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Assuring Quality in High-Consequence Engineering

Marcey L. Hoover and Rachel R. Kolb

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

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Assuring Quality in High-Consequence Engineering

Marcey L. Hoover and Rachel R. Kolb
Surety Engineering
Sandia National Laboratories
P.O. Box 5800
Albuquerque, New Mexico 87185-MS0330

Abstract

In high-consequence engineering organizations, such as Sandia, quality assurance may be heavily dependent on staff competency. Competency-dependent quality assurance models are at risk when the environment changes, as it has with increasing attrition rates, budget and schedule cuts, and competing program priorities. Risks in Sandia's competency-dependent culture can be mitigated through changes to hiring, training, and customer engagement approaches to manage people, partners, and products. Sandia's technical quality engineering organization has been able to mitigate corporate-level risks by driving changes that benefit all departments, and in doing so has assured Sandia's commitment to excellence in high-consequence engineering and national service.

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1. ASSURING QUALITY IN HIGH-CONSEQUENCE ENGINEERING

The challenge faced by high-consequence engineering organizations – those responsible for delivering products with the highest safety, security, and reliability consequences – has traditionally surpassed the challenge of solely delivering products that meet customer performance requirements. High-consequence engineering organizations, by the nature of their work, have been called upon to incorporate engineering and quality approaches to deliver with the absolute highest standard of engineering excellence. Also by the nature of their work, high-consequence engineering organizations have rested their quality assurance models on competency-based tenets in order to achieve their high standard of success. Delivering with engineering excellence means that: 1) customers receive innovative engineered products and services enabled by advances in science and technology, and 2) engineering programs adopt assured quality practices that enable a disciplined approach to engineering products and services. Under this approach, both the customers and the organizations have increased confidence that products will be delivered predictably and consistently while advancing the practice of engineering.

Sandia National Laboratories, an organization that has long been responsible for high-consequence engineering and for seeking innovative solutions to our nation's most demanding national security problems, has a unique responsibility to address an ongoing quality assurance challenge. The challenge is one of assuring the concept raised in the film "Always/Never" – that is, assuring that products *always* work when intended and *never* work when not intended. In Sandia's nuclear weapons responsibilities, functionality and reliability are critical for the national defense, but the consequences for even a single lapse in safety, security, or control can be catastrophic. Addressing the "Always/Never" quality assurance challenge has heightened with changes in the environment to be addressed later in this paper, including increased workload, budget and program changes, and loss of staff expertise. Within Sandia's overall management and product realization framework, the Surety Engineering organization has instilled a strategy to assure quality within the constraints of the current work environment through a new approach for providing technical quality engineering support, best practices for engineering excellence, and quality-focused training programs. This paper describes historic approaches, current challenges, and new strategies for assuring quality within Sandia's high-consequence and expert-based engineering environment. Furthermore, it discusses the approach that the Surety Engineering organization at Sandia has taken to uphold the competency-based tenets of quality assurance, both within the quality engineering departments and more broadly across the Laboratories.

1.1. Sandia's History

Sandia National Laboratories today is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin company, for the United States Department of Energy's National Nuclear Security Administration. Sandia began in 1945 as Z division, the ordnance design, testing, and assembly arm of Los Alamos National Laboratory, before becoming Sandia Laboratory in 1948. A year later, Sandia Corporation was established as a Western Electric

company to manage the laboratory. Sandia's present mission has expanded to include research supporting a broad spectrum of national security issues, but the Laboratories' early Cold War history in developing the nonnuclear components of nuclear weapons has created extensive programmatic experience in top-tier engineering and quality assurance approaches, which evolved from roots within the Manhattan Project of World War II and AT&T Bell Labs.

As a result of Sandia's responsibility for high-consequence engineering, the lab became an early adaptor of quality management systems and basic quality control principles. Sandia, during its early history, was dedicated to participating in the stockpile development activities overseen by the United States Atomic Energy Commission, which had developed a direct quality maintenance program for all the laboratories and facilities in the nuclear weapons complex. This quality maintenance program, officially established at Sandia in 1948, consisted of tests to ensure that all new and stockpiled weapon parts were sampled and inspected for functionality, operated, repaired, and modernized as necessary. During the 1950s, as the Cold War accelerated and nuclear weapons field testing and production reached their peak, the Atomic Energy Commission's approach to quality surveillance and quality assurance enabled managers and employees within the nuclear weapons complex to reach their goals. Quality and reliability were of the utmost importance. However, when field work on nuclear weapons became limited at the beginning of the 1960s, the Atomic Energy Commission discontinued its quality assurance surveillance operations at Department of Defense storage sites, including Sandia. At that time, Sandia and other national laboratories embraced evolving principles of quality assurance for their weapons development programs. These established and traditional quality assurance principles, among others, include a quality management system (called QC-1) that preceded modern quality management systems such as ISO and AS9100.

The high-consequence engineering products that continue to be developed at Sandia are different than mainstream products manufactured in industry, and therefore require different approaches to quality. Sandia's high-consequence products must demonstrate extremely high reliability over the course of their lifetimes. Unlike those of industry, they are produced in very low volumes instead of being mass-produced, and endure as part of the nation's national security deterrent for extremely long lifetimes, often covering several decades. The quality assurance challenge presented by these products is akin to taking an unused 1960s-model automobile out of the garage after four decades and attempting to take it for a drive without a system overhaul or engineering upgrade. This extreme expectation for quality may seem unthinkable in the case of the automobile, but it arises regularly for many high-consequence engineering products developed at Sandia and other national laboratories. These products sit idle for decades, often in extreme environments, yet are still expected to function at a moment's notice. Furthermore, for safety and security reasons, they are expected *not* to function unless expressly intended. For over 60 years, this mission has required Sandia to maintain a competent workforce capable of engineering groundbreaking innovations while upholding the highest safety, security, and reliability standards. These products therefore present a different quality assurance challenge.

1.2. Sandia's Traditional Approach to Quality Assurance

Sandia's traditional approach to quality assurance extended beyond having a quality management system (QMS) and basic quality control, both of which were developed and continually refined at Sandia throughout the 1960s and 1970s. Assuring quality in Sandia's high-consequence engineering applications also relied on other tenets: in particular, a heritage of surety, checks and balances through independent organization structure, and rigorous engineering practices across the full product lifecycle. These tenets will be described in the following paragraphs.

As defined in James T. Ringland's 1997 report, "Sandia's Surety Heritage," surety includes the tasks of assuring product safety, security, control, and reliability. Sandia's role in ensuring surety developed along with its larger nuclear weapons mission. The technical foundations for surety were laid in the late 1940s and early 1950s with the establishment of quality assurance activities and independent reviews for reliability and safety. The cultural foundations of surety developed with the influence of AT&T management and the Bell Laboratories workplace culture. A quality maintenance program was established at Sandia in the 1940s and consisted of tests to ensure that all new and stockpiled weapon parts were sampled and inspected for functionality, operated, repaired, and modernized as necessary. During the 1950s, as the Cold War accelerated and nuclear weapons field testing and production reached their peak, this surveillance approach to quality assurance provided confidence in quality and reliability. However, when field work on nuclear weapons came to an end at the beginning of the 1960s, the ability to rely heavily on surveillance operations for assurance also ceased, which called for a new approach to assuring quality. Sandia's surety focus turned from inspection to design assurance and being guided by a documented QMS. This QMS was QC-1, first published in 1954 and the precursor of modern quality management systems such as ISO and AS9100.

Sandia's modern concept of surety has arisen from a strong sense of corporate and personal responsibility and advocacy, and Sandia's current surety culture centers around the two ideals of responsible activism and knowledgeable independence. Responsible activism refers to an organizational conscience as well as the perceived personal responsibility to assure the safety, security, control, or reliability of the projects to which we contribute. Knowledgeable independence, on the other hand, characterizes our approach to project development, in which we incorporate a deep understanding of the technology at the same time as we maintain the power to speak with absolute freedom if a defect arises. Both responsible activism and knowledgeable independence grant staff members dedicated responsibility and ownership of the product at hand.

In addition to the Laboratories' surety heritage and the role it plays in assuring quality, Sandia's organizational structure is uniquely and intentionally tailored to enable independent assessment as part of the engineering process. The Laboratories' independent reporting structure traces back to the early days of Sandia Corporation, in which Labs Director Paul Larsen recognized that establishing a quality monitoring agency independent of production was necessary to Sandia's work and functionality. Quality assurance and surveillance personnel understood that freedom from the outside influence and production pressures of direct design and production divisions was essential to the quality organization's integrity and performance. In the

initial stages of quality assurance, Sandia's quality group acted as auditors that inspected for quality and reliability, monitored weapon engineering activities, and performed tests on products to determine if functional criteria had been met. Information from this surveillance then informed designers and product realization teams. Furthermore, Sandia's monitoring system incorporated a set of checks and balances that spread the responsibility for quality assurance among different groups, which ranged from product acceptance and quality analysis to surveillance and test methods. The hierarchy of departments and divisions worked to assure quality through various analysis, surveillance, and testing activities placed under a cohesive framework. Sandia's structural system of independent assessment and checks and balances persists to this day. Independent assessment and quality functions still do not intersect with mission work and product realization teams from a management chain perspective until reaching the level of the laboratory director, allowing the quality assurance organization to ensure quality engineering principles without compromise.

Sandia ensured that its engineering practices were definite and continuous through its surety assurance activities, which stemmed from the quality organization and its focus on quality control. In addition to the strategic placement of the quality and assessment functions, Sandia's traditional engineering rigor came from adherence to a set of engineering principles established for the Laboratories' formal nuclear weapons life cycle phases: thorough verification, extensive manufacturing readiness and qualification, rigorous product acceptance and configuration control, and persistent resolution of production issues and performance anomalies. These principles are embodied in the life-cycle process through which nuclear weapons development progresses from concept to production to retirement. They traditionally enabled the Laboratories' design and production divisions to deliver exceptional products to the nuclear weapons stockpile, and are discussed below.

Thorough verification: As part of development engineering, Sandia takes extensive efforts to verify engineering designs thoroughly. The Laboratories conducts experiments, tests, and analyses to evaluate design options and assess their potential for production. Prototypes of each component are tested and evaluated. Verification efforts take exceptional measures in order to ensure thoroughness, passing through many design-test-build cycles and rigorous checks before being approved for production and use in the stockpile.

Extensive manufacturing readiness and qualification: During production engineering and first production, extensive manufacturing readiness and qualification activities are conducted before transitioning a design into a successful manufacturing process. Required production-line equipment and tools are designed to ensure that all required components can be produced. Tooling, gauges, and testers are properly defined and qualified; process development and process prove-in (PPI) are accomplished; materials are purchased; qualification evaluations are conducted on processes; and trainer components are fabricated. Sandia also incorporates a trusted and dedicated supply chain into its production planning and production activities.

Rigorous product acceptance and configuration control: During full-scale production, Sandia practices rigorous product acceptance and configuration control. Sandia enforces strict discipline on all product fabrication and assembly operations, and products are required to meet a high standard of engineering. Prior to products being accepted, quality evidence must be

submitted and reviewed to verify that the product meets all requirements. The Labs recognizes the importance of tracing all design and engineering configuration components for the subsequent years and decades and has established appropriate tracking procedures.

Persistent resolution of production issues and performance anomalies: Throughout production and deployment, Sandia insists on persistent resolution of production issues and performance anomalies. The Laboratories perceives the challenge of resolving problems as vital and unrelenting. Formal processes exist for investigating a problem's cause, extent, and effect on the performance, safety, and reliability of the stockpile.

Successful application of the above-described principles has traditionally depended on having an engineering staff with the highest level of technical competence and regular occasion to exercise that competence, and whose skills and responsibilities help create a strong sense of professional engineering accountability and defined product ownership. Expert judgment is the basis for nuclear weapons performance assessments under the standards of the QC-1 QMS, in which competency-based tenets combine with controlled engineering procedures and statistical methods to assure the safety and reliability of weapon performance. Sandia's quality management program also depended on the contemporary fiscal and political environment, in which the Laboratories were able to achieve performance and engineering excellence standards with less constraint on cost and schedule requirements. Although cost and schedule requirements have always been a reality for Sandia, in today's fiscal environment there is no longer any margin or tolerance for cost overruns or schedule delays. Nevertheless, for many years the combination of Sandia's independent quality assurance structure, a highly competent and experienced staff that adhered to rigorous principles, and a traditional QMS resulted in the Labs' ability to deliver highly performing, highly reliable products as well as to acquire a reputation for engineering excellence.

1.3. Sandia's Current State and Current Challenge

This traditional approach to quality assurance is at risk. Sandia is faced with an amount of work unprecedented in recent decades, as programmatic activity now reaches an all-time high since the Cold War, but in the present environment the basic tenets of our quality assurance model are being challenged. While we still have a rigorous quality management system and strong engineering principles, the current environment presents obstacles to exercising our expertise: attrition rates recently spiked among experienced staff but without a corresponding spike in incoming replacements with the experience to exercise a design and development program at the level of rigor required for nuclear weapons work. In addition, the high level of Sandia's current workload is compounded by the problem of competing program priorities and no tolerance for cost and schedule overruns.

Although the fiscal and political environment has changed, Sandia's products still require an incredible amount of engineering depth, and maintaining staff competence becomes especially important in light of the fact that product lifecycle may span decades, requiring the specialized skill set that can evaluate and maintain them properly. For this reason, the Laboratories remains, and likely always will remain, a competency-based organization. However, the experience level

of the workforce has undergone drastic changes unmatched in Sandia history, due to unprecedented attrition and hiring in the last two years. The model of having long-term engineering owners, who have exercised the Labs' engineering approach and internalized a set of lessons learned, is no longer part of the current environment. Experienced staff members have been placed in new roles and new staff members have entered the organization as heightened hiring rates continue. Additionally, multiple programs are scheduled to run concurrently with a potential impact to productivity. While Sandia still operates under an independent reporting structure and still exercises a set of rigorous engineering requirements, the crucial asset of staff experience has impacted engineering organizations within the Laboratories.

It is not impossible to imagine this assortment of challenges taking its toll on quality: new staff members and high budget and schedule pressures could mean that we are at risk of making mistakes, leading to rework, unnecessary costs, and the loss of Sandia's timeliness and even its reputation. However, due to the nature of Sandia's products, there is no margin for error and risks are unacceptable. Because it is imperative that our products continue to be as safe, secure, and reliable as they have been in years past, having a premier approach to quality is as crucial within the Labs' current environment as is any other factor of our work. Once again, we must invoke the "Always/Never" principle: our products must always work when they ought to, and must never work when they ought not to. In light of the threat environment our nation and our world currently face, quality becomes more than a means for ensuring customer satisfaction. It becomes an essential tool for preserving the national defense.

Finally, with the country's current fiscal situation, we must incorporate quality tools in order to be responsible by following our budget, negotiating competing program priorities, and avoiding schedule overruns and delays. The traditional design-build-test iterations that sustained Sandia's quality assurance approach for so long are currently at risk, and the Laboratories must move to embrace new, management-centered options. We must mitigate this collection of quality-related risks not only by incorporating more competent staff but also by being an advocate for prevention. *The need to assure quality is as high of a priority as ever.*

1.4. Sandia's Strategy and the Role of Quality

The nature of the national laboratories' work, as well as the work of any high-consequence engineering organization, is such that we must continue to assure quality despite contemporary challenges. We must assure that engineering programs use a disciplined approach to engineering products and services. We must find a way to assure that our engineering is performed competently and consistently at all stages of the product development cycle so that we still deliver highly performing, highly reliable products, uphold the concept of "Always/Never," and maintain our standards of engineering excellence. We must do this in a way that doesn't stifle innovation or technological advancements. We must find a way to prevent errors and help our product realization teams do things right the first time in the absence of internalized lessons learned, as they do not have the time or luxury to learn from mistakes.

Our organization defines quality as a premeditated application of disciplined engineering practices directed toward achieving all product-oriented life cycle objectives. In promoting

quality, we identify problems before they occur, assure product excellence by preventing defects at every phase of product realization, and appropriately use a wide range of engineering tools with the end result in mind. We provide internal team support and guidance to ensure that development, design, and production are based on clear, customer-negotiated requirements, and also ensure that performance is appropriately evaluated and documented for reliability. Finally, we apply systematic, disciplined, and quantifiable approaches to all product realization efforts, while ensuring top-tier engineering and encouraging innovation. Thus, Sandia as well as other technical quality engineering organizations, as experts and advocates for prevention as well as rigor, consistency, and discipline, are well positioned to play a key role in helping high-consequence organizations assure quality. The quality assurance group can use this expertise both to sustain competency and mitigate the risks that accompany short-term staff attrition.

Sandia's Surety Engineering organization has developed a strategy to sustain top-tier engineering principles in a high-consequence, competency-based organization. The strategy aims at developing the people, partners, and engineering practices necessary to assure a vision of quality in a new era of high-consequence engineering. Our choice of these elements as critical focus areas for quality improvement stems from ongoing strategic analysis of the challenges Sandia faces, particularly in terms of how the quality organization can contribute solutions. The primary challenges as well as the value of each focus area are summarized below.

- People: In a time of high attrition and turnover, we must hire the right people and rapidly accelerate our approach to staff development so that our engineers are deeply technical, competent, and credible. We have adopted a new, lean staffing and onboarding model that will result in our quality engineers being integral to all projects. In doing so, we are modeling the way to hire the best candidates and incorporate them into the organization in a rapid, streamlined manner.

- Partners: To deliver quality across the Laboratories during this season of change, we must effectively engage with our customers (both internal and external) and our stakeholders to ensure optimal use of our engineering capabilities in order to anticipate and catch issues before they occur. Our new models for engagement and communication include serving as advocates of engineering rigor and preventive approaches, maintaining consistency across all production efforts, and informing customers of the full range of our tools and capabilities. We are therefore able to better understand the technical quality challenges that exist across Sandia, to detect issues early, and to provide feedback to inform decision makers and address lessons learned that a seasoned set of "responsible activists" would have previously known and internalized.

- Products: To maintain and improve on Sandia's history of effective high-consequence engineering and national security solutions, we must efficiently deliver high-quality products, follow innovative approaches to technical quality engineering, and bring value to our customers' preventive efforts. We must do this through rebuilding our laboratory's experience base, advancing our engineering practices, and maintaining expertise in our business practices. We have instituted a corporate-wide training program, the National Security Quality Training (NQT) program, to offer preventive quality engineering techniques to others and further our mission of being advocates of prevention.

Our strategic initiative, through these focus areas, seeks to deliver the robust, high-quality products that have been part of Sandia's history, while pursuing greater operational efficiency.

Our vision will require new quality approaches and new tools: we will need respected, technically competent quality engineers. We will need a concept of quality that will appeal to the type of engineering staff that works at the Laboratories, based on minimizing or eliminating defects while understanding the entire product instead of blindly following a process. And we will need a set of training and competency development programs that will equip all of our staff for success.

1.5. People, Partners, and Products: A Strategy for Quality Success

To address both our internal and external challenges, our organization has instilled a strategy for developing the people, partners, and engineering practices that will enable success. In other words, driving this new approach to quality assurance requires capable quality engineers, early engagement, and quality advocacy with the product realization process. It also requires a deep level of training in preventive quality approaches, both for our engineers and other technical staff across the Laboratories.

Our strategy for people has focused on bringing technically competent and capable engineers to the Surety Engineering organization. We have adopted a new hiring and staffing model that, as a result, will make our engineers integral to all projects. This strategic, streamlined hiring approach recruits staff experienced in product design and development who have technical credentials equal to or exceeding project team members. To keep our hiring process lean, we created a mechanism for up-front screening and binning of resumes and created dedicated points of contact with established roles and responsibilities for hiring. Organizational support staff have played a key role in this overhaul of our approach to hiring.

We have focused on recruiting engineers from a variety of specific technical disciplines and backgrounds whose credentials meet or surpass those held by project teams. To maintain a balance with recent technical knowledge, we also recruit recent college graduates who have studied engineering and design assurance, from a variety of degree programs and degree accreditation levels. The quality of our hires exceeded corporate objectives for FY12 and FY13.

With so many new hires entering our organization, we have also established a mentoring program, based on an affinity approach, and a quick start program to introduce incoming staff to the basics and practices of the quality profession. Our quality engineer "boot camp" training program launched in June 2012, and consists of four two-hour sessions that cover a range of quality topics, which include the role of quality in the product development process; quality engineer roles and expectations; and access to subject matter experts, tools, and references. More experienced staff also attend the courses so that a variety of voices can engage in the dialogue and exchange ideas. Two staff members (one new, one senior) established and operated this training program as a fraction of their time over the course of a few months at very low cost to the entire organization. The class is peer taught and was completed by over 80% of staff within

the first nine months of offering. As others at Sandia outside the quality organization have heard about this "boot camp," requests have increased for a similar course to be offered at the corporate-wide level. As a result of these requests, we are developing in more detail the course section on engineering process, system development, and programmatic requirements.

Our strategy for partners includes building relationships with our customers and stakeholders through new models for engagement and communication. We have aimed to intentionally and proactively engage with our customers and serve them as informers to their decisions, with the goal of placing ourselves in a better position to understand and anticipate quality problems, thereby helping our customers avoid making errors and feel more confident in their engineering process. We have established relationships with peers at all management levels, from directors to senior and department managers, and in the process have identified a quality manager and staff point of contact for each customer we work with. We have tracked the resulting one-on-one interactions, which are targeted to discuss quality principles and current product realization engineering needs, and we have established "zipper plans" with customers.

The senior manager and the department managers maintain about 100 people on our zipper plans, and are working to track several metrics in regards to these plans, including the percentage of intended interactions that happened and the results of the interactions. We negotiate, document, and report on work through formal work package agreements and monthly state of quality reports. We have also sought to communicate internal successes and recognize individuals through laboratory-wide newsnotes. As customer engagement has increased, so has the number of laboratory-wide requests for technical quality engineering support.

Finally, as part of our efforts to rebuild the Labs' experience base and advance our engineering practices, we have instituted a corporate-wide training program based on modern technical quality engineering principles to develop our own capabilities as well as those of others. Most Sandia engineers and managers have not learned the strategies and applications of advanced quality tools through their academic programs and other prior accreditation. The National Security Quality Training (NQT) program offers a variety of classes, from business processes to advanced engineering tools, and supports a layered defect prevention approach. During FY12, the NQT program had 31 session offerings for 11 different courses, with most of the courses being taught multiple times over the duration of the year. NQT courses for FY12 ranged from "Defect Prevention through Requirements Traceability" and "Using Fagan Inspection to Remove Defects from Product Definition" to "Preparing for Successful Product Acceptance" and "Preventing Supplier Quality Problems." Courses are taught by managers, key staff members from the Surety Engineering group, and both internal and external subject matter experts, with the aim of enabling participants to apply concepts and tools to prevent defects successfully at every phase of the engineering process. Phases range from concept assessment to design definition to production/development engineering and full-scale production. Preventive quality techniques covered in the NQT program courses include Fagan inspections, HALT, HASS, mistake-proofing, statistical process control, supplier management, and many others. We have also instilled a NQT speaker series that regularly features experts in quality engineering and management.

FY13 data through the end of July 2013 demonstrate the ongoing growth of the NQT program. As of July 2013, 24 courses had been taught during FY13, with a total attendance of roughly 500 Sandians (around 21 people per course). Four out of every five attendees were from outside the technical quality engineering organization, with many attendees (275 Sandians, or 55% of the total) deriving from Sandia's Science and Technology and Weapons Engineering and Product Realization Divisions. NQT courses have been taught at Sandia's sites in Albuquerque, New Mexico and in Livermore, California, and also for the Sandia External Production (SEP) Conference held in October 2012. For the remainder of FY13, Sandia's Surety Engineering organization projects five more NQT courses to be taught (for a total of 29 courses for FY13) with an attendance of roughly 100 more Sandians (for a total of 600 attendees for FY13).

The NQT program took two years to develop at a cost of roughly $400k, with most of the funds going towards supporting a staff member to develop the program. As the program progresses, it will retain some level of indirect funding even though the development is primarily complete, in part because we are always looking for ways to pursue continual improvement in our courses and administration. We are also retaining a staff member as a technical advisor and looking at mixed mode learning to minimize in-course time. Both internal and external subject matter experts have been brought on board to teach the courses, with the Surety Engineering organization's staff rotating through teaching internal classes. The NQT program is coordinated but not owned by Sandia's corporate learning framework, and is administered by the Surety Engineering organization's business team. There is a charge for taking the NQT courses, but only to cover requisite costs.

There is initial evidence that the Surety Engineering organization's new strategy for assuring quality is working. There is increasing demand for our people, the technical quality engineers, to join product development teams. Recent requests are reaching roughly 5% of overall project costs, which is aligned with industry best practices for the contributions of the quality engineering organization. As of halfway through FY12, the Surety Engineering organization had received technical quality engineer requests for 143 projects across the Laboratories, based on labor summary reports. As a marker of comparison, in the entirety of FY11 a total of 144 projects were charged to the technical quality engineering organization.

Attendance at the quality training program sessions is increasing, with over half the attendees being non-quality professionals. During FY12, around 700 attendees took NQT courses, with 80% of those attendees being from outside the Surety Engineering organization. As of halfway through FY12, a total of 16 quality training sessions had been offered, with 10 being internal courses. Laboratory management in the design and development organizations have recognized the importance of quality and has required classes in qualification and acceptance for project team leads. There is evidence that the quality training and defect prevention concepts are being incorporated into engineering practices: attendance has increased at NQT sessions for quality and non-quality engineers alike, and metrics show that product realization teams are using preventive methods as part of their engineering process. Finally, customer feedback and metrics on engagement with our partners indicate progress.

1.6. Quality Projections and Conclusion

The efforts of our Surety Engineering organization at Sandia have already made visible impacts on the Laboratories, but we must keep working in pursuit of continuous improvement. We must continue our focus on executing quality for all our engineering projects; with this goal in mind, we are looking at ways to measure impact, retain top engineers, and expand the influence of quality across the Labs.

Sandia's high-consequence engineering environment has led the Laboratories' quality assurance approaches to be heavily dependent on staff competency and ability to conduct high-level engineering activities with expertise. Such a competency-dependent quality assurance model is at risk when the environment changes and drives the basis for engineering excellence away from its historical foundations, as it has in recent years. However, Sandia's competency-dependent culture has also been, and will continue to be, a place for the quality organization to shine. Through helping the Labs to sustain a high level of competency as well as to mitigate risks when they do arise, the quality engineering organization can have an unmatched impact on Sandia's mission to render exceptional service in the national interest. Our new approach to managing people, partners, and products through changes to hiring, training, and customer engagement approaches has been a key driver in incorporating this change. The Surety Engineering organization has been able to innovate tools to mitigate corporate-level risks by driving changes that will benefit all departments and all parts of Sandia in the long term.

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