U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Guidance for Certification of Military and Special Mission Modifications and Equipment for Commercial Derivative Aircraft (CDA)

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This advisory circular (AC) provides guidance for the certification of commercial derivative aircraft (CDA). CDA are aircraft that have been modified with specialized equipment to perform military and other non-civil missions. CDA are operated-by, or under the operational control of, governmental entities. With certain limited exceptions, they are operated as public aircraft. This advisory circular (AC) sets forth acceptable means, but not the only means, to show compliance to the provisions of Title 14 of the Code of Federal Regulations (14 CFR) parts 23, 25, 27, and 29 regarding type certification requirements for commercial derivative aircraft (CDA). This AC is presented as companion material to the procedures outlined in Order 8110.101, *Type Certification Procedures for Military Commercial Derivative Aircraft.*" The guidance provided in this AC is for use on certification projects for Military CDA. Certain provisions of this AC may also be applicable to certification projects for non-military CDA e.g., aircraft operated by state or local governments under public-use or aircraft owned by a foreign government.

For
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INTRODUCTION

1. Purpose.

a. This advisory circular (AC) sets forth acceptable means, but not the only means, to show compliance to the provisions of Title 14 of the Code of Federal Regulations (14 CFR) parts 23, 25, 27, and 29 regarding type certification requirements for commercial derivative aircraft (CDA). CDA are aircraft that have been modified with specialized equipment to perform military and other non-civil missions. CDA are operated-by, or under the operational control of, governmental entities. With certain limited exceptions, they are operated as public aircraft.

b. The extensive variety of CDA applications and equipment often present challenges for civil type certification because they may not have a comparable civil function or purpose. Methods for showing compliance with civil regulations may not have accepted precedence or appropriate guidance material. The intent of this AC is to answer frequently asked questions regarding acceptable certification approaches for CDA projects. This information should assist applicants in developing certification plans by providing acceptable means of compliance for unique CDA modifications. This AC is presented as companion material to the procedures outlined in Order 8110.101, *Type Certification Procedures for Military Commercial Derivative Aircraft*." The guidance provided in this AC is for use on certification projects for Military CDA. Certain provisions of this AC may also be applicable to certification projects for non-military CDA, e.g., aircraft operated by state or local governments under public-use or aircraft owned by a foreign government. The information contained herein is for guidance purposes only and is not mandatory or regulatory in nature. Acronyms used throughout this AC are defined in appendix A. Whenever specific airworthiness standards are cited in this AC, we have made reference to the rule as implemented in part 25. Contact the FAA Military Certification Office for applicability to part 23, 27, or 29.

2. Applicability. The audience for this AC may include applicants, type certificate (TC)/production approval holders, aircraft modifiers, military contractors, parts manufacturers, maintenance and repair organizations, or operators of military or other government CDA.

3. Cancellation. This AC does not supersede other existing FAA guidance and policy material related to approvals for specific civil aircraft mission operations.

4. Related Guidance. The material contained herein applies to military CDA (certain section of this AC may also be used for non-military CDA) proposed to be FAA certified as normal, utility, acrobatic, commuter, transport, or restricted category aircraft; type-certificated under Civil Aviation Regulations (CAR) 3, 4b, 6, 7; or 14 CFR parts 23, 25, 27, and 29; and produced under 14 CFR part 21, § 21.125 or § 21.143, as may be appropriate. Specific FAA type certification procedures are contained in Order 8110.4C, *Type Certification*, and supplemented by Order 8110.101. FAA directives and guidance are referenced at their revision level at the time of publication of this AC. The most current FAA directives and guidance should be used. Other references and guidance material for certification of systems and equipment include, but are not limited to:

a. AC 25-10, Guidance for Installation of Miscellaneous, Non-Required Electrical Equipment

b. RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification

c. AC 20-115B, RTCA, Inc., Document RTCA/DO-178B

d. RTCA/DO-160, Environmental Conditions and Test Procedures for Airborne Equipment

e. AC 21-16F, RTCA Document DO-160 versions D, E and F, "Environmental Conditions and Test Procedures for Airborne Equipment"

f. RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware

g. AC 20-152, RTCA, Inc., Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware

h. RTCA/DO-313, Certification Guidance for Installation of Non-Essential, Non-Required Aircraft Cabin Systems & Equipment

i. AC 20-168, Certification Guidance for Installation of Non-Essential, Non-Required Aircraft Cabin Systems & Equipment

CHAPTER 1. COMMERCIAL DERIVATIVE AIRCRAFT (CDA)

1. What is a CDA? For purposes of this AC, a CDA is defined as a commercial type-certificated aircraft converted for operational use by the U.S. Armed Forces or other U.S. government agencies, with associated mission modifications or equipment approved to civil airworthiness standards through the FAA type certification process. Typically a CDA is owned/leased and operated by a government agency. However a CDA may also be owned by a private commercial entity and operated under contract to a government agency as a public-use aircraft. These operations are referred to as contracted air services. CDA are utilized in operations for which the baseline commercial aircraft was originally designed such as training, transportation, and carriage of passengers or cargo. CDA are also used to conduct other special missions. Special missions are defined as aircraft operations conducting unique military, law enforcement, or other government operations not typically conducted as civil operations. Unique military special missions include patrol, surveillance, target towing, aerial refueling, intelligence collection, military training, and military support missions. Some examples for special missions that have shared applications for the civil and military sectors include medevac, parachute operations, aerial spraying, flight inspection, search and rescue, aerial photography, and survey or mapping. In order to conduct special mission operations, CDA may be equipped with modifications and special mission equipment (SME) not typically used in the civil sector. Some special missions cannot be conducted under civil operational rules, but are permissible as public-use aircraft operations. These limitations will be prescribed as part of the FAA airworthiness certification.

2. Why does the FAA accept military commercial derivative aircraft (MCDA) certification projects? Aircraft operated by the military are by statute public-use aircraft and are not subject to the civil regulatory requirements for certification, maintenance, and operation. Aircraft operated by U.S. government agencies (including the FAA) are also public-use aircraft and may also be exempt from compliance with civil airworthiness regulations, and to some extent, operational regulations. Though not required by FAA regulations, some governmental agencies have policies to maintain the airworthiness of the baseline aircraft by requiring FAA approval for any modifications. Some U.S. government agencies do not have the necessary aeronautical airworthiness expertise to evaluate aircraft modifications. They may rely upon the FAA or a military airworthiness authority (MAA) to approve their aircraft. Each U.S. Armed Force has a competent MAA responsible for ensuring their aircraft are airworthy. These MAA could complete airworthiness approvals for MCDA using their own processes. However, it is recognized by the military and the FAA that approving modifications to CDA should consider the original civil design and airworthiness criteria for the baseline aircraft. The MAA have issued policies requiring FAA certification be obtained for their MCDA when it is efficient or practical to do so. The FAA and the U.S. Armed Forces have signed a Memorandum of Agreement (MOA) to support that need. A special FAA aircraft certification office (ACO) designated as the FAA Military Certification Office (MCO) was created for this purpose. In the FAA certification process, the modifications and SME installed on CDA are found to comply with applicable civil airworthiness regulations. The MAA then uses the FAA certification to support their airworthiness approval for MCDA.

3. What is the FAA MCO? The MCO, located in Wichita, Kansas, was established in October 2004. The MCO provides certification, continued airworthiness, and technical assistance services for MCDA acquired by U.S. Armed Forces. Under the MOA, upon request by a sponsoring U.S. Armed Force, the MCO may also execute certification programs for the following entities: other U.S. Government agencies, foreign military/government under a U.S. security assistance program, or private entities operating under contract to the U.S. military. Military sponsored projects are accomplished by the MCO, through the responsible directorates, and other ACOs may be utilized. The MCO also assists the FAA Aircraft Engineering Division, AIR-100, in developing unique policy and guidance for military and special mission projects.

4. Can the MCO certify all CDA? There are situations where the MCO may find that an application for military CDA is inappropriate for civil certification. If any one of the following conditions applies, the MCO may determine that civil type certification is impractical for a military CDA and, as provided for in the MOA, may not accept the application, or may find the project is not executable as proposed:

a. If the modifier cannot produce an adequate certification plan, does not have the technical resources, or a sufficient schedule is not available to allow conduct of the type certification project in accordance with prescribed MCO procedures, the MCO may determine the project is not executable as proposed and may return the application and close the project. The applicant must have the ability and technical competence to show compliance with applicable regulations, and the FAA must be allowed the time required to perform its duties.

b. If the changes required for the proposed aircraft cannot be certified to existing regulatory airworthiness criteria (with limited exceptions) to the extent that the basic airworthiness and continued operational safety of the aircraft is assured, the MCO may decline to execute the project.

c. If the changes required for the proposed aircraft are so extensive that a substantially complete investigation of compliance is required, thus requiring application for a new TC in accordance with 14 CFR § 21.19, the aircraft is a new aircraft and no longer defined as a derivative aircraft. A TC application for a new aircraft that has no civil utility or purpose must be reviewed and approved by the Aircraft Certification Service, Aircraft Engineering Division, AIR-100. Applications submitted for this purpose will likely require a Program Specific Service Agreement with the sponsoring U.S. Armed Force (see Chapter 2 of Order 8110.101).

d. If the proposed aircraft will be routinely or intentionally operated outside the airworthiness limitations published in the approved airplane flight manual (e.g., operating weights, load factors, airspeeds, altitudes, or other environmental limitations, etc.), the FAA type certification is not valid assurance for continued airworthiness. The existing instructions for continued airworthiness are not viable, and continued operational safety support cannot be provided by the FAA. This is contradictory to the rationale and principles for obtaining the civil airworthiness certification for a military CDA. These aircraft will require airworthiness approval from the MAA, including the possibility that a full military qualification will be required.

5. How are applications for sponsored military projects handled? Can applications be made for CDA at other ACOs?

a. Applications for sponsored military certification projects must be made directly to the MCO in accordance with Order 8110.101. The MCO will evaluate the applications and certification plans to determine the scope and feasibility of the project and to determine whether it can be conducted using standard certification procedures and practices. Not all CDA military projects are appropriate for FAA certification, and the application may be rejected by the MCO. The MCO will issue a unique FAA military certification project number and Certification Program Notification to coordinate with the directorate and other ACOs that may be involved. The MCO determines if the project will be retained and worked by the MCO or if it will be worked by another ACO. If the project involves an amended TC, the MCO will coordinate for the project to be administered and conducted through the Certificate Management ACO for that TC. The MCO will work with the applicant and the ACO to determine the best possible use of FAA and designee resources to support the project. If the project is complex or has many military unique issues, the MCO will conduct or may retain partial involvement in the project. If the project has limited military issues and is best served by the applicant's local ACO, the project may be delegated and conducted at the applicant's local ACO. However, the military project number must be used to collect data and identify it as work done that is eligible for reimbursement by the U.S. Armed Forces.

b. Applications for other CDA which are NOT sponsored by the U.S. Armed Forces (other U.S. government agency, foreign military, or commercial special mission aircraft) are considered to be civil projects, and the applicant submits the application to its geographic ACO in accordance with Order 8110.4C.

6. What is different about a military project versus a typical civil project? Military CDA certification projects are similar to standard civil certification projects, but are conducted in accordance with Order 8110.101. The applicant must demonstrate that the design of the aircraft (new TC) or design changes/modifications to an existing approved design (amended TC, or supplemental TC (STC)) meet minimum safety standards by showing compliance to the applicable civil airworthiness requirements. The differences between an FAA military project and a civil project depend on the modifications and SME installed on the CDA platform. Some military off-the-shelf (MOTS) SME may be shown to meet civil safety standards and may be fully certified. Other SME or modifications may not meet civil certification requirements, and the FAA may only be able to establish that structural or system provisions meet applicable civil standards. SME may also pose hazards to the aircraft, other aircraft, personnel, or property that exclude consideration for FAA approval (e.g., self-defense systems such as flare and chaff dispensers). Military modifications or equipment may require first investigating whether certification is possible, and then considering what suitable means of compliance the applicant must show to meet applicable regulations. In some cases, the FAA may make agreements with the responsible MAA to accept technical data, provide expertise for SME, or otherwise assist the FAA in obtaining the information needed to find compliance with civil regulations. It must be shown that the type design changes meet all applicable regulatory requirements for the modified aircraft to be eligible for a civil standard airworthiness certificate, if required. (Some military aircraft and other U.S. government agencies operate under civil registration and maintain

standard airworthiness certificates.) The MAA is obligated under their system to issue an airworthiness approval, clearance, or flight release that is similar in purpose and effect (if not format) to an FAA airworthiness certificate. FAA approval of modifications on CDA projects may be used to satisfy all or part of their airworthiness requirements and is used by the MAA to support their airworthiness approval. When full FAA certification cannot be completed on a MCDA because applicable civil standards do not exist or civil certification is not possible for certain systems, then military airworthiness qualification and approval are required. MCDA platforms can become "hybrid" aircraft because some type design changes have been FAA certified, and some modifications have been approved by the military. Management of that "seam" between the civil and military approvals is required to ensure that all aspects affecting airworthiness of the CDA platform are addressed, but not duplicated.

7. How does The FAA Aircraft Certification Service manage complex integrations which involve multiple approvals? Military CDA platforms may require extensive modifications and complex integrations of multiple mission systems. Integration of numerous systems on the CDA platform often results in several specialized subcontractors performing a portion of the work on the aircraft. Competition and risk sharing for government contracts has further encouraged the creation of work share partnerships between contractors and subcontractors. The requirement to obtain FAA approval for the platform to the maximum extent possible may result in several companies applying for FAA approval for their portion of the modification to the CDA. There may be several applicants in various locations seeking approval for complex amended TC and/or STC for the same aircraft. The FAA has always held the person installing the aircraft modifications responsible for determining that modifications to an aircraft are compatible with each other and with the existing conditions on the aircraft. The FAA has a regulatory and oversight role, and cannot direct design activity on numerous independent approvals to make sure integration and certification requirements are coordinated for all changes approved for a single model or aircraft serial number. These are the responsibilities of the military contractors as both system integrators and type certification applicants. To ensure that these issues are addressed for complex projects, the FAA may require that certification must be accomplished under a single FAA approval. Or, the FAA may require limitations that link approvals to interdependent or pre-requisite installations. Just as the military must have a prime contractor identified as the system integrator, the FAA may find it necessary to hold one applicant responsible for airworthiness certification compliance in order for the project to be viable.

CHAPTER 2. COMPLIANCE AND CERTIFICATION FOR CDA PROJECTS

1. Can the FAA certify a CDA that requires special utility arrangements necessary for the mission, such as operator stations in the passenger compartment or troop carriage?

a. It is important to note that the civil requirements are generally distinct for passenger compartments, crew compartments, and cargo compartments; combining aspects of these compartments complicates civil certification. Unless the special mission is associated with carrying passengers or dignitaries, military and special mission aircraft may have a need to mix elements of these areas for aircraft utility. If not properly evaluated and executed, this can create compliance problems in civil certification. Aircraft layout, floor plans, and occupied areas must be analyzed to determine which civil regulations may apply, and what must be done to avoid non-compliances. Aircraft layout and interior arrangement drawings should always be submitted with the certification plan for a CDA. The proposed means of compliance for areas designated as occupied areas and cargo compartments should be included, as well as applicant requests for equivalent level of safety (ELOS) findings by the FAA.

b. Civil airworthiness regulations have safety criteria designed for personnel and cargo accommodations. The requirements associated with the safety of crew and passengers in occupied compartments are extensive. These include regulations associated with seating, berths, passenger information, placards, emergency provisions (e.g., emergency exits, evacuation, lighting, and aisle widths), ventilation and heating, pressurization, fire protection, and others. Passengers on civilian airplanes may be any person, e.g., children, aged, or infirmed, and may be untrained or unfamiliar with the hazards that could affect the aircraft or other occupants. While occupied areas of the aircraft may be equipped with stowage compartments (14 CFR § 25.787), cargo compartments have different requirements and are accessible only by a crew member for specific purpose, but may not be occupied (14 CFR § 25.855.)

c. For purposes of this AC and general guidance for a CDA, it is best to start with basic definitions with respect to civil airworthiness regulations:

(1) A *crewmember* is defined in 14 CFR part 1 as “a person assigned to perform duty in an aircraft during flight time.” This could include a pilot, copilot, flight engineer, flight attendant, mechanic, mission system operator, mission technician, etc. Crew members will be familiar with the aircraft, their function on board, and be trained in emergency procedures and use of emergency equipment. A crew member may sit in a crew seat or a passenger seat.

(2) A *passenger* is not a crew member, but may be anyone else that can be an occupant on the aircraft, seated in an area approved for occupancy by a passenger. The passenger may not be familiar with the aircraft, emergency procedures, or emergency equipment, other than what may be provided as a pre-flight safety briefing provided by a crew member. A passenger may only sit in an approved passenger seat.

(3) A *supernumerary* is a crewmember or employee of the agency operating the aircraft who may be carried on the aircraft *as a passenger* for transportation or repositioning, but may not necessarily have duties associated with execution of the current mission of the aircraft.

A supernumerary can occupy a passenger seat, or under some circumstances, an unoccupied crew seat if familiar with the aircraft type and trained in emergency procedures and the use of emergency equipment that may be required to occupy that crew seat.

(4) A *crew seat* is located in the occupied compartment, and the crew seat must meet all the criteria for the occupied compartment in which it is located, i.e., a pilot compartment or passenger compartment.

(5) A *passenger seat* is located in a passenger compartment.

(6) *The maximum number of occupants* approved for the CDA mission configuration consists of the provided crew seats, supernumerary seats, and passenger seats, which may be occupied for takeoff and landing. This cannot exceed the maximum number of occupants limited on the baseline aircraft TC.

d. It is possible to certify a crew station, such as an operator's console or mission workstation in the passenger compartment. Depending on the hazards associated with the work station, it may be necessary to restrict the seating or unattended access to the equipment from passengers. Cabin safety regulations must be addressed for crashworthiness, e.g., emergency exits, aisle widths, and head injury criteria. In some cases, mission crew stations or consoles located in a passenger compartment may require an ELOS, special conditions, or an exemption in order to be approved for their intended function in a passenger compartment.

e. Sling seats, bench seats, cargo compartment seating, or seating areas on a floor area designated for carriage of troops are not defined in civil regulations and cannot be certified by the FAA. Current troop seat designs do not meet civil airworthiness regulations for cabin safety, crashworthiness, or emergency procedures. While it may be possible to obtain approval for installation of these articles in a CDA to the extent that compliance can be found with some regulations, cargo compartments will not be approved for occupancy, and troop seats will not be approved for carriage of crew or passengers.

2. What special mission equipment (SME), by definition, cannot be certified to civil regulations? Any combat system, component, or store that may be hazardous to the aircraft, its occupants, other aircraft, other personnel or property on the ground is ineligible for FAA certification. Examples of this include weapon systems, such as guns, rockets, missiles, or other armament. This can also include defensive combat systems and self protection systems if they utilize active countermeasures that could be considered hazardous. Active countermeasures include chaff, flares, lasers, or other energy sources that could be hazardous to other personnel or aircraft. SME that is designed for jamming radio frequencies are ineligible for civil certification, as well as approvals for hazardous stores, such as ammunition, bombs, flares, or other pyrotechnics. Other types of SME that may be ineligible for certification include active emitters (communications, signal, or tactical), which interfere with the host aircraft or other civil aircraft systems, or civil communication, navigation, or position information. Approvals for these types of SME will be limited to provisions-only, safe-carriage, or military-use-only if design features can be provided to render the equipment inoperable, or operational restrictions are imposed to prohibit unauthorized operation (see Chapter 8 of Order 8110.101). However, if FAA approval

for provisions is pursued, the impact to fundamental airworthiness requirements for the end configuration and aircraft envelope should be addressed. See discussion on 'Provisions-only' in Order 8110.101 and this AC.

3. Can other SME be certified to civil regulations?

a. The basic tenets of military and civil airworthiness are the same; however, there are real and necessary differences in military approval criteria and civil airworthiness regulations based upon operational need. FAA requirements and standards were developed for civil operations and not for military or special mission operations; although, some military specifications are still used for civil certification. The proposed operation and applicability of specific regulations must be considered to determine the feasibility of certification. The acceptability of any proposed qualification or compliance data are factors to be considered to determine the feasibility of certification. For the FAA to certify any aircraft to civil airworthiness standards, the type design presented to the FAA must comply with all applicable airworthiness regulations and be free from hazards or potential unsafe conditions. If SME cannot be shown to meet these criteria, it cannot receive a complete FAA approval. Existing SME currently in use as airborne equipment has typically been shown to meet military airworthiness requirements on military organic aircraft (military aircraft whose airworthiness was determined by a military qualification process). It must be determined if SME will be examined for compliance as either required or non-required aircraft equipment. These two different approaches for civil certification approval depend upon the equipment function and integration with existing aircraft systems.

(1) *Non-Required Equipment*. Type certificated commercial aircraft are equipped with all required equipment to meet airworthiness standards. Most SME adds functionality to the airplane but, is not required by the civil airworthiness standards to safely operate the airplane. Although this installed SME may be *mission essential* for the military user, the SME is still defined as *non-essential equipment* for civil certification purposes. Civil certification compliance for non-required systems and equipment focuses on the impact of the SME, its failure modes, and functionality has on the safety of the aircraft and interface with the civil environment. The operational importance of military *essential* SME often results in robust design criteria for the components (when compared to consumer grade commercial equipment). Safety and reliability may meet or exceed the civil criteria for certification of the SME as *non-required* aircraft equipment. Although the SME may have no purpose or use in the civil environment, the type design or function itself may not necessarily conflict with civil airworthiness standards. Typical examples can include military tactical communications, encryption systems, and surveillance equipment. Military intelligence gathering equipment and sensors, such as communications intelligence (COMINT), electronic intelligence (ELINT), or image intelligence (IMINT), can often be certified to civil regulations (even though access to the technology, type design, or hardware may be restricted for security reasons). Operation of this SME may also be illegal for the general public. The SME may have been intentionally designed as a benign and passive system to escape detection. Therefore, installations can be designed such that electro-magnetic interference or other safety impacts are eliminated for the host aircraft. Some technologies used for military purposes are similar to those used for civil purposes, such as magnetic anomaly detection (MAD), which has long been used by the military

for submarine detection, and also has civil uses for geological survey and oil exploration. Military encryption technology or other signal processing may or may not conflict with civil airworthiness certification rules; it is important that the functionality and effects of the SME be understood. It may be necessary to impose civil operational restrictions for use of certain functions or capabilities of the SME.

(2) *Required Equipment*. Most military communication and navigation equipment is compatible with the civil environment as the military must operate in the civil environment during peacetime. However, it is often necessary to replace required and previously approved civil radios or equipment with military versions that provide expanded capabilities, such as the ability to communicate or transmit data on both civil and military frequencies. This is permissible as long as the military equipment meets the same criteria as the required civil equipment it replaced, meets civil certification requirements, and the additional military functions do not interfere with the required civil functions. Advances in military or civil technologies are often shared when the benefits can be realized in both environments. When military technology is introduced into the civil environment, it requires civil certification approval for civil use and operation. An example of a military technology that has been widely adopted for civil use includes the Global Positioning System (GPS). It has become an essential part of the civil aviation safety system. Special mission functions may also be added to required civil systems, such as the addition of search or tracking patterns to a flight director or flight management system. In general, approval for required SME or modification to civil equipment for these purposes requires the use of FAA accepted policy, guidance, and compliance methods to ensure safe integration.

b. A limited discussion of required/essential versus non-required/non-essential electrical equipment as it pertains to government furnished equipment/special mission equipment (GFE/SME) is provided in appendix B.

4. What performance and/or environmental qualification standards should be applied to new SME?

a. If the proposed aircraft configuration includes prototype mission equipment or equipment of new design, the objective for certification is to ensure the equipment will survive and function in the airborne environment in a safe manner. Qualification requirements can be incorporated in the design of the new equipment to ensure it provides satisfactory service. Certain FAA/industry qualification standards or environmental conditions may be imposed, even on the non-required equipment, e.g., RTCA/DO-178B and RTCA/DO-160D are applied to non-required electrical equipment (see AC 25-10). This is an indirect application of 14 CFR § 25.1309(a) and a direct application of 14 CFR §§ 25.1431(a) and 25.1353(a) showing the non-required equipment does not affect required equipment. 14 CFR § 25.1435(a) mentions specifically that critical environmental conditions must be considered. When military-unique reliability and/or performance requirements, imposed by contract or military performance specification, are also a factor, the equipment must be tested to the most stringent requirements. The objective would be to develop one series of qualification tests, including the most severe requirements, which would satisfy both the civil certification requirements and the military requirements without repeating similar tests.

b. AC 21-16F recognizes RTCA Document DO-160 versions D, E, and F, "Environmental Conditions and Test Procedures for Airborne Equipment," as a standard for environmental testing. It defines standard environmental test conditions (categories) and applicable test procedures for airborne equipment. The tests in RTCA/DO-160 provide a laboratory means of demonstrating the performance characteristics of airborne equipment in environmental conditions that may be encountered in operation.

5. What if the proposed SME package includes existing off-the-shelf hardware?

a. For SME that already exists as commercial-off-the-shelf (COTS) or military-off-the-shelf (MOTS) hardware, FAA-accepted performance and/or qualification standards associated with the applicable regulations should be first examined. By FAA-accepted performance and/or qualification standards, we mean related advisory material and related FAA-accepted industry standards. If the equipment was qualified to different standards, then comparisons should be made and additional qualification and testing may be needed, as necessary. If there are no performance and/or qualification standards associated with the applicable regulations, or there are no applicable regulations, then performance and/or qualification standards may be defined and accepted by the military customer. Operating limitations may be appropriate under 14 CFR § 25.1301(a)(2). Note also 14 CFR § 25.1585(b).

b. Order 8110.101, chapter 7, section 4, refers to completion of a comparison analysis matrix. This matrix should include, for the environmental aspects of GFE/SME, comparison of civil environmental standards to the test data from the military or other sources. For non-required SME, at a minimum the following RTCA/DO-160 sections should be reviewed and included in the matrix: sections 4.0, 7.0, 8.0, 9.0, 15.0, 18.0, 20.0, 21.0, and 23.0. The category of each section is dependent on where the GFE/SME is installed and should be agreed on between the applicant and the MCO.

c. If the performance or qualification standards proposed are different than that required by regulation and/or guidance, the applicant should propose an ELOS finding. The FAA, at its discretion, may leave acceptance criteria to be defined by the military.

d. For failure conditions, certain rules, such as 14 CFR §§ 25.1309 and 25.1431 and related advisory material apply whether the GFE/SME is required or not, thus specific associated performance or qualification standards apply. If the GFE/SME was qualified to a different performance or qualification standard, such as a military standard, then comparisons should be made and additional analysis and/or testing applied as necessary.

e. Appendix C contains an example for consideration of necessary compliance findings for installation of a MOTS item, a mechanical military clock installed in a cabin mission console.

6. Can the applicant submit, and will the FAA accept, previously accomplished equipment qualification data (test analysis, reports, etc.) to be used in support of compliance findings? As previously discussed, if there is reasonable confidence the qualification data is applicable, valid, and from a trusted source, the FAA may choose to accept the data. If the equipment was qualified to a different performance or qualification standard than that required or associated with FAA guidance, then a comparison analysis matrix should be prepared and additional analysis and/or testing applied, as necessary. If the data is accepted, the installation of the SME will be evaluated like any other equipment that must be installed under amended TC or STC certification procedures. Further analysis or testing may be required if the equipment performance may be affected by the installation and/or where the equipment may affect the aircraft's required systems.

7. What happens if the COTS/MOTS equipment fails to meet minimum qualification requirements for the environment or function for the intended use? If the qualification testing shows that COTS/MOTS equipment cannot meet minimum safety requirements, one should consider if there is other equipment available that may be more suitable for the application. It is recognized that SME, i.e., equipment for a special or unique purpose, may limit options for hardware available to do the job. Depending on the circumstances, it may be necessary to incorporate modifications to the off-the-shelf configuration to render it suitable for the airborne application. The equipment may no longer be considered off-the-shelf if required modifications are extensive. However, when the intent and purpose of the certification is to ensure a minimum level of safety for the aircraft and its occupants, there is no room for compromise. There may be other avenues to consider. Repackaging, hardening, or designing an enclosure to contain or mitigate hazards as part of the installation design may be an option.

8. What about approvals for software embedded in GFE/SME?

a. AC 20-115B, "Radio Technical Commission for Aeronautic Inc. Document RTCA/DO-178B" recognizes RTCA/DO-178B as an acceptable means of compliance for securing the FAA's approval of software in airborne systems and equipment. Keep in mind that RTCA/DO-178B is a means, but not the only means, to secure FAA software approvals.

b. Any alternative means of compliance is assessed in terms of how well it satisfies the objectives of RTCA/DO-178B. A system level functional hazard assessment needs to be accomplished to determine the criticality of the mission software. Depending on the criticality of the mission software, a software correlation matrix may need to be developed comparing the objectives of RTCA/DO-178B to the alternate means.

c. Some aircraft mission equipment installation factors to consider are:

(1) Is the mission equipment completely isolated and self contained, other than aircraft power, with no dependencies or interfaces with other aircraft systems or equipment?

(2) Is the mission equipment only a receiver?

(3) Is the mission equipment a transmitter?

(4) Does the mission equipment interface with other aircraft systems and/or equipment?

d. AC 20-148, "Reusable Software Components," addresses acceptance of reusable software components, i.e., software libraries, operating systems, and communication protocols. Order 8110.49, "Software Approval Guidelines," is used as a guide by certification officials and their designees on how to apply RTCA/DO-178B for approving software used in airborne equipment.

9. To what depth does the FAA participate in finding compliance with 14 CFR § XX.1309(a), for SME?

a. The following is a discussion of the application of 14 CFR § 25.1309(a) with respect to non-required or non-critical equipment when operating normally, i.e., not the failure case.

b. Previously, there has been wide variation as to how 14 CFR § 25.1309(a) has been applied for certification of SME on a CDA. The variations go from doing nothing, to demonstrating that the system does not interfere with the airplanes equipment, to demonstrating the airplane's equipment does not interfere with the non-required equipment, to demonstrating that the equipment performs within its design envelope.

c. Interference: 14 CFR § 25.1309(a) applies to each item of installed equipment, thus it applies to non-required or non-critical equipment as well. So, part of the compliance with 14 CFR § 25.1309(a) is showing the equipment doesn't interfere with its own function or other equipment doesn't interfere with its function. Further, it must be shown that this equipment doesn't interfere with equipment on other airplanes, a requirement in 14 CFR § 25.1309(a) as applied to the other equipment. In the later case, certain other regulations and associated guidance may come into play as well, such as 14 CFR § 25.1353.

d. We may establish there is no interference, but that does not mean we have established that the equipment is functioning properly. A primary finding is that the equipment is functioning within its design envelope. However, the design envelope, if not specified by some regulation or associate guidance material, can be selected at the discretion of the applicant or may be dictated to the applicant by the aircraft purchaser as part of the purchaser's contract. The purchaser would have to specify in the purchase agreement if he or she wants the modifier to certificate the performance of the equipment to a specific performance envelope under 14 CFR § 25.1309(a).

e. In demonstrating that the SME complies with 14 CFR § XX.1309(a), the assessment of compliance may be accomplished as follows:

(1) With respect to the regulations, if the GFE/SME is required, is essential for safe operation, or affects the aircraft's performance, the FAA will assess compliance using normal FAA procedures. Assessment will typically be, but not limited to, exercising the equipment (i.e., verifying the equipment is functional and is not being interfered with) and assessing compliance (functions properly) for the full operational/environmental envelope. For embedded military or

special mission functions, the FAA may not be able to establish appropriate criteria to make this finding. FAA findings may be supported by assessments from the receiving military authority or other U.S. government agency.

(2) With respect to the regulations, if the GFE/SME is not required, is not essential for safe operation, or does not affect the aircraft's performance, but whose function is essential to the mission of the aircraft, the FAA may not be able to establish appropriate criteria to make this finding. FAA findings may be supported by assessments from the receiving U.S. military or other U.S. government agency.

f. Establishing who is taking responsibility to verify that the equipment functions properly should be documented in the program specific certification plan and made known to the FAA and MAA.

10. What reliability must GFE/SME have?

a. The applicable regulation and means of compliance may affect the design's reliability. In general regulations that establish or govern the reliability of design include 14 CFR §§ 25.671, 25.672, 25.901, 25.1309, and 25.1431(a). There are other specific rules that require redundancy, such as 14 CFR §§ 25.1307, 25.1333, and 25.1355, that are related to reliability.

b. The reliability specified by the military customer or other end user may be different than that necessary to show compliance. The FAA must assess reliability which is necessary to show compliance for the applicable regulations. If the applicant wishes to demonstrate a finding, certification, or validation of reliability different than that required by the regulations, the FAA, at its discretion, may assess compliance or leave the assessment of compliance to the military, as appropriate.

11. Can the FAA approve provisions for unapproved SME as part of the type certification process? The FAA may approve installed SME if it can be included as part of the type design and be shown to comply with applicable airworthiness standards. In cases where this is not possible or practical, the FAA has defined and may consider alternate levels of approval (see Order 8110.101, chapter 8). The FAA-approved type design could include only provisions for the equipment. In exercising this option, the applicant must show that provisions are designed to meet established space, weight, and power requirements to support the follow-on installation. The structural, weight (and center of gravity), power, and other requirements must be defined, and compliance to applicable airworthiness standards must be shown to keep the end aircraft configuration within the airworthiness limitations for the derivative aircraft. The actual installation of the mission equipment is not part of the FAA-approved type design. Any subsequent modifications, including installation of the equipment for which the provisions were designed, are then approved by the MAA. As this practice requires the establishment of interface criteria for subsequent installation approval, it is the responsibility of the applicant to establish appropriate interface information and limitations as part of the FAA-approved type design. Other information may also be required by the MAA to assess and approve installation of SME. This coordination is conducted between the applicant and the end user. The FAA can

provide technical assistance to the MAA in its understanding of the criteria and limits of the FAA provisions-only approval.

12. For SME that will be FAA certified, but is not required by FAA regulations, what areas may need to be covered by the MAA? As a regulatory agency, the FAA can only mandate compliance to the minimum safety standards defined in the civil airworthiness regulations. Also the FAA does not wish to change policy and guidance material for established means of compliance to these regulations deemed appropriate for civil aircraft operation. These minimum safety standards or the compliance criteria may not meet the military's requirements for the CDA to perform a special mission. Any higher (or different) performance standards or reliability requirements should be imposed by contract. It is not in the best interest of the government or the contractor/applicant to duplicate efforts or address conflicting requirements. When mission and certification requirements overlap, compliance can be shown to appropriate regulations when data is presented, or tests are performed, that shows the type design meets the regulation. Every effort should be made by the applicant to write test plans and generate data that will demonstrate compliance with certification requirements and satisfy overlapping customer requirements, where possible. Particular areas where military or special mission requirements may overlap or exceed certification standards include, but may not be limited to:

a. Environmental qualification to military standards or to mission requirements;

b. System/Equipment performance to criteria desired;

c. Demonstration of function throughout its design envelope;

d. Effects failures may have on the non-required equipments performance;

e. Reliability; and

f. Desired format content of instructions for continued airworthiness.

CHAPTER 3. CONFORMITY INSPECTIONS AND PRODUCTION APPROVALS

1. How is FAA conformity inspection achieved for SME during the type certification process?

a. FAA conformity inspection is required during the type certification process for two principle reasons:

(1) Inspection to engineering requirements ensures that the prototype article(s) used for certification evaluation and test match the type design presented for approval; and

(2) Manufacturing review to ensure the design data is sufficient to produce, procure, and deliver articles that continue to conform to the type design.

b. SME may include COTS hardware, MOTS hardware, or GFE. It is usually not specifically produced for use on civil aviation products, and only limited type design data may be available. Without existing oversight of FAA-approved quality control procedures, questions may be raised about how complete conformity inspection can be obtained.

c. In terms of the level of detail in the type design data, the regulations require the applicant (modifier) to submit the type design, test reports, and computations "necessary" to show compliance with the applicable regulations. Regulations with the word "necessary" include 14 CFR §§ 21.21(b), 21.31(a), 21.33(b), 21.35(b), 21.81(d), 21.83(g), 21.97(b), 21.123(b), 21.143(a), 21.157, 21.303(c)(3)(ii) and (e).

d. What is "**necessary**" is that specifically required by the regulations. The detail necessary to show conformity or compliance for GFE/SME will generally depend on the equipment's complexity, the number of regulations that are applicable, and the potential that the equipment (for normal operation and failure conditions) may create a hazard to flight.

e. There will be a point where the showing of conformity or compliance may become impractical for complex GFE/SME because design, production, or qualification data is unavailable. In these cases, the FAA may consult with the military, and through special agreement, accept a military statement of conformity or military airworthiness approval tag in lieu of the FAA conformity inspection process. If FAA conformity inspection becomes an issue for certification of SME, consultation with the FAA Aircraft Engineering Division, AIR-100, and Production and Airworthiness Division, AIR-200, may be necessary.

2. Can SME be provided as an FAA-approved part if it has not been produced under an FAA production approval?

a. Production requirements for new SME *provided as part of the modification* for installation in MCDA are established in the same way as established for civil aircraft applications. As part of the FAA-approved type design, it must be established that newly manufactured or procured components have been produced using reasonable manufacturing and quality control procedures, and configuration control is maintained.

b. New production, modification, or replacement parts *produced for sale* must be approved under the TC, a production certificate, a technical standard order authorization (TSOA) or FAA letter of TSO design approval, or a parts manufacturer approval (PMA) (reference 14 CFR § 21.303). Where parts included in the type design are not produced as specified under 14 CFR § 21.303, the parts procured must be specified in the type design and must be properly identified if their physical or chemical properties cannot be readily and accurately determined (reference 14 CFR § 21.125(b)(1) and (2)). The aircraft manufacturer, TC holder operating under a production certificate, or an STC holder operating under a production certificate or PMA, may procure SME included on the FAA-approved type design as unapproved parts. However, if the SME is provided as part of the modification, or provided for sale to the military or operator as a spare or replacement part, he or she must obtain FAA approval for the part under a production certificate or obtain a PMA (unless the part is already produced under another FAA-approved production approval system, such as a TSOA). For FAA production approval, the modifier must set up the necessary inspections and tests to show that the equipment meets the regulations, and that these findings are maintained from part to part. These parts become approved parts under the TC or STC type design and TC or STC production systems. It remains the applicant's responsibility to provide configuration control and maintain access to all necessary type design data, and they may do this in accordance with agreements with their suppliers.

3. What about SME supplied as government or customer furnished equipment? In some cases, the mission equipment to be installed is GFE that is supplied by the military to the applicant out of existing government stock, and may not even be a new part. The type design must be available for the FAA to approve as part of the design approval. However, the applicant may not be able to obtain FAA production approval. If original and replacement parts are furnished by the government, and the modification and/or replacement parts are not provided for sale by the modifier, they are not subject to the requirement to obtain production approval under 14 CFR § 21.8. If appropriate, certain GFE items may be classified as "commercial parts" under 14 CFR § 21.9(a)(4). The military or any other U.S. government agency that supplies the part as GFE is responsible for configuration control and airworthiness of the part.

4. Does the FAA accept used parts from the military or other U.S. government entities? This question is basically answered by the previous question. However, if it can be shown with reasonable confidence that government furnished SME has been maintained and/or stored such that configuration control is maintained for replacement parts, then that finding may alleviate some of the effort in identifying the part for the type design relative to complying with 14 CFR § 21.125(b)(1) & (2). In other words, the design must have been accurately identified and the configuration must have been maintained from the initial tested part to the parts being installed.

5. What about parts and components that are installed as military deviations (not included in the type design)? Installation of SME or components not included in the type design (military deviations) is the responsibility of the modifier and the receiving MAA. The FAA may certify provisions for such equipment (mounting or connecting hardware) to the extent that the provisions can be shown to comply with the applicable regulations. This becomes the method of last resort if the criteria described above cannot be met.

CHAPTER 4. MILITARY DEVIATIONS TO FAA-APPROVED TYPE DESIGN

1. Can the FAA establish that uncertified SME (appearing on FAA Form 8130-31 as a military deviation) does not interfere with the airplane and/or flight crew performance for normal operation or a failure case? The FAA and/or FAA designees cannot establish this by making actual compliance findings; however, a technical evaluation or assessment may be provided. Unless it can be established under an FAA-approved process that the system or equipment installed on follow-on aircraft are the same as that evaluated, any evaluation or assessment would apply to the specific serial number examined. Configuration control and applicability of the evaluation for subsequent aircraft would be the responsibility of the MAA. In accordance with the FAA/Armed Forces MOA, the military may request the FAA evaluate military deviations from FAA-approved type design to determine compatibility with the aircraft systems or flight crew performance. They should make that request to the FAA under technical assistance services and make the aircraft available for such evaluations.

2. Why is it required that the FAA find compliance for an aircraft configuration (as defined in type design) even though that FAA-approved configuration may be superseded by military deviations and may never be produced?

a. To approve design changes to a type-certificated product, a configuration must be defined that will establish that the aircraft meets all applicable airworthiness regulations. So, a design data package can only be approved if the type design is complete and eligible for approval. If the equipment or installation is required by regulations, a compliant configuration must be established. If the military chooses to replace this required equipment with equipment that cannot be certified, it should not be included in the proposed type design. On delivery of the aircraft, that equipment will be identified as a military deviation on FAA Form 8130-31. For non-required, equipment that cannot be shown to comply with civil regulations, "safe-carriage" or "provisions-only" installations can be approved (see Order 8110.101, chapter 8), Equipment installed as "safe-carriage" is shown on the type design as disconnected and having no function; therefore, the compliance findings to substantiate operation of the equipment need not be addressed. Other compliance findings may be required to establish that the equipment meets crashworthiness and cabin safety requirements. "Provisions-only" installations are designed without the equipment identified at all. Equipment could later be installed by FAA approval if compliance is shown, but the provisions are usually for installation of SME that will appear as a military deviation approved by the MAA.

b. There are other reasons why a fully compliant type design must be defined to support the FAA approval:

(1) There is no requirement, basis, or need for the FAA to identify and address exemptions, develop special conditions, or make equivalent levels of safety findings for MCDA. If the civil airworthiness regulations are not appropriate, it is the responsibility of the MAA to determine appropriate airworthiness criteria to meet its needs. Deviations from the FAA-approved type design, as documented on Form 8130-31, identify these components for the MAA.

(2) The definition of an FAA-approved type design allows a derivative aircraft to be returned to an FAA-approved configuration at any time. If military deviations are addressed (removal of unapproved equipment and restoration of FAA-approved configuration), the aircraft could conceivably operate as a civil aircraft with a standard airworthiness certificate.

(3) Complete definition of FAA-approved type design, and military deviations thereto, help establish and maintain configuration control for the specific aircraft.

3. Do items identified in the FAA-approved type design, that will not be used in the delivered aircraft, need to be manufactured, conformed, and tested to receive certification? In accordance with 14 CFR § 21.33, the applicant must "allow the Administrator to make any inspection and any flight and ground test *necessary* to determine compliance with the applicable requirements of the Federal Aviation Regulations." This must be handled on a case-by-case basis. If compliance for the type design can be established by inspection of drawings, supporting analyses, and/or similarity to an existing FAA-approved design, it may not be necessary to actually build this hardware for the prototype installation. However, if compliance cannot be determined without a necessary inspection, ground test, or flight test, it may be necessary to manufacture a prototype installation that is later modified, or not used, in the aircraft. The applicant's certification plan should identify components that it does not plan to manufacture or install and a rationale for suitable means of compliance should be identified.

APPENDIX A

Acronyms

14 CFR	Title 14 of the Code of Federal Regulations
AC	Advisory Circular
ACO	Aircraft Certification Office
CAR	Civil Aviation Regulations
CDA	Commercial Derivative Aircraft
COTS	Commercial Off-The-Shelf
ELOS	Equivalent Level of Safety
GFE	Government Furnished Equipment
MAA	Military Airworthiness Authority
MCDA	Military Commercial Derivative Aircraft
MCO	Military Certification Office
MOA	Memorandum of Agreement
MOTS	Military Off-The-Shelf
PMA	Parts Manufacturer Approval
SME	Special Mission Equipment
STC	Supplemental Type Certificate
TC	Type Certificate
TSOA	Technical Standard Order Authorization

APPENDIX B

Discussion of required/essential versus non-required/non-essential electrical equipment

There are numerous regulations that have general applicability to equipment on the aircraft and there are regulations that apply to specific equipment or equipment whose function is required by "this subchapter" or "essential for safe operation." Examples of regulations that apply generally to all electrical equipment are 14 CFR §§ 25.1301, 25.1309(b), and 25.1431. Examples of regulations that apply to electrical equipment "whose functioning is required by this subchapter" or "essential for safe operation" include 14 CFR §§ 25.1309(a) and 25.1353(a).

Equipment, including equipment "not required" or "not essential for safe operation," must be shown not to adversely affect equipment that is required or essential during normal operation and in the case of failure. For example, for electrical equipment, 14 CFR §§ 25.1309(a), 25.1431(a) and (c), and 25.1353(a) apply to normal operation and, 14 CFR § 25.1309(b) applies to the failure case.

1. Non-Required/Non-Essential GFE/SME - Normal Operation:

a. Effect on non-required/non-essential equipment, reference includes 14 CFR § 25.1301.

(1) 14 CFR § 25.1309(a) does not directly apply; therefore, unless another regulation requires a specific design or qualification envelope, the design or qualification envelopes may be that selected by the modifier and may not necessarily have to be FAA-approved. However, operating limitations may be appropriate. Reference 14 CFR § 25.1301, also note 14 CFR § 25.1585(b).

b. Effect on required/essential equipment: Reference 14 CFR §§ [indirect] 25.1309(a), [indirect] 25.1431(a) & (c)], and [direct] 25.1353(a).

(1) For the showing that non-required equipment does not adversely affect required equipment or other electrical equipment essential to safe operation, certain FAA/industry qualification standards may be imposed on the non-required equipment. For example, RTCA/DO-178B and RTCA/DO-160B are applied to non-required electrical equipment, see AC 25-10. This is an indirect application of 14 CFR §§ 25.1309(a) and 25.1431(a) & (c) showing the non-required equipment doesn't affect required equipment.

2. Required/Essential Equipment (Non-GFE/SME) - Normal Operation: Effect on non-required/non-essential GFE/SME [no specific regulation other than 14 CFR § 25.1309(a)]. The scope of this assessment will generally be limited and/or delegated.

3. Required or Non Required/Essential or Non Essential Equipment GFE/SME - Failure Case:

a. Sections in 14 CFR such as §§ 25.1309(b) and 25.1431(a) apply. Note, under 14 CFR § 25.1431(a) critical environmental conditions must be considered when evaluating the failure case of non-required/non-essential equipment on required/essential equipment.

b. The discussions above are limited to 14 CFR part 25. The observations above should be the same for other parts (23, 27, and 29) if the regulations are the same.

APPENDIX C

Example (14 CFR part 25)

The installation of a manually wound 24 hour military clock in the passenger cabin, and the clock is purchased from an unapproved distributor.

Requirements: As the clock is fully mechanical and not required, the applicable regulations include, but are not limited to the following:

1. 14 CFR § 21.125(b)(1) and (2): The GFE/SME design will have to be defined in the type design, including acceptance inspections and tests that would likely be required to comply with 14 CFR § 21.125(b)(1)&(2). The inspections and tests for the type design to comply with 14 CFR § 21.125(b)(1)&(2) should be developed to the extent necessary to establish that the compliance findings with respect to 14 CFR §§ 25.561(b), 25.789, 25.853, 25.1301 and 25.1309 are still valid from part to part.

2. 14 CFR § 21.53: Conformity would be normal, i.e., per type design. See paragraph above.

3. 14 CFR §§ 25.561(b), 25.789 and 25.853: Typical certification compliance effort for an item of mass in the cabin. Structural tests and burn tests may be required for certification.

4. 14 CFR § 25.1301: The accuracy and the environmental envelope that the clock is to operate can be specified by the modifier or by an agreement between the modifier and aircraft purchaser (i.e., whether it needs a second hand, accurate to 1, 0.1 or .01 seconds etc., or needs to meet a military specifications, environmental operating conditions, color, size, etc.). The military or manufacturer's specifications for the clock may provide adequate information.

5. 14 CFR § 25.1309(a): Defining the performance and qualification standards for this installation relative to 14 CFR § 25.1301 are up to the modifier, and the certification assessment is at the discretion of the FAA. The compliance effort may be a spot check for functioning by the FAA.

6. 14 CFR §§ 25.671, 25.672, 25.901(c), 25.903(b) 25.1309, 25.1431(a): The clock's failure does not affect the flight crew or other required equipment. Therefore, there is no FAA reliability requirement other than at the time of certification review "they perform their intended functions" under 14 CFR § 25.1309(a). Defining the qualification standards for reliability for this installation is up to the modifier and the certification assessment is at the discretion of the FAA. The compliance assessment may be delegated or left to statements from the modifier or the clocks manufacturer, if necessary. The military or manufacturer's specifications for the clock may provide adequate information.

Note: The above list of regulations is not all-inclusive. For instance, the affect of the weight of the installation would need to be assessed under the performance and structural regulations.