ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6950.2D

10/1/98

Including change 1
dated 10/6/03

SUBJ: ELECTRICAL POWER POLICY IMPLEMENTATION AT NATIONAL AIRSPACE SYSTEM FACILITIES.

---

1. **PURPOSE.** This order provides guidance for electrical power policy implementation at the National Airspace System Facilities (NAS) in accordance with the latest version of Order 6030.20, Electrical Power Policy. This order identifies standard electrical power configurations to ensure NAS facility availability commensurate with its assigned mission.

2. **DISTRIBUTION.** This order is distributed to the division level in the Airway Facilities; Office of Communication, Navigation, and Surveillance Systems; Office of System Architecture and Investment Analysis; and Office of Acquisitions in Washington; to division level in the FAA Logistics Center and the FAA Academy at the Aeronautical Center; to the division level in the Office of Communication, Navigation, and Surveillance Engineering and Test Division at the Technical Center; to the branch level in the regional Airway Facilities divisions; and to all Airway Facilities field offices with a standard distribution.

3. **CANCELLATION.** Order 6950.2C, Electrical Power Policy Implementation at National Airspace System Facilities, dated November 16, 1987, is canceled.

4. **BACKGROUND.** The modernization of the NAS and revisions to the Electrical Power Policy created the need to revise this implementation order.

5. **EXPLANATION OF CHANGES.**

a. Extensive revisions to this order have been performed to comply with Public Law 104-113, H.R. 2196, the National Technology Transfer and Advancement Act of 1996, and to modernize outdated requirements contained in the existing order.

b. Specific changes have been made to incorporate sensitive electronic power requirements, especially in the power quality area. Appendix 1, Facility Power Source Codes, has been revised to reflect the current facility types. Also, appendix 1 has been divided into two sections - Part A - General National Airspace System (GNAS) and Part B - Air Route Traffic Control Center (ARTCC). Appendix 2, Current Distortion Guidelines, has been added to provide guidance for individual system/equipment harmonic assessment. Appendix 3, Power Criteria, has been added to give a description of the general power quality to be provided to mission related electronic equipment.

Distribution: A-W(AF/ND/SD/SU)-3; A-X(AF)-3; A-Y(ML/MA)-2; A-Z(ACT-300, 3 Copies); A-FAF-0 (STD)

Initiated By: ~~AINS-600~~ AOS-1000

6. **APPLICATION.** This order applies to all Federal Aviation Administration (FAA) NAS facilities without regard to maintenance and operational responsibility. The guidance and electrical power configurations identified by this order shall be used by the responsible organizations in establishing configuration requirements for FAA and non-FAA owned facilities. Those facilities solely for military or private use are exempted from this order. Standby power requirements for non-FAA airport lighting systems are identified in Advisory Circular 150/5340-17B, Standby Power for Non-FAA Airport Lighting Systems.

7. **RESPONSIBILITIES.**

a. NAS Transition and Integration (ANS) will issue technical standards and guidance to implement the power configurations necessary to meet requirements of this order and Order 6030.20.

b. Regional Airway Facilities divisions shall periodically review the performance of facility power systems and recommend changes consistent with operational requirements.

c. The appropriate program office or Integrated Product Team shall identify and budget for the power requirements of new facility types during the development process. The NAS Infrastructure Power Systems (NIPS) Product Team shall identify and budget for sustained power support programs required by the latest version of Federal Aviation Administration Acquisition Management System (AMS).

8. **GENERAL GUIDANCE.**

a. For definitions of facility types and services and facility contractions listed in appendix 1, of this order, use the latest version of Order 6000.5, Facility, Service, and Equipment Profile. Where contractions are not contained in Order 6000.5, they will be identified in the latest version of Order 1380.40, Airway Facilities Sector Level Staffing Standard System, Appendix 1, Facility Types, Contractions, and Definitions and the latest version of Order 1375.4, Standard Data Elements and Codes - Facility Identification and Supplemental Standards.

b. Appendix 1, of this order, identifies the standard power configuration which is effective upon issuance of the order. In many cases these standards will differ from present facility installations due to facility and equipment replacement programs or changes to operational service requirements. Changes to standard configurations in this order do not in themselves provide authority or desirability for change from the present configuration. Transition to new standards shall be accomplished under approved projects through normal budgetary actions. Deviations from the configurations in appendix 1 of this order or changes to baseline configurations shall be requested through the NAS Change Proposal (NCP) process in accordance with the latest version of Order 1800.8, National Airspace System Configuration Management, for all new facility or equipment installations. NCPs are not required for present installations which deviate from these standard configurations provided they are in conformance with prior standards and meet the operational requirements of the facility.

c. The Power Source Codes listed in appendix 1, of this order, are defined in Order 6000.5, Appendix 3, Special Use Facilities Master File Reporting Codes, and are further described as follows:

(1) A - denotes a commercial power source, a standby engine generator and an Uninterruptible Power Supply (UPS). This configuration shall provide uninterruptible, conditioned power with AC voltage in and AC voltage out.

(2) D - denotes a commercial power source and a battery standby power system. A UPS is not included in this category.

(3) V - denotes a photovoltaic or wind generator with a battery system.

(4) Z - denotes a single source of power continuously generated by an independent generating device; e.g., thermoelectric, prime power engine generator, nuclear, fuel cell, etc.

(5) 1 - denotes a commercial power source and a standby engine generator.

(6) 4 - denotes a single source of power.

(7) 8 - denotes dual, independent sources of commercial power; i.e., two separate substations.

d. For an airport identified as a Continuous Power Airport (CPA), as defined in Order 6030.20, only the facilities associated with the operation of the one designated CPA runway shall be configured with CPA facility power service levels indicated in appendix 1 of this order.

e. Where specified, power equipment used for support of Category II and III operations shall be capable of transferring to an alternate source within 1 second. The 1-second transfer time can be obtained by powering the facility with the engine generator during the Category II or III conditions and using commercial power as the standby source. Should the engine generator fail, the facility load will automatically transfer back to commercial power within the required 1-second transfer time. Once the Category II or III conditions have subsided, the facility shall be returned to the commercial (primary) power source.

f. Appendix 1, of this order, indicates the standard power service for each facility type. In some instances, an alternate configuration may satisfy facility requirements more cost-effectively. Requests for the following alternate configurations shall be accomplished through the NCP process:

(1) Power Source Code V may be used in place of Codes 4, 1, and D where reliability and life cycle cost considerations are favorable compared with engine generator systems or the installation and costs of primary commercial power. Battery reserve power for these systems should be sized for a minimum of 4 hours service based on the worst case environmental conditions for the particular facility location.

(2) Power Source Code Z may be used in place of Code 4 where reliability and life cycle cost considerations are favorable compared with the installation and costs of primary commercial power.

(3) Power Source Code D should be used in lieu of Code 1 when equipment upgrade allows facility's operational requirements to be satisfied by a battery standby power system.

g. Facilities with standby power systems, capable of being remotely monitored, should monitor the status of commercial power and standby power systems.

h. FAA facilities with standby power systems authorized by appendix 1, of this order, which are owned and operated by a non-FAA authority, must meet the requirements of the latest version of Order 6950.11, Reduce Electrical Power Interruptions at FAA Facilities.

9. **TECHNICAL GUIDANCE.**

a. Electrical power characteristics of the power provided to electronics equipment shall meet the conditions defined in appendix 3 of this order. Should the electrical power characteristics deviate from appendix 3 requirements, refer to the latest version of Order 6950.25, Use of Electrical Power Conditioning Devices at FAA Facilities, for corrective actions.

b. The quality of electrical power provided shall be of the reliability, availability, and voltage and frequency standards required for the facility. VOLTAGE Total Harmonic Distortion (THD) shall not exceed 5% THD or 3% HD for any single harmonic. These limits shall apply at the service entrance only. These limits are goals at all other facility voltage bus locations. Distortion exceeding these limits, including at the engine generator output, should be evaluated by personnel, who are competent in the technical power quality discipline, for adverse impact to equipment and power distribution system. For CURRENT distortion considerations, refer to paragraph 9j(5).

c. Specific requirements for various power services are as follows:

(1) Facilities which utilize a standby engine generator, Power Source Code 1, shall provide standby power within 15 seconds of a failure of the prime power source and shall be capable of sustained operation. ARTCC facilities using Power Source Code 1, will be provided standby power service as defined in the latest version of Order 6470.5, Maintenance of ARTCCs.

(a) In general, a 72 hour fuel supply shall be maintained. A reduced fuel supply may be maintained at locations where fuel is readily available and delivery agreements are in place; e.g., major airports and where fuel volume is continuously monitored. At facilities with difficult access, fuel supplies shall be determined on a site-by-site basis. In all cases, fuel supplies shall be based on actual engine generator loading, not on maximum engine fuel consumption rates.

(b) Facilities with pipeline-fed standby engine generators do not require stored fuel supplies, with the exception of facilities located in areas subject to pipeline failures. At these locations, fuel supplies shall be established on a site-by-site basis.

(c) Closed transition switching; e.g., Uninterruptible Power Transfer (UPT), shall be installed where justified by operational requirements, after coordination with the electric utility.

(2) Facilities which utilize a battery standby power system, Power Source Code D, shall provide standby power immediately (without interruption) upon failure of the prime power source and shall be capable of sustained operation for a minimum of 4 hours at the lowest normal operating temperature of the facility, usually the inside ambient temperature.

(a) A permanently wired means of connection with an appropriate transfer switch may be provided to permit a safe and accurate means to connect and disconnect an external generator to the facility's electrical system to permit recharge of the batteries in the event of a prolonged prime power outage.

(b) The battery system outputs shall be in multiples of 12 volts; e.g., 12, 24, 36, 48 volts and be sized for the systems served.

d. Facilities which utilize a dual source (Power Source Code 8) shall provide transfer from source to source within a maximum of 15 seconds.

e. Site generated power systems (Power Source Code V and Z) shall be established to provide continuous power without required on-site maintenance activity more frequent than the normal facility preventive maintenance schedule.

f. Agency owned prime engine generator power systems shall only be utilized where no other source of power is available or where the expense of other sources of power would exceed that of establishing and operating such a system. The system shall consist of at least two engine generators specifically designed for continuous operations, and shall have either automatic transfer switches designed in accordance with agency standards or 24-hour attendance.

g. Where system/equipments or subsidiary components are co-located at a facility or shelter and different power configurations are required by appendix 1, of this order, or where "same as host facility" appears in appendix 1, the following criteria shall be used, provided that power quality, capacity, and availability are not degraded:

(1) Where engine generator standby power is available, equipment, systems and components may be configured to Power Source Code 1. Standby battery systems connected to engine generators are not required to have the minimum 4-hour battery reserve.

(2) At facilities where batteries are the primary source of standby power, new equipment that has requirements for standby power may be reconfigured to Power Source Code D.

(3) At facilities with Power Source Code A, only systems/equipments designated as Power Source Code A in appendix 1, of this order, shall be allowed on the output of the facility UPS.

h. Power distribution systems shall be in accordance with FAA orders and specifications and with applicable national and local codes.

i. Power conditioning devices, not addressed by the power source codes in appendix 1, of this order, may be required at some facilities to provide a stable regulated power source. Each installation shall be separately justified, in accordance with the requirements of Order 6950.25. Prior to the installation of a power conditioning device to power specific loads in an existing facility, the following analyses shall be obtained:

(1) An analysis of the existing electronic equipment load characteristics to establish power consumption, current harmonics, inrush current profile, power factor, etc.

(2) An analysis to insure compatibility between the equipment load analysis obtained and the proposed power conditioning device.

(3) An analysis of the impact of the proposed power conditioning device on its source and the rest of the facility; e.g., voltage regulation, harmonic distortion, inrush currents and transient generation, resulting from powering the equipment load.

(4) On a study conducted in accordance with the latest version of Order 6950.27, Short Circuit Analysis and Protective Device Coordination Study (SCA/PDC).

(5) An analysis of the potential to introduce or worsen a "single point of failure" and the subsequent impact to the NAS.

j. Before connecting any equipment to a power bus/system, the following criteria must be satisfied:

(1) The equipment shall be operated and maintained in accordance with established FAA practices. For leased equipment that will be operated or maintained by a contractor, the contract shall require the equipment to be operated and maintained in accordance with FAA practices. Maintenance records and equipment shall be available at each leased equipment location for review and technical evaluation by designated FAA personnel. Equipment shall be tested until the FAA is assured it is compatible with the system from which it will be powered. Testing shall not be performed on a critical power system or on the output of a Power Source Code A system, unless there is an UPS specifically provided for testing purposes. All testing shall be completed and approved prior to the equipment being connected in an operational environment. At no time shall any equipment be connected to an existing facility's power system if it adversely affects the operation or performance of other equipment.

(2) The power required by the equipment must be analyzed to insure that the facility power system does not become overloaded or unbalanced.

(3) Peak inrush current and current THD of electronic equipment shall not exceed the limits specified in Specification FAA-G-2100, Electronic Equipment, General Requirements. All other loads shall have a peak inrush current characteristic that will not cause power anomalies detrimental to the facility operation, nuisance over-current device operation, or operational problems with the source.

(4) Power factor at the service entrance shall be within 0.8 lagging to 1.0 or as required by the local utility contract. Power factor at the engine generator output shall be 0.8 lagging to 1.0. Power factor at all other locations shall be considered with regard to energy conservation and performance of power sources and power conditioners. The total power factor is the product of the displacement power factor and the distortion power factor, $PF_{TOT} = (PF_{disp})(PF_{dist})$.

(5) The impact to the bus of the CURRENT THD of each electronic equipment/ system and environmental equipment/system (such as air conditioners, lighting, UPS, etc.) shall be considered when connecting to a bus. The curve in the graph, Current Distortion as a Function of System Load, in appendix 2 shall be used as a guideline to indicate when current distortion mitigation may be necessary to prevent the connection of high harmonic generative loads that will affect the VOLTAGE THD and thus, the power budget of the facility. When the distortion exceeds the curve for the specific load, an evaluation/analysis shall be performed by personnel, who are competent in the technical power quality discipline, to insure that there are no adverse impacts to equipment operation or the power distribution system.

10. **SPECIAL CONSIDERATIONS.** At some facilities, special situations may dictate a power configuration different from that described in paragraph 8 and assigned in appendix 1. Some of the special situations are discussed below:

a. **Meteorological.** A facility located in an area with a history of electrical, ice, or wind storms, which have caused abnormally frequent prime power disruptions and/or excessively long outages, may qualify for a higher grade power configuration if such disruptions cannot be tolerated.

b. **Accessibility**. A facility located in a remote area where a prime power outage is likely to be of a duration incompatible with operating requirements, and could result in excessive exposure of maintenance personnel to hazards, may qualify for a higher grade power configuration.

c. **Defense Readiness**. In some cases, the requirement to maintain an effective defense readiness posture differs from the normal operational requirement.

d. **Military Requirements**. A higher grade power configuration may be necessary due to specific military requirements.

e. **Power Quality**. A facility located in an area of poor utility power quality, that would adversely affect facility operation.

11. **IMPLEMENTATION**. All commissioned facilities shall be provided with power that is within the prescribed limits established by the facility standards and this order.

a. New installations shall be configured in accordance with this order.

b. An exception to the standard configuration identified by facility standards and this order shall be separately justified in accordance with paragraph 8b when a retention, establishment, modification or improvement project is proposed.

c. Changes to the power system or the installation of new equipment requires the accomplishment or update of short circuit analysis and protective device coordination studies in accordance with FAA-STD-032, Design Standards for National Airspace System Physical Facilities, and Order 6950.27.

Stanley Rivers
Director of Airway Facilities

Appendix 1: Facility Power Source Codes

The tables of Appendix 1 are maintained electronically and are available on the FAA Intranet, Power Services Group website. URLs for Appendix 1 are:

https://employees.faa.gov/org/linebusiness/ato/operations/technical_operations/atc_facilities/power_services/sys_eng_team/stand_specs/media/6950.2%20Appendix%201%20Part%20A.pdf

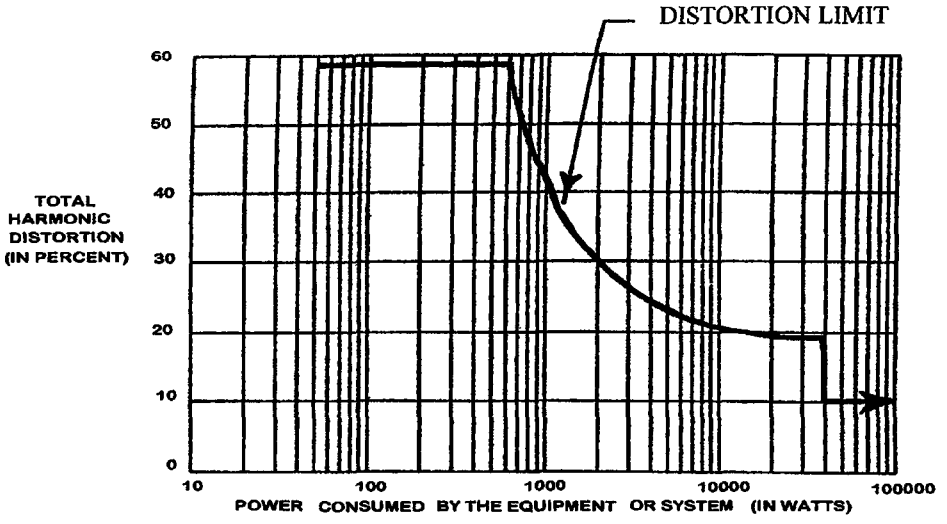
https://employees.faa.gov/org/linebusiness/ato/operations/technical_operations/atc_facilities/power_services/sys_eng_team/stand_specs/media/6950.2%20Appendix%201%20Part%20B.pdf

The published appendix on the web is under Configuration Management control, and shall be considered official. The tables are updated as a result of Configuration Control Decision, CCD. The entry for each Facility Type will include the CCD authorizing the change.

Updates to this appendix shall be published on the Intranet 4 times per year, the first day of each quarter. All additions, deletions, or corrections will be annotated for easy reference.

Personnel responsible for maintaining a technical order library are authorized to print new versions from the web and insert them into this handbook at any time.

APPENDIX 2: CURRENT DISTORTION GUIDELINES



Distortion as a Function of System Load

Current Distortion as a Function of System Load

NOTE: This curve shall only be used as a guideline to indicate the possible need for an in-depth analysis to determine if there is a need for harmonic mitigation action for loads that exceed the harmonic level shown on the graph. The harmonic values shown on the graph from 50 to 60 watts and greater than 40,000 watts are arbitrary and not defining.

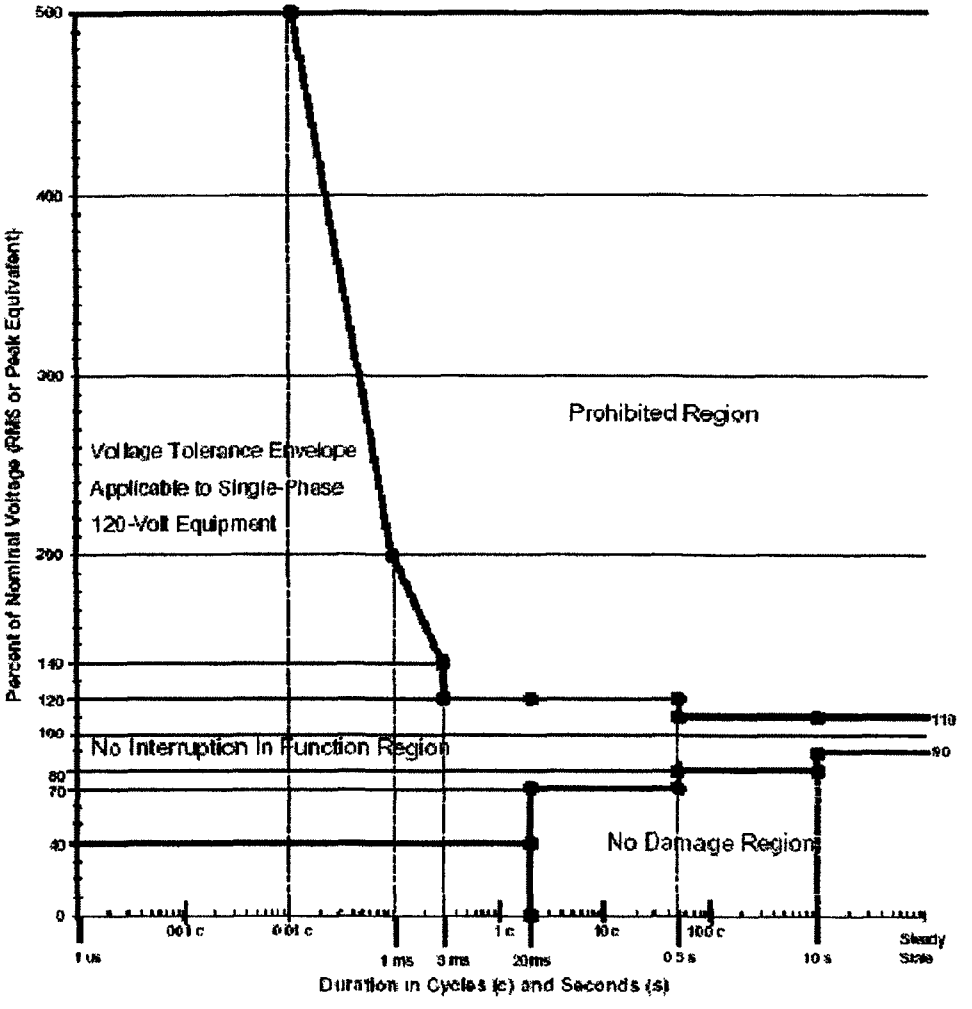
TABLE 1. LIMITS OF INDIVIDUAL HARMONICS		
Harmonic Order	**Maximum Limits (ma) For 50 < W < 600 (1 Phase)**	**Maximum Limits (ma) For 600 < W < 40K (1 or 3 Phase**
2	1.00 x W	400+ (0.05 x W)
3	3.60 x W	1440 + (1.20 x W)
4	1.00 x W	400 + (0.05 x W)
5	2.00 x W	800 + (0.66 x W)
6	0.50 x W	200 + (0.02 x W)
7	1.50 x W	600 + (0.50 x W)
8	0.50 x W	200 + (0.02 x W)
9	1.00 x W	400 + (0.33 x W)
10	0.10 x W	100 + (0.01 x W)
11	0.06 x W	240 + (0.20 x W)
12	0.10 x W	100 + (0.01 x W)
13	0.51 x W	203 + (0.17 x W)
14	0.10 x W	50 + (0.01 x W)
15	0.44 x W	176 + (0.15 x W)
16	0.10 x W	50 + (0.01 x W)
17	0.39 x W	155+ (0.13 x W)
18	0.10 x W	50 + (0.01 x W)
19	0.35 x W	139 + (0.12 x W)
20	0.10 x W	50 + (0.01 x W)

NOTE: W EQUALS POWER IN WATTS

NOTE: W EQUALS POWER IN WATTS.

APPENDIX 3: POWER CRITERIA

ITI (CBEMA) Curve
(Revised 2000)



Published by:

FAA-G2100G

APPENDIX 3: POWER CRITERIA (CONTINUED)

1. Voltage

Nominal FAA Voltage	Voltage Range	
208/120 3 Phase	+10%,-15%	
480\277 3 Phase	"	
240/120 3 Phase	"	
120/240 1 Phase	"	
DC 48 Volts	+ or – 20%	AC Ripple less than or = 5%
DC 24 Volts	"	"
DC 12 Volts	"	"

These are standard FAA Voltages and are widely used in COTS equipments as well as being readily available from utility companies.

2. Voltage phase imbalance, phase to phase: 2% as defined by IEEE STD 141-1986 Paragraph 3.8.2

$$\text{Phase-voltage unbalance} = \frac{\text{Maximum deviation from average phase voltage}}{\text{average phase voltage}}$$

3.

a. Frequency
   1. Steady state 60hz +or – 3 hz
   2. Steady state rate of change 1.5 Hz/sec`
   3. Steady state frequency variation + or – 0.5hz

b. Momentary deviations (.5 cycles to 3 seconds)
   1. 60 Hz + 5 Hz, - 7 Hz
   2. Rate of change 5hz per sec.

NOTE: some of the information was derived from table 4-3, "Matching Sensitive Load and Power Source Requirements With Expected Environments" of IEEE STD 1100-1992 modified to be FAA specific.

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6950.2D CHG 1

10/6/03

SUBJ: ELECTRICAL POWER POLICY IMPLEMENTATION AT NATIONAL AIRSPACE SYSTEM FACILITIES.

1. PURPOSE. This order provides guidance for electrical power policy implementation at the National Airspace System Facilities (NAS) in accordance with the latest version of Order 6030.20, Electrical Power Policy. This order identifies standard electrical power configurations to ensure NAS facility availability commensurate with its assigned mission.

2. DISTRIBUTION. This order is distributed to the division level in the Airway Facilities; Office of Communication, Navigation, and Surveillance Systems; Office of System Architecture and Investment Analysis; and Office of Acquisitions in Washington; to division level in the FAA Logistics Center and the FAA Academy at the Aeronautical Center; to the division level in the Office of Communication, Navigation, and Surveillance Engineering and Test Division at the Technical Center; to the branch level in the regional Airway Facilities divisions; and to all Airway Facilities field offices with a standard distribution.

3. EXPLANATION OF CHANGES.

a. Extensive revisions to this order have been performed to comply with Public Law 104-113, H.R. 2196, the National Technology Transfer and Advancement Act of 1996, and to modernize outdated requirements contained in the existing order.

b. Specific changes have been made to incorporate sensitive electronic power requirements, especially in the power quality area. Appendix 1, Facility Power Source Codes, has been revised to reflect the current facility types. Also, appendix 1 has been divided into two sections - Part A - General National Airspace System (GNAS) and Part B - Air Route Traffic Control Center (ARTCC). Appendix 2, Current Distortion Guidelines, has been added to provide guidance for individual system/equipment harmonic assessment. Appendix 3, Power Criteria, has been added to give a description of the general power quality to be provided to mission related electronic equipment.

4. DISPOSITION OF TRANSMITTAL. After filing the revised appendices, this change transmittal should be retained.

Distribution: A-W(AF/OS/NI/SR/OP/ND/SD/SU)-2; A-X(AF)-3; A-Y(ML/MA)-2 Copies; A-Z(ACT-300)-3 Copies; A-FAF-0 (STD)

Initiated By: AOS-1000

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
Appendix 1 Part A and B	10/1/98	Appendix 1 Part A and B	10/6/03
Appendix 2	10/1/98	Appendix 2 Pages 1 and 2	10/6/03
Appendix 3	10/1/98	Appendix 3 Page 1 and 2	10/6/03

Steven B. Zaidman
Director of Airway Facilities