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Quality Control and Continuous Education: Providing Tools for Contractors to Make Ethical Decisions

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Quality Control and Continuous Education: Providing Tools for Contractors to Make Ethical Decisions

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Abstract/Executive Summary

Quality Control is a developing field in the building construction industry and successful quality control management relies on the ethical decision-making abilities of the inspectors. Research has identified a connection between personality types and the rationale for decision-making based on their type. The Myers-Briggs Type Indicator, a commonly used personality inventory, identifies personality preferences and how people relate to their environment and situations. In relation to construction projects, poor decision-making and clashing personality types in the field result in unsafe work and low quality of the final product.

Companies like DPR Construction Inc., which have a goal of zero defects (Dolezalek, 2003), rely on training and education to develop personnel. When training and education aren't enough, evaluating personality clashes in the organization can clarify how and why negative results and poor decision-making are occurring. Research by Culp (2001), Giritli (August 2008), Kuprenas (February 20, 2000), and Futrell (1985), examine personality types in management personnel, career fields, and overall desired outcomes for recruiting successful individuals to a firm. Their findings contribute to the idea that one personality preference over another will be successful in the construction industry and contribute to producing quality work can be attributed to the individual's sound ethical decision-making abilities.

Research has shown a lack of publicly available training programs specific to quality control in the industry as compared with safety programs. Quality control is also not given the same attention at the collegiate level as safety nor does it have the same comparable regulating organizations as safety. In addition to few training programs, training that does exist on the jobsite level is conducted by superintendents who, despite their years of solid field experience,

do not have a complete focus on quality since they are also responsible for safety and scheduling among other activities.

In addition to the need for formalized quality control training programs as an option to increase efficiency and quality on the jobsite, there is a cost savings element that contractors can realize through continuous education. Despite an upfront cost of training, training can help reduce the number of repetitive punchlist items and strengthen the skills of the inspectors while providing them with tools to efficiently do their job.

Through further training and continuous education, personality weaknesses may become strengths and personal skills developed to aid quality control personnel in better practical decision-making. Regardless of the size of the organization, those which apply formal quality control training can realize lifetime cost savings and improved productivity on their projects with the use of this packaged training program which provides presentation materials and a start-up guide to help implement a quality control program within their organization.

Introduction

Too often carelessness and indifference lead to poor judgment decisions during building inspections by Quality Control (QC) inspectors. As a result of failed inspections, many owners are contractually requiring quality control activities on their projects and therefore mandating ethical decision-making. Research shows a number of influences on a person's ethical decision-making abilities. Certain personality factors combined with personnel who are tied up with cost and schedule influences may make decisions which result in poor quality work, unsafe building conditions, and non-compliant work that will require re-work. The "cost of non-conformance," a term coined by researchers in the field of Total Quality Management (TQM), in the construction

industry costs construction management firms millions of dollars each year in repairs and re-work as a result of unethical QC inspectors.

In the current down-economy of 2009 and 2010, owner's representatives further scrutinize the reputation of a construction firm and their abilities to produce quality work in addition to other prequalification requirements. Quality work does not happen by itself but as a result of the efforts made by the individuals putting the work into place and approval of the work by building inspectors. With funding for projects scarce and budgets and overhead costs lowered, quality work and correct installation at the first attempt have huge potential cost savings. The effect of buy-out using the lowest bidder could have a negative effect on overall quality for the project. It is not proven but suggested that low-bidders take shortcuts to reduce costs for the job and that quality could be sacrificed. If an owner is contracting a project based on the low-bidder, the contractor's overall reputation and quality background should be considered. A company that can promise cost savings will be competitive and attractive to a potential owner.

The intent of a successful Quality Control team is to be independent from the influence of schedule and cost control constraints on a project. Third party firms, such as materials testing organizations, particularly can set themselves apart from the overall project influences since they are hired by one party to perform another task. The QC individual should be well-versed in their definable features of work and specialized areas of interest. The QC individual should be accredited and certified in their area of work as well (U.S. Army Corps of Engineers) and know where to find the correct resources to complete their task. Finally, the QC individual should always strive for ethical decision-making with continuous education.

Key functions of a Quality Control team are to provide on-site training to craft workers about what they are installing and how to achieve a quality product, interpreting specifications

and contract drawings to uphold craft workers to the requirements, inspection and testing of construction materials, and to prevent the need for re-work during the installation process. In the event of non-compliant work, the prime contractor's QC team should have the authority to direct removal of poor work and observed installation of the correct work.

It is the intent of this research to discuss project influences which affect a persons' ability to make ethical decisions within a particular company, how much influence contractually mandated quality control has on a persons' ethical decision-making, and how continuous education can eliminate the need for rework and reduce potential for poor decision-making. The construction management industry will be provided with a training program, which can be implemented on a project to achieve continuous improvement, realize cost savings and value in strong quality control, and identify employees who may be negatively influenced on a project. Clear communication and exhibition of company values, as well as understanding how the employees view and value the company goals, can assist in the achievement of a team of individuals which will make good decisions. These ideas are suited for a general contractor, construction manager, or engineering and materials testing firm who have individuals directly involved in the previously listed quality control functions.

Statement of the Problem

Quality Control is a developing field in the construction industry. Construction management firms without proper Human Resources departments struggle with finding "good-fit" inspectors with integrity and personal ethics. As a result, many inspectors do not handle field situations properly and allow non-compliant or unsafe work to be accepted. In addition, owner's representatives, the government and Department of Defense (DoD) in particular, are becoming stricter on quality requirements for their buildings and contractually mandate quality control

programs for prime contractors. Third party firms must be hired by the prime contractors to perform certain quality control functions on the jobsite. The U.S. Army Corps of Engineers (USACE) and Naval Facilities Engineering Command (NAVFAC) have developed an entire training manual for QC managers on their projects and require construction firm management to attend the class and pass an exam to demand quality QC inspectors (U.S. Army Corps of Engineers). This streamlines and standardizes QC procedures taken on USACE and NAVFAC projects and ensures consistent results. A lack of confidence or apathy toward to final product could subject a construction management firm to damages or lawsuits. It is in the construction management firm's best interest to understand the values of the people who carry out such an important task in the field and make sure that they will make the best ethical decisions when quality is questioned. Specifically, if a third party materials testing technician brings up a discrepancy to the prime contractor, the prime contractor's employees must have the drive and authority to act on the disclosure of information.

As mentioned the "cost of non-conformance" costs construction management firms millions of dollars in repairs, damages, re-work, and litigations. Quality Control personnel who let small issues go unresolved become liabilities. Small issues built up over time can create one big problem. One scenario, for example, is as follows: structural anchor bolts are inspected and the inspector identified the base plate of a column was not grouted but schedule delays were compressing the work load. He/she writes up in their daily report that the base plate was authorized to be covered with concrete despite the incomplete work. The inspector, driven by the steel sequence schedule, wanted to prevent a confrontation with the erection crew and authorized concrete placement around the column without grout. The occurrence caused a structural failure after the building was occupied and resulted in a lawsuit from the owner against the construction

management firm. A confident, unbiased, and ethical Quality Control team can help prevent those problems by possessing good character traits and sound judgment. Jobsite training and education are often inadequate or not project-specific so that project goals and expectations are not understood. People must inherently possess the willingness to “do the right thing” by completing inspections and confronting issues. Organized documentation and ethical decision-making by the inspector could have prevented the structural failure.

Significance of the Problem

Successful management of QC programs begins with successful team building. The MBTI is used by many industry corporations to put together diverse teams consisting of multiple personality types. Outcomes of successful teams can contribute to employee satisfaction, customer satisfaction, overall production, and of course, quality of work. “Since type provides a framework for understanding individual differences, and provides a dynamic model of individual development, it has found wide application in the many functions that compose an organization," write Gordon Lawrence and Charles Martin’.

Quality control is used throughout various industries, which include automotive, construction, manufacturing, and pharmaceutical. A pharmaceutical company recognized that by not evaluating their personnel and having an un-motivated, unqualified person controlling the quality of their drugs was “disastrous” (Schnoll) and resulted in poor quality work. Failure to recognize a person’s weaknesses, relating to stressful situations and personality type, values, and influences will be reflected in the person’s quality of work and essentially in the overall quality of the building. USACE and NAVFAC contribute the overall quality of the building to successful construction quality management led by QC Managers and their teams (U.S. Army

Corps of Engineers) and use merit and reputation as a grounds for awarding work as a repeat client.

While companies put emphasis on technical and safety training and focus large amounts of overhead costs to equipment and training of personnel, quality training for employees self-performing work may not be a priority for delegating resources in smaller subcontracting companies although many large companies do have comprehensive in-house training programs. Often, project goals and requirements are not clearly communicated to those putting in the work being held at the management level and resulting in re-work and schedule delays. It is also possible that what trainings that do exist are ineffective in addressing the learning needs of the participants so there is a lack of knowledge retention.

Beyond training are the factors that influence a person's ethical decision-making abilities. Projects with private owners and which do not mandate quality activities are at higher risk for "letting things slide" and workers accepting sub-par work. The "cost of non-conformance" eats into project profit margins which are already reduced in economic conservatism. The potential for rework, loss of profits, loss of reputation, and lawsuits are high risks for a contractor in a struggling economy.

Statement of Purpose

Aim

To develop a continuous education training program using quality topics to reduce the effect of poor decision-making through rework and increase realized profits on a project.

Objectives

To understand the quality control process, ethics, and influences for decision-making.

To examine the potential negative results in terms of scope of work and cost of poor inspections and non-compliant work.

To understand how decisions are made based on a person's personality type and how it relates to actions in the field.

To understand why certain personality types do not work well in Quality Control.

To prevent unethical decision-making through a continuous education training program.

To generate a cost comparison model showing potential profit savings through reduced re-work.

Definitions

"Cost of Non-Conformance" – The cost of non-conformance relates to monetary amounts and events which are negative results to the construction management firm as a result of non-conforming work being in place.

Dichotomy - The contradictory combination of qualities of the personality types in the Myers-Briggs studies.

Extrovert (E) - An attitude as described by Myers-Briggs in which a person outwardly directs self to people and things.

Feeling (F) - A function as described by Myers-Briggs as a decision-making function.

Field-The "field" when referred to relates to a building construction project's construction location and activities which take place there.

Introvert (I) - An attitude as described by Myers-Briggs in which a person inwardly directs self to concepts and ideas.

Judgment (J) - A lifestyle as described by Myers-Briggs as a way to relate to the surrounding environment.

Myers-Briggs Type Indicator (MBTI) - A personality study described by C.G. Jung and identifies 16 dominant personality traits. The Type Indicator is a tool used to determine a person's dominant personality traits.

Naval Facilities Engineering Command (NAVFAC) - A DoD group facilitated by the U.S. Navy, part of the Base Realignment (BRAC) which aims to provide "sustainable, adaptable facilities; expeditionary capabilities; and contingency response to the Navy Expeditionary Combat responsiveness" (Navy).

Non-conformance/Non-compliant - A non-conformance or non-compliant work is work that does not meet the requirements of the job contract drawings, specifications, contractual requirements, Owner's Request for Proposal (RFP). It includes work that is complete but does not meet owner's quality standards or work that is being put into place that does not meet requirements of related standards and building codes.

Perceiving (P) - A lifestyle as described by Myers-Briggs as a way to relate to the surrounding environment.

Quality Assurance (QA) - A control imposed by owner's representatives to ensure the soundness of a Quality Control team. A Quality Assurance program spot-checks and provides Quality Control over the Quality Control team as opposed to each individual building activity and ensures the team is upholding their contractual obligations.

Quality Control (QC) - A group of people or activities designed to identify flaws and non-conformances in building activities. The group is composed of Quality Control inspectors which individually inspect each component of the building.

Quality Management System (QMS) – A program used by businesses which incorporates their mission in relation to quality tasks. For example, a construction project's QMS may include

inspection processes, written procedures, and other supporting authorizations and documentation which ensure consistent results.

Sensing (S) - A function as described by Myers-Briggs as an information-gathering function.

Safety Task Assignment (STA) – An STA outlines all the safety requirements to complete a work task including preventative measures and personal protective equipment and should be reviewed with the craft worker before conducting each task or at the start of each work day. It directly ties in to what he or she will be doing that day.

Intuition (N) - A function as described by Myers-Briggs as an information-gathering function.

Thinking (T) - A function as described by Myers-Briggs as a decision-making function.

Total Quality Management (TQM) - "TQM is a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society" (Standardization).

Assumptions

All construction management firms are in building construction.

Third party firms relates to geotechnical, engineering, and construction materials testing firms.

All Quality Control individuals are directly involved in quality activities and may be primary employees of the construction management firm or employed by 2nd tier subcontractors or 3rd party inspectors.

Not all construction management firms have Human Resources departments which conduct the recruiting and review of new employees.

"Quality Control" as an action relates to the daily tasks of inspection and documentation, and follow-up of remediation actions.

Quality Control programs are contractually mandated for DoD projects by Army Corps of Engineers and Naval Facilities Engineering Command.

Delimitations

The research will not address dollar amounts as part of the "cost of non-conformance" but will address the issues, events, and results from non-conforming work.

The research will not investigate how many construction management firms have Human Resources (HR) departments, but rather state that the research benefits companies without professional recruiters as a means for overcoming the challenge of not having HR.

Limitations

Many construction management firms do not employ primary Quality Control inspectors, but instead use all employees on the project to aid in the inspection process or rely on the subcontractors to self-perform Quality Control functions.

There is no one particular firm researched for this study but background knowledge was obtained from the author's first-hand industry experience.

Smaller dollar-amount contracts within the construction firm do not mandate a Quality Control program, unless it is a DoD-contract project, and rely on all individuals of the project to assist in inspections without having proper quality training.

There has been no financial trending related to quality control activities and prevention of rework.

Figures generated for the cost-analysis are based on relative figures to show comparison and not real-time construction values.

Literature Review

History of Quality Control

Quality Control (QC) began around 1900 by established college-level engineering programs which attempted to ensure a consistent delivery of quality concrete products to the consumer (Slaton). The engineers homogenized the activities of the concrete construction site and provided technical controls to the operations. In 1902, the National Bureau of Standards (NBS) was established to address outdated practices in the trade industries and its practices could be seen implemented with the United States Army, Department of Agriculture, and United States Geological Survey (Slaton). By 1910, the American Society of Civil Engineers (ASCE) had created the American Society for Testing and Materials (ASTM), which is still used today in the construction industry as standards for testing and inspecting materials and installation (Slaton). Other agencies in the early 1900s, such as the American Railway Engineering Society, also implemented the Quality Control practices of ASTM (Slaton). Over the past 100 years, quality control has expanded to include the pharmaceutical industries, automotive industries, the construction industries, and is most commonly known in assembly-line manufacturing industries.

Quality programs are identified with Lean and Six Sigma business practices. Quality Management Systems (QMS) have been put into place by large and small corporations where QMS has proved to be successful in either scenario- large or small firms. The Construction Quality Management for Contractors (CQM) program was established by the Army Corps of Engineers and Naval Facilities Engineering Command (NAVFAC). It is a type of QMS which was developed as a result of a 1961 clause to the Department of Defense (DoD) contract clauses to standardize the QC process for DoD construction projects (U.S. Army Corps of Engineers). The theories of Total Quality Management (TQM) have revolutionized QC as a function on

building construction projects and they promote total buy-in of quality from the start of a project to the very end and include every individual involved. QC and safety are necessary functions on a building construction projects to ensure that the end product is safe, meets the quality requirements and essentially that the owner gets what they paid for. Safety and quality go hand-in-hand. Without strong quality, safety can be jeopardized.

Personality Studies

Too often, indifference, carelessness, and schedule-driven shortcuts result in non-compliant work by subcontractors. When the Quality Control inspector is caught up in these negative forces, poor-judgment decisions are probable. This research aims to find a link between what drives a person's ethical decision-making skills when confronted with an issue and their personality types. Several personality studies have been reviewed by other researchers and the Meyers-Briggs Type Indicator (MBTI), which is a commonly used comprehensive study of dominant personality preferences ("MBTI Basics,"), will be used as the foundation for personality trait definition for this research. The psychological theories of MBTI were first introduced in the 1920s by Carl G. Jung and then expanded upon in the 1940s with the development of the MBTI as a tool by Isabel Meyers-Briggs ("MBTI Basics,"). It discovers 16 basic personality types based on a person's reaction to events in relation to their perception and judgment ("MBTI Basics,").

One of the earliest personality studies used Woodworth's Personal Data Sheet beginning in 1917 (PDS). Several other known personality studies and indicators that professionals use are the International Personality Item Pool (IPIP) ("International Personality Item Pool,"), the California Psychological Inventory (CPI) (CPP, 2009), and the Minnesota Multiphasic Personality Inventory (MMPI), which also uses the Neuroticism-Extroversion-Openness

Inventory (NEO-I) (Britannica). Each of these personality type indicators attempts to create a mold and identify a group of traits that one can identify with after simple questionnaires. The MBTI is the most commonly used survey with over two million users each year ("MBTI Basics,").

Quality Control for Construction

As it relates to the construction industry, a successful Quality Control program can contribute to the construction management firm being awarded work by repeat clients, having a good reputation in their region, customer satisfaction, employee satisfaction, and overall cost savings for owners and firms. The basic functions of a building project quality control include:

- Structural Inspections
- Life-safety Inspections
- Close-in Inspections (for ceilings, floors, and walls)
- Materials and Submittal Review
- Specification and Contract Drawings Review
- Compilation of work-completion lists and project close-out inspections
- Daily site-walks to ensure installation compliance with requirements

Quality Control is often looked upon as a program that automatically provides standards on certain projects when in reality; QC is directed and implemented by Quality Control Inspectors, individual people with specialized training in the Construction Specifications Institute (CSI) Divisions. The individuals who complete these tasks are often looked upon as “project police” and must be able to monitor building progress and make decisions related to quality and safety. Individuals performing the tasks above must possess characteristics of self-

initiation, confidence, and attention to detail. When viewed as "project police," one can imagine they daily face challenging decisions to make and objective judgment calls.

Personality and Multicultural Management

In reviewing literature related to the topic of personality type indicators and construction management personnel, it is found that personality studies have already been conducted using the MBTI Test. Some of the conclusions from these studies will be utilized with this research topic to prevent duplication of efforts. All authors examined were found to value achievement of a successful and productive team environment and recognized the importance of understanding how different personality types work together for problem solving. Specific to construction, the research team of Yen, et al (May 2002), investigated cross-cultural construction management teams using MBTI. They looked at companies using TQM and Continuous Improvement programs and how management styles were affected by personality (Yen, et al., May 2002). Their study includes its own literature review which points in the direction of other helpful and relevant journal articles.

As mentioned above in the multi-cultural project management category, researchers saw that leadership characteristics were linked to management styles and team dynamics (Miller, Fields, Kumar, & Ortiz, November 2000). In the multi-cultural category was a study conducted in Turkey, which shows that Turkish culture valued different personality traits than the American culture of the studies already reviewed (Giritli & Civan, August 2008). In comparison with the study conducted in Turkey and the other cross-cultural studies, similarities are still drawn as to what firms are looking for in management personalities overall.

Personality and Other Focus Groups

Another category of studies have been conducted analyzing the personalities of focus groups: age groups or careers, like architects and civil engineers (Johnson & Singh, July 1998). For example, the work of Kuprenas (February 20, 2000) analyzed personality trends based on the MBTI preferences with the "younger respondents" range having ages less than 40 and "older respondents" with ages above 40 (Kuprenas & Nasr, February 20, 2000). The conclusions generated about architects and engineers are identifiable to what age groups QC individuals fall into.

Personality for Recruiting

Futrell (1985) suggests that before you can begin a search for personnel, you must identify what you are looking for. A construction company hoping to build a QC team will need to understand the personality types and how they interact in order to decide on a mold they would like their potential employees to fit in. He also suggests that people inherently do not change. They can adjust certain behaviors but are inevitably stuck with their personality types. A construction firm must understand that if an employee is not a good fit for their program, additional training and education may not lead to success overall.

In addition to key personality traits that are easily identifiable, Futrell (1985) discusses the "extracurricular activities" of a person's lifestyle to help identify other positive attributes. For example, volunteerism, athletics, and particular hobbies can suggest the person contains attributes of dedication, ambition, and endurance. The research of Futrell (1985) and the discussion of recruiting techniques used by his firm are useful tactics for the development of this directed project because he broadens the idea of personality traits defined by MBTI. Futrell (1985) discusses basic traits for successful young people they are looking to hire for his

engineering firm by looking beyond the MBTI traits at other defining characteristics. The concepts can be applied to all potential hires for construction firms as well.

Developing a cross-section of personnel using the MBTI surveys will form the best team (Kuprenas & Nasr, February 20, 2000). The research of Gordon Culp (2001) also identifies the importance of understanding personalities and how they interact for team performance since different personalities will approach each situation differently. Culp clearly identifies that understanding personality type can "enhance problem solving and decision making" (Culp & Smith, 2001, p. 25).

Personality and the Individual

Giritli (August 2008) suggests that people chose their profession based on their personality and that it attracts a particular personality type. If this is the case, it will be more difficult to procure a cross-section of personality types for team building. Not all construction management firms have a Human Resources Department and the recruiting of personnel and team development is left to the project management. The research of Albanese, et al (1991), studied 783 construction management firms and identified that only one third had established Human Resources Departments and published mission statements. Project managers typically are not trained in staff procurement and interviewing practices. These project managers are likely to hire people they identify with and it is reasonable to think that they will have similar personality traits. Like Giritli's research, only a particular personality type will be evident on those projects. Developing a guide for hiring will assist these project managers in developing a well-rounded team.

Supporting Evidence and Situational Examples

Of particular interest from Culps' (2001) research are the tables of characteristics and stressful situations for extraverts and introverts. The stressful situations can be applied to any construction project. By understanding the MBTI preferences compared with stressful situations, a construction management firm will be able to put their personnel in the best-fit scenarios. As shown by the tables below, extraverts prefer to work and talk out issues and have self-initiative towards working relationships. The introverts' stressful situations show interacting with others frequently; having to act quickly without time for thinking, and having too many concurrent tasks are problems (Culp & Smith, 2001). These "stressful situations" are identifiable situations a QC inspector faces daily and helps support the idea that introverts will not be best-suited as QC inspectors.

TABLE 1. Characteristics and Stressful Situations for Extraverts

Characteristics of extraverts (1)	Stressful situations for extraverts (2)
• Prefer to communicate by talking • Work out ideas by talking them through • Learn best through doing or discussing • Have broad interests • Are sociable and expressive • Readily take initiative in work and relationships • Think out loud	• Working alone • Having to communicate by e-mail • Lengthy work periods with no breaks or interruptions • Having to focus in depth on only one project task • Getting only written feedback on project performance

(Culp & Smith, 2001, p. 26)

TABLE 2. Characteristics and Stressful Situations for Introverts

Characteristics of introverts (1)	Stressful situations for introverts (2)
• Prefer to communicate in writing • Work out ideas by reflecting on them • Learn best by reflection and mental practice • Focus in depth on their interests • May be seen as private and contained • Take the initiative when the situation or issue is very important to them • Think, then talk	• Working face-to-face with others for prolonged periods • Interacting with others frequently—in person or on the phone • Having to act quickly without time for reflection • Having too many concurrent tasks and demands • Getting frequent verbal feedback

(Culp & Smith, 2001, p. 26)

Ethical Decision Making and the Personality Type

Beyond certain personality types in a QC team are the factors which drive ethical decision-making. The intent of the research is to prove a certain personality type is best-suited for QC work because there are examples of carelessness and indifference in the construction industry which have led to building failures. The personality type can identify whether a person is capable of making ethical decisions. The research of Fan and Fox (2009) list attributes which affect ethical decision-making. Using the list of attributes with Futrell's lists of stressful situations, one can begin to see links between personality traits and decision making. The attributes that affect decision-making, and are related to how others perceive the person, suggest a person with a preference for extraversion.

Another research team, Lauriola et al (November 2007), was able to conduct three studies which investigated that there was a link between certain personality traits and decision-making. Specifically, they found indicators which would lead to risky decision-making or ambiguity. Although the research was not performed in the construction industry, it draws links to the

studies which were performed with architects and engineers in an attempt to find a link between what drives a person's decision-making abilities.

Implementing Ethics

Unethical decision-making occurs as a result of many influences. The challenge for construction firms is getting people to make the correct ethical decisions and not be influenced by outside sources. The individual must want to do the right thing regardless of personal gain. As a way to force compliance, many DoD contracts, such as work by USACE and NAVFAC, mandate quality control programs and staffing. These implementation tactics can include daily reports, deficiency reports, and disclosure of all identified issues. The owners have options to conduct their own 3rd party inspections in many cases, as required in the project specifications.

Ethics should not be forced. Personality studies which researched ethics showed that some personality types will be more motivated to make correct decisions, regardless of contractual requirements. In order to strengthen the abilities of these inspectors, tools such as checklists and quality process meetings assist in educating subcontractors and inspectors of project requirements.

Autonomy and Continuous Improvement

Many studies have been conducted on autonomy and the individuals. One such example is where management has affected the autonomous motivation of employees through teaching and management styles. Employees who feel empowered and that their work is important have higher quality of work (Hardre, 2009). Another study addressed customer satisfaction with empowerment of the workers. Results of the study showed that customer satisfaction was at its highest when the employees where empowered to resolve conflicts and conduct customer service than which employees with no empowerment. Also, customer found higher quality of work

(Grahalm & Sparks). This research supports that quality of work relates to customer satisfaction and that customer satisfaction will contribute to awarding projects as a repeat client.

Conclusions

After reviewing the relevant literature to this research topic, there are recent and older studies which have already been conducted to prove the links between decision-making and personality as well as the effect the motivation of the employees has to produce quality work. Training of the recruiting team and managers to identify good or risky candidates can contribute to the overall success of the project. The research reviewed is helpful to this topic because it spans a variety of industries, including construction management industry, and also spans various continents. The research reviewed was also valuable and was conducted using several study methods, compiled during conferences, and collected from journal sources from credible authors and researchers.

Further research will need to be conducted to examine personality type specific to building inspections-or Quality Control Inspectors and quality training programs companies are implementing. In order to gain information about QC Inspectors, an understanding of how wide QC practices are in the construction industry will need to be understood. Survey of various companies around the country and which of them have formalized QC programs will need to be examined. Finally, most of the research conducted had a psychological approach and none of the research reviewed included financial impact data of quality or empowerment of employees to make good decisions.

Procedures

Stage 1

Literature review. This stage involves review of the literature in peer-reviewed journal articles of the American Society of Civil Engineers database related to personality types in construction management, quality control, personality studies, recruiting practices of construction management firms, and autonomy and self-motivation. Literature to be reviewed will be ethics studies to understand influences of indifference and what causes an individual to make unethical decisions and continuous education and training tactics. Finally investigation into other possible quality training programs will be researched and compared to the training proposal of this project.

Stage 2

Developing the quality training program. This stage involves utilizing skills learned in BCM 581 Construction Training and Development and using the textbook *Effective Training: Systems, Strategies, and Practices Third Edition* by authors P. Nick Blanchard and James W. Thacker (2007). A training module using basic quality topics will be developed which can be implemented directly on job-sites or in a corporate environment. The training module will address specific goals and incorporate a variety of teaching techniques which will address participants different training needs (visual, audio, hands-on, etc).

Stage 3

Writing the training proposal. This stage involves writing the actual training proposal and including potential schedules, budgets, instructor information, and training resources. The training proposal will discuss goals of training, why training is needed, a training needs analysis, identify potential participants, and stress how quality control activities are related to making ethical decisions in practice.

Stage 4

Assessing financial data. This stage will be more limited and difficult to assess. In order to express the importance of ethical decision-making and strong quality control, companies must see the direct financial benefits. In a struggling economy, money talks, and companies can realize profits through quality control activities. Since cost is an influence for ethical decision-making, showing financial data could be a motivating factor for having positive influence.

Stage 5

Writing the research report. This stage involves coordinating the training proposal with the financial analysis to show the importance of why the training is needed. Analysis of the data, conclusions, and recommendations are also part of this stage. The research report will outline the continuous education training program which provides project-specific quality requirements in short-form to salaried and craft employees and promote ethical decision making. The overall intent of the continuous education is to raise the level of awareness that quality work contributes to project by repeat clients and provide tools which promote autonomy and ethical decision-making.

Data or findings

Quality Control Training Programs

Continuous improvement is a keystone of Total Quality Management (TQM). This idea strives to improve construction activities through process control and making each task more efficient. Better training in quality control will take out some of the ineffectiveness in quality control. Many large general contractors in the construction industry have their own internal training programs for safety, quality control, etc. However, those programs are not public and contain their so-called trade secrets. There are few available public sources of training programs for quality control. Several larger entities, one being the Associated Builders and Contractors,

Inc. (ABC), support training programs but do not currently offer training specifically in construction quality control. As seen on the ABC website, they offer a variety of training courses and educational programs, including bilingual classes, but typically they are only in construction management, safety, and other trade specific courses (Contractors, 2010). The Naval Facilities Engineering Commands and Army Corps of Engineers trainings programs, already discussed, are open to the public for a fee and are widely recognized in the construction industry for large general contractors as the standardized quality control process and the requirement on DoD projects. A generic search of collegiate institutions found that there are no certificate or degree programs with emphasis on quality control but there are many occupational safety programs. Some institutions offer course curriculum which includes quality control information. Some on-line school programs include quality control education in conjunction with the safety programs offered.

Just as companies use their safety rating, EMR, and statistics as a marketing tool, those same companies were probably reluctant to comply with strict regulations placed on them by the Occupational Safety and Health Administration (OSHA) due to the increased spending and time needed for compliance. Besides the lack of quality control-based organizations, there are no governing bodies in the realm of quality assurance as large as OSHA. The International Organization for Standardization (ISO) Standardization is currently the largest governing body, however, less than 100 companies in the country are currently certified in ISO 9000 (Harrison). ISO governs requirements for the quality system to follow but not specifically how the requirements should be met in the company or on the project. ISO requires detailed auditing and documentation to make sure that the processes in place are working effectively. The benefit is to avoid frequent audits by the company's clients (Standardization, 2010). Although ISO is highly

effective, the fact that so few companies are certified in it is a result of few clients that require it and the high cost to achieve certification. In order to become certified, there are five stages to complete: a pre-audit of the organizations programs, documentation stage of how the program is run, designing changes to improve the program, complete training in the changes, and a post-audit to assess the changes (Blanchard, 2007, p. 13).

Other building code enforcement is the closest thing to OSHA and governing bodies in quality control. Codes are enforced at the state and federal level by building code officials and inspectors who have the authority to approve building permits and occupancy. The training that is needed is on a more micro-scale, bringing the authorization and regulation down to the contractor level. Eventually, a standardized quality control program, if not complete regulation, would have the same effect on profits as safety and OSHA have proven. Hopefully one day there is also a comparable program which provide quality ranking and rating to contractors similar to how the EMR rates and ranks them on safety.

Contractors do have several options to increase their quality intelligence on the job. For example, certification programs can help strengthen competencies and give competitive edge within the organization. As already discussed, the USACE/NAVFAC program is one option. For a fee, the American Society for Quality (ASQ) offers a range of certification programs, though not specific to the construction industry, the principles of quality and TQM are present. Two examples of certification programs offered by ASQ are the Manager of Quality and Organizational Excellence certification and the Quality Inspector certification (Quality, 2010a).

Also within the ASQ umbrella are training programs offered in International Standardization Organization and Quality Management. Of particular interest in the Quality Management program are topics which range from an introduction to quality control to root-

cause analysis and cost analysis. Each training topic is offered in credit- hour units for a tuition fee. According to the ASQ website, the Quality Cost Principles course covers the following:

> "Improve customer satisfaction, competitiveness, and financial performance by understanding the link between quality improvement and profits. Learn to select, manage, and strategically use Cost of Quality (CoQ) improvement projects within your organization. Surveys show a vast majority of companies either overlook or are unaware of the concept of Cost of Quality (CoQ). Quality Costs (actual plus hidden) can amount to a large proportion of sales, often 25% or more. Learn to successfully use CoQ to strategically manage your improvement projects for bottom-line results" (Quality, 2010b).

This curriculum directly relates to goals of the proposed quality control training program. This course is offered in an on-line setting and is available for forum members and the public. A contractor wishing to expand his/her understanding of direct cost savings as a result of strong quality control is recommended to take this course whether or not they are a forum member.

In addition to lack of training programs is a lack of qualified trainers. As discovered in the personality study review, the industry lacks personalities who are best suited for teaching roles despite the desperate need for mentorship in the industry. In an effort to improve overall teaching skills, unrelated to the construction industry, the formative teaching evaluation was developed in the 1970s to provide teachers with feedback to improve their teaching skills (Bernhold, p. 34). Peer review also provided a check to the teacher's performance and if they were current in their knowledge of the topics (Bernhold, p. 34). Peer review also reinforced the idea of continuous education and improvement (Bernhold, p. 36) in addition to providing accountability of the training materials and protecting the ethical integrity of the material. This

would mean that a trainer or teacher of the topics would have to be accountable for accuracy. Peer reviewing also supports mentoring and guided discovery of training topics. With peer review, in a sense, providing quality control to training instructors, organizations can help develop their employees to be stronger mentors and trainers. In addition to peer review are summative evaluations such as surveys given after a training session to learn what the participants took away from it and what can be improved for next time. Peer review also offers up an opportunity for mentoring within the organization.

As mentioned, few universities have specific quality control courses within their construction management degree programs. One professor attempting to change that is Professor James L. Jenkins of Purdue University in West Lafayette, Indiana. More than ten years ago, Professor Jenkins recognized the need for quality control training within the curriculum and surveyed 20 construction companies to find out what they considered important skills for employees. By determining what the industry considered pertinent, the University could adjust its curriculum to reflect the industry's needs. Proper inspection and testing scored a 3.45 out of 4.0 points and was recognized as a relatively important skill (Jenkins, April 7-10, 1999). Also of interest in the survey was that when asked who performs quality control functions within their organization, 75% of the companies stated that the superintendents performed the activities (Jenkins, April 7-10, 1999). This figure is great by showing that three quarters of the survey participants were engaging QC activities on their jobs. This figure also shows that there are at least some companies that have employees dedicated only to quality control functions and but shows that some companies in the industry could still benefit from a formal QC department. Fortunately, superintendents often have unmatched experience of work processes that QC inspectors do not. This only suggests that a dedicated QC inspector will have more focus on the

details related to quality than a superintendent who is also responsible for safety and scheduling. On the other hand, if there were no dedicated quality control employees, better training for the superintendents of those companies would still contribute to increasing their ethical awareness and need for quality control.

Solution to the Training Need

The solution to the need for training can be solved with a formal quality control training program, offered to small to large general contractors, in one concise and affordable package. Demographic population is changing and training is needed to ease the transition of new employees to the industry with the following points: increased diversity of ethnic and cultural makeup of the workforce, differing generational values and closing the age-gap, and the transition of the baby-boomers retiring and replenishing the talented and skilled workforce (Blanchard, 2007, p. 10). By saying that the demographic population is changing, this means that "old-timers" are retiring in the industry and taking their years of experience with them. New employees to the industry will benefit from their shared knowledge and new training. The following nine points are common elements to successful training as identified by several researchers:

1. Training is not limited to the technical issues and concepts taught by the quality experts. The training effort must also address the human behavioral issues.
2. Training is a job requirement and everyone is involved in the training effort.
3. The training should be carried out by the managers and peers of those being trained.
4. The training effort should be tailored to the group being trained. The subject matter and examples should be relevant to their particular job function.

5. Follow-up training is essential, and should be part of the overall training plan and a job requirement for each individual.
6. Management demonstrates their commitment to the training program through their active participation and support.
7. Training effort is not decreased during a crisis situation.
8. Methods and techniques taught through the training effort should be applied to the job as quickly as possible.
9. The training effort follows a specific plan, and its implementation and effectiveness are carefully tracked. It is initiated in a limited number of pilot teams that have been carefully selected by the planning group. The success stories of the pilot teams are then used to fuel the remaining training effort (Burati Jr., Matthews, & Kaldindi, p. 119).

Appendix A of this report includes a complete proposal for training. This proposal for training includes learning objectives, a needs analysis, training task analysis, schedule and directions for facilitating the training, budget, and evaluation strategies. Appendix B includes a Quality Control Start-up Manual with material which the trainer can use during the training and which will help the organization with their action plan for implementation. Appendix C includes the trainers PowerPoint presentation for use during the training with speaking points attached to each slide. Appendix D includes sample forms for use during the training as well as evaluation forms for the training and the trainer.

The training program addresses issues of ethics and influences of poor decision making in the construction industry in an effort to develop those personalities which are weak in the skills necessary for making the right decisions. While many companies do strive for zero punchlist items, there are many companies without formal quality control programs that still

achieve high quality work. Formal quality control training and programs can both enhance quality delivery of construction projects and result in economic benefits to all parties. Continuous education and training empower the employees to do the right thing and with a successful program, they will also realize their efforts in the bottom-line profits of the job.

If the organization wishes to strengthen their own quality control programs, it would be recommended to administer personality type assessments, such as the Myers-Briggs Type Indicator to get a sense for the employee's personality types and abilities. When the organization understands what types of people are in the team, it can build a successful team of individuals whose personality types work well together and will be able to implement the action plan.

Recognizable Cost Savings with Implemented Training

Typically, with any training program there are upfront costs to conduct the training. Over time, the cost savings are realized throughout the life of the project. During the proposal and bid stage of projects, contractors usually must pre-qualify to bid. Pre-qualification includes safety statistics and incident ratings. Contractors and owners could also realize that quality control ratings and statistics are a potential source of marketing that are untapped much in the same way an EMR is used to market safety within the company.

Professor Jenkins put it well that "defects are not free. Someone was paid to make the mistake (Deming 9). Now someone is paid to correct the defective work. Additional material and equipment costs will also apply to this correction process" (Jenkins, April 7-10, 1999) .The Construction Industry Institute (CII) in Publication 10-2 *Measuring the Cost of Quality in Design and Construction* researched that an estimated $15 billion is lost each year due to the cost of quality rework (Institute, 2010).

The cost of rework can be recognized in several ways. First, consider that return on investment (ROI) is realized through Key Performance Indicators (KPIs). Some ways to identify KPIs are the number of punchlist items and repetitive issues on the project, on-time completion of the project, and the earned man-hour approach to realize production and profits. According to one study, rework can cost up to 6-12% of total expenditures on the project (Cox, Issa, & Ahrens, pp. 143-144). For example, a $100,000 project could be spending as much as $12,000 on rework costs. KPIs showing that the project is behind schedule with excessive repeat punchlist items are indicators contributing to that 6-12% that the project is in need of better quality control management. Specifically, for companies that self-perform work, quality control and rework is a top KPI for ROI and managing profits (Cox, et al., p. 148).

There are several other ways to represent the cost of quality and financial impact of rework. In a training program developed by the Masonry Contractors Association of America and the National Concrete Masonry Association, the cost of quality was represented in the following illustration:

The Cost of Quality =

Cost of Conformance + Cost of Non-Conformance + Cost of Lost Opportunities

(Industry, p. 81)

The masonry industry recognized that in production of masonry blocks, even a 5% loss of unit sales when compared with the hard cost of producing the blocks ($50,000) and the intangible loss of sales ($25,000), their total lost profits would be $75,000 (Industry, p. 84). This $75,000 contributes to overall losses in the industry as recognized by CII.

Costs related to quality control can also be broken down into two categories- costs of prevention and appraisal and costs of deviations where:

Quality costs = quality management costs + deviation costs

And

Quality management costs = prevention costs + appraisal costs

(Burati Jr., et al., p. 121)

For example, prevention costs are the costs associated with training and appraisal costs are the costs associated with auditing the return on investment from the training. Deviation costs are those costs associated with re-work as a result of work put in place incorrectly the first time. Another way to represent cost savings on the job is shown in the following Figure 1. An anonymous general contractor in the Mid-Atlantic region has provided current unit rates and hourly rates for the figures below.

Figure 1.

Quality Management Costs					
Conduct One Training Program	**Unit**	**Cost ($)**	**Amount**	**Total**	
QC Trainer (1)	Hour	30	4	$120.00	
Training Program	Each	1500	1	$1,500.00	
Employees in Training (10)	Each	25	40	$1,000.00	
Evaluation and Auditing	Hour	30	8	$240.00	**Appraisal costs**
Total				$2,860.00	
Build One Drywall Wall Correctly	**Unit**	**Cost ($)**	**Amount**	**Total**	
Drywall Workers (2)	Hour	15	16	$240.00	
Drywall Wall Construction	LF	20	100	$2,000.00	
Trained QC Employee	Hour	25	8	$200.00	**Prevention Costs**
Total				$2,240.00	
Total of Combined Training and Construction of Wall				$5,100.00	
Deviation Costs					
Continue Building Walls with Mistakes	**Unit**	**Cost ($)**	**Amount**	**Total**	
Drywall Workers to Build Wall (2)	Hour	15	32	$480.00	
Drywall Workers to Demolish Wall (2)	Hour	15	16	$240.00	
Drywall Wall Construction	LF	20	200	$4,000.00	
No Quality Control	Hour	25	0	$0.00	
Total				$4,720.00	
Difference between building one wall with mistakes and building one wall with training				**-$380.00**	
Building 10 walls with mistakes				**$47,200.00**	
Building 10 walls correctly after training				**$25,260.00**	
Total Cost Savings for QC training and Construction				**$21,940.00**	

Quality Management Costs in Figure 1 are represented with the training program using one trainer, ten employees who will conduct quality control activities, the purchase price of the training program, and the cost for the trainer to conduct evaluation and auditing after the training. The evaluation and auditing allotment are the appraisal costs. The Quality Management Costs here are $2,860.00. Using the example of construction of a drywall wall we can figure out cost savings for incorporating quality control activities into the construction of the wall. Having one QC inspector involved in the construction are the prevention costs. The wall would require two drywall workers eight hours each to construction 100 linear feet of wall. The wall costs $20.00 per linear foot to construction. Building one portion of 100 linear feet of wall correctly would cost $2,240.00. Combined with training and construction, overall Quality Management Costs are $5100.00.

Next when analyzing the deviation costs, consider that the same wall will need to be construction once, torn down for incorrect work, and then reconstructed. The cost of materials increases, as well as the time needed for the work. No quality control activities were implemented in the construction of the wall. Deviation costs are reflected at $4,720.00. Also considering that with no quality control supervision, the deviation will continue to occur. If the deviation occurs ten times in the life of the project, the contractor has incurred $47,200.00 in costs, or basically building each wall, tearing it down, and rebuilding it. The cost of building ten walls correctly after training would only be $25,260.00. By using trained quality control employees and building the walls ten times, the contractor could save $21,940.00. This cost savings only reflects one specific work activity. With quality control incorporated into every discipline and definable feature of work on the project, that figure can continue grow.

Conclusions, discussions, and recommendations

Despite many personality studies and findings which support that some personality types could struggle implementing quality control activities, continuous education and improvement through the use of training programs can strengthen their skills. Although there are few formal quality control training programs available, university curriculums and trainings provided by the Army Corps of Engineers are a start to increasing awareness in the industry and bring more qualified professionals into the field. At this time, contractors will find the majority of their training resources through training websites and other industry association websites. Programs like the International Organization for Standardization provide a standardized certification program but with more marketing and advertising, there could be a rise in participation from the current 100 certified companies.

Recommendations include advertising for quality control training at industry-sponsored events held by the Associate Builders and Contractors, Associated General Contractors, the Project Management Institute, or Associated Schools of Construction. It is also recommended that organizations putting together their own quality control departments utilize personality type indicators to build teams, understand cultural values, and identify early-on individuals who may not be compelled to confront issues right away. Organizations with a mission to strengthen quality control efforts must also be aware of the negative factors which influence ethical decision-making.

In conclusion, a standardized and complete training for a quality control program will help reduce the amount of deficiencies in building construction projects as well as increase awareness of ethical issues. Formalized quality control training will also reduce the overall

punch-list items for a project and the organization can realize true cost savings by reducing the number of repetitive issues.

Appendix A Training Proposal

APPENDIX A

PROPOSAL FOR TRAINING

QUALITY CONTROL PROGRAM AND PROCESSES

PREPARED BY

JULIE MCDONALD

SPRING 2010

Executive Summary

The following training program is designed for small to large construction industry companies wishing to have a standardized quality control program within their organization. The training provides detailed explanations of each step of the process and a budget for implementing the training. Strong quality control programs directly contribute to cost savings and good contractor reputation providing a marketing tool for the company. In tough economic times, the ability to finish a job within budget and provide quality work set apart the good contractors from the not-so-good contractors and contributes to gaining repeat clients and profits. This four hour lecture and interactive presentation will teach the participants how to assemble a quality control program for implementation within their own organizations and provide tools for reinforcement after the training.

Purpose and Learning Objectives

The purpose of this training program is to provide employees with a tool to aid them in making ethical decisions in the field. Traditionally, focus is placed on training for safety on the jobsite but few formal training programs focusing on quality exist. Poor quality in building projects develops low worker morale, loss of revenues, repeat work, and unsafe conditions. Several large organizations such as the Army Corps of Engineers in conjunction with the Naval Facilities Engineering Command have developed a formal mandated quality control program to be implemented on DoD projects. This program is a full-day training program and is required for quality control personnel and management on those projects. The purpose of this training is to target smaller contractors who may not have a formal quality control department and do not work for government DoD projects. The benefit to producing higher quality products are safer

building and higher potential for repeat clients with an emphasis on supporting small and minority owned businesses.

Training is considered a method of continuous improvement which all companies can address is a benefit. Training specialists P. Nick Blanchard and James W. Thacker clarify the following model for continuous improvement:

- "Identification of performance improvement opportunities and analysis of what caused the opportunity to exist;
- Identification of alternative solutions to the opportunity and selection of the most beneficial solution. A training program is one of many possible performance improvement solutions;
- Design and implementation of the solution (training if it is one of the selected solutions); and
- Evaluation of results to determine what, if any, further action should be taken" (Blanchard, 2007, p. 13).

In this case, quality control is an opportunity for performance improvement where profits and productivity can be increased. A training program is the selected performance improvement solution. This proposal for training fulfills the design and implementation of the solution need. The training program also supports auditing and evaluation at the completion of the training.

The first learning objective for this training will be for participants to gain an understanding of how their decision-making in the field can positively or negatively impact the whole project.

The second learning objection is that participants will learn about the history of quality control and the quality control process from start to finish on a project, using the total quality management approach.

Finally, participants will learn the financial impact of successful quality control programs and discuss action plans to help them implement quality control activities on their own projects.

Rationale and Justification

Importance of Issue, Data, and Trends

The most widely recognized quality assurance program is the International Organization for Standardization (ISO) 9000. However, less than 100 companies in the country are actually certified in this system (Harrison, p. 5). Other regulating agencies in quality control rest at the state and federal level for building code officials and inspectors. These individuals have the authority to issue permits and occupancy but standardization and self-regulation needs to be brought down to the contractor level.

In a 1999 survey of 20 construction companies to find out what they considered important skills for employees, proper inspection and testing scored a 3.45 out of 4.0 points and was recognized as a relatively important skill (Jenkins, April 7-10, 1999). However, when asked who performs quality control functions within their organization, 75% of the companies stated that the superintendents performed the activities (Jenkins, April 7-10, 1999). Superintendents are involved in all aspects of the job from safety to scheduling to craft supervision. When a superintendent must also monitor quality control activities small issues could be missed resulting in poor quality work. If the superintendent must be involved in quality activities, solid training

will help him/her to make the right decisions in the field and be more cognizant of what to look for.

There are several trends for quality control training in the industry. While many general contractors have their own quality control programs and trainings, these are not made public and are kept as trade secrets to maintain their competitive edge in the industry. Large general contractors, specifically on DoD projects are required to implement the Quality Control Management for Contractors program by the United States Army Corps of Engineers and Naval Facilities Engineering Command. Smaller contractors may have their own scaled down quality programs but the trend in the industry is that there is no standardization as recognizable as OSHA safety efforts and regulations.

Best practices that exist now consist of detailed tracking systems of punch-list items and discrepancies, careful review of all contract documents (RFP, specifications, drawings), and meetings with subcontractors to review quality expectations. Best practices in the field would require quality control inspectors to directly confront poor quality work in progress and work with the field staff to quickly and accurately resolve the issue while tracking it until completion. Quality Control as a program must be implemented cradle-to-grave on a project. This training program supports those best practices as well as enhances them.

Some key obstacles for implementing best practices are the cost of running quality control programs and getting total buy-in of the individuals performing the activities. The individuals must identify with the process, understand how it works, and be self-motivated to perform the tasks. Some major obstacles for implementing quality control are the levels of indifference, ethical influences, and poor decision-making present in the industry. This training

program aims to provide positive influences and provide the education for the employees to gain autonomy to make correct decisions in the field. When the employees have the tools to properly implement quality control activities, they will be more likely to use them.

Needs Assessment, Pre-Planning, Data Gathering

The need to assess the work force knowledge base will provide a baseline for developing this quality control program. If a company is trying to determine if training is needed there are several steps they can take. First, the organization should conduct a quality audit to determine the need for a standardized program. A sample audit is provided in Figure 1.

Figure 1.

	Yes?	No?
All key business processes are defined or "mapped out" in quality procedures.		
Quality plans are developed for each project that sufficiently verify quality at a frequency and level of detail that is robust enough to assure quality.		
All quality system documents are controlled ("document control") via a unique document number and a revision number and all employees know where the latest revisions are kept.		
Training records exist to demonstrate that all employees were trained on the procedures that pertain to them.		
Internal audits are conducted periodically to ensure that the quality procedures are being followed ("inspecting the inspectors") ("self-policing") and in order to provide validity and substance to your quality program.		
Methods are in place to ensure that non-conforming work is properly identified and corrected so that your customer does not have to find it.		
Corrective and preventative action is implemented where needed to prevent defects and quality issues from re-occurring.		
Quality system performance data (# of non-conformances, the vital few, etc.) are assessed at least annually by the senior management team to determine if the quality system is working. Changes are made where necessary to drive continuous improvement.		

(Harrison, p. 4)

If responses to the questions result in a majority of “NO” responses, a formal quality control training is recommended.

The second step in the needs analysis is looking at the type of project and contract requirements of the owner. This quality control program will be best suited for building projects but could be modified to work in other realms of the construction industry such as heavy industrial and highway projects. Understanding the contract requirements of the owner is essential in determining what level of quality control services must be provided

Third, the company should analyze previous performance evaluations and see how they were rated. Another indicator that quality control training is needed is a high level of final punch-list items and owner punch-list items at turnover. Providing the employees with quality control training will teach them inspection skills to use throughout the phases of construction and will be directly reflected in a successful turnover with minimal issues.

A fourth indicator that quality control training is needed is discrepancies on previous projects which caused loss of revenue and created damaging schedule delays. Utilize root-cause analysis and lessons learned or determine if the organization uses a Risk Assessment Database to work towards preventing repeat problems. Using the inspection processes in this training program help catch these types of issues early-on before they become cost and schedule inhibitors.

Finally, the project specifications often mandate what levels of quality are required for definable features of work within the CSI Standards. Typically a “Section 3” of the performance specifications will spell out required testing and inspections.

Pre-planning required for this training program requires checking budget feasibility. The program provides a complete presentation with handouts and is supplied in one affordable package. There would only be a one-time fee for purchase of the training materials which could be used multiple times by the same organization. The training materials are reproducible for use in the field and for future trainings. Repetitive trainings within the organization are encouraged since practice makes perfect and productivity can be increased with repetitive activities. In addition, the organization needs to determine if they have personnel in-house who can present this training or if they need to subcontract out a professional trainer to present it.

Corporate Strategy and Mission

The mission of this training program is to develop a culture of quality control within an organization and provide employees with tools to make better ethical decisions when faced with issues of quality. The corporate strategy is to provide quality buildings, maximize profits, and create an environment of pride and productivity.

Priority of Need

The ‘priority of need’ for such a training program is smaller contractors without quality control departments and who do not specifically work on DoD projects which mandate quality control. Quality control activities could potentially be performed by any individual on the project staff; however, some personality studies indicate that extroverted and assertive individuals will have better success at confronting issues and making ethical decisions. Priority for training could be provided to those individuals lacking in those skills. New employees to a company who would be performing quality control functions should also be given priority for training. If time and budget allows, it is highly recommended that all salaried individuals on the project ranging from office engineering, project engineers, project management, field engineers, and even

extended invitations of subcontractor foremen receive training and could benefit from an increased understanding of the total quality management process.

Return on Investment

The return on investment includes anticipated benefits of productivity, profitability, and increased worker morale. Although there are upfront costs for conducting a training program, cost savings can be realized throughout the life of the project. If the organization is in a specialty division of the industry, for example building hospitals, skills learned in the training will continue to develop and the return on investment will be realized in other projects as well.

One way to recognize the return on investment is to use real figures within a definable feature of work or division and break down one construction activity. The cost of implementing the training program versus having no quality control present on the job is compared in Figure 2. Figure 2 breaks down the construction of one 100 linear foot drywall wall using two workers and the cost of deviation where the wall was built incorrectly and must be torn down and reconstructed. No quality control was used in the construction of the incorrect wall. In addition to monetary loss is a productivity loss of 24 hours, or, the time taken to tear down the 100 feet of wall and rebuild it. Figure 2 reflects a cost savings of over $20,000 just by preventing the deviation from occurring in repeated portions of construction. Also consider that this cost savings is for one specific work task. The cost savings can be increased in every division and feature of work by using trained quality control inspectors who will identify non-compliant work during construction before time and funds are lost.

Figure 2.

Quality Management Costs

Conduct One Training Program	Unit	Cost ($)	Amount	Total	
QC Trainer (1)	Hour	30	4	$120.00	
Training Program	Each	1500	1	$1,500.00	
Employees in Training (10)	Each	25	40	$1,000.00	
Evaluation and Auditing	Hour	30	8	$240.00	**Appraisal costs**
Total				$2,860.00	

Build One Drywall Wall Correctly	Unit	Cost ($)	Amount	Total	
Drywall Workers (2)	Hour	15	16	$240.00	
Drywall Wall Construction	LF	20	100	$2,000.00	
Trained QC Employee	Hour	25	8	$200.00	**Prevention Costs**
Total				$2,240.00	
Total of Combined Training and Construction of Wall				$5,100.00	

Deviation Costs

Continue Building Walls with Mistakes	Unit	Cost ($)	Amount	Total
Drywall Workers to Build Wall (2)	Hour	15	32	$480.00
Drywall Workers to Demolish Wall (2)	Hour	15	16	$240.00
Drywall Wall Construction	LF	20	200	$4,000.00
No Quality Control	Hour	25	0	$0.00
Total				$4,720.00

Difference between building one wall with mistakes and building one wall with training **-$380.00**

Building 10 walls with mistakes **$47,200.00**

Building 10 walls correctly after training **$25,260.00**

Total Cost Savings for QC training and Construction **$21,940.00**

Program Outline

Instructional Design and Facilitating the Training

The training is designed to fit into a four hour time slot so that employees will not be absent from their normal work activities for a full day and so that a meal will not be required during the training. Several short breaks are incorporated into the program schedule to allow time to return phone calls and use the restroom. Each section of the training is between 45 minutes and an hour and a half so as to keep the attention of the participants without getting long-winded. Various teaching methods will be used to reach the participants. Studies show that people learn using a variety of methods using senses such as seeing, listening, and hands-on activity. This training program will use lecture and visual aid materials in addition to participation from the participants to address those different learning styles.

Careful selection should be made of the trainer. On-the-job trainers are proven to be effective but the organization should consider the following when selecting a trainer:

- "know the job to be trained,
- Be knowledgeable in the interpersonal skills necessary to interact effectively with those they train,
- Be skilled as trainers, and
- Be motivated to be trainers" (Blanchard, 2007, p. 307).

A well-facilitated training has a well-structured schedule. The schedule for the training program should run with the following time allotments shown in the chart below:

30 Minutes	Brief History of Quality Control and discussion of Ethics
5 Minutes	Break
75 Minutes	The QC Process, lecture about the steps of the QC Process
5 Minutes	Break
60 Minutes	Close-in Inspections and Authorizations, present sample forms
5 Minutes	Break
50 Minutes	Participation Sections, "What Would You Do" Situational Role-Play, Cost-Savings and Financial Impact discussion
10 minutes	Closing, Action Plan, Evaluations
4 Hours	*Total time for training program*

Location

This training can be facilitated in a jobsite or corporate office with accessibility to computer and projection equipment. If no projection equipment is available, the PowerPoint presentation can be printed out in hand-out format for participants to follow along and take notes.

Supplemental Materials

Supplemental materials for the training course are provided in the program package. They include a PowerPoint presentation compatible with Microsoft Office 2007 and older versions which detail the course content, provide sample quality control forms which can be reproduced and distributed at the training, and the Quality Control Start-Up Manual for use as an action plan in the organization.

Training Task Analysis

The following is a general and not all-inclusive list of basic tasks which an employee conducting quality control activities would complete. In a formal training program, these are often referenced as Knowledge, Skills, and Attitudes, or KSAs. Following the task is a description of the knowledge and skills required to complete the task. The knowledge and skills will be acquired with successful completion of the training.

Task **Knowledge and Skills Required**

1. Reviewing subcontractor's capacity for quality work.

    - Knowledge of the subcontractor's previous performance ratings and outstanding punch-list items at project close-out for purposes of buy-out activities.

2. Review of submittals for compliance with project requirements.

    - Knowledge of how to read and interpret specifications and RFP requirements for performance and materials required on the job for the submittal review process.

3. Facilitating the pre-construction meeting.

    - Knowledge of the components which should be incorporated into the pre-construction meeting and knowledge of the required participants.

4. Facilitating building inspections.

    - Knowledge of the project specifications, interpretation of the drawings, and the ability to confront non-conforming work in the field.

5. Writing discrepancy reports, inspection reports, and daily reports.

    - Understanding what information must go in each report and how to properly file it.

6. Maintain detailed tracking logs.

- Knowledge of work activities and work progress in the field as well as the attitude to follow up with issues until resolution.

Distribution of Attendees

The distribution of attendees will be primarily the employees who will participate in quality control activities for the project. As already identified, this group of individuals has priority of need for the quality control training. The training program can be run at project start-up or as needed and depending on size of the training room and staffing availability. It can include as many people on the project at the organization would like. The overall intent is to have all employees pass through the program at some point to build the culture of quality control within the organization.

Required Training Resources

The required training resources will be the packaged quality control training program. This package consists of the Proposal for Training, the Quality Control Start-Up Manual, a PowerPoint presentation, and handouts with examples of standard forms. In order to facilitate the training a conference room or classroom would be acceptable. A computer with projection equipment is also needed to present the PowerPoint presentation. The handout materials are not copyrighted so access to photocopying equipment is needed to make enough copies of handouts for the participants.

Budget

Figure 3 is the budget which depicts the monetary costs of putting the participants through the quality control training. As shown in the table, the first column represents the line item, the second column describes unit of measurement for each line item, the third column are the unit rate costs, and the fourth column is the total.

Figure 3.

Line Item	Unit	Cost	Total
Purchase Price of the Package	1 unit	$1500.00	$1500.00
Time for the Employees to attend training (base 10 employees)	4 hours	$20/hour	$800.00
Cost for copies of the training	60 units/ 45 pages each	$.05/page	$135.00
Computer equipment available	1 unit	$0.00	$0.00
Space to facilitate the training	4 hours/1 unit	$0.00	$0.00
Total			$2,438.00

After the initial cost of purchasing the training program, the cost is dramatically reduced to just the time and money associated with the employees attending it and cost of generating copies of the presentation for the training. As mentioned, there is cost associated with the employees attending training where they are not engaged in productive activities elsewhere on the job. This cost would depend on the hourly rates and ranks of the individuals in training. If the training can be facilitated on the jobsite, there is an assumption that there are no costs associated with renting space or use of computer equipment.

Training Evaluation Strategies

Evaluation Methods

The following nine points are common elements to successful training as identified by several researchers:

10. Training is not limited to the technical issues and concepts taught by the quality experts. The training effort must also address the human behavioral issues.
11. Training is a job requirement and everyone is involved in the training effort.

12. The training should be carried out by the managers and peers of those being trained.
13. The training effort should be tailored to the group being trained. The subject matter and examples should be relevant to their particular job function.
14. Follow-up training is essential, and should be part of the overall training plan and a job requirement for each individual.
15. Management demonstrates their commitment to the training program through their active participation and support.
16. Training effort is not decreased during a crisis situation.
17. Methods and techniques taught through the training effort should be applied to the job as quickly as possible.
18. The training effort follows a specific plan, and its implementation and effectiveness are carefully tracked. It is initiated in a limited number of pilot teams that have been carefully selected by the planning group. The success stories of the pilot teams are then used to fuel the remaining training effort (Burati Jr., et al., p. 119).

At the completion of the training a training evaluation and trainer evaluation should be distributed. The training evaluation will identify if the participants thought it was useful and what areas of the training could be improved. The trainer evaluation will identify if the trainer presented the material well and clearly communicated all information. If the trainer is an in-house employee, this trainer evaluation will help assess if they are competent enough to continue presenting the material or if another employee might be a better candidate. Samples of these evaluations can be found in Appendix D.

A common way to evaluate training is with audits. Audits are a good way to make sure that the i's are dotted and the t's are crossed within the quality control program. After the audit, if a

lot of holes are found in the program, re-training may be needed and a general re-evaluation of ethical standards and goals of the organization. A good audit can consist of the following:

- All files are current and organized in a matter which facilitates finding them easy.
- The process is being followed for each definable feature of work meaning that buy-out, submittal, and pre-construction meetings, mock-up, follow-up, material, and source inspections are being completed.
- In-house, pre-final, and final inspections are completed and all punch-list items closed for each finished space of the project.
- The quality control department is established and roles of each individual are understood.
- Tracking logs and matrixes are detailed and current.
- RFI's are reviewed and posted to the drawings.
- Specification records and contract drawings are maintained with the most current documents.
- Look to the needs assessment checklist for other audit ideas.

Overall, evaluation is a necessary part of facilitating training programs. Careful review and thoughtful consideration of the participant's evaluations help build a strong program and generate autonomy within the organization. It also helps recognize the return on investment.

Performance Indicators

Success of the quality control training program can be measured by performance indicators. After the training is completed and the quality control processes are being implemented on the job, the detailed tracking charts of discrepancies will help show visually that issues are being identified and corrected in the field. At project close-out, reviewing the number

of open discrepancy reports and severity of the issues is another indicator that the process is being used and is working. Having a higher number of severe discrepancies throughout the life of the project isn't always bad, but it is a sign that they are being recognized and followed up. Discrepancies reflect negatively at the end of the job when they are left unresolved. Severe discrepancies, however, do take away from the bottom-line of profits.

Another performance indicator is general punch-list items. Through the use of the inspection processes during construction, issues are being identified while they are minor and can be quickly resolved with cooperation from the subcontractor work force. Through the life of the project there should be a learning process which results is decreased number of repetitive issues by project close-out.

At the completion of the training the participants will discuss their action plan for implementing the quality control processes on their job or within their organization. An action plan may have already been formed by corporate management and it is appropriate at the end of the training to discuss the corporate plan of action and get feedback from the participants. It is important for the participants to accept the action plan as their own and wish to implement what they have learned.

Appendix B Quality Control Start-Up Manual

APPENDIX B

QUALITY CONTROL START-UP MANUAL

PREPARED BY

JULIE MCDONALD

SPRING 2010

Purpose

The purpose of Quality Control is to provide a system of checks and balances for a project and make sure the customer is getting a quality product. The main purpose of Quality Control is to provide Customer Satisfaction. A good QC Department provides confidence to the owner that they will get what they paid for. Quality Control also instills a philosophy of "get it right the first time" in the subcontractors and workers who will be putting the work into place. Finally, the purpose of Quality Control is to make sure that all components of the projects fill the requirements of the contract.

Quality Control strives to make sure the building is delivered using quality materials and putting work into place which meet the requirements of the contract drawings and specifications.

The Quality Control Department is completely independent from cost and scheduling on the project.

Who is responsible for Quality Control

In addition to the Quality Control Department, people on the project who are also responsible for Quality Control are the owner's representatives, subcontractors, foremen, superintendents, project managers. In short-everyone on the job is responsible for quality.

Ethics

Employees of the Quality Control Department will remain objective throughout the course of the project. It is within their right to interpret specifications and contract drawings to the best of their abilities and not to be swayed by project costs and/or schedule. They shall remain independent of cost control and scheduling activities. Employees of the QC Department will have the confidence to promptly identify issues and communicate issues to those responsible for fast remediation. They will follow up on issues until they are resolved and accurately track and document all work. Quality Control Engineers must be honest and accountable for their work. If these qualities are not portrayed, a review with the Quality Control Manager will occur and could lead to termination of position.

Definition of Quality Assurance vs. Quality Control

Quality Assurance is defined as "a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met."

Quality Control is defined as "an aggregate of activities (as design analysis and inspection for defects) designed to ensure adequate quality especially in manufactured products"

To summarize, quality assurance is the program that monitors the quality control activities. Quality Assurance begins at the corporate level and applies to all projects equally while quality control is a project specific program defined by the contract documents and specifications.

Definition of "Definable Feature of Work (DFOW)"

The definition of a "Definable Feature of Work" or DFOW is a single work activity as it relates to the specifications. For example-specification 03300 Cast in Place Concrete is a DFOW and will be tracked as a independent piece of work. Although the DFOW relates to multiple features of work, complete quality control can be practiced when the DFOWs are broken down.

Job Start-up of Quality Control Team/Department

A successful Quality Control Team has a Quality Control Manager and Quality Control Engineers working directly beneath the manager. If the project budget allows and the QA Manager oversees multiple projects, designate a Lead QC Engineer. In addition, if the project is over $XX, hire a QC Administrative Assistant to keep the department organized and maintain control over the documentation and filing systems.

Quality Control Engineers should be discipline-specific. There should be a Engineer for Architectural, Structural, Electrical, and Mechanical. If there are any other large specialized features of work on the project, additional support may be needed.

Individuals working for the department should have 3-5 years experience working in that discipline and should be familiar with basic specifications, certifications, and standards. Certifications, such as CORPS of Engineers, ACI, IBC, etc. are added benefits for the employees.

See Exhibit A for Quality Control Team matrix.

Employees in Quality Control must have a college degree or 3-5 years work experience in a related field.

Employees must also exhibit the following characteristics: organization, credibility, responsibility, accountability, professionalism, competency, and objectivity.

Certifications

Department of Defense (DoD) projects require the Army Corps of Engineers certification.

Other programs available at the discrepancy of the QC Manager are:

ACI Class 1 and Class 2 certifications for structural inspectors

Welding inspection certifications

Asphalt inspection certifications

Position Descriptions

The Quality Control Manager oversees the entire department. In addition to the tasks outlined below for the Quality Control Engineer, the Quality Control Manager handles personnel issues within the department and acts and role model and mentor to new Quality Control Engineers. In addition to being a role model, the Quality Control Manager must strive to exhibit a commitment to the top-down mentality of quality management and risk management from upper-level

management. The Quality Control Manager also maintains records of certifications and training achieved by Quality Control Engineers.

The Quality Control Engineer job requirements are to develop and maintain the QPL, oversee the removal and replacement of non-conforming work, review discrepancy reports and other outstanding issues for resolution, facilitate pre-construction meetings, facilitate testing and close-in inspections, complete all reports as outlined in this Section, assist in training subcontractors and achieving total quality buy-in from the people putting work into place to avoid re-work, and maintain daily reporting log.

The Quality Control Administrative Assistant assists in the documentation of red-line drawings and maintaining all filing systems. The Administrate Assistant must maintain current Quality Points of Contact lists, updated point files and point file index, and assist the Quality Control Manager with testing/inspection scheduling.

A suggested organizational structure would have a Quality Control Manager with Quality Control Engineers and an Administrative Assistant who report directly to the Quality Control Manager. Though this structure is Human Resources intensive, small companies or smaller budgets can package the positions into one person or a few people as needed by the size of the job and job budget.

Self-performed work vs. Contractor-performed work

Self-performed quality inspections generate a quality product because there is pride in one's work, there are self-checks for quality, and the contractor has a total quality program buy-in. In addition, they have a total understanding of the requirements and scope for their work. They understand the specifications and interpret them first-hand.

Contractor or Third-Party performed quality inspections also generate a quality product because it ensure objectivity and they also have a total understanding of the job requirements and specifications.

In both cases, the contractor or third-party performed quality inspections may use the same resources available on the project such as DFOW checklists, standard forms, etc.

Quality Control Plan

Quality Control Process for Definable Features of Work

Buy-Out/Purchasing Meeting

The buy-out and purchasing meeting is conducted at the beginning of a project or project phase. This is a meeting in which bidding and buyout of a subcontractor is completed and the project is ready to contract the subcontractor company. Goals of the meeting are to determine subcontractor's scope of work, procure documentation and subcontract, evaluate the subcontractor's commitment to quality, and establish dates for submittals to be returned for approval. The participants in this meeting are the Project Manager and Project Engineers as well

as the subcontractors' management, or, the people who will be responsible for purchasing materials through the subcontractor. Quality Control Engineers are not a part of this meeting.

Pre-Mobilization/Submittals Meeting

The pre-mobilization and submittals meeting occurs after the contracting and bonding/insurance paperwork is processed. It allows the contractors an opportunity to meet the on-site teams. Specifications and contract drawings must be 100% at this time. The subcontractor meets with the Project Engineers and Office Engineers and review submittal requirements, and shop drawing requirements. They also briefly mention quality requirements and provide a copy of the QC Process flow-chart to the subcontractor's management.

Pre-Construction Meeting

The pre-construction meeting occurs approximately one to two weeks prior to start of work for a subcontractor. During this meeting, the quality requirements and discussed in detail with the subcontractor. The requirements are found in the specifications, contract drawings, and product submittals. In attendance are the subcontractor foremen, quality engineer assigned to the DFOW, office engineer, and superintendents who will be monitoring the work progress. This meeting makes sure the subcontractor understands and commits to quality control on the project. They are also presented with DFOW checklists to facilitate self-performed quality checks. During this meeting, the mock-up inspection is organized. During the pre-construction meeting, the agenda should include: compliance with contract documents, status of submittals, schedule, planned staff and equipment, planned shutdowns, notifications, coordination of testing agencies, and AHJs, etc.

Please see *Form D 111*

Mock-Up Inspection

The mock-up inspection occurs no more than two weeks after the preparatory meeting. This timing is important so that team members involved in the DFOW do not forget the quality requirements. At this time, the subcontractor has installed an in-place mock-up which is evaluated for compliance with all requirements. In attendance are the office engineer, superintendent, quality engineer, subcontractor foreman, and owner's representative as required per contract. Any discrepancies identified must be corrected before work continues. If no discrepancies are identified, the work is approved, the quality standards established, and work continues.

Follow-up Inspection

The follow-up inspection(s) occur on a regular basis as work progresses. Depending on quantity and frequency of work, follow-up inspections should occur between two and four weeks apart. The follow up inspection is an opportunity to select at random a section of recently installed work under a DFOW and verify that quality standards are being met. Only the quality engineer must be present for this inspection. If discrepancies are identified, the foreman is promptly notified and issues tracked until resolved. See attached Exhibit for DFOW checklist template.

Please see *Form D 101*

Source/Plant Inspection

The Source/Plant Inspection is conducted for DFOWs products as required by the specifications or Owner requirements. For example, if 03300 Cast in Place Concrete specifications call for a batch plant inspection, the QC Engineer sets up an inspection with the plant managers. The QC Engineer visits the batch plant and takes a tour of the facility to see storage conditions for materials, discuss quality controls in place at the batch plant, testing and certification requirements, and discuss how non-compliant work is identified and addressed. See Exhibits for Source/Plant Inspection form.

Material Inspections

The Material Inspection is a weekly inspection where the QC Engineer selects at random a product being used in the field and related to the DFOW they are assigned to. The QC Engineer inspects the material in place-where and how it is being stored, storage conditions, etc. The material is compared to the specifications, approved submittals, and contract drawings for compliance with all requirements. If a discrepancy is identified, the superintendent and/or subcontractor is immediately notified and the material should be removed from site or storage and use conditions corrected. See Exhibits for Material Inspection form.

Please see *Form 110*

Final DFOW Inspection

The final DFOW inspection occurs after the final piece of work under the DFOW is installed. This inspection closes out the DFOW and verifies that all quality standards have been met throughout the work process. In attendance at the final inspection should be the quality engineer, subcontractor foreman, and owner's representative as required by contract. All parties sign-off on the final inspection paperwork and the work is officially accepted.

Project Close-Out Inspections

In-House Inspection

The in-house inspection is an opportunity for the QC Engineers to inspect work with the subcontractor foreman to directly identify incomplete or damaged work during the turn-over phase of the project. As areas of the project are completed, the QC Engineer walks it with related foremen and superintendents. This inspection is not DFOW specific and all DFOWs should be looked at as a whole completed product at this time. A punch-list is generated and the items are to be corrected by the superintendents and foremen in a timely manner. See attached Exhibit for In-House Inspection form.

Please see *Form 105*

Pre-Final Inspection

The pre-final inspection is the inspection where the QC Engineers verify all in-house punch-list items are completed. In attendance should be the QC Engineers, punch-list team comprised of

representatives from various subcontractors, and the owner's representatives. A punch-list is generated and the items are to be corrected by the superintendents and foremen in a timely manner. See Exhibits for Pre-Final inspection form.

Please see *Form 106*

Final Inspection

The final inspection is the last inspection for a location on the project. All punch-list items should be complete at this time. This is the final walk-through for the owner's representatives and QC Engineers. No more punch-list items should be generated at this time. After completion of final inspection, access to the space should limited and locked-down when possible to prevent re-work.

Please see *Form 107*

Testing

Owner-Funded vs. Subcontractor-Funded Testing Agencies

When starting up a Quality Control department, the project must establish whether the testing will be conducted by an owner-funded agency or a subcontractor-funded agency. When using an owner-funded agency, objectivity is achieved, the agency is result-driven, and they often use strong documentation, and can consist of a third-party testing agency. Contractor-funded testing agencies do not have always have full objectivity, but have more flexibility. They have a desire to get the right results and get the work completed correctly. If they are performing the tests, they can take the time needed to work on the product until testing passes. The quality checks and testing are self-performed. Often on a project, the owner-funded and subcontractor-funded testing groups work together.

Master Test Register Set-up

The Master Test Register is a complete list of all testing requirements per specification and who is responsible. The test register shall identify which specification section the test is reference from, any codes or standards reference, the DFOW it relates to as well as CSI number, a description of the test and testing frequency. A matrix should be made and kept up to date with all testing requirements. As testing results are submitted, they should be added to subsections of the Master Test Register to provide one location where all results can be located. The Master Test Register shall be reviewed during buy out, in preparation for pre-construction meetings, and each time new specifications are released.

Third Party Testing

Qualifications

The third party testing agency provides qualified, trained, and objective employees to complete testing and inspections on the project in addition what the capabilities of the Quality Control Engineers. Things to consider when selecting an agency are proximity to the project, contract requirements such as hourly rates or lump sum costs, laboratory and personnel available, and

overall experience. Individuals selected as testers/inspectors shall have basic levels of certifications and training relevant to the scope of work in which they will work and minimum requirements as outlined in the specifications.

Testing Procedures

All employees involved in testing must arrive at the testing location five minutes before requested start of test. Testing parameters must be visually inspected with contract drawings and/or shop drawings. Subcontractor foreman responsible for work must also be present during test. When applicable, owner's representatives will also be present. The testing begins and all discrepancies identified are documented and/or corrected and addressed immediately. If testing fails, a retest time is established to occur after corrections are made. All results will be documented in the daily report.

Daily Reporting

All employees of the third party testing agency must furnish a daily report at close of business the day of testing which records the location, parameters, type of test, duration, specified results and requirements, actual results, start and end time and any discrepancies identified and corrected.

Documentation

Documentation is an important function of all members of the Quality Control team. When possible electronically scan hand written documents for ease of access, sharing, and distribution. Hand written documents should be written legibly in ink, but there is no restriction to blue or black ink. See below for documentation standards.

Point File Legend

The point file system is used throughout the project and designates a file number for each document in a logical order. For example, if the number designated for quality control was 10, all files in the quality control section would begin with 10. All subsequent files within quality control would also be given numbers and a detailed index must a kept. If daily reports are kept in quality control section 15, the file legend would read: (Project number) 10.15 and so on depending on sub-folders. This ensures that after an individual has moved on from the project or during close-out, documents can easily be found.

i. Folder Label Templates

Establishment of Folders and Content Required

The Quality Control Folders are a tool which keeps each DFOW organized. The project should purchase 8-tab folders. Each tab should be labeled with the following headings:

1) Subcontract

2) Pre-mobilization meeting agenda, RAD, Specification

3) Approved submittals/shop drawings

4) Manufacturer's Recommendations, RFIs, Change/Orders, ASTM

5) DFOW Checklist (blank)

6) Pre-construction meeting agenda, sign-in sheet, JHA

7) Mock-up inspection report

8) Follow up inspection reports

Work for each section should be filed according to each tab. This folder provides convenience where all requirements can be found in one location and carried out to the field. All subsequent reports related to the DFOW are found in one location as well so discrepancy tracking can be more efficient.

Quality Control Standard Forms

The following is a list of standard Quality Control Forms which should be available within the department. Each form can be modified for project specificity and enhanced based on project needs.

1. Meeting Agendas
2. Sign-in Forms
3. Inspection Report Forms
4. Material Inspection Report Form
5. Source Inspection Report Form
6. Risk Assessment Form
7. Inspection Checklist Template
8. In-House/Pre-Final/Final Inspection Punch-list Templates
9. Tracking Charts and Graphs

Recording/Tracking on Contract Drawings

Updated contract drawings should be kept by the responsible QC Engineer. As testing, inspections, and close-ins occur they should be marked out on a contract drawing. Each highlighted area should be signed and dated. Red-lined changes and RFIs should also be documented on the contract drawing. When highlighting an area, it is important to use a contrasting color highlighter or ink from the drawing. Color coding is strongly encouraged. When testing sections of mechanical or electrical work, the QC Engineer must make sure to illuminate the parameters of the test. When conducting close-in inspections, make sure get encompass the full location from column line to column line. Verify the upkeep of record document by the general contractor and all subcontractors by conducting weekly review of all documents and confirm posting of all revisions (i.e. RFIs, ASIs, addenda, change orders, field adjustments, etc.)

Photographs

Photographic documentation should accompany the following reports: Material Inspections, Initial Inspections, Follow up Inspections, and Final Inspections. Photographs should be in color and capture the section of work inspected. A close-up and a distance shot should be captured as well as multiple angles when applicable. Photographs should be labeled with the date, specification number, location, and a description. For example:

09-0401 03300 East Wing col. Lines 1-2 Foundation

Photographs should be in digital format and stored in the appropriate point file. Photographs should also be printed out and submitted with inspection reports.

Photographs should be used for warranty purposes, discrepancy identification and tracking, and to use as reference for mock-ups.

When photographs are not allowed on the project, set up a plan with the Owner's Representatives to have them take photographs and transmit them to the firm or set up a plan that allows photographs to be reproduced after review and approval by the Owner. This is common on Federal Projects.

Daily Reporting

Daily Reporting is of the utmost importance for a QC Engineer. A daily report should be completed for each day of work and should discuss all work activities observed, discrepancies identified, and testing or inspections completed. Daily reports should include daily temperature highs and lows and weather conditions. All open issues identified should be closed in a subsequent report. Daily Reports can be used in a court of law and should accurately and honestly reflect the day's work. Proper names should be used. When names are used, be sure to identify the person's company and job title as well. Relate all work back to a DFOW.

Please see *Form 108*

Submittal Review and Specification Interpretation

Project submittals and contract drawings will be checked against project specifications for compliance with requirements. A constructability review and/or value-engineering review is also completed at this time. Review should be completed with Office Engineers and Quality Control Engineers. When Quality Control Engineers review the documents, they will also be verifying that all products requiring submittals have been submitted and approved by the Architects and/or Owners. Product storage and handling, warranties, operation and maintenance requirements, installation, and protection procedures should be reviewed. Compile and maintain a log of submittals which identifies the status of each item and issue the updated log prior to each progress meeting and discuss critical submittals at the meeting.

What to Review:

Details

Shop Drawings
Manufacturer's Recommendations

Specifications

MSDS

Product Data Sheets

Schedules

Discrepancy Reports

A Discrepancy Report is filed when work that does not meet requirements of the specifications is installed and is larger than a punch-list item. An example of a Discrepancy Report would be in concrete mix was placed into a foundation that did not meet slump, air, temperature, and mix design requirements. The report would be filed describing in detail the time, date, location installation occurred, how the work is non-conforming, and what the intended resolution is. After break reports or notice from the structural engineer, for example, are received accepting the installation the Discrepancy Report can be closed. The importance of the Discrepancy Report is that it allows the owner's to also track major discrepancies and provides credibility to the Quality Control program that restrictions are in place and enforced.

Please see *Form 109*

Quality Rewards Programs

Quality Rewards incentive programs are a good way to get total quality buy-in on a project. Examples of incentive programs include weekly or monthly prizes to the contractor which had the fewest punch-list items, token towards a list of prizes for individuals who exhibit extra effort to produce quality work, and awards presented to a subcontractor company in front of a group of their peers. Friendly competition can be generated and studies show that competition can actually drive production as well.

Site-Specific Quality Training Topics

Site-specific quality training topics can include presentations about the QPL, specification reviews and interpretation sessions, and/or bringing professionals to site to conduct certification classes.

Job Close-out Procedures for Quality Control

In addition to project close-out procedures, processes significant to Quality Control are verification that all required inspections are completed and tracked on the QPL, all open action items and punch-list items are completed, the point file systems are filed appropriately, completely, and organized, all required testing and commissioning is completed, and red-lined drawings and test-reports are bundled for transmittal to the owner. Conduct correction period

inspection 11 months after issuance of substantial completion certificate and compile a list of non-compliant work and outstanding work requiring correction. Prior to expiration of the 11 month correction period, inspect all corrected work and update the list of all items which require action. Repeat the inspection process until all issues are closed.

Exhibits:

Exhibit 1-CSI Master Format

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP:

- Division 00 — Procurement and Contracting Requirements

SPECIFICATIONS GROUP

General Requirements Subgroup

- Division 01 — General Requirements

Facility Construction Subgroup

- Division 02 — Existing Conditions
- Division 03 — Concrete
- Division 04 — Masonry
- Division 05 — Metals
- Division 06 — Wood, Plastics, and Composites
- Division 07 — Thermal and Moisture Protection
- Division 08 — Openings
- Division 09 — Finishes
- Division 10 — Specialties
- Division 11 — Equipment
- Division 12 — Furnishings
- Division 13 — Special Construction
- Division 14 — Conveying Equipment
- Division 15 — RESERVED FOR FUTURE EXPANSION
- Division 16 — RESERVED FOR FUTURE EXPANSION
- Division 17 — RESERVED FOR FUTURE EXPANSION
- Division 18 — RESERVED FOR FUTURE EXPANSION
- Division 19 — RESERVED FOR FUTURE EXPANSION

Facility Services Subgroup:

- Division 20 — RESERVED FOR FUTURE EXPANSION
- Division 21 — Fire Suppression
- Division 22 — Plumbing
- Division 23 — Heating Ventilating and Air Conditioning
- Division 24 — RESERVED FOR FUTURE EXPANSION
- Division 25 — Integrated Automation
- Division 26 — Electrical
- Division 27 — Communications

- Division 28 — Electronic Safety and Security
- Division 29 — RESERVED FOR FUTURE EXPANSION

Site and Infrastructure Subgroup:

- Division 30 — RESERVED FOR FUTURE EXPANSION
- Division 31 — Earthwork
- Division 32 — Exterior Improvements
- Division 33 — Utilities
- Division 34 — Transportation
- Division 35 — Waterway and Marine
- Division 36 — RESERVED FOR FUTURE EXPANSION
- Division 37 — RESERVED FOR FUTURE EXPANSION
- Division 38 — RESERVED FOR FUTURE EXPANSION
- Division 39 — RESERVED FOR FUTURE EXPANSION

Process Equipment Subgroup:

- Division 40 — Process Integration
- Division 41 — Material Processing and Handling Equipment
- Division 42 — Process Heating, Cooling, and Drying Equipment
- Division 43 — Process Gas and Liquid Handling, Purification and Storage Equipment
- Division 44 — Pollution Control Equipment
- Division 45 — Industry-Specific Manufacturing Equipment
- Division 46 — RESERVED FOR FUTURE EXPANSION
- Division 47 — RESERVED FOR FUTURE EXPANSION
- Division 48 — Electrical Power Generation
- Division 49 --- RESERVED FOR FUTURE EXPANSION

Exhibit 2-Recommended Quality Control Supplies:

Flashlights
Mechanic's telescoping mirrors
25' tape measure
4' builders levels and torpedo levels
Sharpie markers, multi-colored highlights, multi-colored pens, mechanical pencils
Marking ribbon and work completion tags
Painter’s Tape or Fluorescent stickers
Heat sensing laser thermometers
Concrete thermometers
Assured grounding/continuity testers

Exhibit 3-Codes and Standards, Reference Library

Codes important to know for Quality Control:

Civil (ASTM)
Electrical (NEMA)
Plumbing (IPC)
Mechanical (ASHRAE)

Fire Suppression (NFPA, ANSI)
Fire Alarm (NETA)
Life Safety
Building Codes (IBC, ICC)
Structural (ASTM, ACI)

Appendix C Training Presentation

Quality Control Training

PREPARED BY JULIE MCDONALD

SPRING 2010

Agenda

- History of Quality Control and Ethics Discussion
- Break
- The Quality Control Process
- Break
- Sample forms and role-playing
- Break
- Closing, action plan

History of Quality Control

- 1900-College-level engineer programs started for concrete
- 1902-National Bureau of Standards (NBS) established
- 1910-American Society of Testing and Materials (ASTM) established
- 1961-Department of Defense (DoD) added clause to contracts which standardized the QC process for government construction projects
- Today QC is implemented by pharmaceutical, automotive, construction, manufacturing industries

Ethics and Quality Control

- Negative influences:
  - Apathy-don't care
  - Corruption-political deals
  - Schedule-driven minds
  - Costs-cutting corners to save
  - Stressful situations for the personality type
- Results in non-compliant work

Ethics and Quality Control

- Remain objective
- Don't be afraid to "be the bad guy"
- QC is not schedule or cost driven
- Do the right thing-identify issues and promptly notify responsible persons
- Follow up until issues are resolved
- Accurately track and document everything

Ethics and Quality Control

- Ethics cannot be forced!
- You must want to do the right thing!
- Good ethics and strong decision-making skills allow you to impact the overall safety and quality of the project!

BREAK

- Please return in five minutes

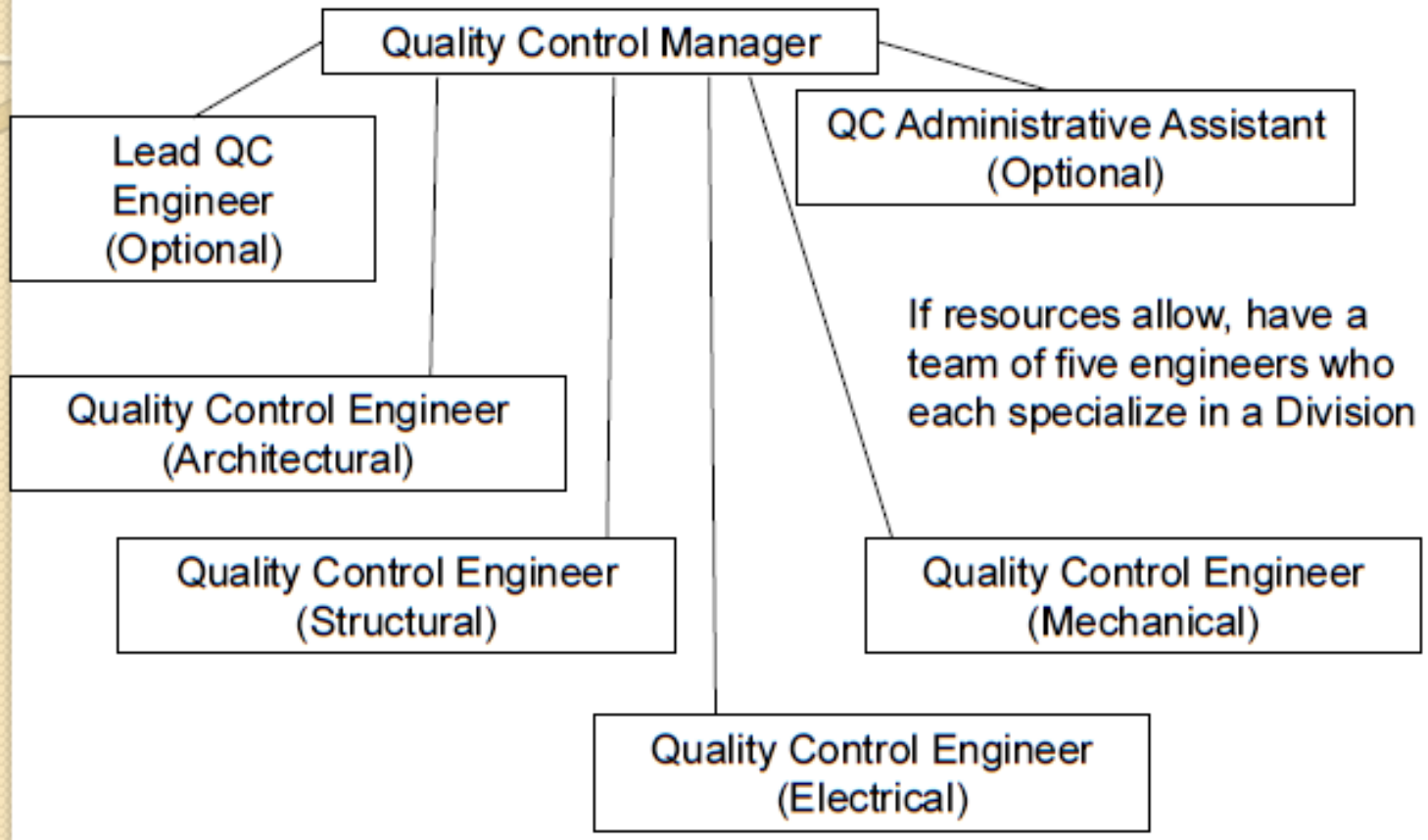
Purpose of Quality Control

- System of checks for quality
- Customer satisfaction
- Provides confidence in product
- "right the first time"

Who is responsible?

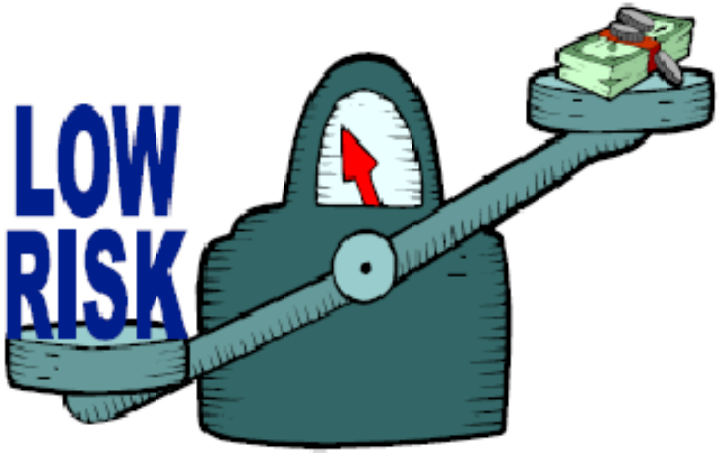
- Owner's representatives subcontractors, foremen, superintendents, project managers- EVERYONE ON THE JOB

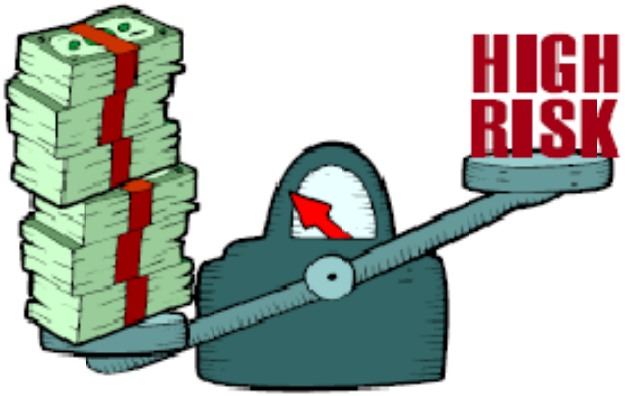
Quality Control Team



Quality Control Plan

- Organization
- Documentation
- Credibility
- Responsibility
- Accountability
- Professionalism
- Competency
- Objective
- Risk Management





The Process

1. Buy Out/Purchasing Meeting
   - Not a fundamental activity of QC
2. Pre-Mobilization Meeting
   - Not a fundamental activity of QC
3. Pre-Construction Meeting
   - Presented by QC to express expectations, field staff must participate also
4. Mock-up Inspection and Approval
   - QC, Field Staff, Subcontractor

The QC Process

5. Material Inspections
   - QC makes sure subcontractor is using what they have submitted and that it meets criteria of specifications
6. Source/Plant Inspections
   - QC checks what levels of quality exist before the jobsite
7. Follow-up Inspection
   - QC routinely checks progress and expected level of quality
8. Final Definable Feature of Work (DFOW) Inspection
   - QC has final acceptance of work when scope is completed

Testing

- Although testing is a function of commissioning, there is a QC function
- Master Test Register
  - Documents and tracks all testing and locations
- Third Party Testing
  - Soils, Concrete, Steel, etc.
  - QC acts as liaison between 3rd party and field staff
  - Objectivity

Documentation

- Use a point file system for filing
- Quality Process Log (QPL)
  - Tracks dates each event occurred

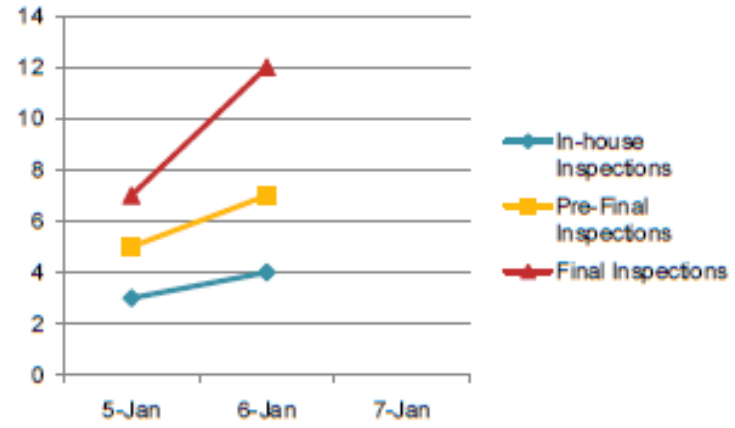
DFOW	Buy Out	Pre-Mobil.	Pre-Con.	Mock-up	Follow-up	Final
033000 Concrete	(Date)	(Date)	(Date)	(Date)	(Date)	(Date)

  - Maintain order by tracking when each date is overdue and completed

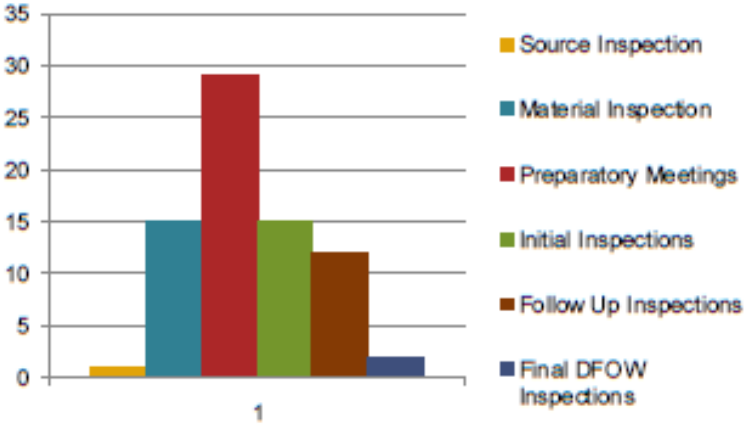
Submittal & Specification Review

- In preparation for pre-construction meeting
- Side-by-side check with contract drawings and specifications to verify compliance
- This function is usually already completed by Office staff but is checked a second time by QC
- Make sure there are no scope busts

Tracking Charts



Punch-list Tracking
-Find trends of reoccurring issues
-Track amount of work completion until finish date
-In theory want as low a number as possible at Final



Process Tracking
-Shows amount of work QC is completing
-Number of Initials should equal number of Preparatory Meetings
-Materials should equal number of weeks on the project

BREAK

- Please return in five minutes

Project Close-Out Inspections

- In-House Inspections
  - Generates a work completion list for subcontractors
- Pre-Final Inspections
  - Inspection with owner's representatives to accept final product
- Final Inspections
  - After owner's punch-list items are completed and verified

Standard Forms

- DFOW Checklists
  - For use by Engineers and Subcontractors to self-perform QC checks
- Concrete pre-placement acceptance and Wall and Ceiling Close-in Checklists
- Meeting Agendas
- Inspection forms
- Daily Reports
  - Daily tracking of QC tasks, issues, and resolutions

What to do if there's an issue

- Discrepancy Reports
  - Tracks a problem from start to finish
    - Example-Damaged anchor bolts in a spot footing
    - Write the problem, when identified, location, and what is required to resolve it
    - Later, close the report when approval from structural engineer is received
  - Let's owner know we are tracking a problem
  - Risk Management

Sample DFOW Checklist

Follow-up Inspection Checklist
03 3000 Cast-in-Place Concrete-SOG

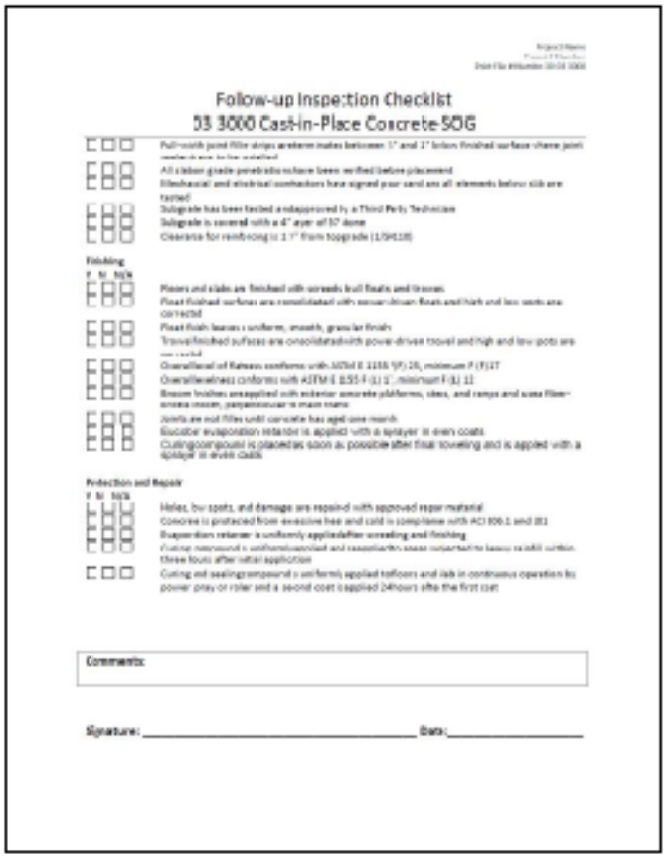
Date:
Contractor:
Inspector:
Location:
Inspection Type: ☐ Initial Inspection ☐ Follow-Up Inspection

Materials:

Y	N	N/A	
☐	☐	☐	Synthetic fiber Fibermesh 300 is fibrillated polypropylene fiber by W.R. Grace Concrete Systems
☐	☐	☐	vapor retarder is plastic and are accompanies by manufacturer's recommended tape for sealing laps
☐	☐	☐	Granular fill is clean crushed ST stone or crushed concrete
☐	☐	☐	Expansion joint filler strips are asphalt saturated organic fills by United Roofing
☐	☐	☐	Epoxy bonding adhesive is Duralcrete Epoxy System by Euclid Chemical Co.
☐	☐	☐	Expansion joint filler is Eight-Gard Fibre Expansion Joint by Right-Pave
☐	☐	☐	Concrete mix is 4000 psi 5x5 with fiber mesh added
☐	☐	☐	Concrete mix has a slump of 4" +/- 1" and air content of 4.5% +/- 1.5%
☐	☐	☐	Reinforcing bars are Grade 3, by Hoadley Burks, Type SBP, 3' leg spacing, in 5' lengths, plain wire with no protectionnce 2" rebar chairs
☐	☐	☐	Boarder strips are wood, ½" x ¼" minimum
☐	☐	☐	Recess liquid floor drains is 12 inch Omega channel by Husky
☐	☐	☐	Evaporation retarder (all-curing) by Euclid Chemical Co.
☐	☐	☐	Moisture retaining cover is Husky Barrier Sheeting
☐	☐	☐	Curing and sealing compound is Super Diamond Clear VOX by Euclid Chemical Co

Installation

Y	N	N/A	
☐	☐	☐	Gravel base is tamped and rolled before vapor barrier is installed
☐	☐	☐	Termiticide application is installed and left for no more than 18 hours before covering with poly
☐	☐	☐	vapor retarders are laid with overlaps of 6" and sealed with Husky Omega Guard Polyethylene Tape and allowed over the clean crushed stone and under the slab
☐	☐	☐	Turndown slab reinforcing uses a 90 degree corner bar and #4 continuous bar with 3" clearance (L/S3501)
☐	☐	☐	Construction joints are saved ½" minimum (6/D0110)
☐	☐	☐	Construction joints are 1 deep of concrete thickness (1" for 4" slab, 2" for 8" slab)
☐	☐	☐	Contraction joints are located at the center of column lines and halfway between column lines for 4" slab
☐	☐	☐	Control joints are cut within 8 hours of placement.
☐	☐	☐	4" slabs are made up as divided and no control joints are installed
☐	☐	☐	Grooved joints are formed after floating and finished to 1/8" wide, grooving is repeated after surface finishes are applied
☐	☐	☐	Saved joint are cut with a shatterproof or diamond-rimmed blade and cut 1/8" wide into CONCRETE
☐	☐	☐	Isolation joints are installed at all appurtenances with vertical surfaces, column pedestals, foundation walls, and grade beams
☐	☐	☐	Joints should have No. 10 felt installed
☐	☐	☐	Joint filler strips extend the full width and depth of isolation joint



Follow-up Inspection Checklist
03 3000 Cast-in-Place Concrete-SOG

☐	☐	☐	Full-width joint filler strips are between ½" and 1" below finished surface where joint sealant is to be installed
☐	☐	☐	All rubber grade penetrations have been verified before placement
☐	☐	☐	Mechanical and electrical contractors have signed pour card are all elements below slab are turned
☐	☐	☐	Subgrade has been tested + approved by a Third Party Technician
☐	☐	☐	Subgrade is covered with a 4" layer of ST stone
☐	☐	☐	Clearance for reinforcing is 1 ½" from topgrade (L/S4110)

Finishing

Y	N	N/A	
☐	☐	☐	Floors and slabs are finished with screeds bull floats and trowels
☐	☐	☐	Float finished surfaces are consolidated with power-driven float and high and low spots are corrected
☐	☐	☐	Float finish leaves a uniform, smooth, granular finish
☐	☐	☐	Trowel finished surfaces are consolidated with power-driven trowel and high and low spots are corrected
☐	☐	☐	Overall level of flatness conforms with ASTM E 1155 'Fl' 20, minimum F (F) 17
☐	☐	☐	Overall levelness conforms with ASTM E 1155 F (L) 15 , minimum F (L) 13
☐	☐	☐	Broom finishes are applied with exterior concrete platforms, steps, and ramps and some fiber-screen cloth, perpendicular to main traffic
☐	☐	☐	Joints are not filled until concrete has aged one month
☐	☐	☐	Evaporation retarder is applied with a sprayer in even coats
☐	☐	☐	Curing compound is placed as soon as possible after final toweling and is applied with a sprayer in even coats

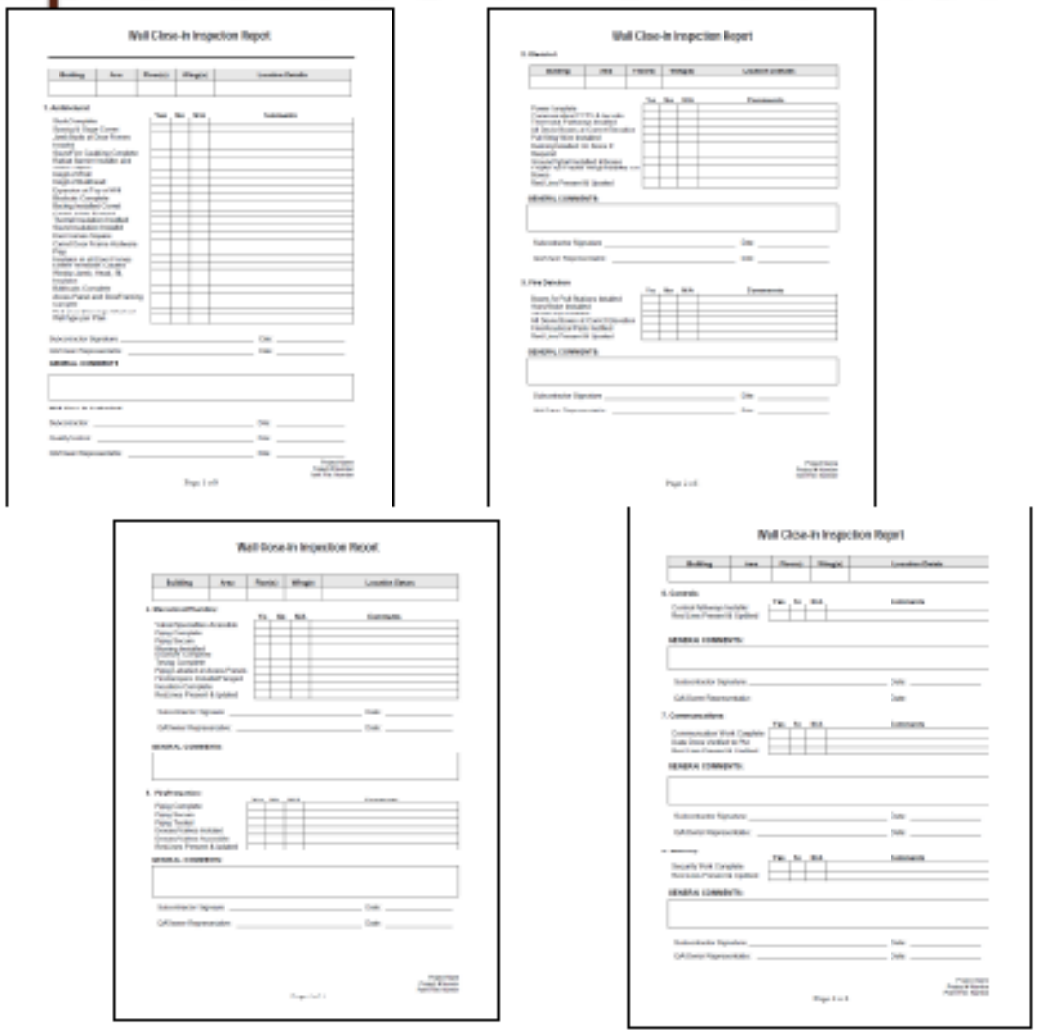
Protection and Repair

Y	N	N/A	
☐	☐	☐	Holes, low spots, and damage are repaired with approved repair material
☐	☐	☐	Concrete is protected from excessive heat and cold in compliance with ACI 306.1 and 301
☐	☐	☐	Evaporation retarder is uniformly applied after screeding and finishing
☐	☐	☐	Curing compound is uniformly sprayed and completely wets concrete but is not left puddled three hours after initial application
☐	☐	☐	Curing and sealing compound is uniformly applied to floors and slab in continuous operation by power pray or roller and a second coat is applied 24 hours after the first coat

Comments:

Signature: _____ Date: _____

Sample Close-in Checklist



BREAK

- Please return in five minutes

Your Turn

- The following are real situations encountered on the job-site.
- As a group we will use the sample forms and discuss how we would document and resolve the issues.

Situation 1

- The Superintendent presents you with a concrete pre-placement card for a slab on grade.
- The field engineer has not verified dimensions.
- You notice ice on the ground and freezing temperatures.
- You identify missing reinforcing.
- DISCUSS HOW YOU WOULD RESOLVE THIS ISSUE

Situation 2

- The Superintendent asks you to conduct a wall-close-in inspection.
- You notice the stud spacing is not correct.
- The mechanical foreman tells you the pipes aren't tested yet.
- The missing electrical box you identified last week still isn't installed.
- DISCUSS HOW YOU WOULD RESOLVE THIS ISSUE

Situation 3

- You are inspecting a new shipment of masonry blocks which arrived on-site.
- You identified that the manufacturer and product is different than the submittal sheet on file.
- You also see that the material does not comply with the required ASTM standard in the specifications.
- DISCUSS HOW YOU WOULD RESOLVE THIS ISSUE

Cost-Savings Impact

Quality Management Costs

Conduct One Training Program	Unit	Cost ($)	Amount	Total	
QC Trainer (1)	Hour	30	4	$120.00	
Training Program	Each	1500	1	$1,500.00	
Employees in Training (10)	Each	25	40	$1,000.00	
Evaluation and Auditing	Hour	30	8	$240.00	Appraisal costs
Total				$2,860.00	

Build One Drywall Wall Correctly	Unit	Cost ($)	Amount	Total	
Drywall Workers (2)	Hour	15	16	$240.00	
Drywall Wall Construction	LF	20	100	$2,000.00	
Trained QC Employee	Hour	25	8	$200.00	Prevention Costs
Total				$2,240.00	
Total of Combined Training and Construction of Wall				$5,100.00	

Deviation Costs

Continue Building Walls with Mistakes	Unit	Cost ($)	Amount	Total
Drywall Workers to Build Wall (2)	Hour	15	32	$480.00
Drywall Workers to Demolish Wall (2)	Hour	15	16	$240.00
Drywall Wall Construction	LF	25	200	$5,000.00
No Quality Control	Hour	25	0	$0.00
Total				$5,720.00

Total Cost Savings for QC training and Construction **$620.00**

Cost-Savings Impact

- In just one activity, in one DFOW, the contractor can save a minimum of $600 through training and implementation of the training in the field.
- Consider the impact spread out over all activities by preventing repeat work!

Closing

- What is your organization's action plan?
- Questions?
- Please complete your training and trainer evaluations

Appendix D Training Handouts and Sample Forms

Form D 101 DFOW Follow-up Inspection Checklist
Form D 102 Concrete Pre-Placement Checklist
Form D 103Wall Close-in Inspection Checklist
Form D 104 Ceiling Close-in Inspection Checklist
Form D 105 In-House Inspection Report
Form D 106 Pre-Final Inspection Report
Form D 107 Final Inspection Report
Form D 108 Daily Report
Form D 109 Discrepancy Report
Form D 110 Material Inspection Report
Form D 111 Pre-Construction Meeting Agenda
Form D 112 Trainer Evaluation
Form D 113 Training Evaluation

Form D 101

Follow-up Inspection Checklist
03 3000 Cast-in-Place Concrete-SOG

Date:
Contractor:
Inspector:
Location:
Inspection Type: ☐ Initial Inspection ☐ Follow-Up Inspection

Materials:

Y	N	N/A	
☐	☐	☐	Synthetic fiber Fibermesh 300 is fibrillated polypropylene fiber by SI Concrete Systems
☐	☐	☐	Vapor retarder is plastic and are accompanies by manufacturer's recommended tape for sealing laps
☐	☐	☐	Granular fill is clean crushed 57 stone or crushed concrete
☐	☐	☐	Expansion joint filler strips are asphalt saturated organic felts by United Roofing
☐	☐	☐	Epoxy bonding adhesive is Duralcrete Epoxy System by Euclid Chemical Co.
☐	☐	☐	Expansion joint filler is Right-Joint Fibre Expansion Joint by Right-Point
☐	☐	☐	Concrete mix is 4000 psi NAE with fiber mesh added
☐	☐	☐	Concrete mix has a slump of 4" +/- 1" and air content of 1.5% +/- 1.5%
☐	☐	☐	Reinforcing chairs are Class 3, by MeadowBurke, Type SBR, 5" leg spacing, in 5' lengths, plain wire with no protection or 2" rebar chairs
☐	☐	☐	Chamfer strips are wood, ¾" x ¾" minimum
☐	☐	☐	Plastic Vapor Retarder is 15 mil Orange Guard by Husky
☐	☐	☐	Evaporation Retarder is Eucobar by Euclid Chemical Co.
☐	☐	☐	Moisture retaining cover is Husky Plastic Sheeting
☐	☐	☐	Curing and sealing compound is Super Diamond Clear VOX by Euclid Chemical Co.

Installation

Y	N	N/A	
☐	☐	☐	Gravel base is tamped and rolled before vapor barrier is installed
☐	☐	☐	Termiticide application is installed and left for no more than 36 hours before covering with poly
☐	☐	☐	Vapor retarders are laid with overlaps of 6" and sealed with Husky Orange Guard Polyethylene Tape and placed over the clean crushed stone and under the slab
☐	☐	☐	Turn-down slab reinforcing uses a 90 degree corner bar and #4 continuous bar with 3" clearance (3/S3501)
☐	☐	☐	Construction joints are keyed ¾" minimum (6/S0110)
☐	☐	☐	Contraction joints are ¼ deep of concrete thickness (1" for 4" slab, 2" for 8" slab)
☐	☐	☐	Contraction joints are located at the center of column lines and halfway between column lines for 4" slab
☐	☐	☐	Control joints are cut within 8 hours of placement
☐	☐	☐	8" slabs on grade are reinforced and no control joints are installed
☐	☐	☐	Grooved joints are formed after floating and finished to 1/8" wide, grooving is repeated after surface finishes are applied
☐	☐	☐	Sawed joints are cut with a shatterproof or diamond-rimmed blade and cut 1/8" wide into concrete
☐	☐	☐	Isolation joints are installed at slab junctions with vertical surfaces, column pedestals, foundation walls, and grade beams
☐	☐	☐	Joints should have No. 30 felt installed
☐	☐	☐	Joint filler strips extend the full width and depth of isolation joint
☐	☐	☐	Full-width joint filler strips are terminated between ½" and 1" below finished surface where joint sealants are to be installed

Form D 101

Follow-up Inspection Checklist
03 3000 Cast-in-Place Concrete-SOG

☐	☐	☐	All slab on grade penetrations have been verified before placement
☐	☐	☐	Mechancial and electrical contractors have signed pour card and all elements below slab are tested
☐	☐	☐	Subgrade has been tested and approved by a Third Party Technician
☐	☐	☐	Subgrade is covered with a 4" layer of 57 stone
☐	☐	☐	Clearance for reinforcing is 1 ½" from top grade (1/S0110)

Finishing

Y	N	N/A	
☐	☐	☐	Floors and slabs are finished with screeds, bull floats, and trowels
☐	☐	☐	Float finished surfaces are consolidated with power-driven floats and high and low spots are corrected
☐	☐	☐	Float finish leaves a uniform, smooth, granular finish
☐	☐	☐	Trowel finished surfaces are consolidated with power-driven trowel and high and low spots are corrected
☐	☐	☐	Overall level of flatness conforms with ASTM E 1155 F(F) 25, minimum F (F) 17
☐	☐	☐	Overall levelness conforms with ASTM E 1155 F (L) 17, minimum F (L) 12
☐	☐	☐	Broom finishes are applied with exterior concrete platforms, steps, and ramps and use a fiber-bristle broom, perpendicular to main traffic
☐	☐	☐	Joints are not filled until concrete has aged one month
☐	☐	☐	Eucobar evaporation retarder is applied with a sprayer in even coats
☐	☐	☐	Curing compound is placed as soon as possible after final troweling and is applied with a sprayer in even coats

Protection and Repair

Y	N	N/A	
☐	☐	☐	Holes, low spots, and damages are repaired with approved repair material
☐	☐	☐	Concrete is protected from excessive heat and cold in compliance with ACI 306.1 and 301
☐	☐	☐	Evaporation retarder is uniformly applied after screeding and finishing
☐	☐	☐	Curing compound is uniformly applied and reapplied to areas subjected to heavy rainfall within three hours after initial application
☐	☐	☐	Curing and sealing compound is uniformly applied to floors and slab in continuous operation by power spray or roller and a second coat is applied 24 hours after the first coat

Comments:

Signature: _____ Date: _____

Form D 102

Concrete Pre-Placement Acceptance Form

		Signatures:	
Location:		Field Engineer:	
Lift Drawing:		Superintendent:	
Placement Date:		Formwork Foreman:	
Mix-Design:		Placement Foreman:	
Slump:		3rd Party Inspector:	
Air:		Owner's Representative:	
Admixtures:		Quality Control Inspector:	
Start Time:		Mechanical Foreman:	
Finish Time:		Plumbing Foreman:	
Total CY Ordered:		Electrical Foreman:	
Total CY Used:		Fire Protection Foreman:	

3rd party test results:	
Slump:	
Air:	
Unit Weight:	
Temperature:	
# of Cylinders:	

	Initials:		Initials:		Initials:		Initials:
Foundation:		Reinforcing:		Tools & Materials:		Curing:	
Subbase dry, stable, tested		Size/Grade Verified		Power with GFCI		Protection	
Water, snow, ice removed		Laps/Splices		Walkways/planks		Temp. Heating	
Elevation verified		Clean, rust free		Cutting equipment		Ventilation	
Vapor Barrier Installed		Clearance		Electric trowels		Cure Method	
Formwork:		Dowels		Hand trowels		FF/FL Verified	
Straight, level, plumb		Support, chairs		Water buckets		Finish Verified	
Ties, braces checked		Wire Mesh		Generator			
Elevation verified		Embedments:		Lighting			
Chamfer Strip		Anchor bolts		Sealer			
Diamonds		Water stop		Vibrator			
Keyway		Control Joints					
Centerlines		Embed plates					

Wall Close-in Inspection Report Form D 103

Wall Close-In Inspection Report

Building	Area	Floor(s)	Wing(s)	Location Details

1. Architectural:

	Yes	No	N/A	Comments
Studs Complete				
Spacing & Gage Correct				
Jamb Studs at Door Frames Installed				
Sound/Fire Caulking Complete				
Radiant Barrier Installed and Seams Taped				
Height of Wall Correct				
Height of Bulkhead Correct				
Expansion Joints Present				
Block-outs Complete				
Backing Installed Correct				
Control Joints Framed				
Thermal Insulation Installed				
Sound Insulation Installed				
Door Frames Square				
Correct Door Hardware Prep				
Insulation in all Door Frames				
Exterior Windows Caulked				
Window Jamb, Head, Sill Insulated				
Bulkheads Complete				
Access Panel Framing Complete				
Red Line Drawings Checked				
Wall Type Per Plan				

GENERAL COMMENTS:

Wall Close-In Authorized

Subcontractor: _____ Date: _____

Quality Control: _____ Date: _____

QA/Owner Representative: _____ Date: _____

Wall Close-in Inspection Report Form D 103

Building	Area	Floor(s)	Wing(s)	Location Details

2. Electrical:

	Yes	No	N/A	Comments
Power Complete				
Communication/CCTV & Security				
Thermostat Pathways Installed				
All Device Boxes at Correct Elevation				
Pull String Wire Installed				
Bushing Installed on Boxes if Required				
Ground Pigtail Installed in Boxes				
Proper Size Plaster Rings Installed on Boxes				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

3. Fire Detection:

	Yes	No	N/A	Comments
Boxes for Pull Stations Installed				
Horn/Strobe Installed				
Strobe Only Installed				
All Device Boxes at Correct Elevation				
Fire/Acoustical Pads Installed				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

Wall Close-in Inspection Report Form D 103

Building	Area	Floor(s)	Wing(s)	Location Details

4. Mechanical:

	Yes	No	N/A	Comments
Valves/Specialties Accessible				
Piping Complete				
Piping Secure				
Blocking Installed				
Ductwork Complete				
Piping Labeled at Access Panels				
Fire Dampers Installed/Flanged				
Insulation Complete				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

5. Fire Protection:

	Yes	No	N/A	Comments
Piping Complete				
Piping Secure				
Piping Tested				
Devices/Valves Installed				
Devices/Valves Accessible				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

Wall Close-in Inspection Report Form D 103

Building	Area	Floor(s)	Wing(s)	Location Details

6. Controls:

	Yes	No	N/A	Comments
Control Pathways Installed				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

7. Communications:

	Yes	No	N/A	Comments
Communication Work Complete				
Data Drops Verified to Plan				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

8. Security:

	Yes	No	N/A	Comments
Security Work Complete				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

Ceiling Close-in Inspection Report Form D 104

Ceiling Close-In Inspection Report

Building	Area	Floor(s)	Wing(s)	Location Details

1. Architectural:

	Yes	No	N/A	Comments
Ceiling Grid Complete				
Spacing & Gage Correct				
Drywall Mudded, Taped, and Patched				
Sound/Fire Caulking Complete				
Radiant Barrier Installed and Seams Taped				
Height of Ceiling Correct				
Height of Bulkheads Correct				
Expansion Joints Present				
Correct Screw Spacing in Grid				
Correct Lap Spacing				
Thermal Insulation Installed				
Sound Insulation Installed				
Ceiling Tile Type Per Plan				
Red Line Drawings Checked				

GENERAL COMMENTS:

Wall Close-In Authorized

Subcontractor: _____ Date: _____

Quality Control: _____ Date: _____

QA/Owner Representative: _____ Date: _____

Ceiling Close-in Inspection Report Form D 104

Building	Area	Floor(s)	Wing(s)	Location Details

2. Electrical:

	Yes	No	N/A	Comments
Power Complete				
Communication/CCTV & Security				
Thermostat Pathways Installed				
All Device Boxes at Correct Locations				
Light Fixtures Set in Grid				
Light Fixtures Properly Supported				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

3. Fire Detection:

	Yes	No	N/A	Comments
Locations of All Devices Verified				
Horn/Strobe Installed				
Strobe Only Installed				
Exit Signs Installed				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

Ceiling Close-in Inspection Report Form D 104

Building	Area	Floor(s)	Wing(s)	Location Details

4. Mechanical:

	Yes	No	N/A	Comments
Valves/Specialties Accessible				
Insulation Damages Repaired				
Piping and Valves Labeled				
Duct Supplies and Returns Set into Grid				
Duct Supply and Return Locations Verified				
Grid Labeled at Valves				
Fire Dampers Tested				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

5. Fire Protection:

	Yes	No	N/A	Comments
Sprinklers at Correct Elevation				
Head Locations Verified				
No Spray-Pattern Obstructions				
Piping/Valves Labeled				
Grid Labeled at Valves				
Sprinkler System Tested n				
Red Line Drawings Checked				

GENERAL COMMENTS:

Subcontractor: _____ Date: _____
Quality Control: _____ Date: _____

Form D 105

In-House Inspection Form

Inspector Name: _____

Date Opened:	Location:	Description:	Division:	Contractor:

Form D 106

Pre-Final Inspection Form

Inspector Name: _____

Date Opened:	Location:	Description:	Division:	Contractor:

Form D 107

Final Inspection Form

Inspector Name: _____

Date Opened:	Location:	Description:	Division:	Contractor:

Form D 108

Daily Report Form

Name:	
Date:	
Jobsite Location:	

Weather:	Low Temp:	High Temp:

Meetings Attended:	
Inspections Completed:	

Detailed Description of Today's Activities:

Opened Discrepancies:
Closed Discrepancies:

Form D 109

Discrepancy Report Form

Originator Name:	
Date Opened:	
Detailed Location:	
Division/Spec Section:	
Party Responsible for Correction:	
Detailed Description of Issue:	
Actions Necessary for Resolution:	

Signed:

Name:	Date:

Form D 110

Material Inspection Report

Date:	
Inspector:	
Material Description:	
Material Location:	
Division & Specification Section:	
Contractor Responsible for Material:	

Is the material inspection in compliance with the project requirements?

Please describe how the material is or is not in compliance with the project requirements.

Actions need to correct non-compliant material:

Please attach a copy of the product cut sheets, MSDS, and/or approved submittall to your report.

Form D 111

Pre-Construction Meeting Agenda Form

Date:	
Location:	
Time:	
Specification Section:	
Attendees:	

Contact Information:	Name	Phone Number
General Contractor QC Inspector:		
Subcontractor Foreman:		
Subcontractor QC Inspector:		

Safety and Security:

-

Materials and Schedule:

-

Relevant Contract Documents, RFIs, Change Orders:

-

Standards and Regulations:

-

Trade Coordination:

-

Quality Requirements and Key Points from Specifications:

-

Action Items:

-

Form D 112

Quality Control Trainer Evaluation Form

Please rate your experience on the 1-5 scales below with 1 being the lowest and 5 being the highest.

1. Was the trainer a primary employee of your organization?

Yes No

2. Did the trainer maintain good eye contact with the audience?

1 2 3 4 5

3. Did the trainer use a voice loud and clear and speak coherently?

1 2 3 4 5

4. Did the trainer involve the audience?

1 2 3 4 5

5. Did the trainer understand all topics being presented and appear to have good technical skills in the subject area?

1 2 3 4 5

6. What did the trainer do well?

7. What can the trainer do better next time?

Form D 113

Quality Control Training Evaluation Form

Please rate your experience on the 1-5 scales below with 1 being the lowest and 5 being the highest

1. How would you rate your understanding and knowledge of the training material before the training?

1 2 3 4 5

2. How would you rate your understanding and knowledge of the training material after the training?

1 2 3 4 5

3. How would you rate your ability to perform quality control tasks before the training?

1 2 3 4 5

4. How would you rate your ability to perform quality control tasks after the training?

1 2 3 4 5

5. Did you feel an appropriate amount of material was covered during this training?

1 2 3 4 5

6. To what extent do you think this training will make a difference in the way you perform your job?

1 2 3 4 5

7. Did you feel that this training positively influenced your future ethical decision making skills?

1 2 3 4 5

8. How likely are you to implement the quality control processes on your job?

1 2 3 4 5

9. Was the time allotted for the training adequate to cover the material?

1 2 3 4 5

10. Were there enough opportunities to engage yourself in the training and interact with the trainer?

1 2 3 4 5

11. Were there enough visual aids?

1 2 3 4 5

12. Were the handouts helpful and easy to read?

1 2 3 4 5

13. What are areas you would like covered in more detail?

_____

_____

_____

_____

_____

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