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Electronic Engine Control Hardware Change Management

RATIONALE

No foreseen need for evolution on this process oriented guide in a near future.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE E-36 Electronic Engine Controls Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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FOREWORD

Changes to engine control systems have traditionally been classified as either minor or major, with the former being defined as having no change to the form, fit or function of the item to be changed. This method of classification has proved somewhat awkward with changes to electronic control or protection functions that address obsolescence.

The change might be to a component or function which is complex or which is obviously safety-related (such as the over speed protection function) while causing no change to form, fit or function. A level of risk may exist with this change which could warrant the use of a modification process, which may involve all parties to determine if an aircraft modification is required. This is often referred to as a ‘Full Modification Process.’

For the full modification process, procedures and review stages not called for in the minor change process will need to be introduced. The resultant level of scrutiny that accompanies the change may be considered more fitting given its complexity or its potential functional impact if not implemented correctly. The use of a full modification process often requires identification of the revised configuration. This enables effective tracking in service should the change prove to have unexpected effects on unit performance. However, a shift from the minor change process to a full modification process could be considered excessive in some situations, as well as unmanageable for any unit that is regularly affected by obsolescence issues.

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1. SCOPE

1.1 General

This document is intended for use by manufacturers of aircraft, engines and Electronic Engine Controls [EECs] as a component change process and evaluation guideline. Its purpose is to provide an effective means of managing the modification of electronic hardware.

The process defined in this document is based upon:

- an understanding of the electronic component market evolution, e.g., obsolescence;
- lessons learned from the effects caused by the introduction of electrical component changes in a service fleet environment;
- industry best practice; and
- an understanding of the applicable regulations.

1.2 Purpose

The introduction of any design change to an Electronic Engine Control system will carry a potential risk to the aircraft safety and operability. The evaluation of the impact for any change can be difficult to manage as it may require involvement of the EEC manufacturer, the engine manufacturer and the aircraft manufacturer, who must each support the showing of conformance to all applicable certification standards.

Further complexity is brought about by the variety in the quantity and quality of the original design data.

The purpose of this document is to provide guidance on how to evaluate and classify a design change. It also provides a definition of the coverage and depth of analysis necessary to manage the risk of impact on aircraft safety and operability to a satisfactory level.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP4754A Guidelines for Development of Civil Aircraft and Systems

2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

14 CFR Part 21 CERTIFICATION PROCEDURES FOR PRODUCTS AND PARTS

14 CFR Part 23 NORMAL, UTILITY, ACROBATIC, AND COMMUTER CATEGORY AIRPLANES

14 CFR Part 25 AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

14 CFR Part 27 NORMAL CATEGORY ROTORCRAFT

14 CFR Part 29 TRANSPORT CATEGORY ROTORCRAFT

14 CFR Part 33 AIRCRAFT ENGINES

TSO C-77B GAS TURBINE AUXILIARY POWER UNITS

AC 33.28-1 Compliance Criteria for 14 CFR §33.28, Aircraft Engines, Electrical and Electronic Engine Control Systems

2.1.3 EASA Publications

Available from European Aviation Safety Agency, Postfach 10 12 53, D-50452 Cologne, Germany, Tel: +49-221-8999-000, www.easa.eu.int.

Part 21	Certification of Aircraft and related product, parts and appliance, and production organisations.
CS - 23	Certification Specifications for Normal, Utility, Aerobatic and Commuter Aeroplanes
CS - 25	Certification Specifications for Large Aeroplanes
CS - 27	Certification Specifications for Normal/Small Category Rotorcraft
CS - 29	Certification Specifications for Transport/Large Category Rotorcraft
CS - E	Certification Specifications for Engines
AMC 20-1	Certification of Aircraft Propulsion Systems Equipped with Electronic Control Systems
AMC 20-3	Certification of Engines Equipped with Electronic Engine Control Systems

2.1.4 Other Publications

IEC/PAS 62239-1	Process Management for Avionics - Preparation of an Electronic Components Management Plan
RCTA DO-254 / EUROCAE ED-80	Design Assurance Guidance for Airborne Electronic Hardware
MIL-STD-883H	Department of Defense Test Method Standard, Microcircuits (Feb 26th, 2010)
MIL-HDBK-61A	Configuration Management Guidance

2.2 Terms and Definitions

Terms not listed below are used in this document as defined in ISO 9000.

ARP: Aerospace Recommended Practice

CCB: Change Control Board

CFR: Code of Federal Regulations

COTS: Commercial Off-The-Shelf

CS: Certification Specification (EASA nomenclature)

DOA: Design Organization Approval

EASA: European Aviation Safety Agency

EEC: Electronic Engine Control

FAA: Federal Aviation Administration

FAR: Federal Aviation Regulation

FADEC: Full Authority Digital Engine Control

IEC: International Electrotechnical Commission

Major Change (as defined in CFR 21.93 (a)): Any change that does not meet the definition of Minor Change.

Minor Change (as defined in CFR 21.93 (a)): A change is considered Minor if it has no appreciable effect on weight, balance, structural strength, reliability, operational characteristics or other characteristics affecting the airworthiness of the product.

ODA: Organization Designation Authorization

Type Certificate: A type certificate is awarded by aviation regulating bodies after it has been established that the design of an aircraft, engine, or propeller has fulfilled all prevailing airworthiness requirements.

3. REGULATION AND GUIDANCE MATERIAL

3.1 Change Management Regulatory Requirements

Part of the designer's responsibility is to control the configuration of their products.

The manufacturing of the complete aircraft [including the engine and its components], along with its use and maintenance by operators (flight operations), requires configuration approval. This configuration approval is referred to as type design certification. Subsequent change to the certified type design must be approved for products to enter and to stay in service.

The EEC is made of analog and digital electronic hardware, operating system and application software. A growing percentage of EECs incorporate Commercial Off-The-Shelf (COTS) electronic components that were not developed specifically for use in EECs. The evolution of the electronic component market is such that many of these components become obsolete in a very short time when compared to the expected service life of the EEC. In order to introduce a change to the bill of materials, a change to the configuration must be approved. Component obsolescence or cost reduction are examples that may cause changes to the bill of materials.

For aircraft and engine type design certificate holders, this approval is regulated by certification requirements such as Part 21, military or other civil authorities' equivalent. Suppliers to these type design certificate holders, such as EEC manufacturers, will usually receive requirements embodied in procurement specifications. This will include requirements to identify and label parts, components, assembly or equipment by part number and in some cases, by serial number.

While the complete aircraft with installed engine must comply with aircraft type design certification requirements, credit can be taken for the data collected and produced as part of the engine type certification activities. It should also be noted that the EEC system is certificated as part of the engine type design.

Change management should be used to guide the evaluation of changes in order to feed the configuration management process. In some cases, it may be simple to conclude that a substitute part will operate in precisely the same manner as the one it replaced. In other cases, however, a more comprehensive process, which includes independent review, may be required to evaluate the change. Depending on the complexity of the change, a review may require involvement of the aircraft type design holder to ensure compliance with applicable aircraft requirements is maintained.

The ultimate goal is to maintain compliance to both the engine and the aircraft type design certifications when changes to the EEC design are introduced. Reasonable and practical procedures are presented to efficiently manage such change.

3.2 Change Management and Fleet Management Guidance

Whenever design choices are made related to changes to already certified products, the potential impact of those choices on the fleet users must be considered. Aircraft are managed by configuration. The configuration of each item on the aircraft must be available to the end user, the operator. The usual way to manage this configuration is by using part numbers.

In terms of configuration management, all items with the same part number are identical. If a change is introduced without a corresponding part number change, and if there is a need to identify or locate these changed products in service or storage, it can be difficult and costly.

Tools are used by airlines to determine, in real time, the configuration of each aircraft. If a change is introduced to an item without a change to its part number, then some of these tools would not be able to identify the difference between a changed and unchanged item. The identification of changed items would therefore require review of the maintenance log and the confirmation could require access to inspect the parts, component or equipment labels, which can only occur when the aircraft is on the ground.

It is desirable to have a means to isolate potentially suspect units. It is also desirable to minimize proliferation of configurations. The level of difficulty associated with locating a changed part in the field must therefore be considered when assessing the necessity to modify the part number; serialization (serial number or lot) may also be considered.

3.3 Product Configuration Management

Outside of certification considerations and constraints, the EEC, engine and aircraft manufacturers may have different needs for controlling the configuration of the product. Change control is a high level process which includes within it, configuration management activities. In the context of the changes that are addressed in this document, we have to answer the question: “what kind of change do we have to manage under configuration and at which level (EEC, engine, aircraft)?”

The difficulty is to determine the level, up to which, a component change needs to be managed in configuration. Obviously, identification and control of hardware and software part numbers at some level is required. Any change in form, fit or function needs to be identified and controlled at the appropriate (engine and/or aircraft) level to ensure compliance with the aircraft type design. If this is required at the aircraft level then it should also be required at the engine level. However, if it is required at the engine level, it may not be required at the aircraft level.

Additionally, the end user (airlines, military, etc.) also needs this type of configuration control to manage its aircraft maintenance tasks and to verify that mandated changes have been incorporated into their fleet as required by the regulatory agencies.

Part substitution at the piece-part level of equivalent or improved piece-part is at the discretion of the EEC supplier, provided it can be shown that the change truly meets the definition of a “Minor” change (refer to 3.4.1).

Consequently, the product is usually managed under configuration at different levels using different methods. It is not uncommon to have multiple identification plates on the same EEC, one dedicated to the aircraft configuration management (equipment part number), one for the engine manufacturer, and one for the EEC manufacturer.

3.4 Major versus Minor Change Classification

For simple changes, such as that described in 3.4.1, a classification of Minor may be appropriate.

Beyond a certain level of complexity, the change should no longer be classified as Minor because the risk of altered equipment behavior becomes too high. In this case, the ability to track the change in service is necessary and re-identification of the equipment at some level is required. Consequently, higher-level stakeholders (engine manufacturer or aircraft manufacturer), should become involved, as required.

Whenever possible Major changes should be packaged together to minimize the amount of change requests submitted to the aircraft manufacturer. A notification process, in which the engine or aircraft manufacturer is notified of changes, clearly judged as Minor by the EEC manufacturer, without a formal change request, may be used. It should be noted, changes that are classified as significant at the EEC level might not require configuration management at a higher level than the EEC, depending on the nature of the change.

Any change which clearly affects the form, fit or function will automatically be managed under configuration control and will usually require part number re-identification.

The extent and significance of the impact of a component substitution/change may be difficult to quantify depending upon several factors. For example, the component being changed may be borderline simple, may be used in a safety critical area of the design, may be used in several places within the design, or may be a fairly simple component in a complex analogue or digital design and so on. The level of change should be discussed and agreed between all stakeholders in a timely manner.

Sections 5 and 6 introduce methods that may be used to aid selection of the change classification threshold and to accurately classify change. Section 5 describes the use of a complexity analysis to help define the risk introduced by the change. Section 6 introduces a checklist approach to determine whether configuration management is required at the aircraft level.

3.4.1 Alternative Sources

The introduction of an alternative source of part/component is recognized to be a minor change, provided the following conditions are met:

- The activities at component level are conducted in accordance with an electronic component management plan, compliant with a standard like IEC/PAS 62239-1.

- The component is identified as Simple (refer to RTCA/DO-254 for a full definition of a Simple component).

Such a change is not required to be configuration managed at a higher level than the EEC. In some cases, it could be identified as a revision letter change to the EEC or one of its sub-components. If obsolescence leads to several component changes, either simultaneously or sequentially, the complexity analysis considerations of Section 5 may help to define when the level of change becomes significant enough to warrant configuration management at a higher level.

3.4.2 Product Improvements

Product improvement changes, such as those to increase production yield or field reliability, would typically be classified as Minor, and provided the change has no impact upon the system functionality.

In some cases, a component change may introduce an effect that necessitates a corresponding change to specification or a statement of deviation to a requirement. This type of change will be classified as Major as it does impact the system functionality.

Another type of change may be the addition of a functional requirement, as requested by the engine or aircraft manufacturer. This type of change will be classified as Major as it can impact the system functionality.

3.5 Class I and Class II Versus Major and Minor Classification

MIL-HDBK-61 has been developed to provide guidance to ensure the application of product and data configuration management to defense materiel items. It allows the Government to control the item configuration based on Government CCB approval of any Class I (Major) Changes and Government concurrence in Class II (Minor). It is not an aircraft application dedicated document.

The document addresses wide topics such as commercial-off-the shelf (COTS) configuration management and obsolescence issues associated with advanced technologies.

The primary objective of configuration control defined in this military standard is to establish and maintain a systematic change management process that regulates life-cycle costs. This contrasts with the Part 21 requirements which are driven by safety.

The change review process and the Class I/II modifications process defined in MIL-HDBK-61 are very similar to the processes defined in this document, while the classification criteria is not.

4. DESIGN CHANGE EVALUATION

4.1 Product, Market and Design Process Evolutions

With the advent of DO-254 in recent years, EEC development practices have evolved with respect to requirements capture, traceability and flow down as well as low-level verification of the unit's building blocks. DO-254 has been published with the intention of defining a development process to support electronic hardware technologies (particularly complex programmable logic devices). This ARP refers largely to DO-254 processes that are now well known and widely used.

For products developed prior to DO-254, it is difficult to show comprehensive design verification coverage at any one level within the V-model (as defined in contemporary standards such as ARP4754A). It is also often difficult to retrieve the original detailed design data and corresponding requirements.

The recent rapid evolution of the electronic component market has caused obsolescence to become a major issue for EEC manufacturers. Justification that component substitutes introduce no modification to the fit, form and function of the unit must be provided, even if the unit has been developed prior to DO-254. In other words, the manufacturer will have to demonstrate equivalence between a new version of a unit and an older version, whose requirements may not have been fully documented. In this context, datasheet comparison is not sufficient as there are often differences between obsolete and substitute component technical data. Furthermore, the design may rely on aspects of component performance that are either not in the datasheet or merely implied by the datasheet.

Another difficulty may come from the fact that between the original type certification and the date of the design change, all key stakeholders (EEC, engine and aircraft manufacturers) are likely to have improved their own design processes. These new processes will rely on data that has or should have been generated as part of the development process. At the time of the design change evaluation, each stakeholder shall identify the gaps between existing design data and the activity outputs specified by the most recent processes, mainly for design assurance requirements. In order to take advantage of the improved processes, appropriate activities should be carried out to fill these gaps, as part of the design change.

The challenge for manufacturers is to introduce the change with an acceptable level of risk, not only from the safety point of view, but also from the aircraft production and operation point of view.

The following processes should be deployed for each change. The complexity of the change will impact the extent to which a given process is engaged, but it is recommended that all changes follow the recommended process steps defined in 4.2.

4.2 Hardware Development Cycle

The development cycle comprises of three main phases:

- the Planning Phase;
- the Specification Phase; and
- the Verification Phase.

4.2.1 Planning Phase

EEC component management of Minor Change is distinguished by the fact that a change can be managed at engine level only; these are low-risk changes.

It is recommended that all Minor Changes be briefly summarized in a Minor Change Notification Letter to the airframe manufacturer, on an agreed periodic basis. This gives the airframe manufacturer an opportunity to become involved in those changes that are of interest or importance to them.

The airframe manufacturer will be specifically involved in reviewing and approving all changes that are not classified as Minor as configuration control of these changes is managed at the aircraft level.

The introduction of both Major and Minor Change will require management and co-ordination of resources, risk and schedule across multiple organizations. This will include EEC manufacturer, the engine manufacturer and, in some cases, the aircraft manufacturer.

The intent of this phase is to detail the planning activities which define the development methodology, resources, organization, responsibilities, milestones, data, and documents required to introduce the change with an acceptable level of design maturity. The proposed design methods and risk mitigations should be defined, explained and recorded.

Another objective of the planning phase is to ensure the proposed change and its impact on the type certificate design, are fully understood. The impact that the change has may be assessed by a formal method such as a complexity analysis described in Section 5 of this document. The resultant impact should be included in the planning. The method outlined in Section 5 results in three categories of risk/complexity. Such categorization may be useful at the planning stage to determine the number of depth of design reviews and document reviews needed for the change. It may also be used to aid selection of the change classification described in Section 6.

The change impact assessment should provide a full description of the new aspects of the design and of the known or potential impact of these new aspects on the EEC overall design. This analysis should also describe how subsequent processes, such as development and verification, will be involved in support of the change.

At the end of this phase, each organization should be able to answer to the following questions:

- During the development of the equipment/hardware, will the resources and processes be in place and on time?
- Have lessons learned been captured and will they be managed such that future programs are obliged to consider them formally, as part of their development and change management processes?
- Have risks been captured and means of mitigation shared with the stakeholders?
- Has the change been appropriately classified?

4.2.2 Specification Phase

The objective of the specification phase is to fully define the product requirements. Equally, when implementing a product change, the impact upon the requirements must be fully understood and recorded.

In the case of addressing a component obsolescence issue, the requirements for the system are not affected and so changes to the specification will not be necessary.

In some cases, a component change may introduce an effect that would require a specification change or as a minimum, require a deviation to a specification requirement. An example of this could be substitution of a data bus driver that is less capable than the current device and can only drive six loads versus eight. This component substitution may or may not be acceptable at the aircraft level depending on the system architecture margin. The specification may require the interface to drive eight loads, so either a specification change must be made or a permanent deviation be put in place.

Another type of change may be a functional requirements change requested by the engine or aircraft manufacturer, for example to add a new sensor interface. This type of change would require a product specification change.

The impact of an EEC change to address parts obsolescence and product improvements is best determined using a bottom-up approach where the system level effect can be defined and evaluated. For changes that may modify product specification requirements, a top down approach may be more appropriate.

The requirements capture process should identify and record the hardware item requirements associated with the change. This process may be iterative since additional requirements may become known during the design phase. The effect of any requirements change upon the safety assessment should be reviewed and the safety assessment revised accordingly.

The design process will produce a high-level design concept that may be assessed to determine if the EEC will meet the current or new requirements following the proposed modification. The results of this activity may be used to evaluate the change classification, as described in 3.4.

The objective of an obsolescence fix is to repeat the component selection process as it had been performed when the original component was chosen. The selection of an alternate component will be based on the key design parameters; a simple component datasheet comparison is not recommended.

Experience has shown that for older designs, the retrieval of original requirements may not be possible. Where this is the case, reverse engineering using any available validation data may be required.

When evaluating the potential impact of the change upon the EEC specification, both the hardware and software interfaces shall be considered.

It is recommended that a design assurance process be utilized by the EEC manufacturer to ensure that the specification is complete and correct. The review that marks the end of the specification phase is traditionally identified as the PDR (Preliminary Design Review). It is important to clearly define the objectives and acceptance criteria for this review.

4.2.3 Verification Phase

The verification phase can be defined as the activities needed to verify the product against its pertinent requirements (new, modified, or legacy) at any required level (circuit, board, box, etc.).

RTCA/DO-254 §10.4 states "(validation and verification data) provides assurance that the hardware has been developed to its requirements and design, correctly produced, and the design objectives achieved". Testing at most levels should utilize the proposed type design, production representative hardware. Testing may be at the component, board, EEC or engine level; aircraft integration simulation or flight test may also be considered.

Where hardware test methods cannot provide sufficient test coverage, additional methods, including simulation may be used.

Agreement on the required testing should be established, between all parties (EEC, Engine and Aircraft Manufacturers), before testing is performed. Test Summary distribution details should also be agreed.

The verification process breaks the equipment down into hierarchical levels. If we consider the system level as being the highest, the lowest level is the electronic component level (or the implementation as identified by RTCA/DO-254). Depending on the magnitude of the change and the risk it introduces, the verification coverage and depth, at each level (Aircraft, Engine and EEC levels), will be adjusted.

The hardware becomes functional when embedded software starts running. It is usually only after this software is loaded that the hardware internal parameters can be monitored. In order for the hardware to be fully evaluated during the verification stage, it may be acceptable or even required to use test software that stimulates the hardware in a different way to the fielded operational software.

An evaluation should be performed regarding the differences between the software used during this stage and the software that will run in service. It should be demonstrated that the hardware/software interface requirements are verified at the appropriate hierarchical level and with the depth required to mitigate the risk associated with the change.

The main deliverables for this phase are the verification results reports and the verification coverage matrix. This matrix should establish traceability between each requirement affected by the change and the corresponding verification results. The scope of these deliverables will vary greatly with the complexity of the change.

The results of all verification testing must be subsequently evaluated to determine if they support the assumptions and analysis defined in 4.2.1. This includes establishing that the results support or do not invalidate any previous traceability flow down. RTCA/DO-254 §10.4.1 defines traceability in the following way: “hardware traceability establishes a correlation between the requirements, detailed design, implementation, and verification data that facilitates configuration control, modification and verification of the hardware item”.

Lastly, while formal environmental qualification tests may be performed on this change, it is not unusual that this be covered through a similarity analysis rather than by repeat testing. The verification activity should determine whether the assumptions which support certification by analysis are valid.

5. ASPECTS OF COMPLEXITY ANALYSIS

It should be noted that this section is primarily written for the case where an obsolete component is being replaced by a new component of similar or identical functionality. However, in some cases, where a replacement component is implemented, additional, supporting circuit modifications may be required in order to fully replicate the functionality of the obsolete component. This section is equally applicable to that scenario.

5.1 Complexity Analysis

The complexity assessment is based upon a regression analysis which aims to define the nature of the change and to assess how widespread the potential influence of the change may be.

Many hardware components have a wide sphere of influence in terms of requirements and the areas of functionality affected. The regression analysis supports the complexity assessment by defining the impact that the change has on other functionality at unit level and system level. It should be kept in mind that a component type may be used in a number of places in the unit design, if the component is part of a functional block. In this situation, repeated iteration of the process (steps 1, 2, and 3) would be required, for each instance of the change.

Step 1: Interface Identification: All instances of the circuit block containing the new component are identified.

Step 2: Circuit Functionality: The functional states of the circuit block containing the new component are identified.

Step 3: Complexity Assessment: The results obtained during the previous two steps are combined to define the change complexity.

5.1.1 Step 1: Interface Identification

An understanding of the number and type of interfaces potentially affected by the change is required to assist in the complexity assessment. A change can be complex if many interfaces are affected, even if the component being replaced is not complex.

Design data (circuit/system diagrams, requirements, design calculations, etc.) is required to carry out this assessment. The key objective is to gain an understanding of the component's application and to determine all the functions that it supports, or interfaces with; key elements for this step are:

a. Functional Boundary: The circuitry where the component being changed, is used, should be defined by its function (e.g., gain stage, buffer stage, mux) or by the higher level functional area in which it resides (e.g., Overspeed Protection, Power Supply, etc.) at the EEC level.

b. Number of Interfaces: Define how widespread the change is in terms of the number of interfaces to the affected circuit blocks and/or the number of instances of the change, throughout the EEC.

5.1.2 Step 2: Circuit Functionality

This step is used to characterize the circuit block that contains the new component: its expected inputs, expected outputs and possible noise factors. This can be used to determine the number of associated functional states, in normal and abnormal [failure] conditions.

Noise factors are any form of variation of the circuit block characteristics (e.g., power supply variation, input/output stability, etc.) that should be considered when analyzing the circuit block performance.

The objective of the circuit functionality phase is to assess:

a. Functional States Against the Original Circuit Implementation*:* This step should evaluate if there are altered functional states or new states compared with the original implementation. This should include both normal operation and abnormal operation, such as those covered by an FMEA of the functional circuit block or those that occur due to the influence of noise factors.

b. The Potential Influence of Connecting Circuit Blocks: This step should review adjacent circuit blocks which may comprise an input to the impacted circuit block or an output from it. It should be determined if the expected range of inputs can influence the noise susceptibility of the changed circuit or if its outputs could adversely influence the circuit blocks to which they connect.

5.1.3 Step 3: Change Complexity Assessment

This step utilizes the data from steps 1 and 2 to determine the level of complexity that the change is likely to introduce at the EEC level. All interface changes are assessed in terms of number of functional states, potential for noise variation, number of recurring instances and number of impacted adjacent circuit functions. The result of this assessment will determine the level of complexity the change is likely to create. The following definitions are suggested:

a. High Complexity: The changed component may be used in multiple circuit blocks, in a variety of separate functions, it may introduce a very complex device which is difficult to completely assess or it may affect a circuit which interfaces with many other functional blocks.

b. Medium Complexity: The changed functional block interfaces with a number of other functional circuit blocks but they are either easily assessed or the authority of the changed block is low.

c. Low Complexity: The change impacts minimal interfaces, is easily assessed for potential impact, and is relatively limited in its ability to impact adjacent or connecting circuit functions.

The level of Complexity assessed above should be used in the decision making processes discussed throughout this document.