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AIR FORCE SUSTAINMENT CENTER

AIR FORCE SUSTAINMENT CENTER
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Maintenance

INDUSTRIAL PROCESS CONTROL

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(Mr. Robert Wright)
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This instruction implements MAJCOM policy found in Air Force Materiel Command Instruction (AFMCI) 21-100V1, Depot Maintenance Principles, and extends guidance found in Air Force Sustainment Center Manual (AFSCMAN) 21-102, Depot Maintenance Management. It applies to industrial processes at Ogden Air Logistics Complex, Oklahoma City Air Logistics Complex, and Warner Robins Air Logistics Complex, as well as any geographically separated units that are organizationally aligned to the air logistics complexes. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the DAF 847, Recommendation for Change of Publication. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Instruction (AFI) 33-322, Records Management and Informational Governance Program, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located at **https://www.my.af.mil/afrims/afrims/afrims/rims.cfm**. The use of a name of any specific commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

SUMMARY OF CHANGES

This interim change revises AFSCI 21-104 by (1) updating the references from AFSCMAN 21-102 to the one of the three appropriate volumes of AFMCI 21-100 AFSC Supplement or AFSCI 20-101, and (2) providing a new and functional link to the IPC SharePoint site. A margin bar (|) indicates newly revised material.

Opening Paragraph. This instruction implements MAJCOM policy found in Air Force Materiel Command Instruction (AFMCI) 21-100V1, Depot Maintenance Principles, and extends guidance found in Air Force Material Command Instruction (AFMCI) 21-100V1_AFSCSUP, Depot Maintenance Principles, Air Force Material Command Instruction (AFMCI) 21-100V2_AFSCSUP, Depot Maintenance Production, Air Force Sustainment Center Instruction (AFSCI) 20-101, Depot Process and Programs Management. It applies to industrial processes at Ogden Air Logistics Complex, Oklahoma City Air Logistics Complex, and Warner Robins Air Logistics Complex, as well as any geographically separated units that are organizationally aligned to the air logistics complexes. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the DAF 847, Recommendation for Change of Publication. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Instruction (AFI) 33- 322, Records Management and Informational Governance Program, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located at **https://www.my.af.mil/afrims/afrims/afrims/rims.cfm**. The use of a name of any specific commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

Chapter 1

GENERAL INFORMATION

1.1. Overview. Each Air Logistics Complex (ALC) is a multifaceted organization consisting of many moving parts. The ALC can be viewed as a production machine, built from subordinate machines consisting of industrial processes and support functions that are planned, conducted and executed in the depots. An industrial process, in regard to the context of this publication, consists of actions or steps taken to achieve product requirements, as stated in technical data. Industrial process boundaries can be chosen to include a shop, a set of shops, a set of sub-processes, or product(s), etc. Industrial process boundaries should be selected to facilitate effective risk management of the particular function. IPC is defined as the method of ensuring that an industrial process is predictable, stable, and consistently operating at the target level of performance with only normal variation.

1.2. Applicability. IPC foundationally is best aligned to levels 1, 2 and 3; however, IPC application is beneficial to all levels. IPC application to level 4 processes is not required and may entail some modification to the IPC structure.

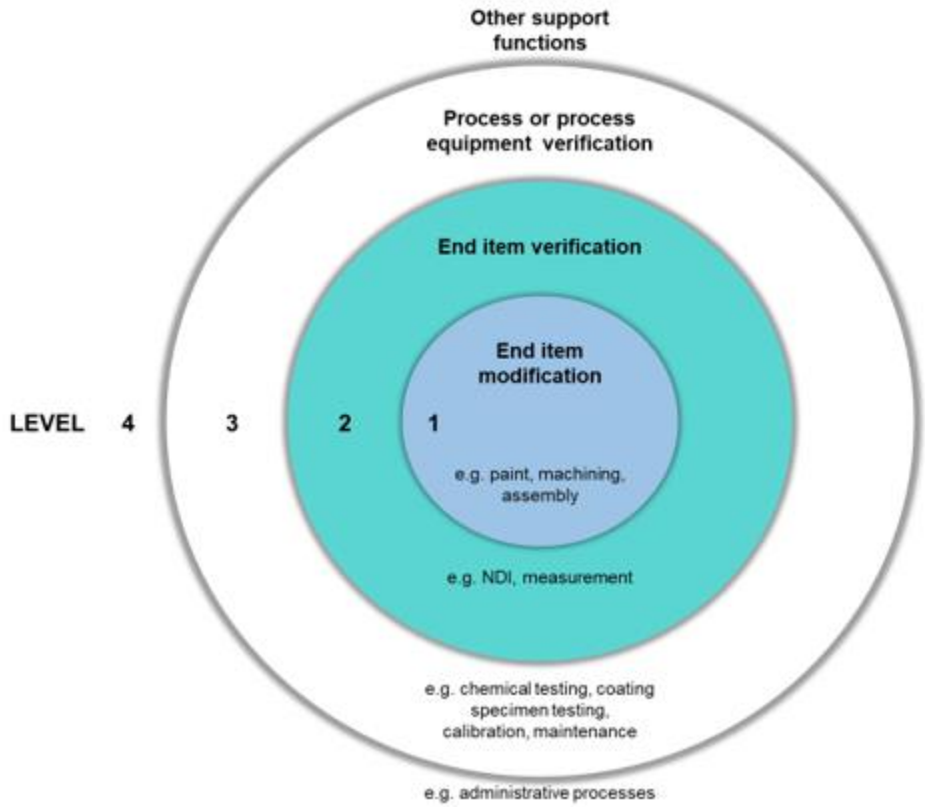
1.2.1. Level 1 End Item Modification. Level 1 includes processes that modify end items such as paint, welding, machining, disassembly, assembly, plating, plasma spray, shot peen.

1.2.2. Level 2 End Item Verification. Level 2 includes end item verification processes such as Non-Destructive Inspection (NDI) (e.g., Eddy current, FPI, ultrasonic inspection, X-ray), and measurement with computer numerical control (CNC) machines, vernier calipers, etc.

1.2.3. Level 3 Process Data Verification or Process Equipment Verification. Level 3 include technical data verification processes that directly impact production such as chemical testing, coating specimen testing, calibration and equipment maintenance.

1.2.4. Level 4 Administrative Processes. Level 4 includes other support functions that do not directly impact production and are administrative such as tool control.

Figure 1.1. Industrial Process Levels.



1.3. AFSC-wide focus remains on true north metrics of speed, safety, quality, and cost effectiveness. To support these four areas, it is imperative to have both cognizance and control of all requisite industrial processes. IPC enables quantitative process benchmarking and control, allows for understanding of acceptable variation within the process, and serves as an avenue for future improvement within these boundaries. These actions will enable predictable industrial processes, in which data driven decisions can be made to improve true north metrics. This operating instruction (OI) describes the technical engineering authority for the ALC production machine, as well as roles and responsibilities for the establishment of an industrial process control program consisting of industrial process characterization, industrial process change management, and risk management.

1.4. It is optimal when IPC and Art of the Possible (AoP) are used together, as both programs are mutually supportive. Specifically, when the nature of an industrial process is fully defined, and factors which influence process outcomes understood, process owners can readily identify process variances/deficiencies, implement countermeasures, perform effective CPI's (continuous process improvements), and reduce likelihood of regression.

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. Air Force Sustainment Center (AFSC)/Commander (CC) will:

2.1.1. Assure establishment and maintenance of an IPC program.

2.2. AFSC/EN will:

2.2.1. Provide policy and systems engineering support for IPC.

2.2.2. Organize and oversee periodic IPC townhalls.

2.3. ALC/CC will:

2.3.1. On behalf of AFSC/CC, ensure establishment and maintenance of an IPC program for their respective Complex programs and authorities.

2.4. ALC Technical Director (TD) will:

2.4.1. Oversee the complex's IPC program.

2.4.2. Coordinate with other ALC TDs to leverage best practices and standardization opportunities for industrial processes.

2.4.3. Ensure maintenance groups are exercising their respective risk management plans (see **chapter 4.**).

2.4.4. Advocate for resources and support necessary to appropriately manage industrial processes.

2.5. Maintenance Group (MXG)/CC/CL will:

2.5.1. Utilize MXG engineering and engineering resources to ensure technical requirements of industrial processes are met.

2.5.2. Accept risks related to industrial processes for the maintenance group or establishes risk acceptance authority levels and thresholds per DAFI 90-802.

2.5.3. Ensure the following for the MXG IPC program.

2.5.3.1. Industrial processes are managed and controlled to meet workload requirements.

2.5.3.2. Risk management plans are active at the industrial process level.

2.5.4. Ensure production/process engineering is a key team participant during maintenance group continuous process improvement (CPI) events.

2.6. MXG/Engineering (EN) Chief will:

2.6.1. Be accountable to the MXG/CC/CL on technical matters within their industrial processes.

2.6.2. Serve as the maintenance group's technical authority over industrial processes and engineering support functions in the production machine as laid out in AFSCI20-101.

2.6.3. Execute the IPC program for the maintenance group.

2.6.3.1. Manage and control technical aspect of industrial processes to meet workload requirements.

2.6.3.2. Assign appropriate technical resources to industrial processes.

2.6.4. Ensure production/process engineers support development and sustainment of AoP/production science (e.g. Little's Law, Theory of Constraints, and Drum Buffer Rope) in industrial processes.

2.6.5. Ensure production/process engineers are documenting industrial process characteristics to establish continuity and to enable measurement of variations.

2.6.5.1. Establish and maintain an access-controlled repository of industrial processes and their characteristics for ease in management and reviews.

2.6.5.2. Ensure production/process engineers are using systems engineering for making decisions involving industrial processes (see **Paragraph 3.3**.).

2.6.6. Ensure production/process engineers are actively assessing technical risk IAW their risk management plan, defined for the respective industrial process (see **Chapter 4.**).

2.6.7. Coordinate and seek appropriate approval for proposed changes to industrial processes that may impact the weapon system Operational Safety, Suitability and Effectiveness (OSS&E) baseline. Leverages Technical Manual Change Recommendation and Reply (AFTO22), Engineer Technical Assistance Request (AFMC 202), and other established means of communication as appropriate.

2.6.8. When applicable to the maintenance group, ensure production/process engineers are participating in the following production/process events or activities: safety incident investigations, mishap investigations, impoundments, Quality Deficiency Reports (QDR), Production Planning Teams (PPT) and Pre-Production Planning Teams (PPPT), Request for Quotes (RFQ), Source of Repair Assignment (SORA), Engineering Requirements Review Process (ERRP), partnerships, and other new work and work change processes.

2.6.9. Ensure production/process engineers are key team participants during CPI events affecting their industrial process.

2.6.10. Formally document any delegation of these roles and responsibilities.

2.6.11. Review IPC repositories to ensure IPC requirements are being met.

2.7. Production/Process Engineer will:

2.7.1. Responsible for technical elements that impact the AoP goals (i.e., speed, safety, quality, and cost effectiveness) of an industrial process.

2.7.2. Provides expertise on how to meet technical requirements to production and provides support to production to ensure industrial processes are technically mature.

2.7.3. Supports the development and sustainment of AoP/production science (e.g. Little's Law, Theory of Constraints, Drum Buffer Rope, Define, Measure, Analyze, Improve, and Control (DMAIC), and Statistical Process Control (SPC)) to improve speed, safety, quality, and cost effectiveness. This includes, but is not limited to metrics, customer requirements, capacity, throughput, work in process (WIP), and cycle time. Reference AFSCH 60-101 AoP Handbook for more on production science.

2.7.4. Determines and documents substitution equivalency (when authorized by the technical order (TO) or other technical data).

2.7.5. Develops/maintains (e.g. monitors for technical data changes) technical characteristics of industrial processes that do not conflict with technical requirements. Technical requirements exist in the TOs. Technical characteristics refer to attributes of engineering systems, which must adhere to particular metrics to fulfill the specified technical requirements in the TOs.

2.7.5.1. When there are technical data changes, verifies that the technical characteristics of industrial processes are adhering to particular metrics to fulfill the specified technical requirements in the TO. .

2.7.5.2. Remains knowledgeable of industrial process attributes, such as capacity, constraints, throughput, and cycle time.

2.7.5.3. Develops and monitors process control metrics as required on assigned industrial processes.

2.7.5.4. Recommends and reviews proposed changes to technical characteristics of industrial processes and follows a documented change management process to revise the configuration.

2.7.5.5. Conducts or supports root cause analysis or 8-step process evaluation on industrial processes as necessary.

2.7.6. Develops risk management plans to assigned industrial processes, as appropriate.

2.7.7. Include additional enterprise disciplines (e.g., safety, quality, planning, production) to support the development of characterization (e.g., process flow chart, process control plan) and risk management artifacts (e.g. FMEA).

2.7.8. In exceptional cases when an MXSG industrial process (e.g., lab processes, NDI) lacks engineering oversight, documented IPC Process Engineering roles and responsibilities default to process owners (e.g., scientists, chemists, Level 3 NDI technicians).

2.8. Quality Offices will:

2.8.1. Assist in developing the baseline of industrial processes to measure product quality.

2.8.2. Identify industrial processes that aren’t meeting technical requirements.

2.8.3. Support MXGs with quality metrics as a feedback of IPC implementation effectiveness.

Chapter 3

INDUSTRIAL PROCESS CHARACTERIZATION AND INDUSTRIAL PROCESS CHANGE MANAGEMENT

3.1. Overview. Characterization of an industrial process facilitates a detailed organizational understanding of the process and aids in maintaining process consistency. Technical characteristics refer to attributes of engineering systems, which must adhere to particular metrics to fulfill the specified technical requirements in the TOs. Documenting the technical characteristics of industrial processes enables health monitoring and a means for quantitative process improvement and benchmarking.

3.1.1. The technical baseline of an industrial process is established when the completed characterization documents are stored in an access-controlled repository. The minimum baseline is a process control plan IAW 3.2.4. Documentation should include the following: industrial process name, owner, customer, as-of-date and version. This will identify, document, and control the functional and physical characteristics of the industrial process.

3.1.2. For change management, document and coordinate any significant changes to the configuration of an industrial process with the MXG EN Chief and the production process owner. A significant change is any change made to the baseline of an industrial process beyond that which is administrative in nature and would affect the outcome of a process dictated by a technical order, aircraft work specification, process order, engineering drawing, or equivalent. Proposed changes that may impact OSS&E shall be coordinated with the respective Program Executive Officer and/or support staff (e.g. Program Manager, Lead Systems Engineer, etc.) with delegated engineering authority.

3.1.3. A time-phased plan to baseline current industrial processes within the respective maintenance group will be developed and assessed annually. The plan will identify all industrial processes within the MXG per **Figure 1.1** and prioritize IPC implementation based on risk. The plan will be assessed and approved by the MXG EN Chief annually. During the annual assessment, prioritization of implementation and process boundaries (including baselined industrial processes) should be evaluated for effective risk management.

3.2. Industrial Process Characterization. The level of characterization detail required for a given industrial process is based on its criticality, risk, resources, performance and maturity, and is approved by the MXG EN Chief. At a minimum, the following integrated product team (IPT) will be included in the development of characterization artifacts: engineering, planning, production. When necessary, quality, safety and ALC customers (e.g., program office engineer) will be included. Union representatives will be invited.

3.2.1. Critical processes. Per MIL-HDBK-896, Manufacturing and Quality Program, a critical process is a process that creates or substantially affects a key characteristic. A key characteristic is a feature of a material, part, assembly or system in which variation from nominal has a significant influence on fit, performance, reliability, or cost of the part. A critical process can also include processes critical to achieving planned flow days (i.e. achieving critical path), or if it has an environmental, safety, and/or health impact to workers. The equivalent term in AFMCI21-100V2_AFSCSUP is critical task/operation.

3.2.2. Complexes may choose to leverage processes and process artifacts produced or identified in the NADCAP or other internationally recognized standards and accreditation (e.g., NIST, ISO) to meet industrial process characterization requirements.

3.2.3. Potential characterization items can include:

3.2.3.1. Configuration items, technical data, and any other documentation that is associated with the industrial process (e.g., Work Control Documents (WCDs), Process Orders, Technical Orders, Drawings, etc.).

3.2.3.2. Process flow chart.

3.2.3.3. Production science (e.g., Little's Law, Theory of Constraints, Drum Buffer Rope, DMAIC and SPC). Identify all current production science measures/metrics, used in the industrial process to measure output, quality, or speed (e.g., Takt time, inventory turns, flow time, throughput, etc.).

3.2.3.4. Statistical process control (e.g., key process input variables (KPIV), key process output variables (KPOV), controls charts, capability analysis, analysis of variance (ANOVA), Pareto charts, design of experiments).

3.2.3.5. Industrial process customers. The customer is not necessarily the organization to which the product is passed. Typically, it is the organization that ultimately defines "goodness" and defines the standard in the industrial process' product.

3.2.3.6. Critical Safety Items impacted by the industrial process.

3.2.3.7. Special training/skills/certifications required of workers involved in the industrial process, such as the Production Acceptance Certification (PAC) Program (see AFMCI21-100V1_AFSCSUP), when applicable.

3.2.3.8. Limiting factors (LIMFACs) involved with industrial process such as equipment limitations or size constraints.

3.2.3.9. Specialized equipment, facilities, tooling, and fixtures used in the industrial process.

3.2.3.10. Engineering economic analysis to determine best value when choosing between two or more proposed new processes.

3.2.3.11. CPI events completed within the last year, currently on-going, or planned, which involve the industrial process.

3.2.3.12. Model/simulation inputs/outputs/assumptions or results that could influence/improve process outcomes.

3.2.4. The process characterization deliverable is a sustainable process control plan that shall include: (1) a description of the process inputs, outputs, feedback loops, variables, and parameters, (2) a description of the mechanism for measuring process performance (e.g., run/control charting), (3) identification of trigger (or review) mechanisms for improving process outputs by removing special cause variation (e.g., upper/lower specification & control limits), and (4) identification of a review cycle to allow for governing technical data changes.

3.3. Industrial Process Change Management. When a significant change (IAW **para 3.1.2**) to the technical characteristics of an industrial process is required, the production/process engineer documents the specifics and applies the concepts of systems engineering. Below is a description of how to apply systems engineering to change management in maintenance (reference Air Force Instruction (AFI) 63-101/20-101):

3.3.1. User/customer requirements definition. Upon receiving the user/customer (e.g., cognizant engineer, environmental office, maintenance shop) requirements, the production/process engineer coordinates with the user/customer to document an agreed upon requirements definition.

3.3.2. Technical requirements analysis. The production/process engineer works with the owner of the requirement to adequately translate and decompose the technical requirement into process requirements. The translation needs to identify all necessary attributes to properly accomplish the requirement.

3.3.3. Design/configuration. The production/process engineer translates the outputs of the technical requirement(s) analysis into design solution(s) and documents the evaluation of the solution(s). The evaluation(s) includes any impacts the proposed solution(s) could have on support functions such as equipment, facilities, training of personnel, etc. The evaluation(s) should then be reviewed and coordinated with the production/process engineer, management, and the systems program office or office of delegated engineering authority if there is a potential impact to OSS&E.

3.3.4. Implementation. The production/process engineer develops/builds the final design/configuration for the chosen solution.

3.3.5. Integration. The production/process engineer tests the design and identifies and analyzes any constraints and/or conflicts that may occur when integrating the design into production.

3.3.6. Validation/Verification (Val/Ver). The production/process engineer provides evidence that the design performs its intended function and meets requirements.

3.3.7. Transition. The production/process engineer moves the design into the operational environment or production.

Chapter 4

RISK MANAGEMENT

4.1. Industrial Process Risk Management. All industrial processes have inherent risks that include, but are not limited to cost, schedule, performance, safety, occupational and environmental health risks. As defined in AFI 90-802, risk management is a continuous, systematic decision-informing process consisting of five primary steps: Risk Identification, Risk Assessment, Develop & Decide Controls, Implement Controls, and Supervise & Evaluate Control Effectiveness.

4.1.1. Risk Identification and Assessment. Utilizing an IPT (e.g., production, safety, quality, planning) to identify and assess risk is recommended. The production/process engineer may use the 4x5 hazard risk matrix, the 5x5 matrix, or a Failure Mode Effects Analysis (FMEA) for identifying and assessing risks. Historically, the 4x5 hazard risk matrix, per AFI 90-802 and MIL-STD 882E has been applied to safety risks and the 5x5 matrix, per AFPAM 63-128 has been applied to life cycle risks. The last example is a FMEA which provides a step-by-step approach for identifying all possible failures in a system.

4.1.2. Develop & Decide Controls. The production/process engineer may use the following instructions to develop mitigation plans for the identified risks.

4.1.2.1. AFI 90-802 and/or Air Force Pamphlet (AFPAM) 90- 803 as guidance for addressing and eliminating environmental, safety and occupational health risks.

4.1.2.2. AFI 63-101/20-101, AFPAM 63-128, and/or Military Standard (MIL-STD) 882E to address and eliminate life cycle risks (e.g., performance, quality, schedule and cost) within industrial processes.

4.1.2.3. AFI 91-202 and AFSCI 21-102 will provide additional guidance on how to apply the hierarchy of controls when dealing with risks that involve hazardous materials.

4.1.3. Implement controls IAW AFI 90-802 para 3.3.4.

4.1.4. Supervise and evaluate control effectiveness IAW AFI 90-802 para 3.3.5.

4.2. Technical Risk Assessor. The production/process engineer is the technical risk assessor, and assesses technical risks, documents risk management plans, and actively manages risks at the industrial process level when applicable.

4.3. Risk Acceptor. The MXG/CC/CL is the risk acceptor or will establish risk acceptance authority levels and thresholds per AFI 90-802. Risk management plans will enable the risk acceptor to make informed decisions on when to accept risk and when to allocate resources and implement controls to mitigate or eliminate risk. Risk acceptance will be documented on on a form (e.g., AF 4437), or in a risk acceptance database.

4.4. Risk Management Plans Annual Assessment. Maintain risk management plans in an access-controlled repository and assess annually. Annual high-level risk management plan reviews should address process changes (e.g., new equipment, updated technical requirements), readdress previously identified risks and apply the 5 components of risk management (e.g., risk identification, assessment, develop and decide controls, implement controls, supervise & evaluate controls). If needed, update and re-coordinate risks with the appropriate risk acceptor. Annual assessment will be documented.

Chapter 5

IPC MATURITY MATRIX

5.1. IPC Maturity Matrix. The purpose of the IPC Maturity Matrix is to provide a continuous measurement tool to help assess and guide the progression of a maintenance group's IPC program towards world-class performance. The maturity matrix provides a standard measurement through which each group can self-assess their IPC program's current maturity level, as well as identify elements required to progress to the next level.

5.2. Annual IPC Maturity Matrix Assessment. Each group will report their IPC Maturity Matrix assessment annually through a tasker initiated by AFSC/ENS.

5.3. IPC Maturity Matrix Availability. The IPC Maturity Matrix will be maintained by AFSC/ENS and made available on the IPC SharePoint. **https://usaf.dps.mil/sites/TMCA19337/ENS/ENSP/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FTMCA19337%2FENS%2FENSP%2FShared%20Documents%2FIndustrial%20Process%20Control&viewid=dcce116b%2D42c6%2D48e4%2D9497%2D7a826587be06**.

STACEY T. HAWKINS, Lt Gen, USAF
Commander, Air Force Sustainment Center

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

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OO-ALCI 21-402, OO-ALC Industrial Process Control Program, 19 Jul 2023

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Adopted Form

DAF 847, Recommendation for Change of Publication

Abbreviations and Acronyms

AFI—Air Force Instruction

AFMCI—Air Force Materiel Command Instruction

AFPAM—Air Force Pamphlet

AFSC—Air Force Sustainment Center

AFSCI—Air Force Sustainment Center Instruction

AFSCH—Air Force Sustainment Center Handbook

ALC—Air Logistics Complex

ANOVA—Analysis of variation

CC—Commander

CL—Civilian Leader

CPI—Continuous Process Improvement

DMAIC—Define, Measure, Analyze, Improve, and Control

EN—Engineering

ERRP—Engineering Requirements Review Process

FMEA—Failure Mode Effects Analysis

IAW—In Accordance With

IPC—Industrial Process Control

KPIV—Key Process Input Variable

KPOV—Key Process Output Variable

LIMFAC—Limiting Factors

MIL-HDBK—Military Handbook

MIL-STD—Military Standard

MXG—Maintenance Group

NADCAP—National Aerospace and Defense Contractors Accreditation Program

OI—Operating Instruction

OPR—Office of Primary Responsibility

OSS&E—Operational Safety, Suitability and Effectiveness

PPPT—Pre-Production Planning Team

PPT—Production Planning Team

RFQ—Request for Quote

RDS—Records Disposition Schedule

SORA—Source of Repair Assignment

SPC—Statistical Process Control

TD—Technical Director

WCD—Work Control Documents

WIP—Work in Process