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The
Electrical Contracting
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Thomas E. Glavinich, D.E., P.E.

Quality Assurance Guide for Inside and Outside Electrical Contractors

THE POWER OF THE FUTURE

The Electrical Contracting Foundation, Inc.

QUALITY ASSURANCE GUIDE FOR INSIDE AND OUTSIDE ELECTRICAL CONTRACTORS

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PREFACE

A. QUALITY ASSURANCE GUIDE DEVELOPMENT

This guide presents the results of a research project supported by The Electrical Contracting Foundation, Inc. (ECF) entitled *Guide for the Development of a Project-Specific Quality Assurance Program for the Electrical Contractor.* The goal of this research project was to develop a detailed guide that can easily be used by both inside and outside electrical contractors to prepare effective quality assurance programs. This goal was supported by the following three research objectives:

- Identify the needs and requirements of inside and outside electrical contractors for a quality assurance program.
- Provide a tool that can be an integral part of the electrical construction firm's total quality management (TQM) program.
- Develop and publish a guide that can easily be used by both inside and outside electrical contractors to develop and implement effective quality assurance programs for electrical construction.

For the *Quality Assurance Guide* to be used and accepted in the electrical construction industry, this guide had to address the needs of the electrical contractor and be user friendly. To ensure that this guide met these requirements, a task force of representatives from the electrical construction industry was selected by the ECF based on their expressed interest in this project. The purpose of this task force was to provide guidance and feedback throughout the research project. The members of the task force are listed in Appendix C of this guide.

The author would like to take this opportunity to thank the ECF and the members of the Quality Assurance Task Force for their continuous support and guidance throughout this research project. The members of the task force kept me on track and ensured that this guide would be both practical and useful to both the inside and outside electrical contractor wanting to develop and implement an effective quality assurance program within his or her firm. Additionally, I would like to thank the many others in the electrical

construction industry both here and abroad who were not officially a part of the task force but contributed greatly to the success of this research project.

B. QUALITY ASSURANCE GUIDE PURPOSE & OBJECTIVES

The purpose of the *Quality Assurance Guide* is to provide guidance in the preparation and implementation of quality assurance programs for electrical construction. The *Quality Assurance Guide* provides the electrical construction firm with the means to easily develop a customized quality assurance program that will improve the quality of construction and increase productivity. The quality assurance program should also serve as a feedback mechanism for the continuous improvement of field operations.

Successful electrical construction firms already have an effective quality assurance program in place or they would not be successful. What is usually missing is the formalization of this program in writing. In most instances, the development of a formal quality assurance program will involve only documenting those processes that already exist within the electrical construction firm. The documenting of existing operations should lead to a better understanding of the firm's processes as well as their improvement.

Currently, both inside and outside electrical contractors must start from the beginning when developing a quality assurance program. This *Quality Assurance Guide* provides a comprehensive starting point for the electrical contractor that can be customized and adapted for the electrical contractor's own organization and needs. This guide should expedite the program development process and save the electrical contractor a great deal of time and effort.

C. QUALITY ASSURANCE GUIDE BASIS

The ISO 9000 series of quality management and assurance standards was chosen as the basis for the *Quality Assurance Guide*. This series of standards is promulgated by the International Organization for Standardization (ISO) in Geneva, Switzerland. The ISO 9000 standards are the internationally recognized standards for quality assurance in the manufacturing and service industries. These standards have been adopted by countries throughout the world and are becoming the basis for international trade in goods and services. In the United States, these standards have been adopted by the

American National Standards Institute (ANSI) through the American Society of Quality Control (ASQC). This guide is based on the 1994 edition of the ANSI/ASQC Q9000 standard series which is equivalent to the ISO 9000 standard series.

Many domestic manufacturing and service firms that want to operate in the global marketplace are becoming ISO 9000 registered. Examples in the electrical construction industry include Square D and Bussmann along with an increasing number of other electrical equipment manufacturers. ISO 9000 registration means that an independent third party has reviewed the firm's quality processes and determined that the firm has an effective and comprehensive quality assurance program in place.

Part of ISO 9000 registration involves ensuring that suppliers are also committed to quality. Suppliers do not have to be ISO 9000 registered but they do need to demonstrate that they are dedicated to quality assurance and have an operational quality assurance program. By definition, the electrical construction firm is a supplier of electrical construction services to its customers and needs to have a documented quality assurance program.

Inside electrical contractors working for firms that are marketing their products and services globally are feeling pressure to have a formal quality assurance program in place. This pressure is felt as a subcontractor through the general contractor in a traditional project delivery system or as a prime contractor working directly for the owner in an alternative project delivery system. Outside electrical contractors are also feeling the pressure to have a formal quality assurance program as utilities and heavy industrial customers become more quality conscious.

As noted above, suppliers such as the electrical contractor do not need to be ISO 9000 registered but electrical contractors are usually requested to provide one of the following concerning their quality assurance program:

- Proof of ISO 9000 registration in the form of a certificate issued by an accredited registrar, or

- Written response to an extensive questionnaire concerning the electrical contractor's quality assurance program.

ISO 9000 registration can be a very time consuming and expensive process which few electrical contractors can afford to undertake. In addition, ISO 9000 registration is not a one-time effort but an ongoing process where the electrical contractor's quality assurance program is reviewed by an outside third party on a regular basis.

As part of this project, several questionnaires that electrical contractors have been required to respond to were reviewed. In general, these questionnaires dealt with the documentation of the electrical contractor's processes and

quality assurance program. The questions asked usually reflected the content of the ISO 9000 standards and their documentation requirements.

In addition to questionnaires, two quality assurance manuals prepared by electrical contracting associations outside of the United States were reviewed. The two quality assurance manuals reviewed were sponsored by the following two associations:

- The Electrical Contractors Association of New South Wales, Australia, and
- The Electrical Contractors Association of Great Britain.

The quality assurance manuals prepared by both these associations were based on the ISO 9000 standards for quality management and assurance. Therefore, basing this guide on the ISO 9000 standards will help ensure that quality assurance programs developed by U.S. electrical contractors will be in agreement with those being developed and used by electrical contractors in other parts of the world. This guide should also satisfy owner requests for information about the electrical contractor's quality assurance program. Additionally, this guide can serve as a first step to becoming ISO 9000 registered for any electrical construction firms wishing to pursue registration.

D. QUALITY ASSURANCE GUIDE OVERVIEW

This guide has been divided into eight chapters and three appendices. Each of the eight chapters builds on the information presented in the previous chapters. The goal of this guide is to provide inside and outside electrical contractors with a comprehensive understanding of quality assurance as it applies to electrical construction and how an effective quality assurance program can benefit both the electrical construction firm and its employees. Additionally, this guide provides the electrical contractor with a step-by-step approach for developing, documenting, and implementing an effective quality assurance program.

Chapter 1 introduces the concepts of project quality, quality assurance, and quality assurance programs for electrical construction. A quality assurance program model is then presented in Chapter 2 which provides a template for the development of a quality assurance program based on ANSI/ASQC Standard Q9001. The organizational steps required for the development and documentation of an effective quality assurance program are provided in Chapter 3.

Documenting the quality assurance program is covered in Chapters 4 and 5. These chapters provide sample quality assurance manuals based on the program template developed in Chapter 2. Chapter 6 builds on Chapters 4 and 5 by covering the documentation of installation, inspection, and testing procedures. Chapter 7 continues to build on Chapters 4, 5, and 6 by providing sample forms, tags, checklists, and records that can be used to document and control construction process quality.

There must be regular evaluations in order to ensure continuous improvement of processes within the electrical construction firm. This evaluation requirement not only includes the electrical construction firm's business and production processes but also its quality assurance program. Chapter 8 provides methods by which the electrical construction firm can self-evaluate its quality assurance program. Only through self-evaluation can the firm know what is and is not working and how the quality assurance program can be improved and made more effective.

Appendix A provides a selected bibliography dealing with quality assurance and the ISO 9000 standards. Appendix B provides a diskette with text files that contain the sample quality assurance manuals in Chapters 4 and 5 as well as the sample forms, tags, checklists, and records contained in Chapter 7. Appendix C provides a list of the Quality Assurance Task Force members.

CHAPTER 1
QA FOR ELECTRICAL CONSTRUCTION

A. INTRODUCTION

This chapter introduces the concepts of project quality and quality assurance as they apply to electrical construction. In addition, this section addresses a number of questions frequently asked by inside and outside electrical contractors concerning the development and implementation of quality assurance programs for electrical construction. This section is the basis for the remainder of the guide and addresses the following:

- What is project quality?
- What establishes the customer's requirements?
- What is quality assurance?
- Is QA the same as quality control?
- Why is a QA program needed?
- What are the costs and benefits of a QA program?
- What is the connection between QA and TQM?
- What are the prerequisites for a successful QA program?
- What are the key components of a comprehensive QA program?
- How should the QA program be developed?
- What should the QA program be based on?

B. WHAT IS PROJECT QUALITY?

The first step in the development of a quality assurance program is the definition of quality. A clear and concise definition of quality is critical to the success of the program. The definition of quality is central to the quality assurance program because it provides a reference point to those performing the work in the field. An unambiguous definition of quality that everyone can understand and relate to is required to provide focus for employees charged with implementing the quality assurance program.

The term "quality" means many things to many people. Without a precise definition that everyone associated with the project can work toward, people will define quality in their own way. Instead of one definition that pulls everyone together working toward a singular goal, there will be as many definitions of quality as there are people associated with the project. Multiple definitions of quality will result in frustration, contradiction, and confusion on the project. This lack of direction will reduce the effectiveness of the quality assurance program and eventually leave it a program in name only.

Quality in the field must be defined in terms of the customer's stated needs for either a competitively bid or negotiated project.

The definition of quality in the field must reflect the realities of the marketplace for both the inside and outside electrical contractor. To be successful, the electrical construction firm must remain competitive while meeting the needs of its customers. Quality in the field must be defined in terms of the customer's stated needs for either a competitively bid or negotiated project. To define quality as something more than the customer's stated needs may result in one of the following two scenarios:

- A noncompetitive bid or proposal resulting in the loss of a project to a competitor, or
- A budget overrun during construction that results in either reduced profits or a loss on the project.

Quality in electrical construction should be defined as the Construction Industry Institute (CII) Quality Management Task Force (QMTF) defines quality:[1]

Quality is conformance to established requirements.

This definition was used to define quality in the field in the model TQM program for electrical construction[2] and agrees with The Associated General

[1]W. B. Ledbetter and James L. Burati, Jr., "On the Trail of Quality Costs," *The Construction Specifier*, May, 1990, p. 127.

Contractors of America's (AGC) definition of quality which is expressed as *conformance to standards.*[3]

C. WHAT ESTABLISHES THE CUSTOMER'S REQUIREMENTS?

The construction contract establishes the requirements that define quality for the inside and outside electrical contractor. In particular, the project's plans and specifications establish the technical requirements that must be met by the electrical construction firm. Under the above definition, the sole criterion for judging the quality of electrical work in place is compliance with the contract documents. It should be noted, however, that the above criterion for judging quality in the field assumes that the contract documents are in compliance with all applicable codes, standards, and industry practices. If this is not the case, the criterion for judging field quality is not valid and the electrical construction firm should either avoid the project or seek to have the contract documents revised.

The concept of quality as it applies to electrical construction is not always understood. Quality in construction should not imply that the inside or outside electrical contractor is to be held to a higher standard of care than that specified in the contract documents. Quality in the field is not defined by degree of goodness. In a competitive bid situation, the electrical construction firm must base its bid on the requirements set forth in the project plans and specifications. Field construction must also adhere to plans and specifications or the bid estimate will be invalidated. Any enhancement to these requirements will affect the electrical construction firm's ability to compete in the marketplace and may not provide the owner with what is really wanted or needed.

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[2]Thomas E. Glavinich and James E. Rowings, *Total Quality Management for the Electrical Contracting Industry*, The Electrical Contracting Foundation, Inc., Bethesda, Maryland, 1994, p. 86.

[3]The Associated General Contractors of America, *An Introduction To Total Quality Management*, AGC of America, Washington D.C., 1992, p. 12.

D. WHAT IS QUALITY ASSURANCE?

Quality assurance (QA) is a broad term that refers to the development and application of procedures that ensure that a product or service meets the customer's performance criteria. As noted above, in electrical construction the customer's performance criteria are defined by the project contract documents which include the plans and specifications. Quality assurance is concerned with ensuring compliance with the contract documents through the systematic monitoring and control of the construction process on an ongoing basis. The goal of quality assurance is that the finished work in place is in compliance with the contract documents avoiding costly and time consuming rework to correct deficiencies.

The American National Standard ANSI/ISO/ASQC A8402 entitled *Quality Management and Quality Assurance - Vocabulary* defines quality terms as they apply to the field of quality management. In particular, ANSI/ISO/ASQC Standard A8402 defines terms as they apply to the ANSI/ASQC Q9000 series of quality management and assurance standards. ANSI/ISO/ASQC Standard A8402 is based on and equivalent to the International Organization for Standardization (ISO) Standard 8402. ANSI/ISO/ASQC A8402 defines quality assurance[4] as follows:

It is important to note that quality assurance is not about continuous improvement. Continuous improvement is the domain of TQM.

All the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfill requirements for quality.

This definition agrees with the general description of quality assurance provided above.

It is important to note that quality assurance is not about continuous improvement. Continuous improvement is the domain of TQM. Quality assurance is assuring that the processes are in place that ensure that the customer receives what is needed when it is needed. Quality assurance is about giving the customer confidence that your firm can meet his or her needs and expectations per the contract documents. Customer confidence comes from having key construction processes documented that will ensure all necessary steps and procedures will be satisfactorily completed when installing and testing electrical materials and equipment.

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[4] *Quality Management and Quality Assurance - Vocabulary*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ISO/ASQC Standard A8402-1994, Section 3.5, p. 5.

Within the ANSI/ISO/ASQC A8402 definition of quality assurance there are two key terms that need to be defined further. These two key terms are as follows:

- Quality
- Quality System

These two terms will be discussed in relation to the *Quality Assurance Guide* in the paragraphs that follow.

ANSI/ISO/ASQC A8402 defines quality[5] as *the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.* This definition of quality agrees with the definition of project quality which was previously defined in this chapter. Applying the ANSI/ISO/ASQC A8402 definition of quality to electrical construction, "entity" can be taken to mean the finished work in place at the project site. Further, "stated and implied needs" refer to the requirements set forth in the project contract documents.

"Stated needs" refers to the construction requirements explicitly called out in the plans and specifications. "Implied needs" refers to codes, standards, and other documents referenced in the contract documents. For example, the minimum requirements for electrical installations in the United States are usually defined by the *National Electrical Code* (NEC) *or National Electrical Safety Code (NESC).* The *NECA Standard of Installation* defines the phrase "neat and workmanlike manner" either as a stated specification requirement or individually through the NEC Section 110-12 by reference. OSHA sets standards for electrical safety in the workplace. These and many other industry codes and standards might be categorized as "implied needs."

Quality system[6] is defined in ANSI/ISO/ASQC A8402 as *the organizational structure, procedures, processes and resources needed to implement quality management.* The quality system is in essence the quality assurance program that is developed by the electrical construction firm using this guide. The quality assurance program is the framework that will ensure continuous improvement of the construction process, quality in the completed work, and customer satisfaction.

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[5]Ibid., Section 2.1, p. 2.

[6]Ibid., Section 3.6, pp. 5-6.

E. IS QA THE SAME AS QUALITY CONTROL?

The terms quality assurance (QA) and quality control (QC) are often used interchangeably. Quality assurance and quality control are not the same and this guide differentiates between them. Quality control is just one part of the overall quality assurance program. Simply stated, quality assurance is proactive with regard to project quality whereas quality control is reactive.

Quality control is concerned with checking that the completed work in place is in compliance with the project plans and specifications. Any identified deviation from the plans and specifications is reviewed, and if warranted, action to correct the deficiency is taken. Quality control focuses on correcting deviations from the plans and specifications once the required work is in place. Quality control leads to very expensive correction of quality problems which could be avoided through an effective quality assurance program.

...quality assurance is proactive with regard to project quality whereas quality control is reactive.

An example of a common quality control activity in the construction industry is the "punchlist." The punchlist is important because it gives the owner and architect/engineer an opportunity to review the completed work and determine if it is in compliance with the construction documents prior to accepting it. The punchlist should not be used as a substitute for an effective quality assurance program.

Point No. 3 of Dr. Deming's "14 Points for Management" advises management to *cease dependence on inspection to achieve quality.*[7] According to Deming, reliance on inspection is the same as planning for defects. By relying on inspection to improve quality, the electrical contractor is acknowledging that the construction process is incapable of conforming with plans and specifications the first time and rework will always be required. Inspection neither improves nor guarantees quality. It is not possible for the electrical contractor to inspect quality into the completed work.

[7]W. Edwards Deming, *Out Of The Crisis*, Massachusetts Institute of Technology, Center for Engineering Study, Cambridge, Massachusetts, 1986, pp. 28-29.

F. WHY IS A QA PROGRAM NEEDED?

A successful project is one that is completed in accordance with the contract documents, on schedule, and within budget. Inside and outside electrical contractors need a quality assurance program to ensure that the completed project meets the project requirements as stated in the contract documents. An effective quality assurance program will help the electrical construction firm achieve a successful project. A quality assurance program will improve quality and help prevent problems caused by oversight and lack of attention to detail.

All successful electrical construction firms have a quality assurance program. This quality assurance program may be informal and not in writing but everyone associated with the firm knows that it exists. The management of the electrical construction firm conveys its dedication to quality and customer satisfaction through both its words and actions. However, on many projects today inside and outside electrical contractors are being required by the owner to provide a written quality assurance program as part of the prequalification process or prior to start of work. This is especially true for those owners who have an active commitment to formal quality assurance programs and have either attained or are working toward ISO 9000 registration.

By relying on inspection to improve quality, the electrical contractor is acknowledging that the construction process is incapable of conforming with plans and specifications the first time...

There is increasing external pressure from quality conscious owners for the electrical construction firm to formalize its quality assurance program and commit it to writing. Formalizing the quality assurance program provides advantages to the electrical construction firm beyond the fulfillment of project requirements. A formal quality assurance program will benefit the entire organization as well as other projects not requiring a formal quality assurance program. The very act of preparing a formal quality assurance program requires that the inside or outside electrical contractor work through and document all of the processes that affect construction quality. Once these processes are documented, the information contained in the formal quality assurance program can be used as a baseline for process improvement as well as a tool for communicating the firm's commitment to quality both within and outside the firm.

G. WHAT ARE THE COSTS AND BENEFITS OF A QA PROGRAM?

1. QA PROGRAM COSTS

The costs associated with the development and implementation of a formal quality assurance program for the electrical construction firm include the following:

- Original QA Program Development
- Ongoing QA Program Evaluation & Upgrading
- Initial & Ongoing Employee QA Training

(a) Original QA Program Development

The firm's employees, no matter what level, must be made solely responsible for the quality of their own work.

The cost of the original quality assurance program development can be substantial for the electrical construction firm. This is because key employees must be involved in the development of the quality assurance program. These key employees will need to be trained in quality assurance and then will need to develop the quality assurance program. All of this takes these key employees away from their daily work which means someone else will have to perform their work or the work will not get done. The use of outside consultants may help to facilitate the program development process but consultants cannot be substituted for the involvement of the firm's key employees. To be effective and successful, the quality assurance program must fit within the firm's existing culture and employees must feel a sense of ownership with regard to the program.

(b) Ongoing QA Program Evaluation & Upgrading

Once the quality assurance program has been developed, there must be an ongoing evaluation and upgrading of the program. This again requires the involvement of key employees throughout the firm and a substantial investment of their time. If the quality assurance program is not continuously evaluated and upgraded, it will soon become outdated and useless.

(c) Initial & Ongoing Employee QA Training

The quality assurance program will not work without the involvement of all the employees working for the electrical construction firm. The firm's employees, no matter what level, must be made solely responsible for the quality of their own work. Along with this responsibility must come empowerment or the authority to take corrective action when the employee sees the need to ensure the quality of their work. Without employee

participation, quality assurance will regress back to quality control with management unsuccessfully attempting to inspect quality into the finished work.

All employees must receive initial training to acquaint themselves with the firm's quality assurance program. In addition, all employees must receive ongoing training where appropriate regarding changes to the quality assurance program. All of this takes employee time and can be very expensive. However, there is no substitute for employee involvement.

2. QA PROGRAM BENEFITS

The benefits of an effective quality assurance program should far outweigh the costs. In fact, the cost of developing and implementing the quality assurance program should be seen as an investment in the firm's future. Benefits from the successful implementation of a quality assurance program should include higher employee morale, greater productivity, less rework, avoidance of claims, and satisfied customers. Individually, these benefits may be difficult if not impossible to quantify on individual projects. However, as a whole these benefits should manifest themselves in increased market share and greater profits for the firm.

Benefits from the successful implementation of a quality assurance program should include higher employee morale, greater productivity, less rework, avoidance of claims, and satisfied customers.

H. WHAT IS THE CONNECTION BETWEEN QA AND TQM?

The quality assurance program should be an extension of the electrical construction firm's in-house total quality management (TQM) program. The quality assurance program should address the inside or outside electrical contractor's production processes which are critical to the survival and continued growth of the firm. An effective quality assurance program will provide a valuable feedback mechanism for continuous improvement of electrical construction processes.

I. WHAT ARE THE PREREQUISITES FOR A SUCCESSFUL QA PROGRAM?

The prerequisites for a successful quality assurance program include the following:

- Management Commitment

- Quality Policy
- Employee Empowerment

1. MANAGEMENT COMMITMENT

Like the electrical construction firm's TQM program, the success of the quality assurance program is linked directly to the support of upper management. Upper management must strongly support the development and implementation of the quality assurance program in both words and actions. An effective quality assurance program requires a dedication of both time and money as well as personal support and encouragement. Without a genuine commitment by upper management, the quality assurance program will not be effective and fall short of its goal of continuous improvement of construction operations.

2. QUALITY POLICY

Upper management must strongly support the development and implementation of the quality assurance program in both words and actions.

Part of upper management's commitment to the firm's quality assurance program is the formulation and communication of a quality policy. A quality policy alerts employees to the fact that upper management is serious about quality. To be effective, the quality policy must be drafted and disseminated by top management.

According to Philip Crosby, the policy statement should be direct and to the point. For the inside or outside electrical contractor, the quality policy could be as simple as the following:[8]

> *Perform work to the exact requirements of the customer unless those requirements are formally changed to what we and our customers really need.*

The quality policy provides employees with the guidance they need for dealing with customers on a day-to-day basis. At the construction site the quality policy provides project managers, superintendents, foremen, and employees with guidance on how to address everyday quality issues. The quality policy along with the knowledge that the electrical construction firm's upper management is dedicated to quality provides field personnel with a mandate to do the job right the first time.

3. EMPLOYEE EMPOWERMENT

Quality assurance must begin in the field. Employees must be empowered by upper management to carry out the firm's quality policy. This is especially

[8]Philip B. Crosby, Quality Is Free: The Art of Making Quality Certain, McGraw-Hill Book Company, New York, 1979, pp. 150 - 151.

true of field personnel who must ensure compliance with the project plans and specifications. Field personnel need to have the ability to adjust means and methods in order to address changing field conditions and correct problems as they arise.

J. WHAT ARE THE KEY COMPONENTS OF A COMPREHENSIVE QA PROGRAM?

The key components of a comprehensive quality assurance program for electrical construction are as follows:

- Design Management
- Construction Organization & Management
- Safety & Accident Prevention
- Document Control
- Procurement & Materials Management
- Tool & Equipment Management
- Construction Process Planning
- Inspection, Testing, & Start-up

Employees must be empowered by upper management to carry out the firm's quality policy.

The following paragraphs will address each of these key components.

1. DESIGN MANAGEMENT

For the electrical construction firm involved in design-build projects, it is imperative that design management be an integral part of the quality assurance program. During design, the owner's needs and expectations for the completed project must be identified, documented, and translated into design criteria. It is also at this stage that many potential field quality and constructability problems can be identified and avoided at minimal cost.

2. CONSTRUCTION ORGANIZATION & MANAGEMENT

The construction organization plays a vital role in quality assurance. It is through the construction organization that the responsibility for quality in the field is established. Also, construction management ensures that processes

are in place which allow the workforce to achieve the level of quality necessary for the project.

3. SAFETY & ACCIDENT PREVENTION

Safety and accident prevention are key to ensuring quality in the field. Concerns about safety will detract from the employee's focus on quality. Safety issues and concerns must be identified and resolved jointly by project management and employees as soon as possible.

4. DOCUMENT CONTROL

Document control ensures that information vital to the successful completion of the project is received, recorded, and disseminated to those project participants that need it. Controlling the flow of project information ensures that the information needed to get the project completed on time, within budget, and in accordance with the contract documents is available when and where it is needed. Information is key to the successful completion of any construction project.

5. PROCUREMENT & MATERIALS MANAGEMENT

Procurement and materials management is very important to the assurance of quality in the constructed project. Materials and equipment must meet the technical requirements of the project and be available when needed for installation. Procurement processes ensure that materials and equipment meet the technical requirements of the contract documents.

Materials management involves the handling of materials and equipment at the site once received from the vendor. Having the right materials at the right place and time is key to both quality and productivity in the field. Effective materials management processes are an important ingredient of a successful construction project.

6. TOOL & EQUIPMENT MANAGEMENT

The right tools and production equipment must be available to the employee when needed. Additionally, tools and equipment must be in good working order and calibrated where necessary. The employee cannot be expected to perform quality work if he or she does not have adequate and sufficient tools and production equipment.

7. CONSTRUCTION PROCESS PLANNING

Construction processes must be planned to ensure that those performing the work have the information, materials and installed equipment, and tools and production equipment necessary to complete the work. Construction process planning should take place both on the project and activity level. At the

project level, the inside or outside electrical contractor should plan his or her work within the framework of the owner's requirements and/or the general contractor's project schedule. At the activity level, each activity needs to be preplanned to ensure that whatever is necessary for the employee to perform the work is available.

8. INSPECTION, TESTING, & START-UP

Lastly, inspection, testing, and start-up activities play an important role in assuring the quality of electrical construction. Plans and procedures must be in place for checking that the work in place is in conformance with the contract documents. Inspection, testing, and start-up activities should not necessarily be last but instead integrated into the ongoing construction process in order to discover and correct problems as soon as possible.

K. HOW SHOULD THE QA PROGRAM BE DEVELOPED?

The quality assurance program should be developed by the firm's employees. Outside consultants can be used to facilitate the development process but not be used to directly develop the quality assurance program. The quality assurance program must reflect the firm's culture and dedication to quality. In addition, for the quality assurance program to be successful, employees must feel a part of the program's development.

L. WHAT SHOULD THE QA PROGRAM BE BASED ON?

The quality assurance program should be based on the International Organization for Standardization (ISO) 9000 series of quality management and assurance standards. The ISO 9000 series standards are the internationally recognized standards for quality assurance in both manufacturing and service industries. These standards have been adopted by countries throughout the world and are becoming the basis for international trade in goods and services. In the United States, these standards have been adopted by the American National Standards Institute (ANSI) through the American Society of Quality Control (ASQC) as the ANSI/ASQC Q9000 series of quality management and quality assurance standards that will be referenced throughout this *Quality Assurance Guide*. The ANSI/ASQC Q9000 standard series is equivalent to the ISO 9000 standard series.

By basing the quality assurance program on the ANSI/ASQC Q9000 standards, the quality assurance program should satisfy owner requests for information about the electrical construction firm's quality assurance program. Additionally, the preparation of a quality assurance program in accordance with the ANSI/ASQC Q9000 standards can serve as a first step toward ISO 9000 registration.

Five individual standards make up the ANSI/ASQC Q9000 standard series and each of these standards have an ISO standard counterpart. The current edition of the ANSI/ASQC Q9000 standard series is the 1994 edition which is what this guide is based on. (The previous edition of the ANSI/ASQC standard series was the 1987 edition and was designated as the ANSI/ASQC Q90 series.) The five ANSI/ASQC quality standards along with their ISO counterparts are shown in *Table 1.*

Table 1: ANSI/ASQC Q9000 Standard Series and ISO Standard Counterparts

ANSI/ASQC Standard	ISO Standard	ANSI/ASQC Standard Title
Q9000	9000	Quality Management and Quality Assurance Standards - Guidelines for Selection and Use
Q9001	9001	Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing
Q9002	9002	Quality Systems - Model for Quality Assurance in Production, Installation, and Servicing
Q9003	9003	Quality Systems - Model for Quality Assurance in Final Inspection and Test
Q9004	9004	Quality Management and Quality System Elements - Guidelines

ANSI/ASQC Standard Q9000 presents the principal quality concepts and lays the groundwork for ANSI/ASQC standards Q9001, Q9002, and Q9003. ANSI/ASQC Standard Q9001 is the most comprehensive standard of the group and deals with the design, development, production, installation, and servicing of the product or service. ANSI/ASQC Standard Q9002 is more restrictive in its scope excluding design and development. ANSI/ASQC Standard Q9002 deals only with the production, installation, and servicing of the product or service. Even more focused is ANSI/ASQC Standard Q9003 which deals only with the final inspection and testing of the product or service. ANSI/ASQC Standard Q9004 provides guidance regarding the design and implementation of quality systems within the firm itself.

Typically, inside and outside electrical contractors should base their quality assurance programs on ANSI/ASQC Standard Q9002 because this standard deals with the installation of a product in accordance with given plans and

specifications. However, this guide is based on the more comprehensive ANSI/ASQC Standard Q9001 which includes design and development for the following reasons:

- Many inside electrical contractors produce custom power distribution, control, and communications equipment for customers based on performance specifications.

- There is a trend in the electrical construction industry toward more design-build work for the inside electrical contractor.

- Inside and outside electrical contractors have increasing responsibilities to their customers for guarantees and warranties, ongoing maintenance, and servicing of power, control, and communications systems after installation.

All of the sections contained in ANSI/ASQC Standard Q9002 are contained in the more comprehensive ANSI/ASQC Standard Q9001. Chapter 2 of this guide covers the content of the more comprehensive ANSI/ASQC Standard Q9001 in detail which includes all of the requirements of the more restrictive ANSI/ASQC Standard Q9002.

CHAPTER 2
QA PROGRAM MODEL

A. INTRODUCTION

Chapter 1 of this guide gave an overview of quality assurance for the electrical contractor and concluded that any quality assurance program developed today should be based on the ISO 9000 series of quality management and assurance standards. The ISO 9000 standard series is the internationally recognized standard for quality assurance in all types of industries. The ISO 9000 standard series is equivalent to the ANSI/ASQC Q9000 standard series adopted by the American National Standards Institute (ANSI) and sponsored by the American Society for Quality Control (ASQC) in the United States.

This chapter will use the ANSI/ASQC Q9000 series of quality management and assurance standards as the basis for identifying the requirements of a model quality assurance program for inside and outside electrical contractors. Specifically, this chapter will address the following:

- QA Model Selection
- Definition Of QA Terms Used
- ANSI/ASQC Q9001 & Q9002 Requirements
- Adapting ANSI/ASQC Q9001 & Q9002 To Electrical Construction

The selection of either ANSI/ASQC Q9001 or Q9002 by the electrical contractor should be based on the nature of work performed and markets served.

B. QA MODEL SELECTION

As discussed in Chapter 1, inside and outside electrical contractors should base their quality assurance programs on either ANSI/ASQC Q9001 or Q9002. The selection of either ANSI/ASQC Q9001 or Q9002 by the electrical contractor should be based on the nature of work performed and markets served. The following paragraphs will help the electrical construction firm select the quality system standard that is right for it.

ANSI/ASQC Q9001[9] is the most comprehensive of the quality system standards. ANSI/ASQC Q9001 deals with the design, development, production, installation, and servicing of the product or service. ANSI/ASQC Q9001 applies when the electrical contractor is involved in a design-build project. The design-build portion of the electrical construction market is growing. For this reason, the quality assurance program model presented in this chapter and the sample quality assurance manual contained in Chapter 4 are based on the more comprehensive ANSI/ASQC Q9001.

ANSI/ASQC Q9002[10] is more restrictive and deals only with the production, installation, and servicing of a product or service. ANSI/ASQC Q9002 applies when the electrical contractor is involved in a traditional project that requires the installation of material and equipment at the project site in accordance with plans and specifications provided by the owner. All of the requirements of ANSI/ASQC Q9002 are included in the more comprehensive ANSI/ASQC Q9001 which includes both design and construction. Most work performed by both inside and outside electrical contractors falls under ANSI/ASQC Q9002 which is cross-referenced throughout this chapter and serves as the basis for the sample quality assurance manual contained in Chapter 5.

C. DEFINITION OF QA TERMS USED

ANSI/ISO/ASQC 8402[11] defines terms as they apply to quality management and assurance. In particular, ANSI/ISO/ASQC 8402 defines terms as they are used in the ANSI/ASQC 9000 standard series. When interpreting the ANSI/ASQC 9000 standards, the definitions provided in ANSI/ISO/ASQC 8402 should be used. This is similar to Article 100/Definitions in the

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[9] *Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ASQC Standard Q9001-1994.

[10] *Quality Systems - Model for Quality Assurance in Production, Installation, and Servicing*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ASQC Standard Q9002-1994.

[11] *Quality Management and Quality Assurance - Vocabulary*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ISO/ASQC Standard A8402-1994.

National Electrical Code (NEC)[12] where technical terms that are used in more than one article are defined as they apply to the NEC.

In addition to the terms specific to quality management and assurance, the adaptation of ANSI/ASQC Q9001 and Q9002 to the electrical construction industry in this chapter contains a number of terms that are unique to both general and electrical construction. These terms are meant to be interpreted in accordance with normal industry practice in the area where the electrical contractor works. No attempt is made to standardize these terms or cite a reference for their definition since their meaning can vary from place to place and even project to project.

Lastly, the term "electrical contractor" is used throughout this chapter in a variety of contexts and refers to both inside and outside electrical contractors. "Electrical contractor" is substituted for the term "supplier" which is used throughout both ANSI/ASQC Q9001 and Q9002 when referring to the organization that supplies the product to the customer.[13] Since each electrical construction firm is organized and operated differently, no attempt is made to assign specific responsibilities within the electrical construction firm for meeting specific quality assurance program requirements. The assignment of responsibility for quality will have to be done by each electrical construction firm individually as part of its own quality assurance program development. As far as the electrical contractor's customers are concerned, there is single-point responsibility for quality and that responsibility rests with the firm itself. How the electrical construction firm decides to delegate responsibility for quality within the firm is strictly an internal matter as far as the customer is concerned.

D. ANSI/ASQC Q9001 & Q9002 REQUIREMENTS

1. SUMMARY OF REQUIREMENTS

Both ANSI/ASQC Q9001 and Q9002 include a Section 4 which is broken down into twenty paragraphs that provide quality system requirements for conformance with the standards. Both standards are intentionally written generically so that they can be applied to any manufacturing or service

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[12]*National Electrical Code*, National Fire Protection Association, ANSI/NFPA 70, 1993 Edition, Quincy, Massachusetts, 1992, Article 100.

[13]*Quality Management and Quality Assurance - Vocabulary*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ISO/ASQC Standard A8402-1994, Section 1.10, p. 2.

industry. This chapter adapts the ANSI/ASQC Q9001 and Q9002 requirements to the electrical construction industry. A copy of ANSI/ASQC Q9001 or Q9002 can be obtained from either ASQC or ANSI at the following addresses:

American Society for Quality Control
611 East Wisconsin Avenue
P.O. Box 3005
Milwaukee, Wisconsin 53201-3005
Telephone: (414) 272-8575
Telefax: (414) 272-1734

American National Standards Institute
11 West 42nd Street
New York, New York 10036
Telephone: (212) 642-4900
Telefax: (212) 302-1286

A copy of either ISO 9001 or 9002 can be obtained from the International Organization for Standardization at the following address:

International Organization for Standardization
Promotion & Press Department
Caisse Postale 56, CH-1211
Geneve 20, Switzerland
Telephone: 41-22-749-01-11
Telefax: 41-22-733-34-30

Table 2 provides a listing of the ANSI/ASQC Q9001 and Q9002 sections. As can be seen from Table 2, both ANSI/ASQC Q9001 and Q9002 contain the same sections. The major difference between these two standards is in Paragraph 4.4/Design Control. ANSI/ASQC Q9001 provides detailed quality system requirements for design control in Paragraph 4.4. Paragraph 4.4 of ANSI/ASQC Q9002 states that this standard does not cover design control and that this section is included only to keep the section numbers consistent with ANSI/ASQC Q9001. Also, Table 2 references the specific paragraph within Section D of this chapter that addresses the electrical contractor's responsibilities under each ANSI/ASQC Q9001 and Q9002 quality system requirement.

Table 2: Quality System Requirements

Chapter 2 Section D Reference	ANSI/ASQC Q9001 & Q9002 Quality System Requirements	ANSI/ASQC Standard Q9001	Q9002
2	Management Responsibility	4.1	4.1
3	Quality System	4.2	4.2
4	Contract Review	4.3	4.3
5	Design Control	4.4	4.4
6	Document & Data Control	4.5	4.5
7	Purchasing	4.6	4.6
8	Control of Purchaser-supplied Product	4.7	4.7
9	Product Identification & Traceability	4.8	4.8
10	Process Control	4.9	4.9
11	Inspection & Testing	4.10	4.10
12	Control of Inspection, Measuring and Test Equipment	4.11	4.11
13	Inspection & Test Status	4.12	4.12
14	Control of Nonconforming Product	4.13	4.13
15	Corrective & Preventive Action	4.14	4.14
16	Handling, Storage, Packaging, Preservation, & Delivery	4.15	4.15
17	Control of Quality Records	4.16	4.16
18	Internal Quality Audits	4.17	4.17
19	Training	4.18	4.18
20	Servicing	4.19	4.19
21	Statistical Techniques	4.20	4.20

2. *MANAGEMENT RESPONSIBILITY (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.1)*

Management responsibility is divided into the following three requirements:

- Quality Policy
- Organization
- Management Review

(a) Quality Policy

The electrical contractor must define and document its quality policy and make an overt commitment to quality. ANSI/ISO/ASQC A8402 defines "quality policy" as the overall intention and direction of an organization regarding quality as formally expressed by management.[14]

(b) Organization

The electrical contractor is required to define the responsibility of all personnel with regard to quality. This includes the identification of personnel responsible for verifying that the work in place meets specified requirements. Additionally, the electrical contractor must assign the responsibility for direct oversight of the quality program to one member of the electrical contracting firm's upper management.

(c) Management Review

The quality assurance program must be reviewed by the electrical contractor on a regular basis in order to ensure its continued validity and effectiveness.

3. *QUALITY SYSTEM (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.2)*

"Quality system" is defined in ANSI/ISO/ASQC 8402[15] as the organizational structure, responsibilities, procedures, processes, and resources needed to implement the quality assurance program which is aimed at achieving the quality objectives. The electrical construction firm must develop and maintain a documented quality assurance program in the form of a quality assurance manual and implement that program.

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[14]Ibid., Section 3.1, p. 5.

[15]Ibid., Section 3.6, pp. 5-6.

4. CONTRACT REVIEW (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.3)

ANSI/ASQC Q9001 and Q9002 require that the electrical contractor develop procedures for contract review to ensure the following:

- That the requirements of the contract for providing electrical construction services are adequately defined and documented.
- That any contractual requirements that differ from the bid documents are identified and resolved.
- That the electrical construction firm has the resources and expertise to meet the contract requirements.

A record of the contract review and any subsequent discussions with the client concerning the contract must be maintained by the electrical contractor.

5. DESIGN CONTROL (ANSI/ASQC Q9001: PARAGRAPH 4.4)

When the project requires that the electrical contractor provide design services as in the case of a design-build project, the electrical contractor is required by ANSI/ASQC Q9001 to ensure that the project owner's needs and requirements are met. Specifically, ANSI/ASQC Q9001 requires that the electrical contractor do the following:

- Plan and schedule the design process.
- Identify organizational and technical interfaces.
- Assign design activities.
- Determine the owner's design requirements.
- Document the design.
- Perform design reviews.
- Address design changes.

(a) Plan & Schedule the Design Process

The electrical contractor undertaking a design-build project must first plan and schedule the design process. The planning of the design process must involve the identification of the following:

- Responsibility for supplying or obtaining design information.

- Systems that are to be designed and who is responsible for those systems. For example, the design of a life safety/security system for a commercial building might be the responsibility of the manufacturer of the selected system.

- Design milestones that must be met. For example, specific dates when design documents must be available for construction to proceed as in the case of fast-track construction projects.

- Interface points between various subsystems that the electrical contractor is responsible for designing as well as interface points with other non-electrical systems such as the heating, ventilating, and air conditioning (HVAC) system.

- Design review points to ensure that the client's needs and requirements are met by the power, control, and communications systems designed.

(b) Identify Organizational & Technical Interfaces

The electrical contractor needs to identify organizational and technical interfaces to facilitate the design process. These organizational and technical interfaces exist both within the electrical contracting firm and with outside entities that have a stake in the design. These outside entities include the owner, other specialty contractors, insurance carriers, material and equipment manufacturers and suppliers, specialty design consultants, code authorities, and others.

The electrical contractor must identify individuals within the owner's organization that have the ability to make design decisions as well as obtain design criteria and other needed information from the end user of the system or facility. Additionally, the electrical contractor needs to identify individuals within material and equipment suppliers' organization who will be responsible for the project and are capable of providing technical information as required and committing to design and delivery schedules. This information should be documented and distributed to everyone who needs to know these contact points.

(c) Assign Design Activities

The responsibility for the performance of the various design activities needs to be assigned and documented. In the case of joint ventures with design firms and arrangements with manufacturers and suppliers providing system design, this documentation would take the form of the scope of services included in the contract documents. For in-house personnel, written work assignments should be developed, negotiated, and agreed to by individuals responsible for the work. In either case, this documentation should clearly state the scope of work or

systems to be designed, schedule for design, and delineate the design deliverables, and any other non-technical design requirements that need to be addressed.

(d) Determine the Owner's Design Requirements

The design team must identify and document the owner's design requirements in order to ensure that the completed project meets the owner's needs and requirements. The owner's performance specification must be converted into specific and measurable design requirements and reviewed with the owner to ensure accuracy and completeness. Any conflicting or ambiguous requirements must be resolved prior to proceeding with the design.

(e) Document the Design

The design must be documented as it proceeds. Documentation certainly includes the plans and specifications that will be used to order materials and equipment from manufacturers and suppliers as well as to put work in place in the field. However, design documentation also includes information gathered about existing conditions at the physical site, manufacturer and supplier information, design calculations, code reviews, and design memoranda, in addition to other relevant information.

(f) Perform Design Reviews

Regular design reviews should be planned at critical points during the design process. These design reviews should involve the owner and design team as a minimum. In addition to ensuring that the evolving design meets the owner's technical needs and requirements, these design reviews should also include constructability reviews and value analyses to ensure that the project can be efficiently and economically built and operated as designed.

(g) Address Design Changes

The electrical construction firm must have procedures in place to identify, document, and approve changes in the design when they occur for any reason.

6. DOCUMENT CONTROL (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.5)

ANSI/ASQC Q9001 and Q9002 require that the electrical contractor develop and implement procedures for project document control. For design-build projects, this document control requirement includes the cataloging and filing of all design documents as well as construction documents. The purpose of this requirement is to ensure that all the project requirements are met and documented for future reference.

During construction, the electrical contractor must have procedures in place that ensure current construction documents are available in the field. These procedures should make sure that the latest revision of the drawings and specifications are available, all field directives and change orders are noted on the latest revision of drawings and specifications, and all superseded documents are removed, cataloged, and filed for future reference. In addition, document control includes documenting daily field operations and the filing of all correspondence, memoranda, schedules, budgets, inspection and testing reports, shop drawings and catalog cuts, material and equipment shipping and receipt records, among other documents.

In addition to maintaining project documents for use in managing the project's construction, the electrical contractor must also ensure that field employees have the information needed to build the project in accordance with specified requirements. This requirement can be met by providing ready access to the latest construction documents and carefully planning day-to-day construction operations at the site.

7. PURCHASING (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.6)

It is the electrical contractor's responsibility to ensure that materials and equipment purchased for incorporation into the project meet the technical requirements specified in the plans and specifications. Per ANSI/ASQC Q9001 and Q9002, ensuring that purchased materials and equipment meet specified requirements involves the following three processes:

- Assess Suppliers
- Review Purchasing Data
- Verify Purchased Product

(a) Assess Suppliers

Suppliers should be selected based on their ability to supply materials and equipment that meet the project's technical requirements and delivery schedule. In addition, the supplier's commitment to quality, quality assurance program, and the electrical contractor's past experience with the supplier should be part of the selection criteria. The supplier selection criteria and the selection process should be documented and followed by the electrical contractor. If a single-source supply is specified, the electrical contractor should assess the supplier's capabilities and establish a working relationship as soon as possible to avoid problems and miscommunication during construction.

(b) Review Purchasing Data

Prior to purchase, ANSI/ASQC Q9001 and Q9002 require that the electrical contractor request and review purchasing data to ensure that the material and equipment ordered will meet the technical requirements of the project. The electrical contractor should verify that the purchased material and equipment will meet the project requirements through catalog cuts, shop drawings, samples, certified testing results, or visits to supplier production and/or testing facilities.

Where the specification requires that the electrical contractor submit purchasing data to the owner and/or engineer for review and approval, the electrical contractor should review the data in advance to ensure that it meets both the specified technical and submittal requirements prior to forwarding the data on to the general contractor, owner's representative, and/or engineer. A log of all purchasing data required, submitted, and the status of that information in the review process should be maintained for the project as part of the project document control requirements. A log such as this is commonly kept during construction and referred to as a "shop drawing log." A copy of all purchasing information should be kept on file for ready reference during construction.

8. CONTROL OF PURCHASER-SUPPLIED PRODUCT (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.7)

ANSI/ASQC Q9001 and Q9002 require that the electrical contractor establish and maintain procedures for the verification and storage of owner-furnished equipment and materials.

9. PRODUCT IDENTIFICATION & TRACEABILITY (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.8)

The electrical contractor should maintain records of the installation of materials and equipment. This requirement of ANSI/ASQC Q9001 and Q9002 can be met by establishing procedures in the field that ensure an accurate and complete set of as-built record drawings are kept. In addition, records of where specific materials and equipment are installed should also be kept. For example, if similar equipment from multiple manufacturers is used on a particular project, knowing which manufacturer's equipment is installed where may be helpful during system startup and troubleshooting throughout the life of the installation.

10. PROCESS CONTROL (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.9)

The production process in electrical construction is the installation of materials and equipment at the project site. ANSI/ASQC Q9001 and Q9002 require that the installation of materials and equipment at the site be carried out under controlled conditions. In order to control the installation process, the electrical contractor must do the following:

- Preplan The Work
- Monitor & Control The Work
- Test & Inspect The Work
- Establish Criteria For Workmanship

(a) Preplan the Work

Work in the field at the activity level must be planned in advance to ensure quality. Employees must have the technical information, skills, tools and production equipment, materials and equipment, and place and time to perform the work. Without any one of these ingredients, quality and productivity will suffer.

Preplanning a construction activity includes documenting work instructions and defining the means and methods of installation. Preplanning goes beyond the end result that is defined in the plans and specifications. Preplanning works out in advance how the end result defined in the plans and specifications can be accomplished. Preplanning defines the construction process at the activity level.

Preplanning starts with defining the scope of a construction activity based on the construction plans and specifications. Construction activities should be defined by the electrical contractor's overall project schedule and budget. Once defined, the means and methods for accomplishing the construction activity must be identified and documented. Wherever possible, the means and methods should either be worked out in conjunction with the employees performing the work or reviewed with the employees prior to finalizing the preplan. In addition to defining what the work is and how it will be accomplished, other information that should be part of the preplan is as follows:

- Drawing and specification references as well as any additional activity requirements or restrictions contained in the general, supplemental, or special conditions.
- Crew size and skill mix allotted to the activity.
- Type, quantity, and location of materials and equipment including expendables such as pulling compound.
- Type, quantity, and location of tools and production equipment including those supplied by other entities on site such as cranes for lifting and hoisting.
- Location(s) of the work to be performed.

- Time(s) allotted to perform the work.
- Interface points with the owner, engineer, manufacturers and suppliers, other trades, or other outside entities.
- Budget for performing the work defined in dollars, employee hours, or material quantities if appropriate.
- Where the crew goes once this work is finished.

(b) Monitor & Control the Work

During the performance of the work, it is the electrical contractor's responsibility to monitor and control the quality and progress of the work. Monitoring and controlling the work can be accomplished in a number of different ways which include observation and regular meetings with the construction crew(s). Wherever possible, quality and progress should be tracked quantitatively, preferably graphically, and shared with the crew(s). In this way, potential problems in the construction process can quickly be identified and resolved with the help of the crew performing the work.

(c) Test & Inspect the Work

Tests and inspections should be carried out during construction wherever required by the technical specifications or the electrical contractor's quality assurance program. These tests and inspections should be documented as to their results and the planned corrective action that will be taken when necessary. Finally, the resolution of the problem or the results of the corrective action should also be documented.

(d) Establish Criteria for Workmanship

The criteria for judging workmanship must be defined by either the technical specifications or the electrical contractor's quality assurance program. Workmanship criteria should be reasonable, achievable, and measurable and must be made known to the employees performing the work.

Workmanship criteria should be documented and, wherever possible, reference industry codes and standards. For example, the installation of materials and equipment is usually required to be in a "neat and workmanlike manner" either explicitly in the technical specifications or implicitly by requiring compliance

with the NEC.[16] The phrase "neat and workmanlike" is defined by the *NECA Standard of Installation.*[17]

11. INSPECTION & TESTING (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.10)

The electrical contractor is required by ISO 9001 to test and inspect materials and equipment as follows:

- Receiving Inspection & Testing
- In-Process Inspection & Testing
- Final Inspection & Testing

The electrical contractor must maintain records of all inspection and testing which includes the results of those inspections and tests.

(a) Receiving Inspection & Testing

The electrical contractor must ensure that incoming materials and equipment are not incorporated into the work until it has been inspected and verified as conforming to the project requirements. Verification should be in accordance with either the technical specifications or the electrical contractor's quality assurance program. It is the electrical contractor's responsibility to determine how much inspection of incoming materials and equipment needs to be done given the supplier's quality assurance program and past experience with the supplier.

(b) In-Process Inspection & Testing

The electrical contractor must inspect and test work in process where required by either the project technical specifications or the electrical contractor's quality assurance program. Documented inspection and test methods must be used to determine whether or not the work in process is in conformance. Wherever possible, criteria for conformance should be quantifiable and measurable. Procedures also need to be in place to identify nonconforming work and initiate corrective action as soon as possible. An example of common in-process inspection and testing is the testing of medium-voltage cable insulation, terminations, and splices after installation.

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[16]*National Electrical Code*, National Fire Protection Association, ANSI/NFPA 70, 1993 Edition, Quincy, Massachusetts, 1992, Section 110-12.

[17]*NECA Standard Of Installation*, National Electrical Contractors Association, Bethesda, Maryland.

(c) Final Inspection & Testing

ANSI/ASQC Q9001 and Q9002 require that the electrical contractor perform final inspection and testing in accordance with the project technical specifications or the electrical contractor's quality assurance program prior to turning the completed work over to the owner. The final inspection and testing requirement also requires that the electrical contractor ensure that all required receiving and in-process inspection and testing have also been performed. Records of final inspection and testing should be kept.

In construction, the final inspection and testing is usually considered to be the "punchlist" prepared by the owner and/or engineer following a walk through of the completed project. Under ANSI/ASQC Q9001 and Q9002, it is not sufficient for the electrical contractor to use the "punchlist" as a measure of quality. The electrical contractor must take a proactive role and perform all necessary inspection and testing prior to the final inspection and testing by the owner and/or engineer. It should be the electrical contractor's goal to have all problems identified and, if possible, corrected prior to the final inspection and testing by the owner and/or engineer.

12. CONTROL OF INSPECTION, MEASURING, & TEST EQUIPMENT (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.11)

The electrical contractor is responsible for calibrating and maintaining test equipment used on the project whether it is owned, leased, or borrowed. In addition, only equipment suitable for the required inspections, measurements, and tests should be used. Equipment must be used so that measurements are made within the equipment's capabilities. The following guidelines regarding the use of equipment should be adhered to:

- Measurements should be taken in accordance with material and equipment manufacturer's recommendations and industry standards. For example, the testing procedure for medium-voltage cable is usually specified by the manufacturer.

- Equipment should be appropriate for the application and capable of the measuring accuracy and precision necessary. For example, a true RMS meter should be used in place of an average or peak measuring meter where there is a high concentration of nonlinear loads.

- Calibration of equipment should be performed at prescribed intervals or prior to use.

- Equipment should be clearly marked to show its calibration status.

- Calibration and maintenance records should be maintained for equipment.

- Environmental conditions should be suitable for the calibration and use of the equipment.

- Equipment should be handled, transported, and stored so that its accuracy and calibration is maintained.

- Where auxiliary test hardware or software is used with inspection, measuring, and test equipment, it should be checked on a regular basis for accuracy and suitability for use.

13. INSPECTION & TEST STATUS (ANSI/ASQC Q9001 & Q9002: SECTION 4.12)

The inspection and test status of materials, equipment, and work in place must be identified by the electrical contractor. Inspection and test status includes both conformance and nonconformance with the inspection and test criteria. ANSI/ASQC Q9001 and Q9002 require that the inspection and test status of materials, equipment, and work in place be clearly identified using markings, stamps, tags, labels, inspection records, software, physical location, or other suitable means. The required inspection and test status indication must remain in place throughout construction.

14. CONTROL OF NONCONFORMING PRODUCT (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.13)

The electrical contractor must establish and maintain procedures to ensure that materials, equipment, or work in place that does not conform to specified requirements is identified and corrected in order to comply with either ANSI/ASQC Q9001 or Q9002. Nonconforming materials, equipment, and work in place must be rectified in one of the following three ways:

- Reworked, or modified in order to meet specified requirements.

- Accepted with or without rework or modification by concession.

- Removed and replaced in total.

Where nonconforming materials, equipment, or work in place is accepted as is, the electrical contractor must document the nonconformance its acceptance. Replaced, reworked, or modified materials, equipment, or work in place must be reinspected and retested in accordance with the technical specifications and/or the contractor's quality assurance program.

15. CORRECTIVE & PREVENTIVE ACTION (ANSI/ASQC Q9001 & Q9002: SECTION 4.14)

In order to comply with the requirements of ANSI/ASQC Q9001 and Q9002, the electrical contractor must develop, document, and implement procedures to do the following:

- Investigate and analyze the cause of the nonconformance.
- Define the corrective action necessary to prevent recurrence.
- Initiate corrective action.
- Ensure that the corrective action taken is effective.
- Revise existing procedures and processes in accordance with the corrective action taken.

16. HANDLING, STORAGE, PACKAGING, PRESERVATION, & DELIVERY (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.15)

Procedures must be developed, documented, and implemented by the electrical contractor for doing the following:

- Handling Materials & Equipment
- Storing Materials & Equipment
- Packing Materials & Equipment
- Delivering Materials & Equipment

(a) Handling Materials & Equipment

The electrical contractor must develop, document, and use means and methods of handling materials and equipment that prevent damage or deterioration. For example, medium-voltage cable must be handled in accordance with manufacturer recommendations.

(b) Storing Materials & Equipment

The electrical contractor must provide secure storage areas in order to prevent damage or deterioration of the materials and equipment prior to integration into the work. In the case of bulk materials, the electrical contractor should establish material control procedures in order to maintain the integrity of the inventory at the site. For example, a motor control center delivered to the site

prior to installation must be protected from the elements as well as damage from other ongoing work.

(c) Packing Materials & Equipment

Materials and equipment must be properly packed for movement. This includes informing the manufacturers or suppliers as to the anticipated conditions that materials and equipment will encounter during shipment. This requirement is especially important when materials and equipment will be temporarily stored at an intermediate location prior to being shipped to the project site.

(d) Delivering Materials & Equipment

ANSI/ASQC Q9001 and Q9002 require that the electrical contractor protect materials and equipment from damage during delivery.

17. CONTROL OF QUALITY RECORDS (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.16)

In order to comply with ANSI/ASQC Q9001 and Q9002, the electrical contractor must maintain quality records to demonstrate that the specified level of quality has been attained. The electrical contractor must establish and maintain procedures for identifying, collecting, cataloging, and filing these records. Supplier and subcontractor quality records should also be a part of the electrical contractor's quality records.

18. INTERNAL QUALITY AUDITS (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.17)

ANSI/ASQC Q9001 and Q9002 require that the electrical contractor establish, document, and carry out a comprehensive system of internal quality audits. The purpose of these internal quality audits is to ensure compliance with the quality assurance program. The internal quality audits should be performed in accordance with documented procedures. The results of the internal quality audits should be documented and shared with the personnel that are responsible for the processes being audited.

19. TRAINING (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.18)

Procedures must be developed, documented, and implemented to ensure that all employees performing activities that affect quality are qualified. Employees can be qualified on the basis of education, training, and/or experience. Where training is required for employees to perform a particular task, it is the electrical contractor's responsibility to ensure that effective training is provided. The electrical contractor must maintain training records.

20. SERVICING (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.19)

When after-construction servicing is part of the construction contract, the electrical contractor must establish, document, and implement procedures to ensure that the servicing meets stated requirements. The stated requirements include those specified in the technical specifications as well as those required by the electrical contractor's own quality assurance program. For example, it is common in many construction contracts to require the electrical contractor to warrant the installation for one year after substantial completion. In addition, there are manufacturer and supplier guarantees and warranties that must be honored.

21. STATISTICAL TECHNIQUES (ANSI/ASQC Q9001 & Q9002: PARAGRAPH 4.20)

Where the electrical contractor uses statistical techniques to verify the acceptability and conformity of materials, equipment, or work in place, the statistical techniques must be appropriate for the application and properly applied.

E. ADAPTING ANSI/ASQC Q9001 & Q9002 TO ELECTRICAL CONSTRUCTION

This section identified the requirements of ANSI/ASQC Q9001 and Q9002 as they apply to the electrical contractor involved in the design and installation of electric power, communications, and control systems. The next step in this process is to implement this model within the electrical contracting firm which requires development of a customized quality assurance program. Chapter 3 provides a process that can be used to develop and implement a customized quality assurance program. Chapter 4 takes the ANSI/ASQC Q9001 requirements outlined in this chapter and provides a sample quality assurance manual. Similarly, Chapter 5 provides a sample quality assurance manual based on ANSI/ASQC Q9002. The quality assurance manual is the documented basis for the electrical contractor's quality assurance program.

CHAPTER 3
STEPS IN DEVELOPING A QA PROGRAM

A. INTRODUCTION

This chapter outlines the steps involved in the development of an effective quality assurance program for the electrical construction firm. To be viable, the quality assurance program has to be more than a one-time effort to put together a quality assurance manual. The quality assurance manual only documents the existing processes within the electrical contractor's organization that are used on a daily basis to ensure that projects are completed on time, within budget, and in accordance with the contract documents. Quality assurance and the quality assurance program must become part of the corporate culture and a priority for all employees if the program is to succeed.

B. QA PROGRAM DEVELOPMENT

The development of an effective quality assurance program is the same for both inside and outside electrical contractors. The development of a quality assurance program is a process that can be broken down into a series of eight discrete steps. These eight steps are as follows:

- Step 1: Establish A QA Program Team
- Step 2: Develop A QA Plan
- Step 3: Assign QA Responsibility
- Step 4: Identify & Analyze Processes
- Step 5: Establish & Document Procedures
- Step 6: Write The QA Manual
- Step 7: Provide QA Training

- Step 8: Implement The QA Program

The remainder of this chapter will describe each of the eight steps in detail.

C. STEP 1: ESTABLISH A QA PROGRAM TEAM

The first step in developing an effective quality assurance program is the establishment of an in-house cross-functional team that is responsible for the program development. Members of this team must have an in-depth knowledge of the firm, its operations, and an understanding of quality assurance. The QA Program Team should report directly to upper management through the member of the management team who has been assigned the responsibility for quality within the electrical construction firm.

QA Program Team members must be carefully selected. Team members should come from the various functional areas within the firm that will be addressed in the firm's quality assurance program. It is not necessary that there be a team member representing each function covered in the firm's quality assurance program. It is only necessary that the team as a whole be knowledgeable in all the processes that will be addressed by the quality assurance program. The size of the team will, of course, depend on the size of the electrical construction firm and the complexity of its internal operations and the projects it takes on. The QA Program Team should not exceed four to six people including the member from upper management.

The member of upper management that is responsible for the firm's quality assurance program should be a member of the QA Program Team. The reason for this is that this individual will be responsible for leading the implementation effort and must have a thorough knowledge of how the quality assurance program was developed. In addition, active participation of a management team member demonstrates upper management's commitment to quality and the quality assurance program.

Formation of the QA Program Team and its efforts in the development of an effective quality assurance program is the first opportunity upper management has to demonstrate its unwavering support for the program and its development. Normally, members of the QA Program Team will be the firm's best performers and current or future leaders. These individuals will necessarily be in middle-management positions which will provide them with the knowledge of how the firm actually operates on a day-to-day basis.

Being part of middle management, these individuals have key responsibilities for ongoing operations within the firm. These responsibilities cannot be neglected while developing the firm's quality assurance program. To put these

individuals in the position of neglecting ongoing operations in the interest of developing a quality assurance program would be a mistake. These individuals would rightly forsake the development of the quality assurance program to take care of their day-to-day responsibilities. This would doom the quality assurance program to failure before it even got started.

It is here that management must provide these individuals with the additional support they need to continue to meet their day-to-day obligations as well as the time needed to develop the quality assurance program. Very often the development of a quality assurance program is stillborn because of everyday pressures. The additional support needed can take a variety of forms including the temporary assignment of existing personnel, redefinition of subordinates' duties and responsibilities, or bringing in outside help on a temporary basis.

Some middle managers may not be comfortable delegating key responsibilities to subordinates. If this is the case, then upper management may want to reconsider the selection of that individual. To have an effective organization, there must be trust at all levels and a dedication to employee growth and development. A middle manager who will not delegate for whatever reason is stifling the firm's growth and either needs additional training or replacement.

Once the QA Program Team has been established, upper management must draft and provide the team with a clear and unambiguous mission statement. This mission statement must state what is expected of the team and the scope of their effort. This mission statement should also note available resources, time frames and deadlines, as well as any restrictions on the QA Program Team's operations.

D. STEP 2: DEVELOP A QA PLAN

The first thing that the QA Program Team should tackle is the development of the quality assurance implementation plan. Within the confines of the mission given to the QA Program Team by upper management, the QA Program Team should decide exactly how it is going to achieve the stated objectives. This plan will detail how the quality assurance program will be developed, who will be responsible for what, when things should be done, and what the final product will include.

E. STEP 3: ASSIGN QA RESPONSIBILITY

Within the framework of the organization, responsibility for quality needs to be established. Everyone in the organization is responsible for the quality of their own work. However, certain people within the organization must have overall responsibility for the implementation of the firm's quality assurance program. In particular, these people are responsible for ensuring that the quality assurance procedures developed and documented as part of the quality assurance program are carried out as well as the training of people within the organization in these procedures.

Assignment of responsibility for quality assurance should be done by job title only and not by individual. The assignment should be made based on the position's responsibilities, authority, and accountability. It is important that responsibility for quality assurance be established early because the position responsible for a particular portion of the quality assurance program may determine the procedures developed.

Assignment of responsibility for quality assurance should be done by job title only and not by individual.

The assignment of quality assurance responsibility may also require the revision of job descriptions throughout the organization. Everyone will now be responsible for the quality of their own work. In order to ensure that everyone understands their role in the firm's quality journey, employee job descriptions should be expanded to reflect each individual's responsibility for quality.

F. STEP 4: IDENTIFY & ANALYZE PROCESSES

Once responsibility for quality assurance has been determined, the next step is to identify and analyze the processes that will form the basis for the firm's quality assurance program. The processes selected must all contribute to quality and will vary to some extent from electrical contractor to electrical contractor. However, as noted in Chapter 2 of this guide these processes will probably be the same for most electrical contractors serving the same market. Typical electrical construction processes include the following:

- Contract Document Review
- Document Control
- Design Management
- Procurement & Expediting

- Tool & Equipment Management & Calibration
- Material & Installed Equipment Management
- Construction Management
- Inspection, Testing, & Startup

The QA Program Team does not get into the details of continuous improvement of these processes. The QA Program Team's objective is to document existing processes. If improvement is required, the improvement of existing processes should be left to specially formed quality improvement teams as part of the firm's overall continuous improvement or total quality management (TQM) program. The QA Program Team cannot get involved in the improvement of processes or it will never get done with its work.

G. STEP 5: ESTABLISH & DOCUMENT PROCEDURES

The key is to provide enough detail in the process description so that anyone with minimal training can understand and effectively carry out the process.

Once the electrical construction firm's processes have been identified and analyzed, the next step is to establish and document procedures used to carry out those processes. Procedures can be documented in a variety of ways that include anything from verbal descriptions to graphical representations or a combination of methods. The key is to provide enough detail in the process description so that anyone with minimal training can understand and effectively carry out the process. One test often applied to determine the adequacy of process documentation is: If all personnel were suddenly replaced, could the new people with proper training use the process documentation to continue providing the product or service as before?

H. STEP 6: WRITE THE QA MANUAL

The cornerstone of the quality assurance program is the quality assurance manual. The quality assurance manual provides an overall guide that describes how the electrical construction firm's quality assurance system works. Where additional detail is required, the quality assurance manual references more detailed documents for specifics. Chapters 4 and 5 provide sample quality assurance manuals that inside and outside electrical contractors can use as a starting point for developing their own customized manuals.

I. STEP 7: PROVIDE QA TRAINING

The QA Program Team that develops the quality assurance program cannot be charged with its implementation. Implementation of the quality assurance program must involve everyone working for the electrical construction firm. Therefore, the electrical contractor must provide training to employees to familiarize them with the quality assurance program and their role in its implementation.

J. STEP 8: IMPLEMENT THE QA PROGRAM

The last step in the development of an effective quality assurance program is its implementation. The quality assurance program must be implemented throughout the organization in accordance with the quality assurance manual.

The QA Program Team that develops the quality assurance program cannot be charged with its implementation.

K. CONTINUALLY REVIEW & IMPROVE THE QA PROGRAM

The quality assurance program should be dynamic and not static. The quality assurance program should be reviewed on a regular basis and improved constantly. It is not enough to simply develop a quality assurance program. The processes on which the quality assurance program are built should be in a state of continuous improvement. This means that the quality assurance program will need to be constantly updated so that it accurately reflects the electrical contractor's current processes. Chapter 8 of this guide addresses methods for evaluating the quality assurance program once it is in place.

CHAPTER 4
WRITING THE QA MANUAL: ANSI/ASQC Q9001 VERSION

A. INTRODUCTION

As discussed in Chapter 3, the quality assurance program must be formalized in writing. The quality assurance manual documents the electrical contractor's quality assurance program. This chapter assists the electrical contractor in this process by providing a sample quality assurance manual for a fictitious electrical construction firm named XYZ Electric. The sample quality assurance manual is based on ANSI/ASQC Q9001 as discussed in Chapter II. In order to expedite the quality assurance manual development, a diskette is provided with this guide that contains the sample quality assurance manual text files.

B. USING THE SAMPLE QUALITY ASSURANCE MANUAL

The sample quality assurance manual is provided to assist the electrical contractor in developing an effective quality assurance program. The sample quality assurance manual should not be used without customization by the electrical construction firm. Every electrical construction firm is different and every quality assurance program will also be different. Therefore, the electrical contractor must develop a quality assurance program that reflects the unique aspects of the firm, market, and internal processes as described in Chapter 3.

XYZ ELECTRICAL CONSTRUCTION, INC.

QUALITY ASSURANCE PROGRAM

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OUR COMMITMENT TO OUR CUSTOMERS ...

XYZ Electrical Construction, Inc. is committed to quality. This document details XYZ Electric's commitment to quality through our quality assurance program. The purpose of our quality assurance program is to ensure that our customer's needs are met the first time and every time. Our quality assurance program provides the framework that ensures continuous improvement of our design and construction services, quality in our completed work, and customer satisfaction.

We recognize that our customers and our ability to meet their needs are the sole reason for XYZ Electric's existence. Our customers rely on our expertise in electrical design and construction to provide them with safe, reliable, and efficient power, control, and communications systems. We make every effort to be deserving of our customer's trust and high expectations. In today's world, our customer's business depends on reliable and efficient power, control, and communications systems to stay competitive in the global marketplace.

XYZ Electric does not rely on chance to provide our customers with the quality they need and deserve. All of our employees understand XYZ Electric's customer focus and commitment to quality.

John E. Doe
President
April 15, 19XX

QUALITY ASSURANCE PROGRAM
VERSION 1.0 REVISIONS

DATE	PAGE		COMMENTS	APPROVED (NAME/DATE)
	NO.	REV.		

NOTICE

Photocopies of this manual are not controlled. Photocopied manuals may not contain the latest revisions of XYZ Electric's quality assurance program and be obsolete. Please request a current copy of this manual from the Corporate Quality Officer before providing this manual to customers or employees.

Written By: Molly R. Jones		**Initial:** MRJ	**Date:** 4/10/XX
Approved By: Mark F. Lewis		**Initials:** MFL	**Date:** 4/12/XX
Manual Ver: 1.0	**Page Rev:** 1	**Date:** 4/15/XX	**Page No:** XX

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1 CORPORATE PROFILE

1.1 CORPORATE STRUCTURE

XYZ Electric is incorporated in accordance with the laws of Anystate.

1.2 MARKET SERVED

XYZ Electric serves commercial and industrial customers in the metropolitan area of Anytown.

1.3 MISSION STATEMENT

XYZ Electric's mission statement is as follows:

> *XYZ Electric and its employees are committed to becoming recognized by our customers as the best provider of electrical construction and maintenance services in this region.*

XYZ Electric's mission statement is implemented through our strategic planning process.

1.4 STRATEGIC PLANNING PROCESS

XYZ Electric developed a comprehensive strategic plan in 19XX. The objective of this strategic plan was to provide a structured program that will lead to the realization of our corporate goal as articulated in our mission statement.

XYZ Electric works toward its corporate mission through the achievement of defined and measurable corporate objectives. XYZ Electric uses a rolling five-year planning horizon in its strategic planning process. The strategic plan is reviewed, evaluated, and updated annually by XYZ Electric's management team in October of each year. XYZ

Electric's Board Of Directors reviews and approves the updated strategic plan for the following year at its December meeting. Those portions of the strategic plan that affect everyday operations and departmental policies and procedures are reviewed with employees at the annual January employee meeting.

2 CORPORATE COMMITMENT TO QUALITY

2.1 QUALITY ASSURANCE PROGRAM

2.1.1 Purpose

The purpose of our quality assurance program is to delineate the structure, responsibilities, procedures, processes, and resources needed to ensure that XYZ Electric meets the needs of our customers.

2.1.2 Basis

Our quality assurance program is based on ANSI/ASQC Standard Q9001[1]. A cross reference between our quality assurance program as documented in this manual and ANSI/ASQC Standard Q9001 is provided in Section 12. ANSI/ASQC Standard Q9001 is equivalent to ISO 9001.[2]

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[1]ANSI/ASQC Q9001-1994, *Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, American Society for Quality Control, Milwaukee, Wisconsin, 1994.

[2]ISO 9001:1994, *Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, International Organization for Standardization, Geneva, Switzerland, 1994.

2.1.3 Definition Of Terms Used

Unless otherwise noted, terms used in this quality assurance manual are defined in accordance with ANSI/ISO/ASQC Standard A8402[3].

2.1.4 Distribution

A copy of this manual is provided to all XYZ Electric permanent employees at the time of their quality assurance training. These manuals are registered to the individual employee. A copy of the this manual is also available in the XYZ Electric job trailer at each construction site for field employee reference.

2.1.5 Training

All XYZ Electric employees received training in the quality assurance program within three months of its acceptance by the Board of Directors on August 15, 19XX. Every new employee who has joined XYZ Electric since August 15, 19XX has received training in the quality assurance program within one week of his or her employment date.

Field employees working with XYZ Electric receive training on the specific portions of the quality assurance program that apply directly to their work. Training of field employees is carried out at the job site by the project manager or the project's designated trainer. Training of employees working in XYZ Electric's home office is performed by the employee's department head or the department's designated trainer.

A record of all formal training is kept in the employee's personnel file.

2.1.6 Revisions And Updates

Revisions and updates to XYZ Electric's quality assurance program are issued to all registered holders of the this manual. All registered holders of this manual are

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[3]ANSI/ISO/ASQC A8402-1994, *Quality Management And Quality Assurance - Vocabulary*, American Society for Quality Control, Milwaukee, Wisconsin, 1994.

responsible for updating the manual as required. At each job site, the project superintendent is responsible for maintaining and updating the manual as required. Periodic checks of the quality assurance manuals are made by the Corporate Quality Officer to ensure that all revisions and updates have been included.

Employees are responsible for understanding and implementing revisions and updates to the quality assurance program. When there are a number of significant revisions or an overall update of the quality assurance program, each employee is required to attend a formal training session covering the revisions or update. Project and department managers are responsible for disseminating changes and updates that affect employees.

2.2 QUALITY POLICY

2.2.1 Quality Policy Statement

XYZ Electric's quality policy is as follows:

> *Perform work to the exact requirements of our customers as defined by the contract documents unless those requirements are changed in accordance with procedures defined in the contract.*

2.2.2 Quality Policy Objective

The objective of XYZ Electric's quality policy is to ensure that each employee understands that he or she is responsible for quality and empowered to ensure that customers' needs and expectations, as expressed in the contract documents, are met.

2.2.3 Quality Policy Dissemination

XYZ Electric's quality policy is posted in conspicuous places throughout the home office and at all job sites. This policy is reinforced verbally at all company and job site meetings that deal with quality and continuous improvement.

2.3 RESPONSIBILITY FOR CORPORATE QUALITY

2.3.1 Levels Of Responsibility

XYZ Electric recognizes its responsibility to customers for providing quality electrical work. Within XYZ Electric, there are three levels of responsibility for quality:

- Corporate
- Project
- Individual

2.3.2 Corporate-Level Responsibility

The primary responsibility for quality at XYZ Electric is the Quality Steering Committee which consists of the following three members of senior management:

- President
- Senior Vice President
- Vice President Of Operations

The Senior Vice President serves as the Corporate Quality Officer for XYZ Electric. The Corporate Quality Officer is responsible for ensuring that the organization adopts and adheres to the quality policy. The Corporate Quality Officer is also responsible for getting feedback from customers and ensuring that XYZ Electric is a quality organization committed to customer satisfaction and continuous improvement.

2.3.3 Project-Level Responsibility

XYZ Electric's project managers assist the Corporate Quality Officer. Project managers are responsible for overseeing quality in the field and customer satisfaction. Section 10.3 addresses the project manager's responsibility for field quality in greater detail.

2.3.4 Individual Responsibility

The key to the successful implementation of any quality assurance program is the individual employee. The employee performing the work is the only person who can truly control quality during the construction process. XYZ Electric empowers employees to control quality through its quality policy and encourages open communications between employees and management about quality improvement.

2.4 MANAGEMENT REVIEW

The Corporate Quality Officer and designated staff conduct regular internal semiannual reviews to ensure that the quality assurance program is being properly and effectively implemented. These management reviews include close scrutiny of the following:

- Organization structure and its impact on quality.
- Effective implementation of the quality policy.
- Internal evaluation of construction and maintenance services.
- Performance as measured by customer feedback and construction quality.

The management reviews are documented and submitted to the Quality Steering Committee which takes corrective action as necessary. In addition, data and information from previous reviews are used to identify trends and determine if corrective measures are effective.

3 QUALITY SYSTEM

3.1 QUALITY SYSTEM DEFINED

XYZ Electric's quality system is outlined in this manual. The quality system defines the organizational structure, responsibilities, procedures, and processes put in place to achieve XYZ Electric's quality system objectives.

3.2 QUALITY SYSTEM OBJECTIVES

The objectives of XYZ Electric's quality system are fourfold:

- Provide a quality electrical installation that meets the customer's needs and expectations as expressed in the contract documents.
- Avoid rework and delays during construction through early detection and correction of problems.
- Provide a safe and productive work environment for XYZ Electric employees.
- Support the achievement of the corporate mission and strategic objectives.

3.3 QUALITY SYSTEM PROCESSES

XYZ Electric's quality program consists of the control of the following eight processes:

PROCESS	QA MANUAL SECTION
Contract Document Review	4
Document Control	5
Design Management	6
Procurement & Expediting	7
Tool & Equipment Maintenance, Calibration, & Testing	8
Materials & Installed Equipment Management	9
Construction Management	10
Inspection, Testing, & Startup	11

The following sections of the manual discuss each of these processes and its control in detail.

4 CONTRACT DOCUMENT REVIEW

4.1 PROCESS SCOPE & OBJECTIVES

This process involves the review of the project contract documents to ensure that these documents accurately define the scope of XYZ Electric's work. The objective of this process is to ensure that XYZ Electric understands the customer's needs and requirements as expressed in the contract documents and can meet those needs and requirements.

4.2 DOCUMENT REVIEW PROCESS

4.2.1 Bid Documents

The document review process begins with the review of bid documents. These documents define the scope and requirements of the project. The bid documents normally include the following information:

- Invitation To Bid
- Bid Form
- Construction Agreement
- General, Supplemental, & Special Conditions
- Insurance & Bond Requirements
- Work Included & Excluded
- Drawings & Specifications
- Addenda
- Owner Furnished Materials & Equipment
- Project Milestone Dates

4.2.2 Site Visit

A site visit is scheduled with the customer prior to bidding. The purpose of the site visit is for XYZ Electric to become familiar with site and its condition. In addition to the physical site, XYZ Electric will investigate project logistics and local conditions that may impact the construction process.

4.2.3 Prebid Meeting

XYZ Electric will attend any scheduled prebid meetings in order to interact with the customer and clarify the project scope and requirements. Where no formal prebid meeting is scheduled, XYZ Electric will contact the customer resolve any questions concerning the project scope and requirements prior to bidding.

4.2.4 Contract Award

Prior to executing the contract, XYZ Electric will meet with the customer to review the contract scope and requirements and agree on any administrative procedures not previously addressed. Once an understanding of all outstanding details and questions have been resolved, XYZ will execute the contract.

4.2.5 Post-Contract Award

Following contract execution, XYZ Electric will start work as directed by the contract. During construction, XYZ Electric will keep the customer informed of any problems, delays, or deviations from the specified requirements in accordance with the contract documents.

5 DOCUMENT CONTROL

5.1 PROCESS SCOPE & OBJECTIVES

This process involves the cataloging, filing, and distribution of project documents. The objective of this process is to ensure that information needed to manage and perform the work is readily available to those that need it.

5.2 DOCUMENT CONTROL PROCEDURES

5.2.1 Documents To Be Controlled

All documents that affect project quality are required to be cataloged, filed, and distributed as required. Controlled documents typically include the following:

- Contract formation and maintenance documents that include the construction contract; general, supplemental, and special conditions; addenda, change orders, and field directives; among others.
- Planning and design documents that include design criteria, site information, material and equipment information, calculations, drawings, specifications, among others.
- Procurement and expediting documents that include quotations, agreements and purchase orders, shipping and receiving records, test and inspection documentation, warranties and guarantees, among others.
- Tool and equipment maintenance and calibration procedures and records.
- Material and equipment shop drawings and catalog cuts along with review and approval documents.
- All correspondence, memoranda, meeting minutes, requests for information, schedules, and budgets relating to the construction process.

5.2.2 Responsibility For Document Control

The project manager is responsible for project document control.

5.2.3 Document Control System

All documents received are stamped with the date of receipt. All internally generated documents are dated and marked with the name or initials of the originator. A central project file is established at the beginning of the project and maintained throughout the project. Where appropriate, a document log is kept for particular classes of documents.

6 DESIGN MANAGEMENT

6.1 PROCESS SCOPE & OBJECTIVES

This process involves the design of power, control, and/or communications systems by XYZ Electric for the customer. The objective of this process is to determine the customers needs and produce a set of accurate and complete construction documents that can be used to install and/or construct the required systems.

6.2 DESIGN QUALITY DEFINED

Design quality is defined by the construction documents that translate the customer's needs and requirements into functional power, control, and communications systems that can be efficiently built and operated.

6.3 RESPONSIBILITY FOR DESIGN QUALITY

The project engineer is responsible for design quality. The project engineer will be registered as an electrical engineer in the state where the project is located and affix his or her seal to studies, plans and specifications, and other design documents as required by the licensing laws of that state.

6.4 CLIENT NEED IDENTIFICATION

The first step in the design process is the identification of the customer's needs and requirements. XYZ Electric will meet with the customer and end users of the system(s) or facility to determine the project scope and system performance requirements. The project scope and system requirements will be documented and provided to the customer for review and comment.

6.5 CODES & STANDARDS REVIEW

Once the project scope and system requirements have been identified and agreed to, the next step is to determine what codes and standards are applicable to the project. Applicable codes and standards will be researched to determine specific requirements. The results of the codes and standards review will be documented.

6.6 DESIGN CRITERIA DEFINITION

Based on the project scope and system requirements along with the results of the codes and standards review, XYZ Electric will define specific design criteria for the project. In this step, XYZ Electric will convert the customer's system performance criteria into specific quantifiable and measurable design requirements. Design criteria will be documented and reviewed with the customer to ensure accuracy and completeness. Any conflicting or ambiguous requirements will be resolved prior to proceeding with the design.

6.7 CONSTRUCTABILITY & VALUE ANALYSIS

XYZ Electric will identify viable design alternatives that meet the customer's design criteria. These alternatives will then be analyzed to determine the preferred alternative based on construction, operation, and maintenance considerations. Constructability reviews will be performed to determine how the design can be modified to improve construction efficiency. Value analyses will be performed to select equipment and systems that result in a low life-cycle cost. The goal is to select design alternatives that meet the customer's requirements at a low life-cycle cost.

6.8 DESIGN DOCUMENTATION

6.8.1 System Documentation

Design documentation for electric power, communications, and control systems is divided into the following systems:[4]

- Power Distribution Systems
- Lighting Systems
- Communication And Data Processing Systems
- Life Safety/Security Systems
- Lightning Protection Systems
- Grounding Systems
- Instrumentation And Control Systems

6.8.2 Power Distribution Systems

Documentation of the power distribution system design includes the following:

- System one-line diagram.
- Conductor type, size and insulation type.
- Protective devices and interrupting capabilities.
- Substation, distribution switchboard, panelboard and motor control center (MCC) locations, arrangements, and ratings.
- Circuiting of all outlets and devices.
- Short circuit analysis.

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[4]Adapted from Rule 21H-33 of the Florida Board of Professional Engineers entitled *Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems.*

- Load calculations.
- Legend

6.8.3 Lighting Systems

Documentation of the lighting system design includes the following:

- Lighting fixture performance specifications and arrangements.
- Emergency and exit lighting.
- Lighting control and circuiting.
- Legend

6.8.4 Communication & Data Processing Systems

Documentation of the communication and data processing systems design includes the following:

- System riser diagram.
- Conductor type, size, and insulation type.
- Equipment and device type and locations.
- Special power supply requirements.
- Description of system operation.
- Legend

6.8.5 Life Safety/Security Systems

Documentation of the communication and data processing systems design includes the following:

- System riser diagram.
- Conductor type, size, and insulation type.
- Equipment and device type and location.

- Special power supply requirements.
- Description of system operation.
- Legend

6.8.6 Lightning Protection Systems

Documentation of the lightning protection system design includes the following:

- Air terminal height and spacing.
- Arrangement of down conductors.
- Grounding methods and locations.
- Ground test requirements.
- Legend

6.8.7 Grounding Systems

Documentation of the grounding system design includes the following:

- Type and location of all grounding electrodes.
- Bonding requirements.
- Ground test requirements.
- Conductor material type, size, and protection requirements.
- Legend

6.8.8 Instrumentation And Control Systems

Documentation of the instrumentation and control systems design includes the following:

- Functional diagram.
- Conductor type, size, and insulation type.
- Equipment and device type and location.

- Special power supply requirements.
- Description of system operation.
- Programming Code
- Legend

6.8.9 System Technical Specifications

Specifications for the power, control, and communications systems will be prepared in accordance with Division 16 of the Construction Specification Institute's (CSI) *Uniform System For Construction Specifications, Data Filing, And Cost Accounting* (MasterFormat).

6.9 DESIGN REVIEW PROCEDURES

6.9.1 Internal Design Reviews

Internal design reviews will be performed by XYZ Electric at regular intervals as required by the complexity and size of the project. The project manager will be responsible for scheduling, performing, and documenting the results of these reviews. Internal design reviews should include members of the design team, construction personnel, key suppliers and manufacturers, outside specialists, and others that must interface with the design process. The internal design review will include not only technical reviews but also a review of the projected construction schedule and budget.

6.9.2 Customer Design Reviews

Customer design reviews will be scheduled in accordance with the agreement between the customer and XYZ Electric. The project manager is responsible for scheduling, coordinating, and responding to the results of the customer design reviews.

6.10 DESIGN CHANGE & MODIFICATION PROCEDURES

The project manager is responsible for establishing and documenting design change and modification procedures with the customer. All design changes and modifications are to be reviewed with the customer and documented.

7 PROCUREMENT & EXPEDITING

7.1 PROCESS SCOPE & OBJECTIVES

This process involves the procurement of materials and equipment for incorporation into the work by XYZ Electric. In addition, this process involves procuring the services of qualified specialty subcontractors to assist XYZ Electric in performing the work.

7.2 SUPPLIER AND SUBCONTRACTOR ASSESSMENT

7.2.1 Materials & Equipment

Only those suppliers of materials and equipment that are acceptable to the customer as defined in the contract documents are considered. Acceptable suppliers are then assessed by XYZ Electric based on past experience, commitment to quality and customer satisfaction, ability to meet the construction schedule, material and equipment installation characteristics, and after-sale service and support.

7.2.2 Subcontractors

Specialty subcontractors are assessed by XYZ Electric based on expertise, past experience, commitment to quality and customer satisfaction, and ability to meet the construction schedule.

7.3 REQUESTS FOR QUOTATION

Only those suppliers and subcontractors approved by XYZ Electric are asked to submit a quotation. Requests for quotation sent to suppliers and subcontractors include XYZ Electric's standard agreement as well as a detailed written scope of work. Applicable drawings and specification sections are made available to suppliers and subcontractors to facilitate their quotation preparation. XYZ Electric provides suppliers and subcontractors with as much time as possible to prepare complete and accurate quotations.

7.4 PURCHASING POLICIES & PROCEDURES

XYZ Electric selects a supplier or subcontractor based on the criteria outlined in the request for quotation. In most cases, XYZ Electric selects the successful bidder based on price since the successful supplier or subcontractor is selected from a prequalified pool of equal bidders. Following selection and prior to contract execution, XYZ Electric reviews the successful bidder's quotation for completeness and accuracy and then meets with the successful bidder to review the scope of work, technical requirements, inspection and testing requirements, submittal requirements, and construction schedule. Once an agreement is reached on all technical and administrative issues, the contract is executed.

7.5 SUBMITTALS

Shop drawings, catalog cuts, and test and inspection data required to be submitted to the customer for approval by XYZ Electric will be thoroughly reviewed for completeness and technical requirements prior to submission. XYZ Electric will stamp each submittal as having been reviewed along with the reviewer's name and date of review. The goal of this procedure is to avoid delays due to inadequate or erroneous submittals.

7.6 OWNER-FURNISHED MATERIALS & EQUIPMENT

XYZ Electric will work with the owner to ensure that owner-furnished materials and equipment meet the technical requirements of the project. In addition, XYZ Electric will provide the owner with schedule milestones and information so that the owner-

furnished materials and equipment do not delay or otherwise affect the construction process. If the installation of materials and equipment are XYZ Electric's responsibility, XYZ Electric will inspect the materials and equipment when delivered and properly store them until needed. Records of the receipt and inspection of materials and equipment will be forwarded to the owner.

7.7 IDENTIFICATION & TRACEABILITY

Records will be kept of all materials and equipment incorporated into the work.

8 TOOL & EQUIPMENT MAINTENANCE, CALIBRATION, & TESTING

8.1 PROCESS SCOPE & OBJECTIVES

This process involves the maintenance, calibration, and testing of tools and equipment. The objective of this process is to ensure that the employee in the field has the tools and equipment necessary to work effectively, safely, and efficiently.

8.2 SELECTION OF TOOLS & EQUIPMENT

Tools and equipment supplied by XYZ Electric will be selected based on their suitability for the work to be performed. Wherever possible, XYZ Electric will review tool and equipment selection both before and during the performance of the work to ensure that the proper selection has been made. In addition, XYZ Electric will provide sufficient quantities of tools and equipment to allow employees to work productively.

8.3 TRANSPORTATION & STORAGE OF TOOLS & EQUIPMENT

Tools and equipment will be transported and stored in such a way that they will be protected from damage and deterioration.

8.4 CALIBRATION AND TESTING OF TOOLS & EQUIPMENT

Tools and equipment requiring calibration and/or testing will be calibrated and /or tested at regular intervals or just prior to use. Calibration will be carried out by qualified technicians in a controlled environment in accordance with manufacturer recommendations. Testing will be performed in accordance with manufacturer recommendations. Records of tool and equipment calibration and testing will be kept and a stamp indicating the tool or equipment's calibration and/or test status will be attached.

8.5 REPAIR OF TOOLS & EQUIPMENT

When tools and equipment require repair they will be marked or tagged as soon as the damage or defect is detected to avoid accidental use. Repairs will be carried out in accordance with manufacturer recommendations and instructions by qualified technicians in a controlled environment. Following repair, the tools and equipment will be calibrated and tested as described in paragraph 8.4. Records of all tool and equipment repairs will be kept.

8.6 OPERATING INSTRUCTIONS & PROCEDURES

Operating instructions and procedures will be available with the tool or equipment or maintained on file at the project site for employee reference and use.

8.7 OPERATOR TRAINING & CERTIFICATION

When tools and equipment require training for proper use, XYZ Electric will provide training for employees by qualified instructors. Records of all formal training will be kept. If employee certification is required, XYZ Electric will ensure that the employee is certified prior to using the tool or equipment.

9 MATERIALS & INSTALLED EQUIPMENT MANAGEMENT

9.1 PROCESS SCOPE & OBJECTIVES

This process involves managing materials and equipment from the time they are delivered to the site until they are incorporated in the work. The objective of this process is to ensure that the right materials and equipment are delivered and that they are protected from damage and deterioration until they are installed.

9.2 RECEIVING & INSPECTION

At the time of delivery, all materials and equipment are inspected to ensure that they are what was ordered, they are intact and were not damaged during shipment, and that the proper quantity was delivered. Only after a successful inspection are materials and equipment accepted. If a problem is encountered during inspection, the materials and equipment are either rejected or corrective action is worked out with the supplier prior to acceptance. A record is kept of all material and equipment receipts and inspections.

9.3 STORAGE & PROTECTION

Material and equipment delivered prior to when it is needed will be properly stored and protected to prevent damage or deterioration.

9.4 INVENTORY CONTROL PROCEDURES

For bulk materials, XYZ Electric will establish inventory control procedures to ensure that the correct materials and equipment are used where required.

9.5 MATERIAL & EQUIPMENT DOCUMENTATION

Documentation such as installation instructions, testing and startup procedures, and operation and maintenance manuals will be cataloged and filed. This documentation will be provided to the owner in accordance with the contract documents.

10 CONSTRUCTION MANAGEMENT

10.1 PROCESS SCOPE & OBJECTIVES

This process involves the installation of materials, equipment, and systems at the site. The objective of this process is to ensure that the work is completed efficiently and in accordance with the construction documents.

10.2 FIELD QUALITY DEFINED

Quality in the field is defined as meeting the customer's needs and requirements as stated in the construction documents.

10.3 RESPONSIBILITY FOR FIELD QUALITY

The project manager is ultimately responsible for quality in the field. However, XYZ Electric believes that quality cannot be controlled and must be built into the project by the employee performing the work. Therefore, field quality is everyone's responsibility.

10.4 ORGANIZATION FOR FIELD QUALITY

The project manager is responsible for organizing for field quality and documenting responsibilities. The project organization and delegation of authority and responsibility for quality will vary from project to project depending on the project's complexity and size.

10.5 WORK FORCE QUALIFICATIONS & TRAINING

XYZ Electric employs only the best employees with the training, skills, and experience necessary to perform the work assigned. Each employee is responsible for the quality of his or her own work and has the authority to alter or correct the work when it does not comply with specified requirements.

10.6 INTERFACE WITH OTHER PROJECT PARTICIPANTS

XYZ Electric will plan and coordinate its work with other project participants as required.

10.7 CONSTRUCTION MEANS & METHODS

XYZ Electric will use construction means and methods that are appropriate for the project. The means and methods will be reviewed with the employee(s) performing the work prior to implementation.

10.8 PROJECT PLANNING & SCHEDULING

XYZ Electric will plan and schedule work within the framework of the customer's schedule and the contract requirements. XYZ Electric will work closely with the customer and other affected parties when scheduling required shutdowns and cutovers.

10.9 ACTIVITY PREPLANNING

In order to ensure that employees have the necessary information, materials and equipment, and tools and production equipment to perform the work, XYZ Electric will preplan its construction activities. Preplanning is the responsibility of the foreman and performed with the assistance of the employee(s) who will be assigned to perform the work. Preplans will be documented by the foreman and distributed as required.

10.10 SAFETY & ACCIDENT PREVENTION

Safety and accident prevention is synonymous with quality at the site. XYZ Electric is dedicated to providing a safe work environment for employees. The project manager is responsible for safety and accident programs at the construction site. These programs include regular review of construction means and methods for safety, inspection of the condition of tools and production equipment, and the scheduling of regular safety meetings and training. XYZ Electric believes that safety and accident prevention is everyone's responsibility.

10.11 AS-BUILT CONSTRUCTION DOCUMENTS

As-built construction documents will be maintained throughout construction at the site. At the end of the project, these as-built construction documents will be provided to the customer in accordance with the contract documents.

11 INSPECTION, TESTING, & STARTUP

11.1 PROCESS SCOPE & OBJECTIVES

This process involves the inspection, testing, and startup of materials, equipment, and the systems that they comprise. The objective of this process is to ensure that materials and equipment are supplied and installed in accordance with the technical specifications and systems operate as required.

11.2 VERIFYING CONTRACT COMPLIANCE

11.2.1 Verification Processes

The following three processes are used for verifying contract compliance:

- Work-In-Process Inspection & Testing
- Final Inspection & Testing
- Third-Party Inspection & Testing

11.2.2 Work-In-Process Inspection & Testing

Ongoing inspection and testing of work in process is carried out throughout construction in accordance with manufacturer recommendations, specified requirements, and XYZ Electric's quality assurance procedures. Records are kept of all work-in-process inspection and testing.

11.2.3 Final Inspection & Testing

XYZ Electric performs final inspection and testing on all completed work in accordance with manufacturer recommendations, specified requirements, and XYZ Electric's quality assurance procedures prior to turning the completed work over to the owner. Records are kept of all final inspection and testing.

11.2.4 Third-Party Inspection & Testing

XYZ Electric assists third parties such as the owner, owner's representative, architect and/or engineer, manufacturer, code officials, or others in the performance of required inspection and testing of work in process and completed work. Records are kept of all third-party inspections and testing.

11.3 CORRECTION OF NONCONFORMING WORK

Nonconforming material, equipment, and work in place will be corrected in one of the following three ways:

- Reworked or modified in order to meet specified requirements.
- Accepted with or without rework or modification by the owner, owner's representative, architect and/or engineer, or other authorized entity.
- Removed and replaced in total.

When nonconforming material, equipment, or work in place is accepted as is, XYZ Electric will document the nonconformance and the fact that it has been accepted. Reworked, modified, or replaced material, equipment, or work in place must be inspected and tested in accordance with manufacturer recommendations, the technical specifications, and XYZ Electric's quality assurance procedures.

11.4 STARTUP & TESTING PROCEDURES

Startup and testing procedures for materials, equipment, and the systems they comprise will be performed in accordance with manufacturer recommendations, the technical specifications, and XYZ Electric's quality assurance procedures. A

manufacturer's representative will be brought to the site to inspect the installation, perform final adjustments, perform required tests, and/or startup the equipment or system when required by contract, for technical reasons, or for warranty compliance.

11.5 INSPECTION & TEST RECORDS

All inspection and test records will be maintained by XYZ Electric along with records of any corrective action taken. Copies of the inspection and test records will be provided to the owner, owner's representative, or architect and/or engineer in accordance with the contract documents.

11.6 WARRANTIES & GUARANTEES

XYZ Electric will ensure that all requirements to put warranties and guarantees in force are met. Copies of all warranties and guarantees will be provided to the owner in accordance with the contract documents.

12 ANSI/ASQC Q9001 CROSS REFERENCE

The following table provides a cross reference between ANSI/ASQC Q9001 and XYZ Electric's quality assurance program.

ANSI/ASQC STANDARD Q9001-1994		QA PROGRAM REFERENCE SECTION
SECTION	**SECTION TITLE**	
4.1	Management Responsibility	2
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4.17	Internal Quality Audits	2.4 & 11.2
4.18	Training	10.5
4.19	Servicing	11.6
4.20	Statistical Techniques	N/A

CHAPTER 5
WRITING THE QA MANUAL: ANSI/ASQC Q9002 VERSION

A. INTRODUCTION

Chapter 4 provided a sample quality assurance manual based on ANSI/ASQC Standard Q9001 which included the quality-system requirements for design control. This chapter provides a sample quality assurance manual based on ANSI/ASQC Standard Q9002 which does not include design as discussed in Chapter 2. The sample manual is for a fictitious outside electrical construction firm named Utility Construction, Inc. In order to expedite the development of a quality assurance manual, a diskette is provided with this guide that contains the sample quality assurance manual text files.

B. USING THE SAMPLE QUALITY ASSURANCE MANUAL

The sample quality assurance manual is provided to assist the electrical contractor in developing an effective quality assurance program. The sample quality assurance manual should not be used without customization by the electrical construction firm. Every electrical construction firm is different and every quality assurance program will also be different. Therefore, the electrical contractor must develop a quality assurance program that reflects the unique aspects of the firm, market, and internal processes as described in Chapter 3.

UTILITY CONSTRUCTION, INC.

QUALITY ASSURANCE PROGRAM

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OUR COMMITMENT TO OUR CUSTOMERS ...

Utility Construction, Inc. is committed to quality. This document details Utility Construction's commitment to quality through our quality assurance program. The purpose of our quality assurance program is to ensure that our customer's needs are met the first time and every time. Our quality assurance program provides the framework that guarantees continuous improvement of our construction services, quality in our completed work, and customer satisfaction.

We recognize that our customers and our ability to meet their needs are the sole reason for Utility Construction's existence. Our customers rely on our expertise in electrical construction to provide them with safe, reliable, and efficient power and communications systems. Utility Construction does not rely on chance to provide our customers with the quality they need and deserve. All of our employees understand Utility Construction's customer focus and commitment to quality.

John E. Doe
President
April 15, 19XX

QUALITY ASSURANCE PROGRAM
VERSION 1.0 REVISIONS

DATE	PAGE		COMMENTS	APPROVED (NAME/DATE)
	NO.	REV.		

NOTICE

Photocopies of this manual are not controlled. Photocopied manuals may not contain the latest revisions of Utility Construction's quality assurance program and be obsolete. Please request a current copy of this manual from the Corporate Quality Officer before providing this manual to customers or employees.

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9.11 As-Built Construction Documents

10 Inspection, Testing, & Startup

10.1 Process Scope & Objectives
10.2 Verifying Contract Compliance
10.2.1 Verification Processes
10.2.2 Work-In-Process Inspection & Testing
10.2.3 Final Inspection & Testing
10.2.4 Third Party Inspection & Testing
10.3 Correction Of Nonconforming Work
10.4 Start Up & Testing Procedures
10.5 Inspection & Test Records
10.6 Warranties & Guarantees

11 ANSI/ASQC Q9002 Cross Reference

1 CORPORATE PROFILE

1.1 CORPORATE STRUCTURE

Utility Construction is incorporated in accordance with the laws of Anystate.

1.2 MARKET SERVED

Utility Construction serves commercial, industrial, and utility customers in the metropolitan area of Anytown.

1.3 MISSION STATEMENT

Utility Construction's mission statement is as follows:

> *Utility Construction and its employees are committed to becoming recognized by our customers as the best provider of electrical construction and maintenance services in this region.*

Utility Construction's mission statement is implemented through our strategic planning process.

1.4 STRATEGIC PLANNING PROCESS

Utility Construction developed a comprehensive strategic plan in 19XX. The objective of this strategic plan was to provide a structured program that will lead to the realization of our corporate goal as articulated in our mission statement.

Utility Construction works toward its corporate mission through the achievement of defined and measurable corporate objectives. Utility Construction uses a rolling five-year planning horizon in its strategic planning process. The strategic plan is reviewed, evaluated, and updated annually by Utility Construction's management team in October of each year. Utility Construction's Board Of Directors reviews and approves the

updated strategic plan for the following year at its December meeting. Those portions of the strategic plan that affect everyday operations and departmental policies and procedures are reviewed with employees at the annual January employee meeting.

2 CORPORATE COMMITMENT TO QUALITY

2.1 QUALITY ASSURANCE PROGRAM

2.1.1 Purpose

The purpose of our quality assurance program is to delineate the structure, responsibilities, procedures, processes, and resources needed to ensure that Utility Construction meets the needs of our customers.

2.1.2 Basis

Our quality assurance program is based on ANSI/ASQC Standard Q9002[1]. A cross reference between our quality assurance program as documented in this manual and ANSI/ASQC Standard Q9002 is provided in Section 11. ANSI/ASQC Standard Q9002 is equivalent to ISO Standard 9002.[2]

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[1]ANSI/ASQC Q9002-1994, *Quality Systems - Model for Quality Assurance In Production, Installation, and Servicing*, American Society for Quality Control, Milwaukee, Wisconsin, 1994.

[2]ISO 9002:1994, *Quality Systems - Model for Quality Assurance in Production, Installation, and Servicing*, International Organization for Standardization, Geneva, Switzerland, 1994.

2.1.3 Definition Of Terms Used

Unless otherwise noted, terms used in this quality assurance manual are defined in accordance with ANSI/ISO/ASQC Standard A8402[3].

2.1.4 Distribution

A copy of this manual is provided to all Utility Construction's employees at the time of their quality assurance training. These manuals are registered to the individual employee. A copy of the this manual is also available in the Utility Construction job trailer at each construction site for field employee reference.

2.1.5 Training

All Utility Construction employees received training in the quality assurance program within three months of its acceptance by the Board of Directors on August 15, 19XX. Every new employee who has joined Utility Construction since August 15, 19XX has received training in the quality assurance program within one week of his or her employment date.

Employees working with Utility Construction receive training on the specific portions of the quality assurance program that apply directly to their work. Training of employees is carried out at the job site by the project manager or the project's designated trainer. Training of employees working in Utility Construction's home office is performed by the employee's department head or the department's designated trainer.

A record of all formal training is kept in the employee's personnel file.

2.1.6 Revisions And Updates

Revisions and updates to Utility Construction's quality assurance program are issued to all registered holders of the this manual. All registered holders of this manual are

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[3]ANSI/ISO/ASQC A8402-1994, *Quality Management And Quality Assurance - Vocabulary*, American Society for Quality Control, Milwaukee, Wisconsin, 1994.

responsible for updating the manual as required. At each job site, the project superintendent is responsible for maintaining and updating the manual as required. Periodic checks of the quality assurance manuals are made by the Corporate Quality Officer to ensure that all revisions and updates have been included.

Employees are responsible for understanding and implementing revisions and updates to the quality assurance program. When there are a number of significant revisions or an overall update of the quality assurance program, each employee is required to attend a formal training session covering the revisions or update. Project and department managers are responsible for disseminating changes and updates that affect employees.

2.2 QUALITY POLICY

2.2.1 Quality Policy Statement

Utility Construction's quality policy is as follows:

> *Perform work to the exact requirements of our customers as defined by the contract documents unless those requirements are changed in accordance with procedures defined in the contract.*

2.2.2 Quality Policy Objective

The objective of Utility Construction's quality policy is to ensure that each employee understands that he or she is responsible for quality and empowered to ensure that customer's needs and expectations, as expressed in the contract documents, are met.

2.2.3 Quality Policy Dissemination

Utility Construction's quality policy is posted in conspicuous places throughout the home office and at all job sites. This policy is reinforced verbally at all company and job site meetings that deal with quality and continuous improvement.

2.3 RESPONSIBILITY FOR CORPORATE QUALITY

2.3.1 Levels Of Responsibility

Utility Construction recognizes its responsibility to customers for providing quality electrical work. Within Utility Construction, there are three levels of responsibility for quality:

- Corporate
- Project
- Individual

2.3.2 Corporate-Level Responsibility

The primary responsibility for quality at Utility Construction is the Quality Steering Committee which consists of the following three members of senior management:

- President
- Senior Vice President
- Vice President Of Operations

The Senior Vice President serves as the Corporate Quality Officer for Utility Construction. The Corporate Quality Officer is responsible for ensuring that the organization adopts and adheres to the quality policy. The Corporate Quality Officer is also responsible for getting feedback from customers and ensuring that Utility Construction is a quality organization committed to customer satisfaction and continuous improvement.

2.3.3 Project-Level Responsibility

Utility Construction's project managers assist the Corporate Quality Officer. Project managers are responsible for overseeing quality in the field and customer satisfaction. Section 10.3 addresses the project manager's responsibility for field quality in greater detail.

2.3.4 Individual Responsibility

The key to the successful implementation of any quality assurance program is the individual employee. The employee performing the work is the only person who can truly control quality during the construction process. Utility Construction empowers employees to control quality through its quality policy and encourages open communications between employees and management about quality improvement.

2.4 MANAGEMENT REVIEW

The Corporate Quality Officer and designated staff conduct regular internal semiannual reviews to ensure that the quality assurance program is being properly and effectively implemented. These management reviews include close scrutiny of the following:

- Oganization structure and its impact on quality.
- Effective implementation of the quality policy.
- Internal evaluation of construction and maintenance services.
- Performance as measured by customer feedback and construction quality.

The management reviews are documented and submitted to the Quality Steering Committee which takes corrective action as necessary. In addition, data and information from previous reviews are used to identify trends and determine if corrective measures are effective.

3 QUALITY SYSTEM

3.1 QUALITY SYSTEM DEFINED

Utility Construction's quality system is outlined in this manual. The quality system defines the organizational structure, responsibilities, procedures, and processes put in place to achieve Utility Construction's quality system objectives.

3.2 QUALITY SYSTEM OBJECTIVES

The objectives of Utility Construction's quality system are fourfold:

- Provide a quality electrical installation that meets the customer's needs and expectations as expressed in the contract documents.
- Avoid rework and delays during construction through early detection and correction of problems.
- Provide a safe and productive work environment for Utility Construction employees.
- Support the achievement of the corporate mission and strategic objectives.

3.3 QUALITY SYSTEM PROCESSES

Utility Construction's quality program consists of the control of the following eight processes:

PROCESS	QA MANUAL SECTION
Contract Document Review	4
Document Control	5
Procurement & Expediting	6
Tool Maintenance & Calibration	7
Materials & Equipment Management	8
Construction Management	9
Inspection, Testing, & Startup	10

The following sections of the manual discuss each of these processes and its control in detail.

4 CONTRACT DOCUMENT REVIEW

4.1 PROCESS SCOPE & OBJECTIVES

This process involves the review of the project contract documents to ensure that these documents accurately define the scope of Utility Construction's work. The objective of this process is to ensure that Utility Construction understands the customer's needs and requirements as expressed in the contract documents and can meet those needs and requirements.

4.2 DOCUMENT REVIEW PROCESS

4.2.1 Bid Documents

The document review process begins with the review of bid documents. These documents define the scope and requirements of the project. The bid documents normally include the following information:

- Invitation To Bid
- Bid Form
- Construction Agreement
- General, Supplemental, & Special Conditions
- Insurance & Bond Requirements
- Work Included & Excluded
- Drawings & Specifications
- Addenda
- Owner Furnished Materials & Equipment
- Project Milestone Dates

4.2.2 Site Visit

A site visit is scheduled with the customer prior to bidding. The purpose of the site visit is for Utility Construction to become familiar with site and its condition. In addition to the physical site, Utility Construction will investigate project logistics and local conditions that may impact the construction process.

4.2.3 Prebid Meeting

Utility Construction will attend any scheduled prebid meetings in order to interact with the customer and clarify the project scope and requirements. Where no formal prebid meeting is scheduled, Utility Construction will contact the customer resolve any questions concerning the project scope and requirements prior to bidding.

4.2.4 Contract Award

Prior to executing the contract, Utility Construction will meet with the customer to review the contract scope and requirements and agree on any administrative procedures not previously addressed. Once an understanding of all outstanding details and questions have been resolved, Utility Construction will execute the contract.

4.2.5 Post-Contract Award

Following contract execution, Utility Construction will start work as directed by the contract. During construction, Utility Construction will keep the customer informed of any problems, delays, or deviations from the specified requirements in accordance with the contract documents.

5 DOCUMENT CONTROL

5.1 PROCESS SCOPE & OBJECTIVES

This process involves the cataloging, filing, and distribution of project documents. The objective of this process is to ensure that information needed to manage and perform the work is readily available to those that need it.

5.2 DOCUMENT CONTROL PROCEDURES

5.2.1 Documents To Be Controlled

All documents that affect project quality are required to be cataloged, filed, and distributed as required. Controlled documents typically include the following:

- Contract formation and maintenance documents that include the construction contract; general, supplemental, and special conditions; addenda, change orders, and field directives; among others.
- Planning and design documents that include design criteria, site information, material and equipment information, calculations, drawings, specifications, among others.
- Procurement and expediting documents that include quotations, agreements and purchase orders, shipping and receiving records, test and inspection documentation, warranties and guarantees, among others.
- Tool and equipment maintenance and calibration procedures and records.
- Material and equipment shop drawings and catalog cuts along with review and approval documents.
- All correspondence, memoranda, meeting minutes, requests for information, schedules, and budgets relating to the construction process.

5.2.2 Responsibility For Document Control

The project manager is responsible for project document control.

5.2.3 Document Control System

All documents received are stamped with the date of receipt. All internally generated documents are dated and marked with the name or initials of the originator. A central project file is established at the beginning of the project and maintained throughout the project. Where appropriate, a document log is kept for particular classes of documents.

DESIGN MANAGEMENT

Note: ANSI/ASQC Standard Q9002 does not address quality-system requirements for design control. Refer to Part 6 of the example quality assurance manual contained in Chapter 6 of this ***manual*** *if the electrical construction firm is required to provide design services as part of its contract scope of work.*

6 PROCUREMENT & EXPEDITING

6.1 PROCESS SCOPE & OBJECTIVES

This process involves the procurement of materials and equipment for incorporation into the work by Utility Construction. In addition, this process involves procuring the services of qualified specialty subcontractors to assist Utility Construction in performing the work.

6.2 SUPPLIER AND SUBCONTRACTOR ASSESSMENT

6.2.1 Materials & Equipment

Only those suppliers of materials and equipment that are acceptable to the customer as defined in the contract documents are considered. Acceptable suppliers are then assessed by Utility Construction based on past experience, commitment to quality and customer satisfaction, ability to meet the construction schedule, material and equipment installation characteristics, and after-sale service and support.

6.2.2 Subcontractors

Specialty subcontractors are assessed by Utility Construction based on expertise, past experience, commitment to quality and customer satisfaction, and ability to meet the construction schedule.

6.3 REQUESTS FOR QUOTATION

Only those suppliers and subcontractors approved by Utility Construction are asked to submit a quotation. Requests for quotation sent to suppliers and subcontractors include Utility Construction's standard agreement as well as a detailed written scope of work. Applicable drawings and specification sections are made available to suppliers and subcontractors to facilitate their quotation preparation. Utility Construction provides suppliers and subcontractors with as much time as possible to prepare complete and accurate quotations.

6.4 PURCHASING POLICIES & PROCEDURES

Utility Construction selects a supplier or subcontractor based on the criteria outlined in the request for quotation. In most cases, Utility Construction selects the successful bidder based on price since the successful supplier or subcontractor is selected from a prequalified pool of equal bidders. Following selection and prior to contract execution, Utility Construction reviews the successful bidder's quotation for completeness and accuracy and then meets with the successful bidder to review the scope of work, technical requirements, inspection and testing requirements, submittal requirements, and construction schedule. Once an agreement is reached on all technical and administrative issues, the contract is executed.

6.5 SUBMITTALS

Shop drawings, catalog cuts, and test and inspection data required to be submitted to the customer for approval by Utility Construction will be thoroughly reviewed for completeness and technical requirements prior to submission. Utility Construction will stamp each submittal as having been reviewed along with the reviewer's name and

date of review. The goal of this procedure is to avoid delays due to inadequate or erroneous submittals.

6.6 OWNER-FURNISHED MATERIALS & EQUIPMENT

Utility Construction will work with the owner to ensure that owner-furnished materials and equipment meet the technical requirements of the project. In addition, Utility Construction will provide the owner with schedule milestones and information so that the owner-furnished materials and equipment do not delay or otherwise affect the construction process. If the installation of materials and equipment are Utility Construction's responsibility, Utility Construction will inspect the materials and equipment when delivered and properly store them until needed. Records of the receipt and inspection of materials and equipment will be forwarded to the owner.

6.7 IDENTIFICATION & TRACEABILITY

Records will be kept of all materials and equipment incorporated into the work.

7 TOOL & EQUIPMENT MAINTENANCE, CALIBRATION, & TESTING

7.1 PROCESS SCOPE & OBJECTIVES

This process involves the maintenance and calibration of tools and equipment. The objective of this process is to ensure that the employee in the field has the tools and equipment necessary to work effectively, safely, and efficiently.

7.2 SELECTION OF TOOLS & EQUIPMENT

Tools and equipment supplied by Utility Construction will be selected based on their suitability for the work to be performed. Wherever possible, Utility Construction will review tool and equipment selection both before and during the performance of the work to ensure that the proper selection has been made. In addition, Utility

Construction will provide sufficient quantities of tools and equipment to allow employees to work productively.

7.3 TRANSPORTATION & STORAGE OF TOOLS & EQUIPMENT

Tools and equipment will be transported and stored in such a way that they will be protected from damage and deterioration.

7.4 CALIBRATION AND TESTING OF TOOLS & EQUIPMENT

Tools and equipment requiring calibration and/or testing will be calibrated and/or tested at regular intervals or just prior to use. The calibration will be carried out by qualified technicians in a controlled environment in accordance with manufacturer recommendations. Testing will be performed in accordance with manufacturer recommendations. Records of tool and equipment calibration and testing will be kept and a stamp indicating the tool or equipment's calibration and/or test status will be attached.

7.5 REPAIR OF TOOLS & EQUIPMENT

When tools and equipment require repair they will be marked or tagged as soon as the damage or defect is detected to avoid accidental use. Repairs will be carried out in accordance with manufacturer recommendations and instructions by qualified technicians in a controlled environment. Following repair, the tools and equipment will be calibrated and tested as described in paragraph 7.4. Records of all tool and equipment repairs will be kept.

7.6 OPERATING INSTRUCTIONS & PROCEDURES

Operating instructions and procedures will be available with the tool or equipment or maintained on file at the project site for employee reference and use.

7.7 OPERATOR TRAINING & CERTIFICATION

When tools and equipment require training for proper use, Utility Construction will provide training for employees by qualified instructors. Records of all formal training will be kept. If employee certification is required, Utility Construction will ensure that the employee is certified prior to using the tool or equipment.

8 MATERIALS & INSTALLED EQUIPMENT MANAGEMENT

8.1 PROCESS SCOPE & OBJECTIVES

This process involves managing materials and equipment from the time they are delivered to the site until they are incorporated in the work. The objective of this process is to ensure that the right materials and equipment are delivered and that they are protected from damage and deterioration until they are installed.

8.2 RECEIVING & INSPECTION

At the time of delivery, all materials and equipment are inspected to ensure that they are what was ordered, they are intact and were not damaged during shipment, and that the proper quantity was delivered. Only after a successful inspection are materials and equipment accepted. If a problem is encountered during inspection, the materials and equipment are either rejected or corrective action is worked out with the supplier prior to acceptance. A record is kept of all material and equipment receipts and inspections.

8.3 STORAGE & PROTECTION

Material and equipment delivered prior to when it is needed will be properly stored and protected to prevent damage or deterioration.

8.4 INVENTORY CONTROL PROCEDURES

For bulk materials, Utility Construction will establish inventory control procedures to ensure that the correct materials and equipment are used where required.

8.5 MATERIAL & EQUIPMENT DOCUMENTATION

Documentation such as installation instructions, testing and startup procedures, and operation and maintenance manuals will be cataloged and filed. This documentation will be provided to the owner in accordance with the contract documents.

9 CONSTRUCTION MANAGEMENT

9.1 PROCESS SCOPE & OBJECTIVES

This process involves the installation of materials, equipment, and systems at the site. The objective of this process is to ensure that the work is completed efficiently and in accordance with the construction documents.

9.2 FIELD QUALITY DEFINED

Quality in the field is defined as meeting the customer's needs and requirements as stated in the construction documents.

9.3 RESPONSIBILITY FOR FIELD QUALITY

The project manager is ultimately responsible for quality in the field. However, Utility Construction believes that quality cannot be controlled and must be built into the project by the employee performing the work. Therefore, field quality is everyone's responsibility.

9.4 ORGANIZATION FOR FIELD QUALITY

The project manager is responsible for organizing for field quality and documenting responsibilities. The project organization and delegation of authority and responsibility for quality will vary from project to project depending on the project's complexity and size.

9.5 WORK FORCE QUALIFICATIONS & TRAINING

Utility Construction employs only the best employees with the training, skills, and experience necessary to perform the work assigned. Each employee is responsible for the quality of his or her own work.

9.6 INTERFACE WITH OTHER PROJECT PARTICIPANTS

Utility Construction will plan and coordinate its work with other project participants as required.

9.7 CONSTRUCTION MEANS & METHODS

Utility Construction will use construction means and methods that are appropriate for the project. The means and methods will be reviewed with the employee(s) performing the work prior to implementation.

9.8 PROJECT PLANNING & SCHEDULING

Utility Construction will plan and schedule work within the framework of the customer's schedule and the contract requirements. Utility Construction will work closely with the customer and other affected parties when scheduling required shutdowns and cutovers.

9.9 ACTIVITY PREPLANNING

In order to ensure that employees have the necessary information, materials and equipment, and tools and production equipment to perform the work, Utility

Construction will preplan its construction activities. Preplanning is the responsibility of the foreman and performed with the assistance of the employee(s) who will be assigned to perform the work. Preplans will be documented by the foreman and distributed as required.

9.10 SAFETY & ACCIDENT PREVENTION

Safety and accident prevention is synonymous with quality at the site. Utility Construction is dedicated to providing a safe work environment for employees. The project manager is responsible for safety and accident programs at the construction site. These programs include regular review of construction means and methods for safety, inspection of the condition of tools and production equipment, and the scheduling of regular safety meetings and training. Utility Construction believes that safety and accident prevention is everyone's responsibility.

9.11 AS-BUILT CONSTRUCTION DOCUMENTS

As-built construction documents will be maintained throughout construction at the site. At the end of the project, these as-built construction documents will be provided to the customer in accordance with the contract documents.

10 INSPECTION, TESTING, & STARTUP

10.1 PROCESS SCOPE & OBJECTIVES

This process involves the inspection, testing, and startup of materials, equipment, and the systems that they comprise. The objective of this process is to ensure that materials and equipment are supplied and installed in accordance with the technical specifications and systems operate as required.

10.2 VERIFYING CONTRACT COMPLIANCE

10.2.1 Verification Processes

The following three processes are used for verifying contract compliance:

- Work-In-Process Inspection & Testing
- Final Inspection & Testing
- Third-Party Inspection & Testing

10.2.2 Work-In-Process Inspection & Testing

Ongoing inspection and testing of work in process is carried out throughout construction in accordance with manufacturer recommendations, specified requirements, and Utility Construction's quality assurance procedures. Records are kept of all work-in-process inspection and testing.

10.2.3 Final Inspection & Testing

Utility Construction performs final inspection and testing on all completed work in accordance with manufacturer recommendations, specified requirements, and Utility Construction's quality assurance procedures prior to turning the completed work over to the owner. Records are kept of all final inspection and testing.

10.2.4 Third-Party Inspection & Testing

Utility Construction assists third parties such as the owner, owner's representative, engineer, manufacturer, code officials, or others in the performance of required inspection and testing of work in process and completed work. Records are kept of all third-party inspections and testing.

10.3 CORRECTION OF NONCONFORMING WORK

Nonconforming material, equipment, and work in place will be corrected in one of the following three ways:

- Reworked or modified in order to meet specified requirements.
- Accepted with or without rework or modification by the owner, owner's representative, architect and/or engineer, or other authorized entity.
- Removed and replaced in total.

When nonconforming material, equipment, or work in place is accepted as is, Utility Construction will document the nonconformance and the fact that it has been accepted. Reworked, modified, or replaced material, equipment, or work in place must be inspected and tested in accordance with manufacturer recommendations, the technical specifications, and Utility Construction's quality assurance procedures.

10.4 STARTUP & TESTING PROCEDURES

Startup and testing procedures for materials, equipment, and the systems they comprise will be performed in accordance with manufacturer recommendations, the technical specifications, and Utility Construction's quality assurance procedures. A manufacturer's representative will be brought to the site to inspect the installation, perform final adjustments, perform required tests, and/or startup the equipment or system when required by contract, for technical reasons, or for warranty compliance.

10.5 INSPECTION & TEST RECORDS

All inspection and test records will be maintained by Utility Construction along with records of any corrective action taken. Copies of the inspection and test records will be provided to the owner, owner's representative, or engineer in accordance with the contract documents.

10.6 WARRANTIES & GUARANTEES

Utility Construction will ensure that all requirements to put warranties and guarantees in force are met. Copies of all warranties and guarantees will be provided to the owner in accordance with the contract documents.

11 ANSI/ASQC STANDARD Q9002 CROSS REFERENCE

The following table provides a cross reference between ANSI/ASQC Standard Q9002 and Utility Construction's quality assurance program:

ANSI/ASQC STANDARD Q9002-1994		QA PROGRAM REFERENCE SECTION
SECTION	**SECTION TITLE**	
4.1	Management Responsibility	2
4.2	Quality System	3
4.3	Contract Review	4
4.4	Design Control	N/A
4.5	Document And Data Control	5
4.6	Purchasing	6
4.7	Control Of Customer-Supplied Product	6.6
4.8	Product Identification And Traceability	6.7
4.9	Process Control	9
4.10	Inspection And Testing	10
4.11	Control Of Inspection, Measuring, And Test Equipment	7
4.12	Inspection And Test Status	10
4.13	Control Of Nonconforming Product	10.3
4.14	Corrective And Preventive Action	10.3
4.15	Handling, Storage, Packaging, Preservation, And Delivery	8
4.16	Control Of Quality Records	8.5 & 10.5
4.17	Internal Quality Audits	2.4 & 10.2
4.18	Training	9.5
4.19	Servicing	10.6
4.20	Statistical Techniques	N/A

CHAPTER 6
INSTALLATION, INSPECTION, & TESTING PROCEDURES

A. INTRODUCTION

Establishment and documentation of procedures was Step 5 in the development of an effective quality assurance program in Chapter 3. These documented procedures should be developed by the electrical contracting firm for both its business and production processes. These documented procedures form the basis of a procedures manual that supports the electrical contractor's quality assurance program.

The inside and outside electrical contractor's quality assurance procedures were referenced throughout the sample quality assurance manuals contained in Chapters 4 and 5. These procedures support and are an integral part of the electrical contractor's quality assurance program. The goal of these procedures is to minimize variance in the completed work that will result in higher quality, reduced rework, and improved productivity.

This chapter addresses the documentation of the electrical contractor's production processes which directly affect the quality of work in place and can benefit most from standardization. Business processes are also very important and should also be documented but these processes are unique to each electrical contracting firm and depend greatly on the organizational structure, size of firm, market served, and personalities involved. This chapter focuses on the installation, inspection, and testing procedures that directly affect the quality of work in the field which is what the customer is most interested in. In particular, this chapter answers the following questions:

- Why document production procedures?
- What should production procedures be based on?
- How should production procedures be documented?
- How should documented production procedures be used?

Chapter 7 provides sample quality assurance forms, tags, checklists, and records. These standard forms can be used by the electrical contractor to document the completion and results of installation, inspection, and testing procedures in the field.

B. WHY DOCUMENT PRODUCTION PROCEDURES?

Procedures for the installation, inspection, and testing of materials, equipment, and systems must be developed in order to ensure that the completed work meets the customer's technical requirements as expressed in the contract documents. Documented procedures support the quality assurance program by providing employees with detailed information on how work should be carried out. By documenting these procedures, the electrical contractor ensures that installation, inspection, and testing is carried out consistently throughout each project. In addition, having written procedures allows the electric contractor to compare his or her procedures with those required by the project technical specifications or the manufacturer's requirements to ensure contract compliance.

Documented procedures support the quality assurance program by providing employees with detailed information on how work should be carried out.

C. WHAT SHOULD PRODUCTION PROCEDURES BE BASED ON?

The electrical contractor's documented production procedures should be based on the following:

- Project Technical Specifications
- Design & Installation Codes & Regulations
- Industry Standards & Recommended Practices
- Third-Party Listing & Labeling
- Manufacturer's Instructions & Recommendations
- Industry Custom & Practice

The following paragraphs discuss each of these as a basis for preparing installation, inspection, and testing procedures.

1. PROJECT TECHNICAL SPECIFICATIONS

The project technical specifications along with the general, supplemental, and special conditions; drawings; and other documents referenced in the agreement between the electrical contractor and customer are part of the contract documents. These contract documents establish the customer's requirements for the project which objectively define quality as discussed in Chapter 1. Therefore, the contract documents define the minimum installation, inspection, and testing requirements that the electrical contractor must meet unless more stringent requirements are imposed by local, state or province, or national government. The more stringent of the two sets of requirements, which will usually be the project technical specifications, should establish the minimum installation, inspection, and testing requirements that must be met by the electrical contractor.

2. DESIGN & INSTALLATION CODES & REGULATIONS

Design and installation codes and regulations establish the minimum legal standard for electrical installations. These codes and regulations are normally adopted by the local, state or province, or national government that has jurisdiction over the project being built. In North America, these codes and regulations include the following:

- *National Electrical Code* (NEC)
  (NFPA 70)

- *National Electrical Safety Code* (NESC)
  (ANSI/IEEE C2)

- *Canadian Electrical Code* (CEC)
  Part I - Safety Standard For Electrical Installations
  (CSA C22.1)

- *Canadian Electrical Code* (CEC)
  Part II - General Requirements
  (CSA C22.2)

- *Canadian Electrical Code* (CEC)
  Part III - Outside Wiring
  (CSA C22.3)

- *Occupational Health & Safety Act* (OSHA)
  (29 CFR 1910, Subpart S, Electrical)

When applying design and installation codes and regulations, it is important that the correct edition of the particular code or regulation is used. In the United States, the latest edition of the NEC is not in force until it is adopted

by the governmental body that controls the project. In addition, many localities adopt the NEC with modifications, use only selected parts, or have a local code of their own such as New York, Chicago, and Los Angeles which is based on the NEC. Similarly, Quebec also has its own electrical code which is the CEC with amendments. The electrical contractor must make sure that documented installation, inspection, and testing procedures are in conformance with local codes and regulations.

3. INDUSTRY STANDARDS & RECOMMENDED PRACTICES

Industry standards and recommended practices that specify installation, inspection, and testing procedures are normally not adopted by governmental bodies but adherence may be required by the project technical specifications. When industry standards and recommended practices are referenced in the technical specifications, the electrical contractor should obtain a copy of the document and adhere to any installation, inspection, or testing procedure specified.

In the United States, the latest edition of the NEC is not in force until it is adopted by the governmental body that controls the project.

Industry standards and recommended practices that are frequently encountered in North American electrical construction are promulgated by the following groups:

- American National Standards Institute (ANSI)
- Canadian Standards Association (CSA)
- Certified Ballast Manufacturers Association (CBMA)
- Factory Mutual (FM)
- Illuminating Engineers Society of North America (IES)
- Institute of Electrical and Electronics Engineers (IEEE)
- Insulated Cable Engineers Association (ICEA)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)

Most developed countries have their own industry standards and recommended practices. When working internationally, the electrical contractor needs to be aware of and adhere to the host country's industry standards and recommended practices. Knowledge of manufacturing standards and practices is also important when importing electrical materials and equipment for use in domestic construction to ensure safety, compatibility, and performance.

With the globalization of electrical material and equipment markets, many countries and manufacturing organizations are either adopting the International Electrotechnical Commission (IEC) standards and recommended practices or bringing their own standards and practices in line with the IEC's. The IEC along with the International Organization for Standardization (ISO) are the world leaders in voluntary consensus international standards. Currently, the IEEE, NEMA, and CSA are all working with IEC and each other to cross list and reference standards.

4. THIRD-PARTY LISTING & LABELING

North American third-party testing organizations include the following:

- Underwriters Laboratories, Inc. (UL)
- Electrical Testing Laboratories, Inc. (ETL)
- Canadian Standards Association (CSA)

These third-party testing organizations test electrical materials and equipment to ensure that it is safe for a particular application. If the materials and equipment pass the stringent testing requirements, the materials and equipment are listed and labeled accordingly. This independent third-party testing has the advantage of eliminating the need for on-site inspection and testing of materials and equipment unless there is evidence of damage or that modifications have been made.

This independent third-party testing has the advantage of eliminating the need for on-site inspection and testing of materials and equipment unless there is evidence of damage or that modifications have been made.

For example, the NEC, Section 110-2, allows only materials and equipment that are approved to be used in building construction. "Approved" is defined in the NEC, Article 100, as acceptable to the authority having jurisdiction which is usually the local code inspector. Approval by the inspector is usually based on the listing and/or labeling of the material or equipment by an independent third-party testing organization such as UL or ETL.

If approval of a material or equipment is based on third-party testing, then the electrical contractor should be aware of the test methods and procedures in order to properly install the material or equipment. For example, the NEC, Paragraph 110-3(b), specifically requires that listed and labeled materials and equipment be installed in accordance with test methods and procedures as well as any instructions included.

5. MANUFACTURER'S INSTRUCTIONS & RECOMMENDATIONS

When installing materials and equipment, the electrical contractor should always install them in accordance with any instructions or recommendations provided by the manufacturer. Ignoring manufacturer instructions and recommendations may result in reduced performance and life expectancy for

the material or equipment. In addition, manufacturer warranties and guarantees may be voided if instructions and recommendations are not followed.

6. INDUSTRY CUSTOM & PRACTICE

Industry custom and practice varies throughout North America. Industry custom and practice is usually defined by accepted design and installation methods for similar types of electrical construction in a particular area. In addition, sophisticated owners may also have specific requirements that need to be addressed. When working in a particular area, the electrical contractor must be familiar with local customs and practices regarding the installation of electrical materials and equipment.

Many commercial and industrial project technical specifications require that the materials and equipment be installed in a "neat and workmanlike manner." This requirement can either be explicitly stated in the project technical specifications or be an implicit requirement by requiring that installation be in accordance with the NEC.[18] In either case, NECA publishes the *NECA Standard of Installation*[19] which defines the phrase "neat and workmanlike" to avoid misunderstandings and confusion.

Industry custom and practice is usually defined by accepted design and installation methods for similar types of electrical construction in a particular area.

D. HOW SHOULD PRODUCTION PROCEDURES BE DOCUMENTED?

Procedures should be documented as simply and as concisely as possible. The goal is to communicate the required procedures to those who have to perform them as effectively as possible. Written procedures are of course the standard method of communicating the required information. However, where more effective means are available they should be used. Flow charts, diagrams, photographs, and other graphic methods should be used wherever possible to supplement or even replace written procedures. Videotapes illustrating installation, inspection, and testing procedures could also be used as well as computer simulation and animation if these mediums would more effectively communicate the procedure.

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[18] *National Electrical Code*, National Fire Protection Association, ANSI/NFPA 70, 1993 Edition, Quincy, Massachusetts, 1992, Section 110-12.

[19] *NECA Standard Of Installation*, National Electrical Contractors Association, Bethesda, Maryland.

E. HOW SHOULD DOCUMENTED PRODUCTION PROCEDURES BE USED?

Documented installation, inspection, and testing procedures should be dynamic. One of the purposes of documenting these procedures is to provide a baseline for continuous improvement of construction processes. As new and better ways of performing the work are identified and adopted, the documented procedures should be reviewed and updated to reflect the current state of the art in electrical construction.

CHAPTER 7
QA FORMS, TAGS, CHECKLISTS, & RECORDS

A. INTRODUCTION

This chapter provides sample quality assurance forms, tags, checklists, and records. The purpose of these is to facilitate the documentation of installation, inspection, and testing procedures in the field. Documentation of the completion and results of construction processes is a necessary part of any quality assurance program. Chapter 2 stated that documentation is required for compliance with the ANSI/ASQC Q9000 series of quality management and assurance standards. References to documentation that could be achieved using forms, tags, checklists, and records are also contained throughout the sample quality assurance manuals in Chapters 4 and 5.

B. USE OF FORMS, TAGS, CHECKLISTS, & RECORDS

Standard forms, tags, checklists, and records assist the electrical construction firm in meeting the documentation requirements of its quality assurance program. These standard documents save time in the field and help project personnel provide the data and information about construction operations in a consistent format. Properly maintained and filed, this information can be available for use internally or for meeting the customer's reporting requirements. Internally, this data and information can be very valuable when used to solve project problems or as a feedback mechanism for continuous improvement of the firm's construction operations.

The sample documents contained in this chapter are provided as a starting point for the development of customized forms, tags, checklists, and records. Using these sample documents, customized versions can be developed to meet the unique needs of the firm's quality assurance program as well as the informational requirements of its customers. To assist in the customization process, a diskette containing the text files for these sample documents is provided with this guide.

C. SAMPLE FORMS

Forms are usually developed and used to provide an outline for recording information efficiently in a consistent format. Information recorded can either be a historical record of what has happened on a project or a plan for what is ahead. The following sample forms are provided in this section:

FORM TITLE	PAGE NUMBER
Daily Work Report	123
Activity Preplan	124
Letter of Transmittal	125
Material/Equipment Procurement Log	126
Request For Information	127
Record of Information Received	128

DAILY WORK REPORT

PROJECT:			
PROJECT NO.		REPORT BY	
DAY		DATE	

DAILY EMPLOYEE REPORT			
CARRY OVER	NEW HIRES	LAID OFF	TOTAL WORKING

WORK PERFORMED TODAY:

INSPECTIONS/VISITS TODAY:

DELAYS/PROBLEMS	YES	NO	EXPLANATION
WAITING FOR MATERIALS			
WAITING FOR TOOLS OR EQUIPMENT			
TOOL AND/OR EQUIPMENT BREAKDOWN			
PROJECT/ACTIVITY DELAY			
CHANGES AND/OR REWORK			
WORK ACCESS PROBLEM			
DISRUPTION			
WAITING FOR INFORMATION			
WAITING FOR INSPECTION			
OTHER			

OTHER:

ACTIVITY PREPLAN

PROJECT:			
PROJECT NO.		PLAN BY	
ACTIVITY DESCRIPTION:			
FOREMAN		PLAN DATE	
SCHEDULED START	DATE:	EXPECTED FINISH	DATE:
	TIME:		TIME:
CREW:			
DRAWING/SPECIFICATION REFERENCES:			

MATERIALS/EQUIPMENT/EXPENDABLES REQUIRED	QUANTITY

TOOLS AND EQUIPMENT NEEDED	QUANTITY

WHEN FINISHED WITH THIS ACTIVITY:

LETTER OF TRANSMITTAL

TO:	DATE:
	PROJECT:
	PROJECT NO.
REGARDING:	

WE ARE SENDING THE FOLLOWING ITEMS:					ATTACHED		SEPARATELY
	DRAWINGS		SHOP DRAWINGS		INFO REQUEST		QUOTE REQUEST
	SPECIFICATIONS		CATALOG CUTS		COPY OF LETTER		PURCHASE ORDER
	RECORD DRAWINGS		SAMPLES		QA INFORMATION		CHANGE ORDER
	O&M MANUALS		GUARANTEES		OTHER:		

DOCUMENT DATE	NUMBER OF COPIES	DESCRIPTION

THESE DOCUMENTS ARE BEING TRANSMITTED:			
	FOR YOUR APPROVAL		APPROVED AS SUBMITTED
	FOR YOUR USE		APPROVED AS NOTED
	AS YOU REQUESTED		RETURNED FOR CORRECTIONS
	FOR YOUR REVIEW AND COMMENT		RESUBMIT ___ COPIES FOR APPROVAL
	DOCUMENTS RETURNED AFTER LOAN TO US		SUBMIT ___ COPIES FOR DISTRIBUTION
	OTHER:		RETURN ___ CORRECTED PRINTS

REMARKS:	
COPIES TO:	SIGNED:

MATERIAL/EQUIPMENT PROCUREMENT LOG

PROJECT:					
PROJECT NO.		PREPARED BY			
SPECIFICATION SECTION	MATERIAL/EQUIPMENT DESCRIPTION	SUBMITTAL SUBMITTED (DATE)	SUBMITTAL APPROVED (DATE)	ORDER PLACED (DATE)	MAT/EQUIP RECEIVED (DATE)

REQUEST FOR INFORMATION

RFI NUMBER:	DATE:
TO:	FROM:
PLEASE RESPOND BY:	
PROJECT:	
DRAWING/DOCUMENT REFERENCE:	
INFORMATION REQUEST:	
RESPONSE:	
RESPONSE BY:	DATE:

RECORD OF INFORMATION RECEIVED

PROJECT:	
DATE/TIME:	
INFORMATION RECEIVED FROM:	
INFORMATION RECEIVED VIA: [MEETING] [LETTER] [PHONE] [FAX] [OTHER]	
SUBJECT:	
DRAWING/DOCUMENT REFERENCE:	
INFORMATION RECEIVED:	
PREPARED BY:	**DATE:**

D. SAMPLE TAGS

Tags are intended to convey the status of design and submittal information and the condition of delivered materials and equipment, work in place, or tools and production equipment. Tags provide information in an abbreviated form so that they can be directly attached to materials and equipment in the field. The following sample tags are provided in this section:

TAG TITLE	PAGE NUMBER
Installation Approved	130
Installation Hold	130
Equipment Out of Calibration	131
Shop Drawing Approved	131

INSTALLATION APPROVED

INSTALLATION HAS BEEN INSPECTED AND TESTED AS REQUIRED AND IS IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS

INSPECTED BY:	DATE:
TESTED BY:	DATE:
APPROVED BY:	DATE:

INSTALLATION HOLD

INSTALLATION IS NOT APPROVED DUE TO:

[ ] INSPECTION RESULTS

[ ] TEST RESULTS

[ ] OTHER:

INSPECTED BY:	DATE:
TESTED BY:	DATE:
HOLD BY:	DATE:

EQUIPMENT OUT OF CALIBRATION

THIS EQUIPMENT IS NOT TO BE USED AND THIS TAG IS NOT TO BE REMOVED UNTIL EQUIPMENT HAS BEEN CALIBRATED

TAGGED BY:	DATE:

SHOP DRAWING APPROVED

THIS SHOP DRAWING HAS BEEN REVIEWED AND IS IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.

REVIEWED BY:	DATE:

E. SAMPLE CHECKLISTS

Checklists provide field personnel with a structured list that can be used to ensure that everything that needed to be done has been done. Checklists also provide consistent requirements for the inspection of work in place. The following sample checklists are provided in this section:

CHECKLIST TITLE	PAGE NUMBER
Raceway Installation Checklist	133
Underground Raceway Installation Checklist	134
Underground Duct Bank Installation Checklist	135
Manhole Installation Checklist (Prior To Concrete Placement)	136
Manhole Installation Checklist (After Concrete Placement & Duct Bank Installation)	137
Cable Installation Checklist	138
Indoor Bus Duct Installation Checklist	139
Outdoor Bus Duct Installation Checklist	140
Grounding System Installation Checklist	141

RACEWAY INSTALLATION CHECKLIST

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Conduit, box, and fitting types and sizes are per the drawings and specifications.	
Conduit and boxes are supported in accordance with the drawings and specifications. Installation is neat and workmanlike.	
Conduits are clean, stub-ups are protected, open ends are plugged, boxes are covered, and box openings are plugged. Any damage during construction has been repaired.	
Bend radii are per drawings and specifications. Bends are free of deformities.	
Expansion joints, conduit seals, and drains are installed in accordance with the drawings and specifications. Conduit seals have been poured and marked.	
Spacing between low-voltage communications, instrumentation, and control conduits and power conduits is maintained per the drawings and specifications. Distance from hot piping and surfaces has been maintained.	
Flexible metal conduit is installed in accordance with the plans and specifications with proper fittings.	
Metallic conduit and boxes are permanently and effectively grounded.	
Conduits and boxes have been marked and tagged in accordance with the plans and specifications.	
As-built drawings and raceway schedules have been completed.	

COMMENTS:

UNDERGROUND RACEWAY INSTALLATION CHECKLIST

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Trenching has been checked for location, elevation, levelness, and debris removal. Stub up dimensions and box locations have been verified and checked.	
Conduit, box, and fitting types and sizes are per the drawings and specifications. Conduit ends are sealed and boxes have been covered.	
Bend radii are per drawings and specifications. Bends are free of deformities.	
Conduit spacing supports, tie downs, and expansion joints are installed in accordance with the drawings and specifications.	
Forming and reinforcing is in accordance with the drawings and specifications where required.	
Concrete coverage is per the drawings and specifications. Spacers and reinforcing steel have not been left exposed. Concrete color has been added where required.	
Installation has been backfilled and compacted in accordance with the drawings and specifications.	
Conduit has been inspected and is free of damage and clear of any stoppages.	
Conduits and boxes have been marked and tagged in accordance with the plans and specifications.	
As-built drawings and raceway schedules have been completed.	

COMMENTS:

UNDERGROUND DUCT BANK INSTALLATION CHECKLIST

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY / DATE
Trenching has been checked for location, elevation, levelness, and debris removal. Manhole and handhole window sizes and locations have been checked. Stub up dimensions and locations have been verified and checked.	
Conduit and fitting types and sizes are per the drawings and specifications. Conduit ends have been sealed.	
Bend radii are per drawings and specifications. Bends are free of deformities.	
Conduit spacers, chairs, tie downs, and expansion joints are installed in accordance with the drawings and specifications.	
Forming and reinforcing is in accordance with the drawings and specifications.	
Concrete coverage is per the drawings and specifications. Spacers, chairs, and reinforcing steel have not been left exposed. Concrete color has been added where required.	
Installation has been backfilled and compacted in accordance with the drawings and specifications.	
Conduit has been inspected and is free of damage and clear of any stoppages.	
Conduits have been marked and tagged in accordance with the plans and specifications.	
As-built drawings and raceway schedules have been completed. Spare conduits have been indicated on the as-built drawings.	

COMMENTS:

MANHOLE INSTALLATION CHECKLIST
(PRIOR TO CONCRETE PLACEMENT)

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Duct bank window sizes and locations are in accordance with the drawings and specifications.	
Forming and reinforcing is in accordance with the drawings and specifications.	
Grounding system is installed in accordance with the plans and specifications.	
Concrete inserts are installed per drawings and specifications and provided with fillers.	
Pulling eyes are in place.	
Concrete has been placed and cured in accordance with the drawings and specifications.	
Installation has been backfilled and compacted in accordance with the drawings and specifications.	
As-built drawings have been completed.	

COMMENTS:

MANHOLE INSTALLATION CHECKLIST
(AFTER CONCRETE & DUCT BANK INSTALLATION)

PROJECT:	**DRAWING NO(S):**
LOCATION:	**SPEC SECTION(S):**

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Conduit entrances are clean and free of concrete.	
Pulling eyes are free of concrete and pulling lines are in place.	
Cable rack, hooks, saddles and tray are installed per drawings and specifications and properly supported. Cable supports have been inspected and are free of sharp edges. Required manhole ladders and/or rungs have been installed.	
All metallic supports and raceways are properly grounded in accordance with the drawings and specifications.	
Cables and conductors on racks and in trays have been properly positioned, spaced, and tied.	
Cable splices have been made in accordance with manufacturer requirements and properly supported. Drain wires on high voltage cable splices have been terminated in accordance with the drawings and specifications.	
Cables have been fireproofed in accordance with the drawings and specifications.	
Manhole convenience outlets, lighting, sump pump and other auxiliary systems have been installed in accordance with the drawings and specifications. Manhole has been cleaned and is free of debris.	
As-built drawings and cable and raceway schedules have been completed.	

COMMENTS:

CABLE INSTALLATION CHECKLIST

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Cable voltage class, insulation type, construction, material, and size are in accordance with the drawings and specifications.	
Cable pulling schedule has been checked for direction and method of pull. Cable pulling compound is in accordance with cable manufacturer recommendations.	
Instrument cable has been checked for continuity and isolation from drain wire on reel in accordance with manufacturer recommendations.	
Metalclad cables have been meggered before installation.	
Cables have been inspected after installation for damage.	
Power and control wire and cable have been meggered after installation and the results documented.	
Instrument cable has been meggered for continuity and isolation from drain and ground after installation and the results documented.	
High voltage shielded cables have been hi-potted following installation and the results documented.	
Cables have been identified and marked in accordance with drawings and specifications.	
As-built drawings and cable and raceway schedules have been completed.	

COMMENTS:

INDOOR BUS DUCT INSTALLATION CHECKLIST

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Bus duct components, fittings, and terminations have been inspected to determine proper type, required quantity, and any damage during shipment.	
Bus duct shipping blocks and supports have been removed.	
Bus duct has been routed and securely supported in accordance with the drawings and specifications.	
All connections have been torqued in accordance with manufacturer recommendations. Where required for aluminum bus, a manufacturer recommended oxide inhibitor has been used on all connections.	
Expansion fittings have been installed where required and in accordance with manufacturer recommendations.	
Completed bus duct installation has been successfully meggered and the results recorded.	
Proper bus phasing has been verified and bus bars identified accordingly.	
As-built drawings for the bus duct installation have been completed.	

COMMENTS:

OUTDOOR BUS DUCT INSTALLATION CHECKLIST

PROJECT:	DRAWING NO(S):
LOCATION:	SPEC SECTION(S):

QUALITY ASSURANCE ACTIVITY	CHK'D BY / DATE
Bus duct components, fittings, and terminations have been inspected to determine proper type, required quantity, and any damage during shipment.	
Bus duct shipping blocks and supports have been removed.	
Bus duct has been routed and securely supported in accordance with the drawings and specifications.	
All connections have been torqued in accordance with manufacturer recommendations. Where required for aluminum bus, a manufacturer recommended oxide inhibitor has been used on all connections.	
Drain holes have been unplugged and gaskets installed where required.	
Expansion fittings have been installed where required and in accordance with manufacturer recommendations.	
Completed bus duct installation has been successfully meggered and the results recorded.	
Proper bus phasing has been verified and bus bars identified accordingly.	
Space heaters and controls have been installed and connected and their operation verified.	
As-built drawings for the bus duct installation have been completed.	

COMMENTS:

GROUNDING SYSTEM INSTALLATION CHECKLIST

PROJECT:	**DRAWING NO(S):**
LOCATION:	**SPEC SECTION(S):**

QUALITY ASSURANCE ACTIVITY	CHK'D BY DATE
Size and type of grounding and bonding conductors are in accordance with the drawings and specifications.	
Grounding electrodes have been installed in accordance with the drawings and specifications.	
Connections to grounding electrodes have been made in accordance with manufacturer recommendations and inspected.	
Grounding conductors have been routed in accordance with the drawings and specifications.	
Grounding conductors been properly terminated at the service equipment or separately derived source. Bonding conductors have been installed as required.	
Resistance of the grounding system has been measured and recorded.	
As-built drawings for the grounding systems have been completed.	

COMMENTS:

F. SAMPLE RECORDS

Records provide a structured format for recording the results of tests carried out on installed materials and equipment. The following sample records are provided in this section:

RECORD TITLE	PAGE NUMBER
Construction Inspection Record	143
Punchlist Correction Record	144
Tool/Equipment Calibration Record	145
Tool/Equipment Maintenance & Repair Record	146
Power/Control Wire & Cable Test Record	147
Instrument Wire & Cable Test Record	148
Electrical Equipment Test Record	149
Medium Voltage Power Cable Test Record High Potential Insulation Test - Leakage Current	150
Medium Voltage Power Cable Test Record Continuity And Megger Tests	151
Dynometer Test Record	152
Ground Resistance Record	153

CONSTRUCTION INSPECTION RECORD

PROJECT:			
AREA:			
INSPECTION PERFORMED BY:			
INSPECTION DATE:			
ITEM NUMBER	**DESCRIPTION OF DISCREPANCY**	**DATE CORRECTED**	**CORRECTED BY**

PUNCHLIST CORRECTION RECORD

PROJECT:			
AREA:			
PUNCHLIST PREPARED BY:			
PUNCHLIST DATE:			
ITEM NUMBER	**DESCRIPTION OF DISCREPANCY**	**DATE CORRECTED**	**CORRECTED BY**

TOOL/EQUIPMENT CALIBRATION RECORD

EQUIPMENT:	
IDENTIFICATION NUMBER:	
MANUFACTURER:	**SERIAL NUMBER:**
CALIBRATION PROCEDURE:	

DATE	CALIBRATION RESULTS	CALIBRATION PERFORMED BY	NEXT SCHEDULED CALIBRATION

TOOL/EQUIPMENT MAINTENANCE & REPAIR RECORD

EQUIPMENT:	
IDENTIFICATION NUMBER:	
MANUFACTURER:	SERIAL NUMBER:

DATE	WORK PERFORMED	WORK PERFORMED BY

POWER/CONTROL WIRE & CABLE TEST RECORD

DESCRIPTION:

TEST DESCRIPTION:

CIRCUIT NUMBER	WIRE TAG	WIRE				READING (MEGOHMS)	CHECKED BY
		VOLTAGE	SIZE	FROM	TO		

INSTRUMENT WIRE & CABLE TEST RECORD

DESCRIPTION:

TEST DESCRIPTION:

CABLE NUMBER	CABLE TYPE	READINGS				CHECKED BY
		CONDUCTOR TO CONDUCTOR (MEGOHMS)	CONDUCTOR TO SHIELD (MEGOHMS)	SHIELD TO CONDUIT (MEGOHMS)	OTHER TEST (MEGOHMS)	

ELECTRICAL EQUIPMENT TEST RECORD

DESCRIPTION:

TEST DESCRIPTION:

EQUIPMENT TAG NUMBER	READINGS (OHMS)						CHECKED BY
	A to G	B to G	C to G	A to B	B to C	C to A	

MEDIUM VOLTAGE POWER CABLE TEST RECORD
HIGH POTENTIAL INSULATION TEST - LEAKAGE CURRENT

PROJECT:	DATE:
TESTED BY:	TEMPERATURE:
WITNESSED BY:	HUMIDITY:
TEST EQUIPMENT:	
TEST VOLTAGE:	

CIRCUIT		CABLE	
LOCATION		CABLE CONSTRUCTION	
IDENTIFICATION		CONDUCTOR SIZE	
LENGTH		CONDUCTOR MATERIAL	
RACEWAY TYPE		INSULATION RATING	
TERMINATION TYPE		INSULATION TYPE	
SPLICES		MANUFACTURER	

TEST DATA - MICROAMPERES			
PERCENT TEST VOLTS	PHASE A START TIME CURRENT	PHASE B START TIME CURRENT	PHASE C START TIME CURRENT
10 PCT			
20 PCT			
30 PCT			
40 PCT			
50 PCT			
60 PCT			
70 PCT			
80 PCT			
90 PCT			
100 PCT			
TIME IN SECONDS AFTER REACHING 100% TEST VOLTAGE & HOLDING CONSTANT			
30 SEC			
60 SEC			
90 SEC			
120 SEC			
180 SEC			
240 SEC			
300 SEC			

MEDIUM VOLTAGE POWER CABLE TEST RECORD
CONTINUITY AND MEGGER TESTS

PROJECT:	**DATE:**
TESTED BY:	**TEMPERATURE:**
WITNESSED BY:	**HUMIDITY:**
TEST EQUIPMENT:	
TEST DESCRIPTION:	

CIRCUIT/CABLE INFORMATION			
CIRCUIT NUMBER		**CABLE CONSTRUCTION**	
CIRCUIT FROM		**CONDUCTOR SIZE**	
CIRCUIT TO		**CONDUCTOR MATERIAL**	
MANUFACTURER		**INSULATION RATING**	
RATED VOLTAGE		**INSULATION TYPE**	
OPERATING VOLTAGE			

PHYSICAL INSPECTION & CHECKS	
CABLE SIZE & RATING PER DESIGN & CODE REQUIREMENTS	
CABLE/RACEWAY SUPPORT SYSTEM PER DESIGN & CODE REQUIREMENTS	
CABLE CHECKED FOR VISIBLE DAMAGE	
TERMINATIONS & SPICES INSPECTED FOR PROPER INSTALLATION	
CABLE/RACEWAY FITTINGS INSPECTED FOR PROPER INSTALLATION	

MEGGER TEST (2500 VOLTS @ 1 MINUTE)	**READING (MEGOHMS)**
PHASE "A" TO GROUND WITH PHASES "B" AND "C" GROUNDED	
PHASE "B" TO GROUND WITH PHASES "A" AND "C" GROUNDED	
PHASE "C" TO GROUND WITH PHASES "A" AND "B" GROUNDED	
NEUTRAL (IF PRESENT) TO GROUND WITH ALL PHASES GROUNDED	

CONDUCTOR CONTINUITY TESTS					
PHASE "A"		**PHASE "B"**		**PHASE "C"**	

DYNOMETER TEST RECORD

PROJECT:	DATE:
LOCATION:	TEMPERATURE:
TEST BY:	HUMIDITY:
CIRCUIT NUMBER:	NUMBER OF CONDUCTORS:
MANUFACTURER:	CONDUCTOR SIZE:
RATED VOLTAGE:	INSULATION TYPE:
OPERATING VOLTAGE:	INSULATION THICKNESS:
LENGTH:	OUTER JACKET TYPE:
AGE:	RACEWAY TYPE:
MAXIMUM RECOMMENDED PULLING FORCE:	

INTERVALS	TIME (MINUTES)	PULLING FORCE (FOOT LBS)

GROUND RESISTANCE RECORD

PROJECT:	DATE:
TEST EQUIPMENT:	IDENTIFICATION NUMBER:
TEST DESCRIPTION:	

GROUND LOCATION	AMB TEMP (°F)	SOIL CONDITION	GROUND RESISTANCE (OHMS)	TEST PERFORMED BY	DATE / TIME

CHAPTER 8
EVALUATING YOUR QA PROGRAM

A. INTRODUCTION

As noted in Chapter 3, it is not enough to simply develop a quality assurance program. The quality assurance program must be implemented and must be kept up to date. The quality assurance program must be continually reviewed and updated in order to ensure that it is viable and reflects the firm's current processes. This chapter discusses the importance of ongoing review and evaluation of the quality assurance program as well as provides methods for evaluating the program. Specifically, this chapter addresses the following important questions:

- Why should you evaluate your quality assurance program?
- How often should you evaluate your quality assurance program?
- What evaluation criteria should be used?
- How should your quality assurance program be evaluated?
- Should your firm become ISO 9000 registered?
- How do you go about getting your firm ISO 9000 registered?

B. WHY SHOULD YOU EVALUATE YOUR QA PROGRAM?

You should evaluate your QA program for the following reasons:

- To determine the conformity of your firm's quality assurance program with specified customer requirements.

- To determine the effectiveness of your firm's quality assurance program in meeting your firm's quality objectives.

- To provide the opportunity for feedback to improve your firm's quality assurance program.

Evaluation of your firm's quality assurance program should be viewed as a positive learning experience regardless of whether the evaluation is done internally, by a customer, or by an outside third-party as part of a registration process. If nothing else, quality assurance program evaluations keep quality assurance at the forefront of the electrical construction firm's consciousness.

C. HOW OFTEN SHOULD YOU EVALUATE YOUR QA PROGRAM?

Evaluation of your firm's quality assurance program should be viewed as a positive learning experience regardless of whether the evaluation is done internally, by a customer, or by an outside third-party...

Internal quality assurance program evaluation should take place at regularly scheduled intervals. These internal evaluations should take place more than once a year. If possible, some type of internal quality assurance program evaluation should take place quarterly. The frequency of internal quality assurance program evaluation should be determined during the program development process and adhered to religiously. When possible, internal quality assurance program evaluations should be planned during traditionally slow times when employees have more time to devote to the evaluation process.

D. WHAT EVALUATION CRITERIA SHOULD BE USED?

Comparison of the documented quality assurance program with what is actually being done within the firm is the first step in self evaluation. If what is being done is not in accordance with documented procedures, the reason for noncompliance must be determined. Once the reason for noncompliance is determined, either the documented procedure must be changed to agree with what is actually being done or what is actually being done must be changed to comply with the procedure.

The ability to meet customer expectations regarding the firm's quality assurance program is also an important evaluation criterion. Feedback from customer assessments of the electrical contractor's quality assurance program

will tell the electrical contractor if the program meets the customer's requirements or if it needs to be modified.

The purpose of the quality assurance program is to satisfy the customer by providing improved quality at a lower cost through increased productivity. The most important test of the effectiveness of the quality assurance program is customer satisfaction. Customer satisfaction can be measured through customer feedback in a variety of ways that include written questionnaires and personal interviews. However, the most important feedback that the electrical contractor can get is repeat business.

E. HOW SHOULD YOUR QA PROGRAM BE EVALUATED?

ANSI/ISO/ASQC Standard 10011 provides guidelines for auditing quality assurance programs. This standard is divided into three parts. Part 1[20] of the standard deals with the auditing process. The qualification and selection of auditors is discussed in Part 2.[21] Lastly, Part 3[22] addresses the management of the audit program. If the electrical construction firm is interested in a structured approach to self evaluation, then it should obtain a copy of this standard and use it as the blueprint for performing self evaluations.

The purpose of the quality assurance program is to satisfy the customer by providing improved quality at a lower cost through increased productivity.

In general, the steps required to perform a comprehensive self evaluation include the following:

Step 1 - Define the scope of the evaluation.

Step 2 - Identify the evaluation team.

Step 3 - Develop an evaluation plan.

Step 4 - Perform the evaluation.

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[20]*Guidelines for Auditing Quality Systems - Auditing*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ISO/ASQC Standard 10011-1-1994.

[21]*Guidelines for Auditing Quality Systems - Qualification Criteria for Quality Systems Auditors*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ISO/ASQC Standard 10011-2-1994.

[22]*Guidelines for Auditing Quality Systems - Management of Audit Programs*, American Society for Quality Control, Milwaukee, Wisconsin, ANSI/ISO/ASQC Standard 10011-3-1994.

Step 5 - Prepare and submit an evaluation report.

F. WHO SHOULD EVALUATE YOUR QA PROGRAM?

1. INTERNAL PERSONNEL

Internal personnel can make effective evaluators of the electrical construction firm's quality assurance program. If possible, however, the individuals reviewing a given department's quality assurance procedures should be from another department to increase objectivity.

2. OUTSIDE CONSULTANTS

Outside consultants can also be used to evaluate the electrical contractor's quality assurance program. The use of outside consultants can be particularly valuable if the firm is seeking ISO 9000 registration.

The use of outside consultants can be particularly valuable if the firm is seeking ISO 9000 registration.

3. ANOTHER ELECTRICAL CONTRACTING FIRM

Another electrical construction firm from outside the electrical construction firm's geographic market area or area of expertise can also be an effective evaluator. This is especially true if the two firms take turns evaluating each other's quality assurance programs. This peer evaluation should benefit both firms by providing feedback to the firm being evaluated as well as a look at how the other firm's quality assurance program operates.

4. COMBINATION OF THE ABOVE

The evaluation team could be made up of a combination of the above. This approach takes advantage of the benefits associated with each of the various groups that can be used to perform internal evaluations of the quality assurance program.

G. SHOULD YOUR FIRM BECOME ISO 9000 REGISTERED?

The decision to pursue ISO 9000 registration should be made by comparing the costs and the benefits of registration. ISO 9000 registration is very time consuming and costly. The investment in ISO 9000 registration is also not a

one-time cost but requires an ongoing investment. In addition to the initial registration audit, there are ongoing third-party audits that must be performed on a regular basis in order to maintain registration.

The advantages of ISO 9000 registration include the following:

- If your firm is currently doing business internationally or plans to expand its markets overseas in the near future, customers may require ISO 9000 registration. In short, ISO 9000 registration may be the passport your firm needs to enter the global marketplace.

- If your firm is doing business domestically with quality conscious customers, ISO 9000 registration may give your firm a competitive advantage over other equally qualified electrical contracting firms. This is especially true if you are working for international customers who are also being required to be ISO 9000 registered.

- ISO 9000 registration may reduce the number of on-site audits and information your firm is required to provide quality-conscious customers. Depending on the extent and frequency of customer audits, eliminating these audits may offset the initial and ongoing costs associated with ISO 9000 registration.

- Preparing for and successfully completing the ISO 9000 registration process should result in improved performance throughout your organization.

- Knowing that your firm's quality assurance program will be audited once a quarter by a third-party to maintain your registration will keep quality assurance at the forefront of your employee's consciousness.

The advantages associated with ISO 9000 registration must be weighed against initial and ongoing costs.

H. HOW DO YOU GET YOUR FIRM ISO 9000 REGISTERED?

Getting your firm ISO 9000 registered can be viewed as a two-phase process. The first phase is to develop and implement an effective quality assurance program. This can be accomplished by following the steps described in

Chapter 3 of this guide plus performing regular self evaluations as described in this chapter. Once the first phase of the registration process is complete, the electrical construction firm can proceed with the formal registration process. The registration process can be summarized by the following five steps:

- Step 1 - Select An Assessor
- Step 2 - Submit Documents For Audit
- Step 3 - Undergo On-Site Assessment
- Step 4 - Address Any Deficiencies Identified
- Step 5 - Receive Registration

A current list of assessors in the United States can be obtained from the Registrar Accreditation Board (RAB) which is associated with the American Society for Quality Control (ASQC) as follows:

Registrar Accreditation Board
P.O. Box 3005
Milwaukee, Wisconsin 53201-3005
Telephone: (800) 248-1946
Telefax: (414) 765-8661

Registration can take anywhere from three to eighteen months or longer to obtain depending on how dedicated the electrical construction firm is to becoming ISO 9000 registered. Typically, the electrical construction firm can expect to obtain registration in about six to nine months with concerted effort.

APPENDIX A
SELECTED BIBLIOGRAPHY

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APPENDIX B
QA GUIDE DISK

The disk attached to the inside back cover of this guide is provided to assist the electrical construction firm in preparing a quality assurance manual and implementing an effective quality assurance program. This disk includes the following files:

- Text files that contain the complete text of the sample quality assurance manuals contained in Chapters 4 and 5. These text files are in WordPerfect 5.1 format.
- Text files that contain the quality assurance forms, tags, checklists, and records contained in Chapter 7. These text files are in WordPerfect 5.1 format.

The following is a list of the text files on the diskette:

TEXT FILE	FILE DESCRIPTION	GUIDE REFERENCE	
		CHAPTER	PAGE(S)
EXQA9001.MNL	ANSI/ASQC Q9001 (ISO 9001) Sample Quality Assurance Manual	4	45-80
EXQA9002.MNL	ANSI/ASQC Q9002 (ISO 9002) Sample Quality Assurance Manual	5	82-112
W1DLYRPT.FRM	Daily Work Report	7	123
W2PREPLN.FRM	Activity Preplan	7	124
W3LTRXMT.FRM	Letter of Transmittal	7	125
W4PROLOG.FRM	Material/Equipment Procurement Log	7	126
W5REQINF.FRM	Request For Information	7	127
W6RECINF.FRM	Record of Information Received	7	128
X1INSAPV.TAG	Installation Approved	7	130
X2INSHLD.TAG	Installation Hold	7	130
X3OUTCAL.TAG	Equipment Out of Calibration	7	131
X4SHOPDG.TAG	Shop Drawing Approved	7	131
Y1RWYINS.CKL	Raceway Installation Checklist	7	133
Y2UGRWYI.CKL	Underground Raceway Installation Checklist	7	134
Y3DBINST.CKL	Underground Duct Bank Installation Checklist	7	135
Y4MNHOL1.CKL	Manhole Installation Checklist (Prior To Concrete Placement)	7	136
Y5MNHOL2.CKL	Manhole Installation Checklist (After Concrete & Duct Bank Installation)	7	137

Y6CBLINS.CKL	Cable Installation Checklist	7	138
Y7IBDUCT.CKL	Indoor Bus Duct Installation Checklist	7	139
Y8OBDUCT.CKL	Outdoor Bus Duct Installation Checklist	7	140
Y9GNDINS.CKL	Grounding System Installation Checklist	7	141
Z1CONINS.REC	Construction Inspection Record	7	143
Z2PLCRCT.REC	Punchlist Correction Record	7	144
Z3CALIBR.REC	Tool/Equipment Calibration Record	7	145
Z4REPAIR.REC	Tool/Equipment Maintenance & Repair Record	7	146
Z5WCTEST.REC	Power/Control Wire & Cable Test Record	7	147
Z6INTEST.REC	Instrument Wire & Cable Test Record	7	148
Z7EQPTST.REC	Electrical Equipment Test Record	7	149
Z8MVHPOT.REC	Medium Voltage Cable Test Record/Hi Pot Insulation Test Lkg Current	7	150
Z9MVMEGR.REC	Medium Voltage Power Cable Test Record/Continuity And Megger Tests	7	151
Z10DYMTR.REC	Dynometer Test Record	7	152
Z11GDRES.REC	Ground Resistance Record	7	153

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