POUNDS OF PCBS	PERCENTAGE OF TOTAL POUNDS OF PCBs	UPPER BOUND ESTIMATE OF ANNUAL POUNDS OF PCBs LEAKED/SPILLED
PCB TRANSFORMERS (ASKAREL)	39,640	100	100	74,597,283	45.92	20,448 ^b
LARGE PCB CAPACITORS	2,800,619	100	100	87,552,960	53.90	369,251
MINERAL OIL TRANSFORMERS	20,227,428	11.8	1.1	262,230	0.16	826
MINERAL VOLTAGE REGULATORS	145,159	14.0	1.7	6,707	<0.01	5
MINERAL OIL SWITCHES	385,768	14.0	0	329	<0.01	80 ^c
MINERAL OIL CIRCUIT BREAKERS	180,939	1.8	0	12,685	<0.01	51
MINERAL OIL RECLOSERS	170,158	0	0	410	<0.01	7 ^c
MINERAL OIL ELECTROMAGNETS	76	-	-	0.64 ^a	<0.01	-
MINERAL OIL CABLE	6,545 MILES	-	-	2,311 ^a	<0.01	-

a. Assumes an average PCB concentration of 10 ppm.

b. Assumes moderate leakage rates equal to mineral oil transformers.

c. Assumes moderate leakage rates equal to mineral oil circuit breakers.

TABLE 2 ESTIMATED EQUIPMENT DISTRIBUTION

PCB TRANSFORMERS (ASKAREL)	PERCENTAGE OF EQUIPMENT OWNED BY UTILITY INDUSTRY	PERCENTAGE OF EQUIPMENT OWNED BY NON UTILITY INDUSTRY	ESTIMATED TOTAL NUMBER OF UNITS
	30 ^a	70	132,133
LARGE PCB CAPACITORS	85 ^b	15	3,294,846
MINERAL OIL TRANSFORMERS	80 ^a	20	25,284,285
MINERAL VOLTAGE REGULATORS	85 ^c	15	170,775
MINERAL OIL CIRCUIT BREAKERS	85 ^c	15	212,869
MINERAL OIL RECLOSERS	85 ^c	15	200,186
MINERAL OIL CABLE	85 ^c	15	7700 MILES
PCB ELECTROMAGNETS	1	99	200
MINERAL OIL ELECTROMAGNETS	1 ^d	99 ^d	7600
SMALL PCB CAPACITORS	e	e	500,000,000 ^f

- a. Source: Microeconomic Impacts of the Proposed "PCB Ban Regulations", Versar, Inc., 1978.
 b. As reported by the National Electrical Manufacturers Association and referenced in the EEI/USWAG study.
 c. Assumes a distribution equal to that for large PCB Capacitors.
 d. Assumes that electric utility industry rarely uses electromagnets.
 e. Small capacitors are used by industry and by consumers. EPA has no information indicating that distribution.
 f. Assumes 870 million existed in 1977 and 10 percent are removed from service annually due to equipment or appliance obsolescence and capacitor failure.

IV. Use Authorizations

As previously described, section 6(e)(2) of the TSCA allows uses of PCBs in a totally enclosed manner to continue without restriction. Section 6(e)(2)(C) defines the term "totally enclosed" to mean "any manner which will ensure that any exposure of human beings or the environment to a polychlorinated biphenyl will be insignificant as determined by the Administrator by rule". In the May 31, 1979 rule, EPA defines insignificant exposure as "not measurable or detectable by any scientifically acceptable analytical method". After examining the information submitted in response to the ANPR, EPA has decided that no electrical equipment uses should be categorized as use in a totally enclosed manner. The leakage data contained in the EEI/USWAG study shows that all types of electrical equipment leak during normal operation. Since this leakage could result in some detectable exposure of humans and the environment to PCBs, EPA believes that it is not appropriate to classify the use of this equipment as use in a totally enclosed manner.

Alternatively, the use of electrical equipment could legally continue under an authorization granted by EPA using the provisions of section 6(e)(2)(B) of TSCA. In order to authorize a use of PCBs under this section, EPA must find that such use "will not present an unreasonable risk of injury to health or the environment." To determine whether a risk is unreasonable, EPA must balance the probability that harm will occur from the use, against the adverse effect on society of the proposed regulatory action. In determining whether an unreasonable risk is present, EPA has considered the following factors:

1. The effects of PCBs on human health and the environment.
2. The magnitude of PCB exposure to humans and the environment.
3. The benefits of using PCBs and the availability of substitutes for PCB uses.
4. The economic impact resulting from the rule's effect upon national economy, small business, technological innovation, the environment, and public health.

These are the same types of considerations listed in section 6(c) of TSCA, which describes factors EPA must consider in deciding whether a chemical presents an unreasonable risk under section 6(a) of TSCA.

A. EFFECTS ON HUMAN HEALTH AND THE ENVIRONMENT

In determining whether authorizations are warranted, EPA considered information regarding the effects of PCBs on human health and the environment. The adverse effects of PCBs were described in considerable detail in various documents which were part of the rulemaking record for the May 31, 1979 rule.

In addition, within the last six months, substantial comments have been submitted to EPA on the toxicity of PCBs. These recent comments were based, in part, on analyses by two consultants to industry—Drill, Friess, Hays, Loomis & Shaffer, Inc., and Ecology and Environment, Inc. These studies included a review of recently published information not available during the previous EPA rulemakings on PCBs. The comments contend that these studies show that PCBs do not pose any serious risk of injury to human health.

EPA is currently conducting an evaluation of this information and the recent literature on the effects of PCBs.

As would be expected, available information indicates that the risk of injury to human health and the environment is reduced as exposure to PCBs is reduced. EPA's analysis of alternative conditions for use authorizations includes examining the effectiveness of each condition in reducing exposure and thereby reducing the associated risk.

B. GENERAL BENEFITS OF USING ELECTRICAL EQUIPMENT

The electrical equipment being considered in this rulemaking is used extensively by electric utilities and other industries to provide efficient and reliable electrical energy. There are currently millions of pieces of electrical equipment containing PCBs in use. Although allowing the statutory ban to become effective is theoretically one available alternative, EPA believes an immediate ban on these uses would be unacceptable since it would disrupt electric service throughout the United States. An adequate supply of non-PCB replacement equipment and storage/disposal capacity is not immediately available. The resulting economic impact associated with an immediate ban has been conservatively estimated at about \$175 billion in the Regulatory Impact Analysis prepared for this rulemaking.

The other factors that EPA considered to determine whether these uses warrant authorization, the balancing of these factors, and EPA's conclusions regarding unreasonable risks are

discussed separately in this notice for each category of electrical equipment.

C. USE AND SERVICING OF TRANSFORMERS

Transformers are used extensively by electric utilities and other industries to transmit and distribute electric power efficiently. The use of PCBs in transformers has resulted in some transformers by design containing between 60 and 70 percent PCBs. It has also resulted in transformers designed to contain mineral oil dielectric fluid being contaminated with PCBs during past servicing and manufacturing activities.

From Table 2, there are 39,640 PCB Transformers in the electric utility industry and about 92,000 in all other applications. Many heavy industries, such as primary metals, use PCB Transformers in their plants. The table also shows that there are over 20 million mineral oil transformers in the electric utility industry and about 5 million in all other applications. Mineral oil transformers are used in a wide variety of places, including apartments, offices, and industry.

1. Magnitude of Exposure

Based on the initial inspections required by the Interim Measures Program, the EEI/USWAG study indicates that 12 percent of PCB Transformers show signs of "small" leaks and 4 percent show signs of "Moderate" leaks. A small leak is defined in the EEI/USWAG study as the presence of oil (fluid) on the surface of the equipment, without any oil running off the surface of the equipment. A moderate leak is defined as oil (fluid) running off the surface of the equipment. The EEI/USWAG study did not gather data from which an annual leakage rate could be calculated for PCB Transformers.

The EEI/USWAG study estimates that, on an annual basis, 0.15 percent of mineral oil transformers develop "small" leaks and that less than 0.09 percent develop "moderate" leaks. From electric utility records of PCB spills the study estimates that 0.007 percent of mineral oil transformers will develop a release of PCBs that results in 50 ppm or greater concentration in soil, gravel, fill rubble, other land base substance, or any release of PCBs into water.

From these data, the EEI/USWAG study estimates that 20,448 pounds of PCBs may be expected to leak annually from PCB transformers and less than 826 pounds of PCBs may be expected to leak annually from mineral oil transformers in the electric utility industry. In order to estimate leakage from PCB

Transformers, the study used the annual leakage rate for mineral oil transformers. Although projections from electric utility data to other kinds of transformer applications may be somewhat uncertain, EPA has extrapolated from utility industry leakage figures and used the percentage ownership figures of Table 2 to estimate the total PCB Leakage from transformers. EPA estimates that about 25,000 pounds of PCBs may be expected to leak annually from all PCB Transformers, and about 1000 pounds of PCBs may be expected to leak annually from all mineral oil transformers.

Because many transformers are located in the nation's electrical distribution system, much of which is located near consumers of electric power, leaks from these transformers have the potential to expose humans and the environment to PCBs. In addition, a release of PCBs in the environment has the potential to reach aquatic systems, build up in the food chain and ultimately expose humans.

2. Benefits of PCBs and Availability of Substitutes

Although the electrical properties of PCBs are not as good as mineral oil, PCBs have a higher fire point than mineral oil. It is the fire resistance of PCBs that makes it an excellent dielectric fluid in transformers located where concerns for fire safety are paramount.

Where flammability of the dielectric fluid is not an issue, PCB Transformers can be replaced by comparably rated mineral oil transformers. Mineral oil transformers can also replace PCB Transformers in locations where fire safety is an issue as long as fire codes and insurance requirements allow it. In most cases these restrictions require additional fire prevention measures such as vaults, sprinklers, alarms, etc., or moving the transformer out of the area of concern.

A number of substitute dielectric fluids have been developed to replace PCBs. The National Electrical Manufacturers Association estimates that new transformers to replace all PCB Transformers could be manufactured in five years or less using these substitute fluids. The substitute fluids offer satisfactory electrical properties and flammability characteristics which are much better than mineral oil. The EEI/USWAG study indicates that the dielectric fluids which equal PCBs in flammability are not widely used due to the potential toxicity of these compounds.

Substitutes for mineral oil transformers containing PCBs include

new equipment that does not contain PCBs and existing equipment which has been retrofilled (i.e., drained, flushed, and refilled) or otherwise processed to reduce PCB concentrations. The EEI/USWAG study estimates that replacement equipment and replacement dielectric fluid could be produced in as little as three years.

3. Economic and Environmental Impacts of Regulatory Options

EPA considered many options that would effectively reduce the risks of exposure from the use of PCBs in transformers. The options included: requirements to accelerate their phase-out, requirements to provide secondary containment, requirements to reduce PCB concentrations through retrofilling, requirements to implement inspection and maintenance procedures, and additional servicing restrictions. The costs and benefits associated with several of these options are discussed more completely in the Regulatory Impact Analysis developed for this rulemaking.

a. Accelerated Phase-Out. An accelerated phase-out would require transformer owners to replace their PCB-containing transformers with new equipment before the end of useful life. EPA's evaluation of accelerated phase-out examined current and future manufacturing and disposal capacity, the costs associated with accelerated phase-out, and the benefits of the reduced PCB exposure associated with removing PCB Transformers and mineral oil transformers from service before the end of their useful life.

Achievement of an accelerated phase-out depends upon the ability of transformer owners to remove the transformers, the ability of manufacturers to build replacements and on the ability of facilities to store and/or dispose of PCBs and PCB Transformers. It appears that the ability to remove PCB Transformers from service and replace them with non-PCB transformers is not a limiting factor in phasing out this use. According to the EEI/USWAG study, manufacturers could provide adequate supplies of replacement transformers within approximately 5 years after a requirement to replace them becomes effective.

The EEI/USWAG study estimates that it would require a minimum of 8.7 years for the two currently approved land based incineration facilities to dispose of the PCB dielectric fluid and solvent (used to rinse the transformer) generated from all utility-owned PCB Transformers and an additional 11.3 years to dispose of nonutility owned

PCB Transformers designed to contain PCBs. However, this calculation does not consider the disposal capacity of the incinerator ship Vulcanus which has been granted a permit to dispose of 3.6 million gallons of PCB-containing liquids. The Vulcanus can dispose of 900,000 gallons of these liquids on each trip to sea, with each trip lasting approximately two weeks. With Vulcanus operational, EPA estimates that the disposal of the liquid PCBs in all PCB Transformers can be accomplished in five years or less. Further, if additional disposal facilities become operational, this period would decrease.

The EEI/USWAG study estimated the cost to the phase out, in 10 years, all utility-owned transformers designed to contain PCBs to be \$590 million and the cost for a 20-year phase out to be \$346 million. These figures represent cash flows converted (discounted) to 1981 dollars. EPA's Regulatory Impact Analysis estimates these costs to be \$168 million for a 10-year phase-out and \$7 million for a 20-year phase-out. The reason for such a large difference in costs is that the EEI/USWAG study included in its calculation the expense associated with the purchase of new transformers and the disposal of ones replaced. This calculation ignores the fact that, even without a requirement for accelerated phase-out, these replacement and disposal costs will eventually be incurred anyway. Mandating equipment replacement merely accelerates the replacement schedule that would otherwise have prevailed. The economic impact of such a requirement is the loss of the use of the money spent on the phase-out from the time replacement is required to the time it would have otherwise occurred. The Regulatory Impact Analysis estimates the financial impact of this regulation as the loss of the use of this money. A more detailed explanation of this methodology is found in a 1980 study by Putnam, Hayes, and Bartlett (PHB), "Additional Regulation of Polychlorinated Biphenyls (PCB's) in Food-Related Industries Cost Impact Analysis." Using the ownership data in Table 2 to estimate the cost to phase-out nonutility transformers, EPA estimates that the total impact of a ten-year phase-out of all PCB Transformers could be \$560 million and a twenty-year phase-out could be \$23 million. This estimate uses a twelve-year average remaining life for PCB Transformers.

Accelerated phase-out of PCB-containing transformers would reduce the risks associated with the use of these transformers because all exposure which would have occurred in years

after completion of the phase-out is avoided. In considering the effectiveness of a required phase-out for transformers designed to contain PCBs and oil-filled transformers, EPA compared the economic benefit of authorizing the use of these transformers over various periods of time to the quantity of PCBs estimated to be released through leakage during that time. The economic benefit was calculated to be the benefit of delaying replacement and disposal costs. The pounds of PCBs released were derived from leakage rates contained in the EEI/USWAG study. EPA then calculated the cost effectiveness ratio of each phase-out period evaluated by dividing the benefits of the authorization by the pounds of PCBs released. EPA calculated that the cost effectiveness of authorizations for PCB Transformers with accelerated phase-out were: \$2,661 per pound of PCB released for a ten-year phase-out, \$2,484 per pound for a twenty-year phase-out, and \$2,471 per pound for thirty-year phase-out. For mineral oil transformers, the cost effectiveness of an authorization with an accelerated phase-out period of ten years is \$6,036,000 per pound; for a thirty-year period the ratio is \$13,695,000 per pound. Additional details concerning this analysis are contained in the Regulatory Impact Analysis.

In an accelerated phase-out of all mineral oil transformers containing 50 ppm or greater PCBs, the cost per pound of PCBs prevented from release to the environment is much larger than for PCB Transformers because mineral oil transformers contain less than 0.15 percent as many pounds of PCBs as PCB Transformers. In addition, only 12 percent of the mineral oil transformers contain 50 ppm or greater PCBs, and it would be necessary to test almost every transformer to locate the contaminated ones. The EEI/USWAG study estimates that an identification program would cost \$303 per test or over \$6 billion for all utility-owned mineral oil transformers.

b. Refilling and Secondary Containment. Refilling a transformer involves draining the PCB fluid, flushing the transformer, and refilling it with a non-PCB fluid. The EEI/USWAG study estimated the cost to refill all utility-owned PCB Transformers to PCB concentrations below 1000 ppm would be \$703 million. The estimates calculated in the Regulatory Impact Analysis indicate that the study's estimate is high, in part, because it assumes that three refilling operations are necessary to reduce PCB concentrations below 1000 ppm and

because it includes the cost of disposing of the PCB dielectric fluid originally removed from the transformer. It has been demonstrated that PCB concentrations can be reduced below 1000 ppm in two refilling operations. Also, the cost associated with disposing of the original dielectric fluid is not an incremental cost associated with refilling requirements. Disposal of this dielectric fluid is already required under the existing PCB rule (40 CFR 761.10). Using two refill operations per transformer, EPA estimates the cost to refill all utility-owned PCB Transformers to below 1000 ppm PCB would be \$517 million.

A refill of a PCB Transformer can reduce the PCB concentration of the dielectric fluid from approximately 70 percent to between one and eight percent. This represents a reduction of between 88 and 98 percent of the PCBs originally contained in the transformer. EPA is not aware of any refilling technology that has demonstrated the ability to reduce PCB concentrations further in one refill. Therefore, additional refilling procedures or other processing is required in order to further reduce PCB concentrations.

Secondary containment is a structural containment area in addition to the casing of a piece of equipment. In most cases, secondary containment of a liquid-filled transformer will contain any releases of dielectric fluid within a defined area. However, secondary containment is impractical for some transformers because of the inaccessibility of the specific installation. The EEI/USWAG study estimated the cost to provide secondary containment of all utility-owned PCB Transformers would be between \$417 million and \$722 million. These estimates are based on the assumptions that the secondary containment devices would be rapidly built and that 50 percent of all transformers are already pad-mounted. These estimates are not discounted. Using its own estimates of the average remaining life of transformers, and discounting (using a three percent real rate) the costs of inspection, EPA estimates the cost of secondary containment of all utility-owned PCB Transformers in the Regulatory Impact Analysis to be between \$410 and \$618 million.

Refilling and secondary containment reduce the risks associated with the use of PCB-containing transformers. Refilled transformers reduce potential exposure risks because the PCB concentration of the dielectric fluid has been reduced. Secondary containment reduces the potential that

PCBs released from a transformer will escape containment. However, the Regulatory Impact Analysis shows that the cost to refill all transformers exceeds the cost to immediately replace all of the transformers, and the option of secondary containment has very small positive benefits.

c. Inspection and Maintenance. The February 12, 1981, court order requires certain inspection and maintenance procedures for all PCB Transformers. In order to reduce the risks associated with the release of PCBs from PCB Transformers, this proposed rule considers similar inspection and maintenance procedures as a condition to the use authorization for this equipment.

Transformer leaks can grow over time because the PCB dielectric fluid causes gaskets to deteriorate. The longer a leak goes undetected, the worse it may become. EPA believes that a program of inspection and maintenance for PCB Transformers reduces the amount of PCBs released and PCB exposure by finding and stopping small leaks before they get larger. An inspection program also keeps company personnel informed and alert to the potential impact of PCBs discharged from electrical equipment so that they are more sensitive to observing leaks during their daily activities. Over 40 percent of the comments that were submitted in response to the ANPR either recommend making the requirements of the Interim Measures Program permanent, or find some benefit from such a program. No comments suggested that there is no benefit from the Interim Measures Program.

EPA is not aware of any data which relates the frequency of an inspection program to a specific reduction in releases of PCBs. However, although it is difficult to measure the exact amount of PCBs an inspection program will prevent from release to the environment, such programs do reduce exposures to PCBs with little additional costs. An inspection frequency of once every three months has been demonstrated to be practical and useful for PCB Transformers under the Interim Measures Program. Most comments in response to the ANPR have indicated that a quarterly inspection frequency is reasonable. EPA believes that a quarterly inspection frequency is appropriate for PCB Transformers because the EEI/USWAG study shows that they leak. The EEI/USWAG study estimates the cost to utilities of a quarterly inspection program for transformers designed to contain PCBs to be \$32 million over the useful life of

the transformers. This figure is not discounted and assumes a 20-year average remaining life for all transformers. EPA believes, based on a distribution of transformer ages related to sales of equipment, the correct average remaining useful life is 12 years. Using this figure and discounting with a 3 percent real rate, EPA estimates this cost to be \$14 million. These estimates are discussed further in the Regulatory Impact Analysis. Therefore, the average annual costs of a utility inspection and maintenance program is estimated by USWAG and the Regulatory Impact Analysis to be about \$1.6 million and \$1.2 million, respectively. The cost estimate would be increased by approximately a factor of three to about \$4 million when nonutility transformers are included. EPA believes that since an equivalent inspection program is already underway under the Interim Measures Program, the incremental costs of the proposed inspection program will be less than those estimated.

For all utility-owned mineral oil equipment containing at least 50 ppm PCBs including transformers the EEI/USWAG study estimates that the annual cost of a quarterly inspection program is approximately \$100 million. However, this study also estimates that it would cost an additional \$6.4 billion to identify the individual pieces of electrical equipment that contain PCBs. The EEI/USWAG study indicates that the PCBs in over 20 million mineral oil transformers represent only 0.35 percent of the PCBs in all utility-owned transformers. Therefore, an inspection program for mineral oil transformers would be much less effective at preventing releases of PCBs than would an identical program for PCB Transformers.

d. Servicing Restrictions. In general, if a transformer fails electrically, it can be rebuilt. Rebuilding is an open process that involves draining the transformer, removing and disassembling the core, reworking the coil or winding a new coil, reassembling the core, and refilling the transformer with new fluid.

If the transformer is a PCB Transformer, the shop personnel can be exposed to PCBs during rebuilding because the inner parts of the transformer are saturated with PCBs. For this reason, the May 31, 1979 rule prohibits any servicing of PCB Transformers that requires the removal of the transformer coil from the casing (40 CFR 761.31(a)(3)).

The existing rule also contains restrictions on the types of dielectric fluid that may be added to oil-filled transformers to insure that their level of

PCB contamination is not increased (40 CFR 761.31(a) (1) and (2)).

EPA believes that the current servicing restrictions are appropriate and necessary measures to prevent further PCB contamination of transformers during servicing activities and to reduce the exposure risks to servicing personnel. EPA also considered whether additional servicing restrictions were needed to prevent an unreasonable risk, but no additional servicing restrictions that might be reasonably cost-effective in further reducing risk have been identified. An analysis of existing servicing restrictions is found in the preamble and support documents to the May 31, 1979 PCB rule.

4. Findings on the Use and Servicing of Transformers

In view of the analysis above, EPA proposes to authorize the use of PCBs in PCB Transformers indefinitely. Since rebuilding of PCB Transformers is prohibited, the remaining service life of these transformers is limited. This use is subject to the condition that PCB Transformers receive a quarterly inspection for leaks of dielectric fluid. EPA also proposes to authorize the use of PCBs in mineral oil transformers indefinitely. Both of these uses are subject to existing servicing conditions. The specific use and servicing restrictions are set forth in this notice under 761.31(a) of the proposed language amending the PCB rule.

EPA is proposing no additional servicing restrictions for PCB-containing transformers. After reviewing the existing servicing conditions EPA could not identify any additional servicing restrictions that are reasonably cost effective in further reducing the risks associated with this activity.

EPA believes that authorizing the use of PCB transformers and mineral oil transformers containing PCBs with the proposed conditions does not present an unreasonable risk for the following reasons:

a. If EPA did not authorize the use of PCBs in transformers, it would cost the public and U.S. industry billions of dollars, primarily as a result of the disruption of electrical service. The resulting reduction in risk would not outweigh these substantial costs.

b. The proposed inspection and maintenance program reasonably reduces the exposure risks associated with the use of PCBs in these PCB Transformers, and the servicing conditions prevent further PCB contamination of the transformers. These measures are much less costly than a ban on the use of PCBs in transformers would be.

c. Releases of PCBs to the environment and exposure to humans and biological organisms from mineral oil transformers is expected to be very small. The EEI/USWAG study indicates that these transformers contain 0.35 percent of all the pounds of PCBs used in utility-owned transformers.

d. The costs associated with an accelerated phase-out or requirements to retrofit or contain in-service transformers are not reasonable when compared to the potential reduction in release of PCBs that they would achieve.

That is not to say that secondary containment or retrofitting are not effective means of limiting exposure and releases of PCBs in most cases. In fact these measures have a positive effect on limiting exposure and releases of PCBs from transformers. However, from EPA's initial analysis it appears that authorizing the use of transformers either with a requirement to provide secondary containment or with a requirement to retrofit would not result in net benefits (i.e., on average, equipment replacement would be preferred for economic reasons, although it might be preferable to contain or retrofit individual newer units if their age was known). The calculations supporting this conclusion are found in the Regulatory Impact Analysis.

Some industries have already initiated efforts to contain or retrofit PCB Transformers because of benefits in their specific cases. Therefore, to recognize the positive effect those actions have in reducing risks from PCB Transformers, this proposed rule provides for less frequent inspections for those PCB Transformers. For a PCB Transformer with secondary containment capacity of at least 100 percent of the transformer's total dielectric fluid volume, or a PCB Transformer which contains less than 60,000 ppm (6 percent) PCBs, a visual inspection is required only once every 12 months. Secondary containment of at least 100 percent of the transformer's total dielectric fluid volume will contain virtually all releases of PCBs from the transformer. Retrofitting a transformer reduces the amount of PCBs in a transformer by a factor of between 10 and 15, leaving a residual PCB concentration of between 30,000 and 80,000 ppm. EPA believes that, for transformers with these kinds of reduced risks, it is reasonable to inspect no more often than once per year. For the retrofitting option, EPA chose a 60,000 ppm PCB concentration cutoff because it has been shown to be an

achievable concentration after one carefully conducted retrofit.

The inspection required of a PCB Transformer by this proposed rule is a simple visual inspection for leaks of dielectric fluid on or around the transformer. The extent of a visual inspection will depend on the physical constraints of each transformer installation. No visual inspection should require an electrical shutdown of the transformer being inspected. Data on leakage in the EEI/USWAG study, taken from the Interim Measures Program, suggests that this type of inspection is effective in detecting leaks.

Follow-up maintenance activities to repair a leak are only required if corrective action is necessary to stop the leak. EPA recognizes that some small leaks of dielectric fluid are inherent to the operation of a transformer and repairs are not always required to stop a leak. A leak of dielectric fluid which has run off or is about to run off the external surface of the transformer clearly needs repair to prevent further leaking. A leak of dielectric fluid which does not form a run or drip, i.e. a sweat or a weep, and does not require repair to prevent further leaking, only requires proper cleanup. All leaks must be cleaned up within 48 hours and the PCB contaminated materials properly disposed of in a timely fashion. If dielectric fluid is actively leaking, the leak must be contained to prevent the PCBs from entering the environment and inspected daily to verify that the leak is being contained until the leak is corrected.

Recordkeeping requirements are proposed which indicate each PCB Transformer's inspection and maintenance history. These requirements will assist companies in the operation of their inspection and maintenance program and help management determine that the company is meeting the conditions of the use authorization. Standardizing these requirements aids EPA in assuring compliance with the rule. These records must be maintained for at least 5 years after disposing of the transformer. This time period provides a sufficient history for EPA to monitor compliance with a reasonable interval between compliance inspections. Because reporting requirements for PCB spills of at least 10 pounds are mandated under the Clean Water Act, for discharges to navigable waters, and under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund) for discharges to other

media, this rule does not propose any reporting requirements.

D. USE OF CAPACITORS

Capacitors are also used extensively by electric utilities and other industries. Large PCB capacitors are commonly used to improve the voltage and power factor of the electric power system. Virtually all capacitors manufactured prior to 1978 were filled with PCBs at a concentration near 100 percent. Capacitors manufactured after 1978 did not use PCB dielectric fluid.

1. Magnitude of Exposure

Based on inspections of equipment in substations, the EEI/USWAG study estimates that 2.3 percent of large PCB Capacitors develop "small" leaks and 0.77 percent develop "moderate" leaks, on an annual basis. The study uses electric utility records of PCB spills to estimate that 0.09 percent of large PCB Capacitors will annually develop a releases of PCBs that results in a contamination of 50 ppm or greater PCB in soil, gravel, fill, rubble, or other types of land, or any release of PCBs into water. From these data the study estimates that 369,251 pounds of PCBs may be expected to leak annually from utility-owned large PCB Capacitors. EPA extrapolates from these data and estimates that approximately 70,000 pounds of PCBs may be expected to leak from nonutility owned large PCB Capacitors.

Large PCB Capacitors are located within fenced electrical substations, within buildings, and on poles throughout the service areas of electric utilities. Because of this geographic distribution, these capacitors have the potential for exposing humans and the environment during their use.

2. Benefits of PCBs and Availability of Substitutes

The electrical properties of PCBs are so well suited as a dielectric fluid for capacitors that no other fluids were commonly used in capacitors prior to 1978. Since 1978, electric utilities and other industries have been installing non-PCB Capacitors with no apparent replacement or operational problems.

At current production levels, the EEI/USWAG study estimates that it would require 16.8 years for capacitor manufacturers to produce replacements for all Large High Voltage PCB Capacitors. With moderate changes in production, which would be expected in response to an accelerated phase-out under normal market conditions, the study estimates that production would increase by 50 percent and replacements could be produced within 8.4 years.

3. Economic and Environmental Impacts of Regulatory Options

The options EPA considered to reduce the risks from the use of PCBs in capacitors included: secondary containment requirements, accelerated phase-out requirements, and inspection and maintenance procedures. Retrofitting is not possible for capacitors. EPA also considered the option of authorizing capacitors for thirty years with no risk reducing conditions. A thirty-year authorization is tantamount to an unlimited authorization because no PCB capacitors were manufactured after 1978, and they have an expected life of 20-25 years. A more complete discussion of the costs and benefits associated with these alternatives is presented in the Regulatory Impact Analysis prepared for this rulemaking.

a. Secondary Containment. EPA considered secondary containment as a risk reduction measure for large PCB Capacitors. However, of all alternatives considered, an authorization with a requirement to provide secondary containment results in the lowest economic benefits. The calculation supporting this conclusion is contained in the Regulatory Impact Analysis.

Furthermore, because 65 percent of fluid spills from large PCB Capacitors are estimated to be the result of equipment ruptures, which can easily splatter fluid outside any containment area, EPA believes that secondary containment is limited in effectiveness. In addition, secondary containment may not be physically practical for some large PCB Capacitor installations.

b. Accelerated Phase-Out. EPA's evaluation of accelerated phase-out for large PCB Capacitors included consideration of current disposal and manufacturing capacity, and the cost and benefits of phase-out. The EEI/USWAG study estimated that it would require between 8.4 and 16.8 years for capacitor manufacturers to produce replacements for these units. With current incineration capacity remaining the same, the EEI/USWAG study estimates that it would require 19 years to incinerate existing PCB Capacitors owned by the electric utility industry. As with transformers, these periods would decrease with increases in approved disposal capacity. In the fall of 1981, the two currently approved land-based PCB incinerators performed tests to demonstrate their abilities to dispose of PCB Capacitors. On the basis of these tests, EPA expects that, by the effective date of this rule, these two incinerators could be disposing of PCB

Capacitors at a combined rate of approximately 5000 pounds per hour. Using this disposal rate and the same method of calculation employed in the EEI/USWAG study, it would require less than three years to incinerate all existing PCB Capacitors.

The EEI/USWAG study estimates the total discounted cost to phase out large PCB Capacitors in 10 years to be \$622 million and in 20 years to be \$277 million. EPA's Regulatory Impact Analysis estimates these costs to be \$259 million for a 10-year phase-out and \$17 million for a 20-year phase-out. As is the case for transformer phase-out, the reason for these differences is the methodology used to measure the costs. Including nonutility capacitors increases all cost estimates by about 18 percent.

In considering the effectiveness of a required phase-out for PCB Capacitors, EPA has compared the economic benefit of authorizing the use of these capacitors over various periods of time to the quantity of PCBs estimated to be released through leakage during that time. The economic benefit was calculated to be the benefit of delaying replacement and disposal costs, using the methodology described under "Accelerated Phase-Out" in the discussion of the regulatory options for transformers. The pounds of PCBs released were derived from leakage rates contained in the EEI/USWAG study. EPA then calculated the cost effectiveness ratio of each phase-out period evaluated by dividing the benefits of the authorization by the pounds of PCBs released. EPA calculated that the cost effectiveness of authorizations with accelerated phase-out were: \$166 per pound of PCB released for a ten-year phase-out, \$154 per pound for a twenty-year phase-out, and \$152 per pound for a thirty-year phase-out. Additional details concerning this analysis are contained in Regulatory Impact Analysis.

The advantages of removing large PCB Capacitors from service before the end of their useful lives include the prevention of PCB exposure to humans and the environment, and the avoidance of cleanup costs that result from releases of PCBs during the use of this equipment. PCB Capacitors contain the largest concentration of PCBs, and release the largest amount of PCBs annually of any electrical equipment. In most cases, large PCB Capacitors are only replaced after they have failed. This failure can be associated with leaks or spills of PCBs. Certain failures, such as case ruptures and leaks, are of particular concern because they can spread PCBs over a wide area around

the capacitor. The EEI/USWAG study reported that about 63% of the PCB Capacitors involved in spills suffered ruptures of the casings. These PCB Capacitor failures can release large quantities of PCBs directly in to the environment since each capacitor contains about 25 pounds of PCBs. Over the useful lifetime of PCB Capacitors this could result in releasing about 5.9 million pounds of PCBs in the environment. Although the inspection and maintenance program that is discussed later would probably provide some control over the potential for human and environmental exposure to PCBs from these capacitors, the only way to completely prevent significant releases from leakage and ruptures associated with the future use of PCB Capacitors is to replace them. In recognition of the hazard posed by PCB Capacitors, the potential financial burden associated with cleaning up leaks and ruptures, and other company specific benefits, several major utility companies have begun programs of accelerated phase-out. Typical phase-out periods range from three to eight years.

c. Inspection and Maintenance. The inspection procedures of the Interim Measures Program do not include requirements for PCB Capacitors. The Interim Measures Program was developed with the understanding that small leaks of dielectric fluid cause immediate failure or electrical isolation of a capacitor. Failed capacitors cease to function electrically and are no longer subjected to the stresses which occur during use and which can cause leakage. Therefore, it was the Agency's understanding that all capacitors that have small leaks have already failed electrically and are therefore unlikely to develop additional leakage. However, data from the EEI/USWAG study indicate that small leaks of dielectric fluid from capacitors can occur without causing immediate failure of the equipment. Therefore, an inspection program for leaks of dielectric fluid should be effective in locating some potentially defective capacitors before the capacitor fails and/or releases more PCB dielectric fluid. An inspection program would also locate and speed replacement of capacitors whose electrical failure would otherwise go undetected for a longer period of time and would hasten the cleanup of PCBs that have spilled, thereby reducing human and environmental exposure.

A program of inspection and maintenance is relatively inexpensive for large PCB Capacitors, but its effectiveness in preventing major leaks

and spills is questionable because, unlike the case of transformers, inspections of capacitors do not always provide warning of impending leaks. This is especially of concern to EPA because the EEI/USWAG study estimates 63.2 percent of spills result from case ruptures which normally occur without any warning.

While some large leaks that begin as small leaks may be prevented, the primary benefit of an inspection program is to allow for early detection of spills, thus leading to earlier clean up. However, it appears that the range of in effectiveness of clean-ups is likely to be wide. In some cases, cleanup may significantly reduce the potential for human and environmental exposure. For example, if a capacitor located over a field ruptured, the soil could be removed until no detectable PCBs remained. The contaminated soil would then be disposed of in an EPA-approved landfill. In this case, the cleanup would be very effective. However, if a capacitor located over a body of water ruptured, cleanup would probably be impossible.

The EEI/USWAG study estimates that quarterly inspections of utility-owned large PCB Capacitors over the useful life of the equipment would cost \$168 million. Because of differences in assumptions about the amount of remaining useful life, inspection costs, and the discount rate, the Regulatory Impact Analysis estimates this cost to be \$94 million. Since the average remaining life of a PCB Capacitor is considered to be 15 years by EEI, and 12 years by the EPA analysis, the average annual costs of quarterly inspections are estimated to be \$11.2 million by EEI and \$7.8 million by EPA.

EPA believes that these costs estimates would be reduced if they were calculated on an incremental basis, considering that a certain amount of utility-owned equipment is already being inspected. The EEI/USWAG study indicates that approximately 78 percent of the utilities sampled in the study routinely give these capacitors a visual inspection at least annually, and 31 percent inspect capacitors on a monthly or more frequent basis. EPA believes that the utility industry conducts these inspections to maintain the efficiency of its system since the primary purpose of capacitors is improving the efficiency of electric power transmission, and utilities usually cannot detect a capacitor failure without inspecting it. Because 31 percent of the utilities already inspect their capacitors monthly, the actual economic impact of a required quarterly inspection would be no more than \$40 million. The annual cost of quarterly

inspections should be no more than \$3.3 million, assuming an average useful life of capacitors of 12 years. All costs in this section would increase by 18 percent if nonutility capacitors are included.

4. Findings on the Use of Capacitors

Based on the risks and benefits discussed, EPA proposes to authorize the use of PCBs in capacitors, with conditions EPA believes are necessary to reduce the risks associated with the large quantities of PCBs that are released from large capacitors during their use. A ten-year phase-out is proposed. If large PCB Capacitors were phased out in 10 years, these capacitors would be a minimum of 14 years old and would have served most of their useful service lives.

Although EPA has not received any data which correlate the age of a capacitor with either the failure rate or the quantity of PCBs released upon failure, EPA is concerned that age and the stresses which can occur at failure influence the volume of PCB leaks and spills. EPA requests comments on these concerns, especially data which would document the effects that equipment age has on equipment failure rate and on the quantity of dielectric fluid released from large PCB Capacitors.

If all large PCB Capacitors are allowed to remain in service until they fail, there would be substantial costs associated with cleanup of spills and leaks. By phasing these capacitors out in 10 years, the companies avoid much of this cost. The EEI/USWAG study did not provide specific information concerning the costs of cleanup, but a report from Northeast Utilities Service Company estimated the average cost to clean up the spill from a ruptured capacitor to be \$1000. Using an average cleanup cost of \$1000 per capacitor (this amount could run much higher if the spill contaminated a lot of soil or other materials), and including nonutility capacitors, the costs of cleanups resulting from a 30-year authorization are estimated to be \$96 million more than the costs of cleanups associated with a 10-year authorization. Based on these costs, the ten-year phase-out could reduce total released by about 2.3 million pounds at a net cost of about \$208 million. The incremental cost of a ten-year phase-out would be about \$90 per pound of PCBs prevented from being released. EPA believes that this cost is reasonable, given the large quantity of PCB release that would be avoided.

EPA's cost estimates assume that there will be no transition costs resulting from the replacement of capacitors within ten years other than

those costs associated with early equipment replacement and PCB disposal at current market prices. Because of its tight rulemaking schedule, EPA has not yet had time to investigate, for this proposal, whether markets will be disrupted due to limited availability of equipment, or other factors, for the accelerated replacement. Nor has the Agency been able to examine the distributional impacts associated with the additional cost of phase-out including the impacts on utility financing, returns, electricity costs, and the impacts on firms other than utilities. The Agency requests comments on these and other consequences of the phase-out. The Agency intends to investigate these considerations, based on comments received on the proposal and continuing contractor analysis, prior to promulgating a final rule. Should these analyses reveal large, unanticipated impacts, the agency may conclude that the costs of the ten-year phase-out, are unreasonable and adjust or eliminate the requirement.

EPA also proposes that until large PCB Capacitors are properly disposed of, they must be inspected for leaks of dielectric fluid on a quarterly basis. EPA believes that, although its effectiveness is limited compared to phase-out, this program will prevent some capacitors from releasing PCBs while in use or stored for reuse and will speed the detection and cleanup of some PCB releases which have already occurred.

EPA seeks comments on the relative effectiveness of inspection and maintenance and phase-out, as well as the relative costs.

EPA finds that authorizing the use of PCBs in capacitors, with the proposed conditions does not present an unreasonable risk for the following reasons:

a. The use of PCBs in capacitors for the period specified would avoid disruption of electrical service and would save billions of dollars.

b. The inspection and maintenance program provides some comparatively inexpensive protection to the environment while the PCB Capacitors are in use. The 10-year phase-out should prevent about 2.3 million pounds of PCBs from entering the environment and thus potentially entering the food chain.

c. The cost of the inspection program is very small and reasonable in light of the alternatives and the potential risk reduction it affords.

d. The cost of 10 year phase-out is reasonable when compared to the large amount of PCBs it prevents from entering the environment (\$90 per pound).

The inspection of a large PCB Capacitor is a simple visual inspection for leaks of dielectric fluid on or around the capacitor. The extent of a visual inspection will depend on the physical constraints of each capacitor installation. No visual inspection should require an electrical shutdown of the capacitor being inspected or require that a distribution (telephone) pole be climbed to conduct an inspection.

Follow-up maintenance/replacement activities are required for any capacitor found to have a leak of dielectric fluid in any quantity. Any leak of dielectric fluid from a capacitor indicates that a breakdown in the dielectric fluid has occurred and more leaking and/or failure is forthcoming. This proposed rule requires that leaking capacitors be replaced and any PCBs released from the capacitor be cleaned up.

Recordkeeping is required of each large PCB Capacitor's inspection/replacement history to insure compliance with the conditions of the use authorizations. These records must be maintained at least 5 years after disposing of the capacitor. Recordkeeping for capacitors is needed for the same reasons as described for transformers. No reporting requirements are proposed since reporting requirements for PCB spills of 10 pounds or more are mandated under the Clean Water Act, for discharges to navigable waters, and under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund) for discharges to other media.

5. Small Capacitors

Small PCB Capacitors contain less than 3 pounds of dielectric fluid. These capacitors commonly contain between 0.1 and 0.6 pounds of PCBs and are used in fluorescent light ballasts, household appliances, and industrial equipment. In most applications, the equipment containing the small capacitor in its circuitry cannot function without it. In 1976, an EPA study estimated that 870 million small capacitors, containing 162 million pounds of PCBs, were in use in a wide variety of industrial machines and household appliances. EPA is not aware of any information which indicates that these capacitors have a different propensity to leak than other electrical equipment. Because of the widespread and scattered nature of their use and the small amount of PCBs contained within each individual small capacitor, all regulatory approaches targeted at controlling releases from these capacitors are very expensive when compared to the potential quantity of

PCBs kept from the environment. Consequently, EPA has not identified a reasonably cost-effective regulatory alternative that would result in significantly reducing the risks associated with the remaining small PCB Capacitors in service. Therefore, EPA is not proposing any restrictions regarding the use of PCBs in small capacitors. However, EPA retains its position of encouraging commercial and industrial firms that use the dispose of large quantities of small PCB Capacitors to establish voluntarily a collection and disposal program that results in waste capacitors being disposed of in an EPA-approved incinerator or chemical waste landfill.

EPA finds that the use of small capacitors containing PCBs is not unreasonable because their use provides society with the benefits from the use of millions of industrial machines and consumer products, it avoids the billions of dollars in cost of replacing these devices, and because there appear to be no practical risk reduction measures available.

E. HUMAN FOOD ANIMAL FEED

The February 12, 1981, court order requires special inspection procedures for transformers which are in a location that pose a risk of PCB exposure to human food or animal feed. This exposure risk is presumed to exist in any facility manufacturing, processing, packaging, or holding human food or animal feed, or in any federally inspected meat, poultry product or egg product establishment. The presumption does not apply to retail establishments such as grocery stores and restaurants.

Any leakage from such transformers has the potential to cause severe harm. One incident, involving a single PCB Transformer, occurred at a plant manufacturing animal feed ingredients. The contaminated feed was fed to poultry and livestock resulting in hundreds of millions of dollars of damages. Implicated food and feed products were distributed to nineteen states and two foreign countries.

EPA is considering requiring special risk reduction measures for PCB Transformers and large PCB Capacitors posing an exposure risk to food or feed products. Among the options EPA is considering for PCB Transformers and large PCB Capacitors posing an exposure risk to food or feed products are: An increased inspection frequency, a requirement to provide secondary containment, a requirement to accelerate the phase-out of PCB Transformers, a requirement to accelerate the phase-out of large PCB Capacitors at a faster rate than other

large PCB Capacitors, and a requirement to reduce the PCB concentration of the PCB Transformers to less than six percent.

1. Inspection

A 1980 study by Putnam, Hayes, and Bartlett (PHB) estimated that the food and animal feed industry owned seven percent of the PCB Transformers and large PCB Capacitors in use. Not all of these actually pose an exposure risk to food or animal feed products because some unknown fraction of them are located so that contamination of the products is physically impossible. EPA is considering requiring more frequent inspections only for those PCB Transformers and large Capacitors for which food or feed contamination is a physical possibility.

Even though not all transformers and capacitors pose an exposure risk to food or feed, EPA calculated the cost of an inspection program based on the total number of these units in food and feed facilities. This method will result in an overestimation of these costs. EPA estimated that the maximum total cost of weekly inspection over the remaining useful lives of PCB Transformers and large Capacitors posing an exposure risk to food or feed would be \$158 million. This cost will be spread unevenly over time because there will be less equipment to inspect each year due to attrition.

The Interim Measures Program required the weekly inspection of PCB Transformers and PCB-Contaminated Transformers posing an exposure risk to food or feed products. Several persons submitting comments on the ANPR suggested making this weekly inspection a permanent requirement for PCB Transformers but suggested not including inspection of PCB-Contaminated Transformers because of their lower PCB concentration and associated lower potential for exposure. EPA agrees with this comment. Because large PCB Capacitors also have a very high PCB concentration, EPA is proposing to require weekly inspection of PCB Transformers and large PCB Capacitors posing an exposure risk to food and feed products. EPA believes that PCB Capacitors in food and feed establishments should be inspected at the same frequency as PCB Transformers because this equipment poses similar if not increased risks of exposure and such equipment is usually located in the same general physical area. EPA solicits comments on the effectiveness of this inspection frequency.

The food contamination incident previously described which involved a

single PCB Transformer demonstrates that the cost to society of a PCB spill affecting food or feed can be more than one million dollars per pound of PCBs spilled. Therefore, only a very small reduction in PCB leakage is needed for inspection to be a cost effective measure in food and feed facilities. The Regulatory Impact Analysis contains an examination of the cost effectiveness of an inspection program, expressed as a percentage reduction in volume of PCBs spilled.

2. Accelerated Phase-Out

In considering an accelerated phase-out for PCB Transformers and Capacitors posing an exposure risk to food and animal feed, EPA considered current disposal and manufacturing capacity and the costs and benefits of phase-out. For reasons discussed earlier, EPA does not believe that disposal or manufacturing capacity would present limitations for phase-out periods as short as one year for PCB Transformers and large Capacitors posing an exposure risk to food or feed products.

The 1980 PHB study estimated the impact of replacing all PCB Transformers in food and feed facilities to be \$123 million and the impact of replacing all large PCB Capacitors to be \$209 million. These estimates do not include consideration of the savings from avoided cleanup and disposal costs that are associated with an accelerated phase-out. As discussed earlier, these costs can exceed several hundred million dollars in a food or feed facility.

3. Findings on the Use of PCBs Posing an Exposure Risk to Food and Feed

After considering all of these factors EPA proposes an increased inspection frequency for all PCB Transformers and PCB Capacitors that pose an exposure risk to food or feed products. These proposed restrictions appear as conditions to the use authorizations for this electrical equipment (40 CFR 761.31(a) and (1)). EPA finds that a weekly inspection frequency is not unreasonable primarily because of the large exposure risks associated with the use of PCB Transformers and Large PCB Capacitors near food and feed products. EPA is not proposing any requirements at this time for mineral oil-filled electrical equipment posing an exposure risk to food and feed products since most of this equipment is not used in food and feed facilities and in most cases contains very little PCBs.

EPA solicits comments on whether any of these risk reducing measures or some combination of them should be issued as regulations. Comments are

specially solicited concerning the following: a definition of when transformers and capacitors pose an exposure risk to food and feed, the costs and benefits of each of these options, an appropriate inspection frequency, and an appropriate length of time for phase-out.

In this notice EPA is not proposing to require accelerated phase-out of PCB Transformers in food or feed facilities or the phase-out of PCB Capacitors in these facilities at a faster rate than EPA is proposing for capacitors in other locations. However, because of the potential for accidents which could contaminate large quantities of food and animal feed, EPA is seriously considering such risk reduction measures for adoption in the final rule. EPA requests comments on the effectiveness and impact of accelerated phase-out requirements for PCB-containing electrical equipment in these facilities.

EPA is consulting with the Food and Drug Administration and the U.S. Department of Agriculture concerning whether special measures for PCB-containing electrical equipment should be required.

F. USE AND SERVICING OF VOLTAGE REGULATORS, SWITCH/SECTIONALIZERS, ELECTROMAGNETS, AND CABLE

Voltage regulators, switches/sectionalizers, and cable are used by electric utilities and industry to efficiently transmit and distribute electric power. The EEI/USWAG study described all of this electrical equipment as mineral oil-filled and not designed to contain PCB dielectric fluid. Electromagnets are primarily used over conveyor belts to remove iron from non-magnetic commodities and are not commonly used by the electric utility industry. Electromagnets designed to contain PCBs are used in areas such as coal mines, coal preparation plants, and coal-fired generating stations.

1. Magnitude of Exposure

The total pounds of PCBs in oil-filled voltage regulators, switches, cable, and electromagnets represent less than 0.01 percent of the total PCBs in-service in electrical equipment. The EEI/USWAG study estimates that the annual leakage of oil-filled voltage regulators and switches would amount to a release of 84.63 pounds of PCBs per year, but had insufficient data to estimate the annual leakage rates of oil-filled cable and electromagnets.

Leaks of dielectric fluid from oil-filled electrical equipment have the potential

for exposing humans or the environment to low concentrations (parts per million) of PCBs, because some of this equipment is used in the nation's electrical distribution system which is located near consumers of electric power. In addition, releases of PCBs anywhere in the environment have the potential to reach aquatic systems, build up in the food chain, and ultimately result in human exposure. Leaks of PCBs from electromagnets used in coal-handling systems, however, present negligible risks since the coal in these systems is handled automatically and eventually is burned in combustion devices capable of destroying PCBs.

2. Benefits of PCBs and Availability of Substitutes

The PCBs in almost all of this electrical equipment serve no specific purpose since the PCBs are in such small concentrations and are the result of inadvertent servicing and manufacturing activities. For this equipment, the PCBs provide no significant benefits. For any equipment designed to contain PCBs, the use of PCBs in the equipment provides the same safeguards against fire hazards as that described for transformers.

Substitutes for the mineral oil equipment containing PCBs include replacement with equipment that does not contain PCBs or processing the existing equipment to reduce PCB concentrations. The EEI/USWAG study estimates that replacement equipment and replacement dielectric fluid could be produced in as little as three years.

3. Economic and Environmental Impacts of Regulatory Options

EPA considered whether risk reduction measures were reasonable requirements for this electrical equipment. EPA considered measures including accelerated phase-out requirements, refilling requirements, secondary containment requirements, and inspection and maintenance requirements. These risk reduction measures carry costs and benefits that are similar to those discussed for mineral oil transformers. As is the case for mineral oil transformers, all risk reducing measures considered were very costly. The benefits of these measures ranged from eliminating the risks through phase-out to reducing the risks in other ways.

The PCB concentration in this electrical equipment varies, and the EEI/USWAG study estimates testing costs to be \$303 per sample. EPA has not identified a risk reduction measure which avoids the cost of testing most of the equipment to determine its PCB

concentration and does not require that all of this equipment be assumed to contain a PCB concentration subject to regulation. The small amount of PCBs contained within the oil-filled equipment and the even smaller amounts that are released from this equipment make any risk reduction measure very costly per pound of PCBs prevented from release.

EPA also considered servicing conditions for this use authorization. There are two general categories of servicing electrical equipment: Routine servicing and rebuilding. Routine servicing includes testing the dielectric fluid, filtering the fluid, and replacing gaskets. Routine servicing often requires the removal of some dielectric fluid. Although, these activities result in some human and environmental exposure, the exposure is normally limited to small quantities of PCB. Good management practices and protective clothing further reduce exposure to PCB. Routine servicing reduces the chances of catastrophic equipment failure from inadequate maintenance and also reduces the amount of dielectric fluid released from leaking equipment.

Rebuilding involves draining the equipment; removing, disassembling, and reworking internal parts; and refilling the equipment with new fluid. The inner parts of PCB-containing electrical equipment are saturated with PCBs, leading to much greater human and environmental exposure during rebuilding than routine servicing. Rebuilding a piece of electrical equipment can extend the useful service life of the equipment.

4. Findings on the Use and Servicing of This Electrical Equipment

EPA proposes to authorize the continued use of PCBs in voltage regulators, switches/sectionalizers, cable, and electromagnets indefinitely with no use restrictions. However, EPA proposes conditions for servicing activities in order to prevent this equipment from being further contaminated with PCBs and to reduce PCB exposure of servicing personnel and the environment during these activities. The proposed servicing restrictions are the same as the restrictions previously described and currently applicable to PCB-containing transformers and electromagnets (40 CFR 761.31 (a) and (h)) of the May 31, 1979 PCB rule.

The existing authorization for servicing transformers (40 CFR 761.31(a)) allows routine servicing of all PCB-containing transformers and rebuilding of those transformers that

contain less than 500 ppm PCB. This proposed use authorization contains similar conditions. Routine servicing will result in minimal exposures to PCBs and will lower the chance of catastrophic failure of the equipment and the associated exposure to PCBs. This use authorization prohibits any servicing, including rebuilding, that involves removing and reworking the internal components of electrical equipment containing PCBs at a concentration of 500 ppm or greater. Servicing such as rebuilding this electrical equipment substantially increases PCB exposure. Considering the PCB exposure that would result if such servicing were permitted, EPA believes that the impact of prohibiting such servicing is justified.

EPA finds that authorizing the use of PCBs in voltage regulators, switches/sectionalizers, cable, and electromagnets with the proposed servicing conditions does not present an unreasonable risk for the following reasons:

- Allowing this use of PCBs to continue avoids disruption of electric service and the costs associated with a prohibition.
- There is little PCB contamination of this oil-filled equipment and very small amounts of PCBs are expected to be released annually.
- EPA does not believe that the cost associated with restrictions regarding the use of this equipment is justified by the small PCB exposure that would be prevented by such measures.
- The proposed servicing restrictions will prevent easily avoidable human exposure to PCBs.

G. USE AND SERVICING OF CIRCUIT BREAKERS AND RECLOSERS

Circuit breakers and reclosers are used primarily by electric utilities to protect other equipment in the electric power system from damage caused by electrical faults. Circuit breakers and reclosers are types of oil-filled electrical equipment, generally not designed to contain PCBs. However, the EEI/USWAG study indicates that a small percentage of this electrical equipment contains PCBs resulting from past servicing and manufacturing practices.

1. Magnitude of Exposure

Although approximately 26.3 percent of all oil-filled circuit breakers can be expected to leak during an average year, this could amount to a release of only 50.88 pounds of PCBs, according to the EEI/USWAG study. The EEI/USWAG study indicates that releases of dielectric fluid from reclosers could amount to 6.64 pounds of PCBs per year.

As with other oil-filled electrical equipment, leaks of dielectric fluid have the potential for exposing humans and the environment to low concentrations of PCBs because of the equipment's location in the distribution network of the electric power system.

2. Benefits of PCBs and Availability of Substitutes

Both the benefits and availability of substitutes for PCBs in circuit breakers and reclosers are the same as that discussed for other mineral oil filled equipment (voltage regulators, switches, etc.).

3. Findings on the Use and Servicing of This Electrical Equipment

EPA considered requiring risk reduction measures as conditions on the use of circuit breakers and reclosers containing PCBs. EPA considered similar measures as those previously discussed for other oil-filled electrical equipment. As with the other oil-filled equipment, EPA was unable to identify a risk reduction measure which did not include testing costs (over \$106 million according to EEI/USWAG data) to identify which equipment contained PCBs or require the assumption that all the equipment contained PCBs subject to regulation. Because of the small amount of PCBs contained in this equipment and the even smaller amounts that are released from this equipment during use, any possible risk reduction measure would be very costly in comparison to the pounds of PCBs prevented from release. In addition, conditions to reduce exposure during servicing would have very little positive effect.

Because oil-filled circuit breakers and reclosers are only slightly contaminated with PCBs and only very small amounts of PCBs are released annually from this equipment, EPA proposes to authorize the continued use of PCBs in this equipment indefinitely without use restriction. EPA believes that such use restrictions are not justified by the amount of PCBs they would prevent from reaching the environment. More than 98 percent of this equipment does not contain dielectric fluid that is subject to any PCB disposal requirements. Therefore, EPA proposes only servicing conditions for this equipment to prevent further PCB contamination. EPA believes that this use authorization with the proposed conditions does not present an unreasonable risk.

V. Other Proposed Changes to the PCB Rule

A. PCB-CONTAMINATED ELECTRICAL EQUIPMENT

Although the use of PCBs in certain electrical equipment is authorized regardless of PCB concentration, the disposal requirements of the May 1979 PCB rule makes certain distinctions on the basis of PCB concentration. That is, different disposal requirements apply to PCBs at concentrations of 500 ppm or greater and at concentrations between 50 and 500 ppm. EPA proposes several modifications to its PCB rule to ensure that all oil-filled electrical equipment with similar levels of PCB contamination will be subject to the same requirements. This is appropriate because these different types of equipment use the same oil, and draining the oil from the equipment leaves the same degree of residual PCB contamination.

Because this rulemaking has identified electrical equipment containing PCBs that was not previously recognized in the PCB rule, changes are proposed to the definitions presented in the rule. The proposed rule deletes the definition of a "PCB-Contaminated Transformer" (40 CFR 761.2(z)) and substitutes a definition titled "PCB-Contaminated Electrical Equipment."

"PCB-Contaminated Electrical Equipment" means any electrical equipment that contains at least 50 ppm, but less than 500 ppm PCB. Electrical equipment includes transformers, capacitors, voltage regulators, electromagnets, cable, circuit breakers, reclosers, and switches/sectionalizers.

EPA has received data from the EEI/USWAG study regarding the PCB concentrations in different types of electrical equipment. Data from this study indicate that 12 to 14 percent of oil-filled transformers, voltage regulators, and switches contain PCB concentrations of 50 ppm or greater, but PCB concentrations greater than 500 ppm in this equipment are rare, estimated to occur in less than 2 percent of the equipment. Because the contamination was caused by unintentional manufacturing and servicing practices, it is impossible to determine for certain which pieces of equipment are contaminated without testing them all. According to the EEI/USWAG study, the cost of such testing would be \$6.4 billion. Based on these data, EPA proposes that all oil-filled transformers, voltage regulators, switches, electromagnets and cable must be assumed to be PCB-Contaminated Electrical Equipment

unless the oil has been tested, or otherwise verified, and found not to contain between 50 and 500 ppm PCB. This will allow owners of this equipment to avoid the cost of testing if they choose. Data from the EEI/USWAG study on oil-filled cable was based on test results from only one company. Based on a limited sampling program, this company found no cable oil with PCB concentration in excess of 10 ppm. EPA does not believe that it is appropriate to exclude oil-filled cable from the category of PCB-Contaminated Electrical Equipment based on data from only one company. Therefore, EPA proposes that oil-filled cable must be assumed to have a PCB concentration between 50 and 500 ppm if the concentration is unknown.

The EEI/USWAG study did not contain any monitoring data on the PCB concentration in oil-filled electromagnets. Because the same kind of oil is used in electromagnets as in other types of oil-filled equipment, there is no reason to believe its PCB concentration would frequently exceed 500 ppm. Therefore, EPA proposes that oil-filled electromagnets be included in the category of PCB-Contaminated Electrical Equipment so that they must be assumed to have a PCB concentration between 50 and 500 ppm if the concentration is unknown.

Data from the EEI/USWAG study also indicate that oil-filled circuit breakers and reclosers are rarely contaminated with PCB concentrations of 50 ppm or greater, less than 2 percent. Using the EEI/USWAG data, it should cost approximately one million dollars to identify the utility-owned circuit breakers whose PCB contamination exceeds 50 ppm. Because the cost of either testing all the equipment or treating it as contaminated in excess of 50 ppm is high relative to the number of pieces of equipment that are likely to contain greater than 50 ppm, EPA is proposing that oil-filled circuit breakers and reclosers need not be classified as PCB-Contaminated Electrical Equipment if the PCB concentration is unknown.

B. CLARIFICATION OF EXISTING DEFINITIONS

This proposal changes the definitions of "Large High Voltage Capacitor" and "Large Low Voltage Capacitor" (40 CFR 761.2(d)(2) and (3) respectively) to clarify that the rule includes capacitors operating on direct current (d.c.). EPA's policy has always been to include d.c. capacitors under these definitions.

The definition of a small capacitor is that the capacitor contains less than three pounds of dielectric fluid. In the absence of nameplate information, it is

sometimes very difficult to determine the weight of dielectric fluid in a capacitor. Therefore, this notice proposes to amend the definition of a small capacitor (40 CFR 761.2(d)(1)) to allow the assumption that a capacitor whose total weight is less than 4.0 kg (8.8 lbs) contains less than 1.36 kg (3 lbs) of dielectric fluid. Because some capacitors installed in equipment may be difficult to weigh, this notice proposes to allow the assumption that a capacitor whose volume is less than 1639 cubic centimeters (100 cubic inches) contains less than 1.36 kg (3 lbs) of dielectric fluid. These assumptions are based on information received from one capacitor manufacturer.

This proposal adds a comma to the definition of a PCB Article to clarify that a PCB Container is not a PCB Article.

C. DISTRIBUTION IN COMMERCE

Section 6(e)(3)(A)(ii) of TSCA prohibits the distribution in commerce of PCBs after July 1, 1979, but section 6(e)(3)(C) excludes from this ban PCBs sold before July 1, 1979, for purposes other than resale. Since almost all PCBs were sold for use before July 1, 1979, section 6(e)(3)(C) allows the distribution in commerce of almost all PCB-containing equipment, including the equipment covered by this proposal. EPA incorporated this provision into the PCB rule under 40 CFR 761.30(c)(1), coupling it with the condition that only nonleaking, intact PCB-containing equipment could be distributed in commerce. This was accomplished by requiring that, to qualify for the 6(e)(3)(C) exclusion, the distribution has to be done in a totally enclosed manner, and by finding that the distribution in commerce of intact, nonleaking PCB Transformers, PCB-Contaminated Transformers, PCB Capacitors, and PCB electromagnets is a totally enclosed activity. Intact, nonleaking equipment does not release PCBs. The distribution in commerce of such equipment must therefore be totally enclosed.

EPA included these provisions in the rule to insure that PCBs would not be released from transformers, capacitors, and electromagnets being distributed in commerce under the provisions of section 6(e)(3)(C). In order to have the same assurance for other electrical equipment containing PCBs, EPA proposes to find the distribution in commerce of only intact and nonleaking voltage regulators, circuit breakers, reclosers, switches/sectionalizers, and cable a totally enclosed activity. Coupled with 40 CFR 761.30(c)(1), this will restrict the applicability of section 6(e)(3)(C) to intact, nonleaking equipment. Persons wishing to distribute

in commerce electrical equipment which is not intact and nonleaking must apply for an exemption from the ban on distribution in commerce, using the exemption procedures found in 40 CFR 750.

D. DISPOSAL REQUIREMENTS

Since this rulemaking has identified uses of PCB-containing electrical equipment not recognized in the earlier PCB regulations, changes are proposed in the disposal requirements for PCBs and PCB Items.

1. Mineral Oil Dielectric Fluid

Formerly, mineral oil dielectric fluid from PCB-Contaminated Transformers could be disposed of according to the options under 40 CFR 761.10(a)(2) of the PCB rule. Since the mineral oil contained in PCB-Contaminated Electrical Equipment is the same type of oil as that found in PCB-Contaminated Transformers, this proposed rule allows mineral oil dielectric fluid from any type of PCB-Contaminated Electrical Equipment to be disposed following the requirements of 40 CFR 761.10(a)(2). All mineral oil from transformers, electromagnets, voltage regulators, cable, and switches/sectionalizers is subject to the disposal requirements of this section, unless the oil has been tested (or otherwise verified) and found to contain less than 50 ppm PCBs. Mineral oil from oil-filled circuit breakers and reclosers may be assumed to contain less than 50 ppm PCBs if the actual concentration is unknown. The EEI/USWAG study indicates that it is rare to find a circuit breaker or recloser containing PCBs at concentrations of 50 ppm or greater and the total amount of PCBs in this equipment is small.

2. PCB Items

This proposed rule does not impose any disposal requirements on PCB-Contaminated Electrical Equipment which has been drained of all free flowing liquid under 40 CFR 761.10(b)(4). This is to insure consistency with the existing requirement for the disposal of PCB-Contaminated Transformers.

The existing rule defines a PCB Article as containing PCBs at any concentration equal to or greater than 50 ppm. The rule requires that drained PCB Articles other than transformers be disposed of in an EPA-approved incinerator or an EPA-approved chemical waste landfill. In order to make disposal requirements consistent between PCB-Contaminated Electrical Equipment and PCB Articles with PCB concentrations less than 500 ppm, this proposed rule changes the applicability

of disposal requirements for PCB Articles. Under the proposed rule, the disposal requirements for PCB Articles in 40 CFR 761.10(b)(5) would apply only to PCB Articles whose liquid contents have a PCB concentration of 500 ppm or more. The disposition of a PCB Article containing less than 500 ppm PCBs would not be regulated, once all free flowing liquid has been drained from the PCB Article.

The May 1979 rule lowered the PCB concentration cutoff below which PCB disposal was unregulated from 500 ppm to 50 ppm. In order to handle the associated tenfold increase in volume of PCB waste requiring disposal, EPA added disposal alternatives which are estimated to provide less complete destruction than can be achieved by an EPA-approved incinerator. EPA estimated that this relaxation in disposal requirements would result in only 10 additional pounds of PCBs entering the environment annually, based on an estimated 400,000 pounds of PCBs in mineral oil transformers.

EPA estimates that there are less than 200,000 pounds of PCBs contained in PCB Articles at concentrations between 50 and 500 ppm. Consequently, this proposed change in the disposal requirements will result in the release to the environment of less than five pounds of PCBs per year.

Although this rule does not require testing of mineral oil dielectric fluid for PCB concentration, some people may choose to do so. In order to reduce the costs associated with testing for PCB concentrations in mineral oil dielectric fluid, this proposed rule allows common container collection ("batch testing") of mineral oil dielectric fluid from all electrical equipment containing mineral oil dielectric fluid (see 40 CFR 761.10(g)(1)). Common container collection is permitted so that mineral oil from multiple sources can be collected and tested without requiring a separate test of each individual piece of electrical equipment to determine disposal options.

3. Spills and Leaks

In order to clarify when clean-up of PCB spills and leaks is required and how much clean-up must be done, the Agency is proposing changes in (1) the definition of "disposal" (40 CFR 761.1(h)), and (2) the spills provision of the disposal requirements (40 CFR 761.10(d)). These proposed changes make the disposal definition and spills provision consistent with the use authorizations which are also being proposed today. Like the May 31, 1979 rule, this proposal treats chemical substances and combinations of

substances which have been diluted to contain less than 50 ppm PCBs as PCBs at greater concentrations.

The Agency proposes to clarify the definition of disposal by specifically including spills, leaks, and other uncontrolled discharges of PCBs. This change should alleviate the confusion the Agency has encountered in enforcing the existing rule over whether spills, leaks, and other uncontrolled discharges constitute disposal.

The May 31, 1979 rule regulates disposal of chemical substances and combinations of substances containing 50 ppm or greater PCBs. As dilution is an unacceptable form of disposal under the May 31, 1979 rule, the Agency has the authority to require that contamination from spills, leaks, and other uncontrolled discharges be cleaned up to pre-existing background levels if the source of contamination contained 50 ppm or greater PCBs prior to dilution.

The Agency will require clean-up to background levels in all cases where there is a threat of contamination to water, food, feed, and humans. Examples of such cases include spills, leaks, or other uncontrolled discharges: (1) Into water, (2) near water if runoff or erosion might contaminate the water or sediments, (3) into areas which could expose the public (e.g., schoolyards, parking lots, and residential areas), (4) into food and feed products, and (5) into food and feed production or processing areas. In certain cases the Agency will allow clean-up to levels greater than preexisting background levels. In all cases the Agency will require clean-up to levels below 50 ppm.

VI. Executive Order 12291

Under Executive Order 12291, issued February 17, 1981, EPA must judge whether a rule is a "major rule" and, therefore, subject to the requirement that a Regulatory Impact Analysis be prepared. EPA has determined that this amendment to the PCB rule is not a major rule as the term is defined in section 1(b) of the Executive Order.

EPA has concluded that the amendment is not "major" under the criteria of section 1(b) because the annual effect of the rule on the economy will be less than \$100 million; it will not cause a major increase in costs of prices for any sector of the economy or for any geographic region; and it will not result in any significant adverse effects on competition, employment, investment, productivity, or innovation or on the ability of United States enterprises to compete with foreign enterprises in domestic or foreign markets. In fact, this proposed rule allows uses of PCBs in

electrical equipment to continue that would otherwise be prohibited by section 6(e) of TSCA. This proposed rule, if promulgated, would avoid severe disruption of electric service to the public and industry that would occur if the use were prohibited. It also greatly reduces the economic impact that would result from a requirement to replace the equipment as soon as possible. However, although this proposal is not a major rule, EPA has prepared a Regulatory Impact Analysis using the guidance in the Executive Order to the extent possible within the time constraints of the court's order.

This proposed amendment was submitted to the Office of Management and Budget (OMB) prior to publication as required by the Executive Order.

VII. Regulatory Flexibility Act

Section 603 of the Regulatory Flexibility Act, 5 U.S.C. 603, requires EPA to prepare and make available for comment an "initial regulatory flexibility analysis" in connection with any rulemaking for which there is a statutory requirement that a general notice of proposed rulemaking be published. The "initial regulatory analysis" describes the effect of the proposed rule on small business entities.

Section 604(b) of the Regulatory Flexibility Act, however, provides that section 603 of the Act "shall not apply to any proposed . . . rule if the head of the Agency certifies that the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities.

The effect of this proposed rule is to avoid severe disruption of electric service to industry and the public and to reduce the costs of complying with TSCA. In general, this proposed rule will reduce the burden on small businesses that would otherwise be encountered if an immediate ban on PCB-containing electrical equipment were to take effect. Numerous small businesses will benefit from this proposed rule, albeit indirectly, because they will still have electric power and utilities will not pass on to them the additional costs of complying with TSCA. Since the actual distribution of electrical equipment ownership is unknown, very rough estimates were calculated of the average impact on small utility and non-utility companies. The upper-bound estimate of the impact on the average small utility company of a ten-year phaseout of large PCB Capacitors is \$24,000 per utility. This is an upper-bound estimate since a "small" utility is considered anything other than the 100 largest utilities. The upper-bound impact on the average small non-utility

business was also estimated. Since the number of firms within the smallest segment of non-utility industries was not available, the impact per firm on the bottom 30 of the largest 50 firms in an industry was estimated to be \$50,000, and was used as an approximation of the impact on the average small non-utility company. Spreading out these impacts over the ten year PCB Capacitor phaseout period, the impact would be less than \$2,400 per year for a small utility company, and less than \$5,000 per year for a small non-utility company. For a more detailed discussion of the proposed rule's effect on small businesses, refer to Chapter 6 of the Regulatory Impact Analysis.

Since the effect of this rule avoids the economic impact associated with a disruption of electric service and based on the initial regulatory analysis which indicates that there is a net benefit from the proposed rule, I certify that this rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. Therefore, an "initial regulatory flexibility analysis" is not required and will not be prepared for this rulemaking.

To further carry out the intent of the Regulatory Flexibility Act, EPA especially solicits comments from the owners of small businesses concerning the impact of this proposed rule. In this regard, EPA is sending a copy of this proposed rule to the Electrical Apparatus Service Association, Inc. (EASA), a trade association representing small businesses who handle PCB-containing electrical equipment and to the National Rural Electric Cooperative Association (NRECA), a trade association representing small electric utilities who use PCB-containing electrical equipment. EPA is also sending a copy of the proposed rule to the Chief Counsel for Advocacy of the Small Business Administration.

VIII. Paperwork Reduction Act

The Paperwork Reduction Act of 1980 (PRA), 44 U.S.C. 3501 *et seq.*, authorizes the Director of the OMB to review certain information collection requests by Federal agencies. EPA has determined that the proposed recordkeeping requirements set out in 40 CFR 761.31 constitute a "collection of information," as defined in 44 U.S.C. 3502(4), making these requirements subject to the terms of the PRA.

In 40 CFR 761.31(a) and (1), EPA proposes to grant authorizations for the use of PCB-containing transformers and capacitors, respectively, provided that records are kept which indicate when the equipment was inspected for leaks,

whether any leaks were found, and what action it took if any leaks were found. The person is required to keep the records until 5 years after disposing of the equipment, and upon request, to make them available to EPA for inspection. EPA believes that the proposed recordkeeping requirements minimize paperwork burden and are designed to obtain only information necessary to assure that companies are complying with the rule.

If these requirements are contained in the final rule, the rule will be forwarded to the Director of OMB for review under the terms of the PRA.

IX. Official Record of Rulemaking

In accordance with the requirements of section 19(a)(3)(E) of TSCA, EPA is publishing the following list of documents, which constitute the record of this proposed rulemaking. A supplementary list or lists may be published any time on or before the date the final rule is issued. However, public comments, the transcript of the rulemaking hearing, or submissions made at the rulemaking hearing or in connection with it will not be listed because these documents are exempt from Federal Register listing under section 19(a)(3). A full list of these materials will be available on request by contacting the Document Control Officer (see listing under "ADDRESSES").

A. PREVIOUS RULEMAKING RECORDS

1. Official Rulemaking Record from "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibitions Rule" published in the Federal Register of May 31, 1979, (44 FR 31514).
2. Official Rulemaking Record from "Polychlorinated Biphenyls (PCBs); Proposed Restrictions on Use at Agricultural Pesticide and Fertilizer Facilities," published in the Federal Register of May 9, 1980, (45 FR 30989).

B. FEDERAL REGISTER NOTICES

3. "Polychlorinated Biphenyls (PCBs); Request for Information on PCB Transformers," March 5, 1980, (45 FR 14232).
4. USEPA, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibitions; Use in Electrical Equipment; Court Order on Inspection and Maintenance," March 10, 1981, (46 FR 18090).
5. USEPA, "Polychlorinated Biphenyls (PCBs); Use in Electrical Equipment," March 10, 1981, (46 FR 18096).
6. USEPA, "Polychlorinated Biphenyls (PCBs); Proposed Restrictions on Use at Agricultural Pesticide and Fertilizer Facilities; Abeyance of Proposed Rule Amendment," May 6, 1981, (46 FR 25411).
7. USEPA, "Polychlorinated Biphenyls (PCBs); Use in Electrical Equipment; Interim

Measures Program," May 20, 1981, (46 FR 27614).

C. SUPPORT DOCUMENTS

8. USEPA, OTS, "Regulatory Impact Analysis-for the Proposed PCB-Containing Electrical Equipment Rulemaking."

D. REPORTS

9. Ecology and Environment, Inc., "Summary of the Health Effects of PCBs."
10. Edison Electric Institute and Utilities Solid Waste Activities Group, "Study of PCBs in Equipment owned by the Electric Utility Industry."
11. Rancourt, Leo R., "Capacitor Protective Schemes Investigated by Northeast Utilities."
12. USEPA, OTS, "Review of Studies on the Health Effects of PCB."

EPA will identify the complete rulemaking record on or before the date of promulgation of the final rule, as prescribed by section 19(3) of TSCA. EPA will consider for inclusion in the record additional material submitted at any time between the publication of this notice and the date the Agency identifies the final record.

X. Statutory Authority

Under section 6(e) of TSCA (15 U.S.C. 2605), the Administrator may by rule authorize the manufacture, processing, distribution in commerce or use (or any combination of such activities) of any PCBs in other than a totally enclosed manner if the Administrator finds that it will not present an unreasonable risk of injury to health or the environment. The Administrator has delegated authority to grant further PCB authorizations and to amend or modify the PCB Manufacturing, Processing, Distribution in Commerce, and Use Prohibition Rule (40 CFR Part 761), published in the Federal Register of May 31, 1979, (44 FR 31514) to the Assistant Administrator for Pesticides and Toxic Substances.

List of Subjects in 40 CFR Part 761

Hazardous materials, Labeling, Polychlorinated biphenyls, Reporting and recordkeeping requirements, Environmental protection.

Dated: April 15, 1982.

Marilyn C. Bracken,
Acting Assistant Administrator for Pesticides and Toxic Substances.

Therefore, it is proposed that 40 CFR Part 761 be amended as follows:

PART 761—POLYCHLORINATED BIPHENYLS (PCBs) MANUFACTURING, PROCESSING, DISTRIBUTION IN COMMERCE, AND USE PROHIBITIONS

1. In § 761.2, paragraphs (d) (1), (2), and (3), (h), (i), and (z) are revised to read as follows:

Subpart A—General

§ 761.2 Definitions.

(d) * * *

(1) "Small Capacitor" means a capacitor which contains less than 1.36 kg (3 lbs.) of dielectric fluid. A capacitor whose total volume is less than 1639 cubic centimeters (100 cubic inches) may be considered to contain less than 1.36 kg (3 lbs.) of dielectric fluid and capacitor whose total volume is more than 3278 cubic centimeters (200 cubic inches) must be considered to contain more than 1.36 kg (3 lbs.) of dielectric fluid. A capacitor whose volume is between 1639 and 3278 cubic centimeters may be considered to contain less than 1.36 kg (3 lbs.) of dielectric fluid if the total weight of the capacitor is less than 4.08 kg (9 lbs.).

(2) "Large High Voltage Capacitor" means a capacitor which contains 1.36 kg (3 lbs.) or more of dielectric fluid and which operates at 2000 volts (a.c. or d.c.) or above.

(3) "Large Low Voltage Capacitor" means a capacitor which contains 1.36 kg (3 lbs.) or more of dielectric fluid and which operates below 2000 volts (a.c. or d.c.).

(h) "Disposal" means to intentionally or accidentally discard, throw away, or otherwise complete or terminate the useful life of PCBs and PCB Items. Disposal includes spills, leaks, and other uncontrolled discharges of PCBs as well as actions related to containing, transporting, destroying, degrading, decontaminating, or confining PCBs and PCB Items.

(t) "PCB Article" means any manufactured article, other than a PCB Container, that contains PCBs and whose surface(s) has been in direct contact with PCBs. "PCB Article" includes capacitors, transformers, electric motors, pumps, pipes and any other manufactured item (1) which is formed to a specific shape or design during manufacture, (2) which has end use functions(s) dependent in whole or in part upon its shape or design during end use, and (3) which has either no change of chemical composition during its end use or only those changes of composition which have no commercial purpose separate from that of the PCB Article.

(z) "PCB-Contaminated Electrical Equipment" means any electrical equipment, including but not limited to voltage regulators, switches/sectionalizers, electromagnets, and

cable, that contains 50 ppm or greater PCB, but less than 500 ppm PCB. Oil-filled electrical equipment other than circuit breakers and reclosers whose PCB concentration is unknown must be assumed to be PCB-Contaminated Electrical Equipment. (See § 761.31(a) and § 761.31(h) for provisions permitting reclassification of electrical equipment containing 500 ppm or greater PCBs to PCB-Contaminated Electrical Equipment).

2. In § 761.10, paragraph (b)(1)(ii) is removed and the introductory text of paragraph (a)(2), paragraph (b)(2)(i), the introductory text of paragraph (b)(2)(iii), paragraph (b)(4), (5), paragraph (d), and paragraph (g)(1) are revised and paragraph (b)(6) is added to read as follows:

Subpart B—Disposal of PCB and PCB Items

§ 761.10 Disposal requirements.

(a) * * *

(2) Mineral oil dielectric fluid from PCB-Contaminated Electrical Equipment containing a PCB concentration of 50 ppm or greater, but less than 500 ppm, must be disposed of in one of the following:

(b) * * *

(1) PCB Transformers. * * *

(ii) [Removed]

(2) PCB Capacitors. (i) The disposal of any capacitor shall comply with all requirements of this subpart unless it is known from label or nameplate information, manufacturer's literature, or chemical analysis that the capacitor does not contain PCBs.

(iii) Any PCB Large High or Low Voltage Capacitor which contains 500 ppm or greater PCBs, owned by any person, shall be disposed of in accordance with either of the following:

(4) PCB-Contaminated Electrical Equipment. PCB-Contaminated Electrical Equipment shall be disposed of by draining all free flowing liquid from the electrical equipment and disposing of the liquid in accordance with paragraph (a) (2) or (3) of this section. The disposal of the drained electrical equipment is not regulated by this rule.

(5) Other PCB Articles. (i) PCB Articles with a PCB concentration of 500 ppm or greater must be disposed of:

(A) In an incinerator that complies with Annex I; or

(B) In a chemical waste landfill that complies with Annex II, provided that

all free-flowing liquid PCBs have been thoroughly drained from any articles before the articles are placed in the chemical waste landfill and that the drained liquids are disposed of in an incinerator that complies with Annex I.

(ii) PCB Articles with a PCB concentration between 50 and 500 ppm must be disposed of by draining all free flowing liquid from the article and disposing of the liquid in accordance with paragraph (a) (2) or (3) of this section. The disposal of the drained article is not regulated by this rule.

(6) Storage of PCB Articles. Except for a PCB Article described in paragraph (b)(4) of this section and hydraulic machines that comply with the municipal solid waste disposal provisions described in paragraph (b)(3) of this section, any PCB Article shall be stored in accordance with Annex III prior to disposal.

(d) Spills. (1) Spills, leaks, and other uncontrolled discharges of PCBs constitute the disposal of PCBs.

(2) PCBs resulting from the clean-up and removal of spills, leaks, or other uncontrolled discharges, must be stored and disposed of in accordance with paragraph (a) of this section. In order to determine the contamination level in soil, gravel, sludge, fill, rubble, or other land-based substances, consult with the appropriate EPA Regional Administrator to obtain information on sampling methods and analytical procedures.

(3)(i) Except as provided in paragraph (d)(3)(ii), of this section contaminated material resulting from spills, leaks, and other uncontrolled discharges must be cleaned up to preexisting background levels of PCBs where there is a risk of exposure to water, human food, or animal feed. Any visible signs of PCB contamination must be removed. In all cases, cleanup of PCB-contaminated materials to below 50 ppm PCBs is required.

(ii) Clean-up of PCB leaks which occur during the authorized use of PCB Transformers shall be performed in accordance with paragraph (d)(3)(i) of this section. However, the removal of solidified PCBs from the external surface of the transformer is not required if the solidified PCBs are preventing additional leakage.

(4) These regulations do not exempt any person from any actions or liability under other statutory authorities, including but not limited to the Clean Water Act, the Resource Conservation and Recovery Act, and the Comprehensive Environmental

Response, Compensation, and Liability Act of 1980.

(g) *Testing procedures.* (1) Owners or users of mineral oil dielectric fluid electrical equipment may use the following procedures to determine the concentration of PCBs in the dielectric fluid:

(i) Dielectric fluid removed from mineral oil dielectric fluid electrical equipment may be collected in a common container, provided that no other chemical substances or mixtures are added to the container.

(ii) For purposes of complying with the marking and disposal requirements, representative samples may be taken from either the common containers or the individual electrical equipment to determine the PCB concentration, except that if any PCBs at a concentration of 500 ppm or greater have been added to the container or equipment then the total container contents must be considered as having a PCB concentration of 500 ppm or greater for purposes of complying with the disposal requirements of this subpart. For purposes of this subparagraph, representative samples of mineral oil dielectric fluid are either samples taken in accordance with American Society of Testing and Materials method D-923 or samples taken from a container that has been thoroughly mixed in a manner such that any PCBs in the container are uniformly distributed throughout the liquid in the container.

3. In § 761.20, paragraphs (a)(2) and (c)(1) are revised to read as follows:

Subpart C—Marking of PCBs and PCB Items

§ 761.20 Marking requirements.

(a) * * *

(2) PCB Transformers at the time of manufacture, at the time of distribution in commerce if not already marked, and at the time of removal from use if not already marked. (Marking of PCB-Contaminated Electrical Equipment is not required);

(c) * * *

(1) All PCB Transformers not marked under paragraph (a) of this section (marking of PCB-Contaminated Electrical Equipment is not required);

4. The introductory text of § 761.30 is revised to read as follows:

§ 761.30 Prohibitions.

Except as authorized in § 761.31 the activities listed in paragraphs (a) and (d)

of this section are prohibited pursuant to section 6(e)(2) of TSCA. The requirements set forth in paragraphs (b) and (c) of this section concerning export and import of PCBs for purposes of disposal and PCB Items for purposes of disposal are established pursuant to section 6(e)(1) of TSCA. Subject to any exemptions granted pursuant to section 6(e)(3)(B) of TSCA, the activities listed in paragraphs (b) and (c) of this section are prohibited pursuant to section 6(e)(3)(A) of TSCA. In addition, the Administrator hereby finds, under the authority of section 12(a)(2) of TSCA, that the manufacture, processing, and distribution in commerce of PCBs and PCB Items for export from the United States presents an unreasonable risk of injury to health within the United States. This finding is based upon the well-documented human health and environmental hazard of PCB exposure; the high probability of human and environmental exposure to PCBs and PCB Items from manufacturing, processing, or distribution activities; the potential hazard of PCB exposure posed by the Transportation of PCBs or PCB Items within the United States; and the evidence that contamination of the environment by PCBs is spread far beyond the areas where they are used. In addition, the Administrator hereby finds that any exposure of human beings or the environment to PCBs as measured or detected by any scientifically acceptable analytical method is a significant exposure, as defined in § 761.2(dd). Section 761.2(hh) and TSCA section 6(e)(2)(C) define the term totally enclosed manner as "any manner which will ensure that any exposure of human beings or the environment to a polychlorinated biphenyl will be insignificant. . . ." Since any exposure to PCBs is found to be a significant exposure, a totally enclosed manner is a manner that results in no exposure of humans or the environment to PCBs. The following activities are considered totally enclosed: distribution in commerce of intact, nonleaking electrical equipment such as transformers, capacitors, electromagnets, voltage regulators, switches/sectionalizers, circuit breakers, reclosers, and cable that contain PCBs at any concentration and processing and distribution in commerce of PCB Equipment containing an intact, nonleaking PCB Capacitor. See paragraph (c)(1) of this section for provisions allowing the distribution in commerce of PCBs and PCB Items.

5. Section 761.31 is amended by revising paragraphs (a) and (h) and

adding paragraphs (l) and (m) to read as follows:

§ 761.31 Authorizations.

The following nontotally enclosed PCB activities are authorized pursuant to section 6(e)(2)(B) of TSCA:

(a) *Use in and Servicing of Transformers (Other Than Railroad Transformers).* PCBs at any concentration may be used in transformers and may be used for purposes of servicing including rebuilding transformers (other than transformers for railroad locomotives and self-propelled railroad cars) indefinitely, subject to the following conditions:

(1) *Use Conditions.* (i) A visual inspection of each PCB Transformer (as defined in § 761.2(y)) in use or stored for reuse shall be performed at least once every three months. The visual inspection must include investigation for any leak of dielectric fluid on or around the transformer. The extent of the visual inspection will depend on the physical constraints of each transformer installation and should not require an electrical shutdown of the transformer being inspected.

(ii) If a PCB Transformer is found to have a leak which results in any quantity of PCBs running off or about to run off the external surface of the transformer, then the transformer must be repaired or replaced to eliminate the source of the leak. The leaking material must be cleaned up and properly disposed of according to disposal requirements of § 761.10. Cleanup of the released PCBs must be initiated as soon as possible, but in no case later than 48 hours of its discovery. Until appropriate action is completed, any active leak of PCBs must be contained to prevent exposure of humans or the environment and inspected daily to verify containment of the leak.

(iii) Records of inspection and maintenance history shall be maintained at least 5 years after disposing of the transformer and shall be made available for inspection, upon request, by EPA. Such records shall contain the following information for each PCB Transformer:

- (A) Its location.
- (B) The date of each visual inspection and the date that a leak was discovered, if different from the inspection date.
- (C) The person performing the inspection.
- (D) The location of any leak(s).
- (E) An estimate of the amount of dielectric fluid released from any leak.
- (F) The date of any cleanup, containment, repair, or replacement.

(G) A description of any cleanup, containment, or repair performed.

(H) The results of any containment and weekly inspection required for uncorrected active leaks.

(iv) A reduced visual inspection frequency of at least once every 12 months applies to PCB Transformers that utilize the following risk reduction measure.

(A) A PCB Transformer which has secondary containment capacity of at least 100 percent of the transformer's total dielectric fluid volume.

(B) A PCB Transformer which has been tested and found to contain less than 60,000 ppm PCBs (after three months of inservice use if the transformer has been serviced for purposes of reducing the PCB concentration).

(v) An increased visual inspection frequency of at least once every week applies to any PCB Transformer which because of its location poses a potential risk of contaminating food or feed. PCB Transformers which pose such risk include those located in federally inspected meat, poultry product, and egg product establishments, as well as in facilities manufacturing, processing, packaging or holding human food or animal feed. This requirement does not apply to retail establishments such as grocery stores and restaurants, or to situations where the PCB Transformer is in a location such that a discharge of dielectric fluid cannot contaminate food or feed.

(2) *Service conditions.* (i) Transformers classified as PCB-Contaminated Electrical Equipment (as defined in § 761.2(z)) may be serviced (including rebuilding) only with dielectric fluid containing less than 500 ppm PCB.

(ii) Any servicing (including rebuilding) of PCB Transformers (as defined in § 761.2(y)) that requires the removal of the transformer coil from the transformer casing is prohibited. PCB Transformers may be serviced with dielectric fluid at any PCB concentration.

(iii) PCBs removed during any servicing activity must be captured and either reused as dielectric fluid or disposed of in accordance with the requirements of § 761.10. PCBs from PCB Transformers must not be mixed with or added to dielectric fluid from PCB-Contaminated Electrical Equipment.

(iv) Regardless of its PCB concentration, dielectric fluids containing less than 500 ppm PCB that are mixed with fluids that contain 500 ppm or greater PCB must not be used as dielectric fluid in any electrical equipment. The entire mixture of

dielectric fluid must be considered to be greater than 500 ppm PCB and must be disposed of in an incinerator that meets the requirements in Annex I.

(v) A PCB Transformer may be converted to PCB-Contaminated Electrical Equipment or to a non-PCB Transformer by draining, refilling and/or otherwise servicing the transformer. In order to reclassify, the transformer's dielectric fluid must contain less than 500 ppm PCB (for conversion to PCB-Contaminated Electrical Equipment) or less than 50 ppm PCB (for conversion to a non-PCB Transformer) after a minimum of three months of inservice use subsequent to the last servicing conducted for the purpose of reducing the PCB concentration in the transformer.

(vi) Any dielectric fluid containing 50 ppm or greater PCB used for servicing transformers must be stored in accordance with the Storage for disposal requirements of Annex III.

(vii) Processing and distribution in commerce of PCBs for purposes of servicing transformers is permitted only for persons who are granted an exemption under TSCA 6(e)(3)(B).

* * * * *

(h) *Use in and servicing of electromagnets, cable, switches and voltage regulators.* PCBs at any concentration may be used in electromagnets, cable, switches, and voltage regulators and may be used for purposes of servicing this equipment (including rebuilding) indefinitely, subject to the following conditions:

(1) *Service Conditions.* (i) Servicing (including rebuilding) any electromagnet, cable, switch, or voltage regulator with a PCB concentration of 500 ppm or greater which requires the removal and rework of the internal components is prohibited.

(ii) Electromagnets, cable, switches, and voltage regulators classified as PCB-Contaminated Electrical Equipment (as defined in § 761.2(z)) may be serviced (including rebuilding) only with dielectric fluid containing less than 500 ppm PCB.

(iii) PCBs removed during any servicing activity must be captured and either reused as dielectric fluid or disposed of in accordance with the requirements of § 761.10. PCBs from electromagnets, cable, switches, and voltage regulators with a PCB concentration of at least 500 ppm must not be mixed with or added to dielectric fluid from PCB-Contaminated Electrical Equipment.

(iv) Regardless of its PCB concentration, dielectric fluids containing less than 500 ppm PCB that

are mixed with fluids that contain 500 ppm or greater PCB must not be used as dielectric fluid in any electrical equipment. The entire mixture of dielectric fluid must be considered to be greater than 500 ppm PCB and must be disposed of in an incinerator that meets the requirements of Annex I.

(v) An electromagnet, cable, switch or voltage regulator with a PCB concentration of at least 500 ppm may be converted to PCB-Contaminated Electrical Equipment or to a non-PCB classification by draining, refilling and/or otherwise servicing the equipment. In order to be reclassified, the transformer's dielectric fluid must contain less than 500 ppm PCB (for conversion to PCB-Contaminated Electrical Equipment) or less than 50 ppm PCB (for conversion to a non-PCB classification) after a minimum of three months of in-service use subsequent to the last servicing conducted for the purpose of reducing the PCB concentration in the equipment.

(vi) Any dielectric fluid containing 50 ppm or greater PCB used for servicing electromagnets, cable, switches, or voltage regulators must be stored in accordance with the storage for disposal requirements of Annex III.

(vii) Processing and distribution in commerce of PCBs for purposes of servicing electromagnets, cable, switches, or voltage regulators is permitted only for persons who are granted an exemption under TSCA 6(e)(3)(B).

* * * * *

(l) *Use in capacitors.* PCBs at any concentration may be used in capacitors, subject to the following conditions:

(1) *Use conditions.* (i) A visual inspection of each Large High Voltage Capacitor and Large Low Voltage Capacitor (as defined in § 761.2(d)(2) and (3) respectively) in use or stored for reuse shall be performed at least once every 3 months. The visual inspection must investigate for any leak of dielectric fluid on or around the capacitor. The extent of the visual inspection will depend on the physical constraints of each capacitor installation and should not require an electrical shutdown of the capacitor being inspected.

(ii) If a Large High Voltage or Large Low Voltage Capacitor is found to have a leak in any quantity, the capacitor must be removed from service. Any PCBs released from the capacitor must be cleaned up and properly disposed of according to the disposal requirements of § 761.10. Cleanup of any PCBs released must be initiated within 48

hours of its discovery. Until the capacitor is removed, any active leak of PCBs must be contained to prevent exposure of humans or the environment and inspected daily to verify containment of the leak.

(iii) Records of inspection and removal/replacement history shall be maintained for at least 5 years after disposing of the capacitor and shall be made available for inspection, upon request, by EPA. Such records shall contain the following information for each Large High Voltage and Large Low Voltage Capacitor:

- (A) Its location.
 - (B) The date of each visual inspection and the date that a leak was discovered, if different from the inspection date.
 - (C) The person performing the inspection.
 - (D) An estimate of the amount of dielectric fluid released from any leak.
 - (E) The date and description of any cleanup or containment activity.
 - (F) The date the capacitor was removed/replaced.
 - (G) The results of any containment and weekly inspection required for uncorrected active leaks.
- (iv) An increased visual inspection frequency of at least once every week applies to any Large High Voltage PCB Capacitor or Large Low Voltage PCB Capacitor which because of its location poses a potential risk of contaminating

food or feed. Large PCB Capacitors which pose such risk include those located in federally inspected meat, poultry product, and egg product establishments, as well as in facilities manufacturing, processing, packaging or holding human food or animal feed. This requirement does not apply to retail establishments such as grocery stores and restaurants, or to situations where the PCB Capacitor is in a location such that a discharge of dielectric fluid cannot contaminate food or feed.

(v) After October 1, 1992, the use of Large High Voltage PCB Capacitors and Large Low Voltage PCB Capacitors is prohibited.

(2) [Reserved]

(m) *Use in and servicing of circuit breakers and reclosers.* PCBs at any concentration may be used in circuit breakers and reclosers and may be used for purposes of servicing circuit breakers and reclosers (including rebuilding) indefinitely, subject to the following conditions:

- (1) *Servicing conditions.* (i) Circuit breakers and reclosers may be serviced (including rebuilding) only with dielectric fluid containing less than 50 ppm PCB.
- (ii) Any circuit breaker or recloser found to contain at least 50 ppm PCBs may be serviced only in accordance with the conditions contained in 40 CFR 761.31(h)(1).

(2) [Reserved]

6. In § 761.42, paragraph (c)(2) is revised to read as follows:

Subpart E—List of Annexes

§ 761.42 Storage for disposal.

* * * * *

(c) * * *

(2) Non-leaking and structurally undamaged PCB Large High Voltage Capacitors and PCB-Contaminated Electrical Equipment that have not been drained of free flowing dielectric fluid may be stored on pallets next to a storage facility that meets the requirements of paragraph (b) of this section until January 1, 1983. PCB-Contaminated Electrical Equipment that has been drained of free flowing dielectric fluid is not subject to the storage provisions of Annex III. Storage under this subparagraph will be permitted only when the storage facility has immediately available unfilled storage space equal to 10 percent of the volume of capacitors and equipment stored outside the facility. The capacitors and equipment temporarily stored outside the facility shall be checked for leaks weekly.

* * * * *