TL 9000

*Telecommunications
Quality Standard*

AN EXECUTIVE OVERVIEW

**PERRY JOHNSON
CONSULTING, INC.**

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Telecommunications Quality Standard

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An Executive Overview

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FOREWORD _____

In 1999, the Quality Excellence for Suppliers of Telecommunications (QuEST) Leadership Forum, a group of leading telecommunications service providers, released TL 9000. This international quality management standard, which consolidates ISO 9000, the industry's Bellcore quality standards and other quality requirements, is designed for continual improvement in the quality and reliability of telecommunications service. TL 9000 was revised in 2001 to align with ISO 9001:2008, and then in 2010 to align with ISO 9001:2008.

The goals of TL 9000 are to foster quality systems that effectively and efficiently protect the integrity and use of telecommunications products, including hardware, software and services; establish and maintain a common set of quality system requirements; reduce the number of telecommunications quality system standards; define effective cost and performance-based metrics to guide progress and evaluate results of quality system implementation; drive continual improvement; enhance customer-supplier relationships; and leverage industry conformity assessment processes.

Much of the telecommunications industry is already registered to ISO 9000. An upgrade to TL 9000 registration would incorporate the additional requirements into existing quality programs. A company, organizational unit, facility or product line can be TL 9000 registered in the areas of hardware, software, services or any combination thereof. Registration may be contractually required by regional Bell operating companies.

This guide was created to aid telecommunications suppliers seeking to implement TL 9000, or upgrade from ISO 9000 or an earlier version of TL 9000 (Release 4.0) to TL 9000 Release 5.0. It outlines the general requirements of TL 9000 step by step. Since registering to TL 9000 is a lengthy and detailed process, it is strongly suggested that firms seeking registration retain the services of a reputable consulting firm.
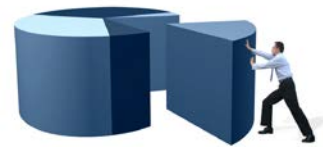
PERRY JOHNSON CONSULTING, INC.
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THE USERS OF THIS GUIDE _____

This guide will be useful to managers and other personnel in telecommunications organizations that meet any of the following criteria:

- Firms supplying hardware, software and/or services to the telecommunications industry.

- Companies planning for future business with the telecommunications industry.

- Suppliers seeking a competitive advantage in the marketplace.

- Firms planning to improve their quality assurance and management programs.

- Companies desiring to make customer satisfaction a top priority.

- Suppliers seeking to meet customer TL 9000 registration mandates.

- Firms already registered to TL 9000 Release 4.0 or ISO 9000 that seek an upgrade to TL 9000 Release 5.0.

- Companies seeking to remain abreast of worldwide quality system standards development.

- Any other firm interested in becoming registered to TL 9000.

WHAT IS TL 9000? _____

TL 9000 is a quality management system standard for the telecommunications industry that is derived from ISO 9000. This standard harmonizes telecommunications quality system requirements for the design, development, production, delivery, installation and maintenance of hardware, software products, and services. Conformance to TL 9000 will decrease time to market and improve the total cost of ownership throughout the supply chain.

TL 9000's structure contains five levels of quality system requirements and measurements. They are ISO 9001:2008; common telecommunications industry quality system requirements (QSRs); hardware, software and services specific quality system requirements; common telecommunications industry measurements; and hardware, software and services specific quality system measurements.

TL 9000 applies to an estimated 10,000 telecommunications suppliers. The U.S. has a $250 billion a year telecommunications market, with worldwide purchases from the industry's suppliers estimated at more than $125 billion by 200 telecommunications service providers (TSPs).

Because ISO 9001 is the foundation of this standard, one must have a basic knowledge of ISO 9000 to fully understand the fundamentals of TL 9000.

The Origin of ISO 9000

ISO 9000 is a series of quality management systems standards created by the International Organization for Standardization (ISO), a federation of 132 national standards bodies based in Geneva, Switzerland. The American National Standards Institute (ANSI) is the member body representing the United States.

The ISO 9000 quality management standards are not specific to products or services, but apply to the processes that create them. The standards are generic in nature so that they can be used by manufacturing and service industries all over the world. First released in 1987 and revised in a limited manner in 1994, they underwent a major overhaul in 2000.

ISO 9000 is the descendant of a number of earlier quality standards, including the British BS 5750 and DEF/STAN 05-8, the NATO AQAP-1 and the U.S. Department of Defense MIL-Q-9858A. The purpose for developing ISO 9000 was to simplify the international exchange of goods and services by creating a common set of quality standards.

BS 5750 had the greatest influence on this international standard when it was first released by ISO in 1987. Most industrialized nations quickly adopted harmonized versions of ISO 9000. These national versions, which are identical to the international standard, include the American ANSI/ISO/ASQ Q9000, sponsored by ANSI and the American Society for Quality (ASQ), and the European Union's EN 29000.

ISO 9000 is intended to establish, document and maintain a system for ensuring the output quality of a process. It is not mysterious or esoteric, consisting instead of a group of common sense and generally well-known precepts laid out in an organized fashion.

When implemented correctly, ISO 9001:2008 can offer a company several advantages. It will guide it to build quality into its products or services, and help it to avoid costly inspections, warranty costs and rework.

Today, the international standards are sanctioned by the 15 nations of the European Union (EU), making ISO 9001:2008 registration a virtual prerequisite for doing business there.

Previously, there were more than 20 ISO 9000 standards and documents, and this proliferation raised concerns among ISO 9000 users and consumers. In response, ISO/Technical Committee (TC) 176, Quality Management and Quality Assurance, agreed that the 2000 revisions would consist of four primary standards, supported by several technical reports. These four primary standards are:

- **ISO 9000:2000**, *Quality Management Systems – Fundamentals and Vocabulary*. This document, which replaced ISO 8402:1994, *Quality Management and Quality Assurance Vocabulary*, and ISO 9000-1:1994, *Quality Management and Quality Assurance Standards – Part 1: Guidelines for Selection and Use*, simplifies the quality language, which consists of the terms, definitions and principles that accompany the standard. It is expected to clear up confusion about the standard's meaning by combining the terms and definitions in ISO 8402 and ISO 9000-1 into one easy to understand document. In addition to a revised vocabulary, this standard includes an introduction to quality concepts.

- **ISO 9001:2008**, *Quality Management Systems – Requirements*. This document replaced the three previous registration standards: ISO 9001:1994*, Quality Systems – Model for Quality Assurance in Design, Development, Production, Installation and Servicing*, ISO 9002:1994, *Quality Systems – Model for Quality Assurance in Production, Installation and Servicing* and ISO 9003:1994, *Quality Systems – Model for Quality Assurance in Final Inspection and Test*. It addresses an organization's quality management requirements, in order to demonstrate its capability to meet customer requirements, and applies to all generic product categories, such as hardware, software, processed materials and services. This standard can be tailored to fit an organization's operations through reduction in scope, thereby eliminating the need for the less comprehensive ISO 9002 and ISO 9003. Section 1.2, Application, states, "Where any requirement(s) of this International Standard cannot be applied due to the nature of an organization and its product, this can be considered for exclusion. Where exclusions are made, claims of conformity to this International Standard are not acceptable unless these exclusions are limited to requirements within Clause 7 (Product Realization), and such exclusions do not affect the organization's ability, or responsibility, to provide product that meets customer and applicable regulatory requirements."

- **ISO 9004:2000**, *Quality Management Systems – Guidelines for Performance Improvements*. This standard, which replaced ISO 9004-1:1994, *Quality Management and Quality System Elements – Part 1: Guidelines*, provides guidance beyond ISO 9001:2008 towards developing a comprehensive quality management system to improve an organization's overall performance. While following the same structure as ISO 9001:2008, it is not an ISO 9001 implementation or conformity guide. Instead, it gives guidance on all aspects of a quality management system, based on the principles of customer focus, leadership, involvement of people, system approach to management, continual improvement, factual approach to decision making, and mutually beneficial supplier relationships. ISO 9004 is useful in auditing the effectiveness of a company's quality management system, with the goal of achieving benefits for all stakeholder groups through sustained customer satisfaction.

- **ISO 19011:2002**, *Guidelines for Quality and/or Environmental Management Systems Auditing*. Initially, ISO/TC 176 was to draft ISO 10011, *Guidelines for Auditing Quality Systems*, which would integrate and replace the three quality system auditing standards: ISO 10011-1:1990, *Guidelines for Auditing Quality Systems – Part 1: Auditing*, ISO 10011-2:1991, *Guidelines for Auditing Quality Systems – Part 2: Qualifications Criteria for Quality Systems Auditors*, and ISO 10011-3:1991, *Guidelines for Auditing Quality Systems – Part 3: Management of Audit Programs*. Instead, the Joint Working Group (JWG) on Quality and Environmental Auditing, consisting of experts from ISO/TC 176/SC 3, Auditing and ISO/TC 207, Environmental Management, SC 2, Environmental Auditing, agreed to draft a joint quality and environmental management systems auditing standard, ISO 19011. It applies to first, second and third party audits; auditor qualification criteria; and audit program management. ISO 19011 replaced ISO 10011-1, ISO 10011-2 and ISO 10011-3, along with the three environmental auditing standards: ISO 14010:1996, *Guidelines for Environmental Auditing – General Principles*, ISO 14011:1996, *Guidelines for Environmental Auditing – Audit Procedures – Auditing of Environmental Management Systems*, and ISO 14012:1996, *Guidelines for Environmental Auditing – Qualification Criteria for Environmental Auditors*.

As of this writing, the remaining old ISO 9000 standards are being reviewed by ISO/TC 176 for incorporation within the four revised standards, withdrawal or reissue as technical reports.

Back to TL 9000

Seeking continual improvement in the quality and reliability of telecommunications service, a group of leading telecommunications service providers (TSPs), including Bell Atlantic, BellSouth, Pacific Bell and Southwestern Bell, formed the Quality Excellence for Suppliers of Telecommunications (QuEST) Leadership Forum in 1996. The QuEST Forum's goal was to develop a consistent set of worldwide telecommunications industry quality system requirements for hardware, software and services, along with leading-edge performance measuring tools.

Establishment of the QuEST Forum was the first time the telecommunications industry banded together to develop quality system requirements. Its membership now consists of more than 150 telecommunications service providers and suppliers, including all Regional Bell Operating Companies (RBOC), AT&T, GTE, Bell Canada and such leading telecommunications suppliers as Alcatel, Fujitsu Network Communications, Inc., Lucent Technologies, Motorola, Nortel Networks, PairGain Technologies, Inc. and Siemens Telcom Network.

Globalization of the telecommunications industry, increased customer and purchaser expectations, and more intense competition had created a need for both service providers and suppliers to implement common quality system requirements and measurements. Better products had to be brought to market faster, with fewer problems and full supplier support.

At the same time, the cost of poor quality (COPQ) had been estimated at $750 million a year in the U.S. and $10 to $15 billion a year worldwide. Some 25 Bellcore quality and reliability standards had been inconsistently used in the industry for years. ISO 9001:1994 failed to meet telecommunications needs for reliability and associated costs, software development, services and continuity. Suppliers seeking to conform to both the ISO 9000 and Bellcore standards faced a confusing maze of overlapping requirements and audits, which escalated the cost of doing business.

In 1997, the QuEST Forum began work on a new standard to harmonize telecommunications quality system requirements for the design, development, production, delivery, installation and maintenance of hardware, software and services. This new standard, which became TL 9000, was intended to consolidate ISO 9000, Bellcore and other quality requirements.

The *TL 9000 Quality System Requirements Book One*, Release 2.5, incorporating ISO 9001:1994, was published in 1999. Following the revision of ISO 9000 in 2000, TL 9000 was revised in 2001, with the *TL 9000 Quality Management System Requirements Handbook*, Release 3.0 using ISO 9001:2000. Further improvements were made in Release 4.0 of the *TL 9000 Quality Management System Requirements Handbook,* and most recently Release 5.0 of the *TL 9000 Quality Management System Requirements Handbook* was revised to be consistent with the ISO 9001:2008 standard.

TL 9000's telecommunications sector-specific quality system requirements are divided into six categories and marked accordingly: common (C), hardware (H), software (S), services (V), hardware and software (HS), and hardware and services (HV). There are no services and software (SV) elements. A supplier is only required to implement the additional elements that fit its scope of operations. Only a hardware and software company that offers a service must implement all sector-specific requirements.

Sources of the sector-specific requirements are the QuEST Forum; three Bellcore standards: GR-1202-CORE, *Generic Requirements for a Customer Sensitive Quality Infrastructure*, GR-1252-CORE, *Quality System Generic Requirements for Hardware* and TR-NWT-000179, *Quality System Generic Requirements for Software*; ISO/IEC 12207:1995, *Information Technology Software Life Cycle Processes*; ISO 9000-3:1997, *Quality Management and Quality Assurance Standards – Part 3: Guidelines for the Application of ISO 9001:1994 to the Development, Supply, Installation and Maintenance of Computer Software*; and ISO 9004-2:1994, *Quality Management and Quality System Elements – Part 2: Guidelines for Services*.

TL 9000 breaks ground by establishing cost and performance based measurements that measure the reliability and quality performance of hardware, software and services. These performance measurement tools, known as metrics in Release 4.5, are important from the customer's point of view and include hardware return rates, system outages, number of problem reports, software update quality, on-time delivery, invoice accuracy, and the efficiency and level of success of the supplier's business processes and activities.

Measurements can quantify the benefits gained, assess progress in quality maturity, identify areas where the quality process improvement will have the greatest cost effect, and provide comparative benchmarking capabilities for the industry. These supplier performance measurements can drive improvements that directly affect the customer and help reduce the annual cost of poor quality (COPQ) within the telecommunications industry.

Measurements link quality improvement to business issues and help senior corporate executives appreciate the value of quality management systems. TSPs can use measurements to determine the financial effects of a supplier's performance on their own operations by applying cost factors to them.

Measurements are reported to the American Society for Quality (ASQ), the QuEST Forum administrator, and are used for benchmarking. They are also reportable to clients if required by contract. Unlike traditional cost-of-quality (COQ) measures, measurements focus on what immediately affects the customer.

TL 9000 also requires telecommunications organizations to establish and maintain a process for communicating with their customers. These requirements are set forth in Element 5.2.C.2, Customer Communication Methods in the Requirements Handbook, and the document *Guidance for Communication with Customers* in the TL 9000 Registration Guidance section of tl9000.org.

REGISTERING TO TL 9000 _____

TL 9000 registration is a tangible expression of a telecommunications firm's commitment to quality that is internationally understood and accepted. TL 9000 registered organizations almost universally realize major increases in customer acceptance, as well as reductions in costs. Many telecommunications firms, already subject to quality system standards imposed by major customers, find that the major effect of TL 9000 registration is on their nonmanufacturing functions, which tend to be overlooked by manufacturing-based quality systems.

TL 9000 registration may encompass an entire company, an organizational unit, a combination of units, several facilities, an individual facility, or a limited and defined product line. The registration scope may be for hardware, software, services or any combination thereof. As a result, there are seven TL 9000 registration options. They are:

- TL 9000-H (Hardware)

- TL 9000-S (Software)

- TL 9000-V (Services)

- TL 9000-H,S (Hardware and Software)

- TL 9000-H,V (Hardware and Services)

- TL 9000-S,V (Software and Services)

- TL 9000-H,S,V (Hardware, Software and Services)

TL 9000 registration is carried out by registrars, accredited organizations that review the quality manual and other documentation to ensure that they meet the standard, and audit the processes to ensure that the quality management system described in the documentation is in place and is effective. Once registration is obtained, the registrar conducts regular surveillance audits to determine if the quality management system continues to meet the standard's requirements.

As it typically takes 6 to 18 months to complete the TL 9000 registration process, telecommunications organizations are advised not to put off registration for too long.

Key Steps to Completing Registration

Before an organization, or part thereof, can be considered for registration, several preliminary steps must be taken:

1) The first step is to implement a quality management system that meets TL 9000 requirements.

2) To qualify for registration, it's not enough to just conform to the standard. A quality manual must be created which stipulates the quality-related policies, procedures and practices. This document plays a vital role in the registration process. Because the manual is the principal document used during an audit, it must be a true reflection of the quality management system. The manual must also address, point-by-point, all applicable TL 9000 requirements.

3) The quality management system must be in operation for a minimum of three to six months so that employees are familiar with the system and an evidentiary trail of documents has been created for auditors to review.

After successfully completing the preliminary steps, a relationship must be established with a registrar. The registrar's job is to verify whether the quality management system has been properly implemented and is in conformance with applicable TL 9000 requirements.

Once the services of an accredited registrar have been obtained, a formal application must be filed. When all of the paperwork has been submitted, the registrar audits the quality manual. After the registrar has verified that the manual is a satisfactory reflection of the quality management system and meets all applicable TL 9000 requirements, an on-site audit is scheduled.

During the audit, the registrar interviews employees, reviews records, and performs a detailed inspection of the quality management system and procedures. The purpose of the audit is to ensure that the quality management system is functioning adequately and conforms to all applicable TL 9000 requirements.

Afterward, the registrar reports its findings in an audit report. If any major or minor nonconformities were found, the organization (or auditee) must take corrective action to remedy the cause of the nonconformity. Nonconformities must be remedied within a set time frame, determined by the registrar. Once the registrar has closed out all outstanding nonconformities, a registration certificate is issued which covers the scope of operations.

To ensure that telecommunications organizations are following applicable TL 9000 requirements after registration is obtained, the registrar conducts on-site surveillance audits two times a year.

Remember: In order to achieve registration to TL 9000, the organization or part thereof must completely embrace the standard, which focuses on performance, documentation and objective/audit evidence.

What to Look For in a Registrar

In selecting a registrar, it is extremely important for every organization to be aware of the relevant qualifications.

A registrar must:

- Be accredited by an accreditation body recognized by the QuEST Forum;

- Maintain a listing of its TL 9000 qualified auditors;

- Have personnel on its governing board or council of experts with relevant telecommunications industry experience;

- Conform to *TL 9000 Accreditation Body Implementation Requirements* found in the TL 9000 Registration Guidance section of tl9000.org;

- Conform to *Code of Practice for TL 9000 Registrars* found in the TL 9000 Registration Guidance section of tl9000.org;

- Conform to ISO/IEC 17021:2006, *Conformity assessment – Requirements for bodies providing audit and certification of management systems.*

What to Look For in an Auditor

Requirements have been established for the auditors working for accredited ISO 9000 registrars. Before an auditor can evaluate an organization, facility or product line to verify whether its quality management system conforms to ISO 9001:2008 requirements, the auditor must satisfy the following conditions:

1) Auditors must have satisfactorily completed the TL 9000 auditor training course and demonstrated their knowledge of TL 9000 by passing an exam. A certificate is awarded to those auditors who have successfully completed this training;

2) Auditors must comply with the *Qualifications and Experience Requirements for TL 9000 Registrar Auditors* found in the TL 9000 Registration Guidance section of tl9000.org, and ISO 17021:2006, regarding their qualifications;

3) They must be recognized and qualified as TL 9000 auditors under the registrar's criteria; and,

4) At least one member of an audit team must have at least two years of telecommunications industry experience within the last 10 years or at least 20 days of on-site auditing experience within the last two years in the relevant Nomenclature des Activities Economiques (NACE) codes for the client.

Before hiring the services of a registrar, it's a good idea to make sure the registrar and its auditors have met the above qualifications.

THE BENEFITS OF TL 9000 _____

TL 9000 is an ideal quality management system for telecommunications suppliers that are serious about quality, with TL 9000 registration providing a competitive edge.

Telecommunications organizations that operate TL 9000 quality management systems tend to exhibit a philosophy of prevention rather than detection; continuous review of critical process points; corrective actions and outcomes; consistent communication within the process, and among facility, suppliers and customers; thorough record keeping and efficient control of critical documents; total quality awareness by all employees; and a high level of executive management confidence and support.

Expected benefits of TL 9000 include:

- Continual improvement of service to subscribers.

- Enhanced relationships between the organization and its customers.

- Standardization of quality management system requirements.

- Efficient management of external audits and site visits.

- Uniform measurements.

- Overall cost reduction and increased competitiveness.

- Enhanced management and improvement of the organization's performance.

- Industry benchmarks for TL 9000 measurements.

These attributes lead to dependable process input, control of quality costs, increased productivity and reduced waste. A well-designed and implemented TL 9000 quality system creates a process that tends to be lean, sensitive to customer needs, highly reactive, efficient and positioned at the leading edge of the marketplace.

Bottom line: A telecommunications organization which chooses to conform to TL 9000 will be operating a top-notch quality management system that focuses on informed and competent management decision making, control of quality costs, increased productivity and reduced waste.

TL 9000 QUALITY MANAGEMENT SYSTEM REQUIREMENTS __

ISO 9001:2008-based requirements are in plain text.

Additional telecommunications sector-specific requirements are in italics.
These elements are marked common (C), hardware (H), software (S),
services (V), hardware and software (HS), and hardware and services (HV).

4   Quality Management System

4.1 General Requirements, requires an organization to establish, document, implement, maintain and continually improve a quality management system (QMS) covering ISO 9001 requirements. The organization must determine and manage the processes necessary to achieve planned results and continual improvement, including outsourced processes.

4.2 Documentation Requirements

4.2.1   General, requires an organization to prepare quality policy and objectives statements, a quality manual, documented procedures, quality records and other documents required to ensure effective operation and control of its processes, and required by ISO 9001. The extent of QMS documentation depends on the size and type of the organization, complexity and interaction of its processes, and competence of personnel.

4.2.2   Quality Manual, requires the organization to establish and maintain a quality manual that includes the scope of the QMS, documented procedures and a description of QMS processes.

4.2.3   Control of Documents, requires QMS documents, including quality records, to be controlled. A documented procedure must be established to approve, review, update, and identify the current revision level of QMS documents; ensure that relevant versions are available at points of use, documents are legible, readily identifiable and retrievable, and documents of external origin determined by the organization to be necessary for the planning and operation of the quality management system are identified and controlled; and prevent unintended use of obsolete documents.

> *4.2.3.C.1 Control of Customer-Supplied Documents and Data, requires the organization to establish and maintain documented procedures to control all customer-supplied documents and data, such as network architecture, topology, capacity and database, if these documents and data influence the design, verification, validation, inspection and testing, or servicing the product.*

4.2.4   Control of Records, requires the organization to control and maintain QMS records to provide evidence of conformance to requirements and of effective QMS operation. A documented procedure must be established for the identification, storage, retrieval, protection, retention time and disposition of records. Records shall remain legible, readily identifiable and retrievable.

5 Management Responsibility

5.1 **Management Commitment**, requires top management to demonstrate its commitment to the QMS and continually improving its effectiveness by establishing the quality policy and objectives; conducting management reviews; communicating to the organization the importance of meeting customer, regulatory and legal requirements; and ensuring the availability of necessary resources.

5.2 **Customer Focus**, requires top management to ensure that customer requirements are determined and met with the aim of enhancing customer satisfaction.

> *5.2.C.1* *Customer Relationship Development, requires top management to demonstrate active involvement in establishing and maintaining mutually beneficial customer-organization relationships.*

> *5.2.C.2* *Customer Communication Methods, requires the organization to establish methods for communicating with selected customers to share expectations and to ensure product quality improvement. The outcome of customer communication should generate actions for resolving identified issues and provide opportunities for improving customer satisfaction.*

5.3 **Quality Policy**, requires top management to establish an appropriate quality policy which includes a commitment to meeting requirements and continual improvement, provides a framework for establishing and reviewing quality objectives, is communicated and understood at appropriate organizational levels, and is reviewed for continuing suitability.

5.4 **Planning**

> **5.4.1** **Quality Objectives**, requires the organization to establish quality objectives that are measurable and consistent with the quality policy, including those needed to meet product requirements.

> > *5.4.1.C.1* *Quality Objectives, requires that objectives for quality include targets for the TL 9000 measurements defined in the TL 9000 Quality Management System Measurements Handbook.*

> **5.4.2** **Quality Management System Planning**, requires top management to plan the QMS to meet Element 4.1 requirements and quality objectives, and ensure that QMS integrity is maintained when changes are planned and implemented.

> > *5.4.2.C.1* *Long- and Short-Term Quality Planning, requires quality planning activities to include long- and short-term plans with goals for improving quality and customer satisfaction. The plans must address business factors relevant to the organization and its customers, including performance objectives established jointly with selected customers. Performance to these goals are to be monitored and reported to Top Management.*

5.4.2.C.2 Customer Input, requires the organization to implement methods for soliciting and considering customer input for quality planning activities. The organization should establish joint quality improvement programs with customers.

5.4.2.C.3 Supplier Input, requires the organization to implement methods for soliciting and using supplier input for quality planning activities.

5.5 Responsibility, Authority and Communication

5.5.1 Responsibility and Authority, requires top management to ensure that responsibilities, authorities and their interrelation within the organization are defined and communicated.

5.5.2 Management Representative, requires top management to appoint a member of the organization's management with responsibility for ensuring that QMS processes are established, implemented and maintained, reporting QMS performance and any need for improvement to top management, and ensuring that awareness of customer requirements is promoted throughout the organization.

5.5.3 Internal Communication, requires top management to ensure communication processes are established within the organization and that communication takes place regarding QMS effectiveness.

5.5.3.C.1 Organization Performance Feedback, requires the organization to inform employees of its quality performance and the level of customer satisfaction.

5.6 Management Review

5.6.1 General, requires top management to periodically review the QMS to ensure its continuing suitability, adequacy and effectiveness, and evaluate opportunities for improvement and the need for changes, including the quality policy and objectives.

5.6.2 Review Input, requires management review inputs to include information on audit results, customer feedback, process performance and product conformity, preventive and corrective actions, follow-ups to previous management reviews, changes that could affect the QMS, and recommendations for improvement.

5.6.3 Review Output, requires management review output to include decisions and actions related to improving the effectiveness of the QMS and its processes, product improvement related to customer requirements, and resource needs.

6 Resource Management

6.1 **Provision of Resources**, requires the organization to determine and provide the resources needed to implement and maintain the QMS, continually improve its effectiveness, and enhance customer satisfaction by meeting customer requirements.

6.2 **Human Resources**

    6.2.1 **General**, requires the organization to assign personnel to work affecting conformity to product requirements who are competent on the basis of appropriate education, training, skills and experience.

    6.2.2 **Competence, Awareness and Training**, requires the organization to identify competency needs and where applicable provide training for personnel performing activities affecting conformity to product requirements; evaluate training effectiveness; ensure that employees are aware of the relevance and importance of their activities, and how they contribute to achieving quality objectives; and maintain appropriate education, training, skills and experience records.

        6.2.2.C.1 *Internal Training Development, requires the organization, where the organization is responsible for developing formal internal training, to establish and maintain a method to ensure consistency in the planning, development and delivery of its training.*

        6.2.2.C.2 *Quality and Process Improvement Concepts, requires those employees who have a direct impact on the quality of the product, including top management, to be trained in and apply the fundamental concepts of continual improvement, problem solving and customer satisfaction.*

        6.2.2.C.3 *Product Quality Training Opportunity Awareness, requires the organization to implement methods to ensure employees are enabled to participate. Methods should address communication of training opportunities and availability of training.*

        6.2.2.C.4 *Electrostatic Discharge (ESD) Training, requires all employees with functions that involve any handling, storage, packaging, preservation or delivery of electrostatic discharge (ESD)-sensitive products to be trained in ESD protection prior to performing their jobs.*

        6.2.2.C.5 *Advanced Quality Training, requires the organization to offer appropriate levels of advanced quality training, which may include for example statistical techniques, process capability, statistical sampling, data collection and analysis, problem identification, problem analysis, and corrective and preventive action.*

> > **6.2.2.C.6** **_Hazardous Conditions Training Content_**_, requires that where the potential for hazardous conditions exist, training content includes task execution; personal safety and appropriate protective equipment; awareness of the hazardous environment; and equipment protection._

> > **6.2.2.HV.1** **_Qualification of Personnel_**_, requires the organization to establish personnel qualification and re-qualification requirements for all applicable processes. These requirements, as a minimum, must address employee education, experience, training and demonstrated skills._

6.3 **Infrastructure**, requires the organization to determine, provide and maintain the infrastructure needed to achieve product conformity, including buildings, workspace and associated facilities; process equipment, both hardware and software; and supporting services, such as transport, communication or information systems.

> **6.3.C.1** **_Infrastructure,_** _requires the organization to identify critical areas of the infrastructure and provide for the security needed to protect these areas, and to develop and periodically assess security restoration plans._

6.4 **Work Environment**, requires the organization to determine and manage the work environment needed to achieve product conformity.

> **6.4.C.1** **_Work Areas_**_, requires areas used for handling, storage and packaging of products to be clean, safe and organized to ensure they do not adversely affect product quality or personnel performance._

7   Product Realization

7.1 **Planning of Product Realization**, requires the organization to plan and develop the processes needed for product realization, which must be consistent with other QMS process requirements and be documented in a form suitable for the organization's method of operations. The organization must determine the product's quality objectives and requirements; the need to establish processes and documents to provide resources specific to the product; required product verification, validation, monitoring, measurement, inspection and test activities, and acceptance criteria; and necessary records to provide evidence that the realization processes and resulting product fulfill requirements.

> **7.1.C.1** **_Life Cycle Model_**_, requires the organization to establish and maintain an integrated set of methods that cover the life cycle of its products. This method must contain, as appropriate, the processes, activities and tasks involved in concept, definition, development, introduction, production, operation, maintenance, and, if required, disposal of products, spanning the product life._

> **7.1.C.2** **_Disaster Recovery_**_, requires the organization to establish and maintain documented plans for disaster recovery to ensure its ability to recreate and service the product throughout its life cycle. Disaster recovery plans shall be periodically assessed and reviewed with appropriate levels of management._

7.1.C.3 ***End of Life Planning***, *requires the organization to establish and maintain a documented procedure(s) for the discontinuance of manufacturing and/or support of a product. The documented procedure(s) should include cessation of full or partial support after a certain period of time, archiving product documentation and software, responsibility for any future residual support issues, transition to the new product, if applicable, and accessibility of archive copies of data.*

7.1.C.4 ***Tools Management***, *requires the organization to ensure that internally developed software and/or tools used in the product life cycle are subject to the appropriate quality method(s).*

7.1.HS.1 ***Configuration Management Plan***, *requires the organization to establish and maintain a configuration management plan, which should include identification and scope of the configuration management activities, a schedule for performing these activities, configuration management tools, configuration management methods and documented procedure(s), organizations and responsibilities assigned to them, level of required control for each configuration item, and point at which items are brought under configuration management.*

7.1.V.1 ***Service Delivery Plan***, *requires organizations that are responsible for the delivery or implementation of a service, and are not responsible for the design and development of that service, to comply with the project plan and risk management requirements of 7.3.1.C.1 and 7.3.1.C.4.*

7.2 Customer-Related Processes

7.2.1 **Determination of Requirements Related to the Product**, requires the organization to determine customer-specified requirements, including requirements for delivery and post-delivery activities; requirements not specified by the customer, but necessary for specified or intended use, where known; statutory and regulatory requirements applicable to the product; and any additional requirements considered necessary.

7.2.2 **Review of Requirements Related to the Product**, requires the organization to review requirements related to the product before committing to supply it. This review must ensure that product requirements are defined, changes in contract or order requirements are resolved, and the organization is able to meet the requirements. Records of review results and follow-up actions must be maintained. Customer requirements must be confirmed by the organization before acceptance if not previously documented by the customer. When product requirements are changed, relevant documentation must be amended and relevant personnel must be made aware of the changes.

7.2.2.C.1 *Closure Tracking, requires that all actions resulting from requirements reviews be tracked to closure.*

7.2.2.C.2 *Contract Review, requires that an organization establish and maintain a contract review process that includes product acceptance criteria and criteria review process, method(s) for handling of problems detected after product acceptance, including customer complaints, plan for removal and/or correction of nonconformities after applicable warranty period or during product maintenance contract period, identification of risks and possible contingencies, adequate protection of proprietary information, definition of the organization's responsibility with regard to outsourced work, activities carried out by purchaser, especially the purchaser's role in requirement, specification and acceptance, facilities, tools and software items to be provided by the purchaser, all referenced standards and procedures.*

7.2.3 **Customer Communication**, requires the organization to identify and implement effective communication arrangements with customers relating to product information; inquiries, contracts or order handling, including amendments; and customer feedback, including complaints.

7.2.3.C.1 *Notification About Problems, requires the organization to establish and maintain a documented procedure(s) to notify all customers who may be affected by a reported service problem.*

7.2.3.C.2 *Problem Severity Classification, requires the organization (subject to its product category) to assign severity levels to customer reported problems based on the impact to the customer. The severity level of critical, major or minor must be used in determining the timeliness of the organization's response.*

7.2.3.C.3 *Problem Escalation, requires the organization to establish and maintain a documented escalation procedure(s) to resolve customer-reported problems.*

7.2.3.C.4 *Problem Report Feedback, requires the organization to provide the customer with feedback on their problem reports in a timely and systematic manner.*

7.2.3.HS.1 *Product Replacement, requires the organization to establish and maintain a documented procedure(s) to identify and recall products that are unfit to remain in service.*

7.2.3.HS.2 *Design and Development Process Quality Measurements Data Reporting, requires, on request of the customer, communications to include reporting and evaluation of a jointly agreed set of design and development process measurements.*

7.3 Design and Development

7.3.1 Design and Development Planning, requires the organization to plan and control design and development of product. This planning determines the design and development stages; appropriate review, verification and validation activities; and responsibilities and authorities for design and development activities. Interfaces between different groups involved in design and development must be managed to ensure effective communication and clarify assignment of responsibilities. Planning output must be appropriately updated as the design and development progresses.

7.3.1.C.1 Project Plan, *requires the organization to establish and maintain a project plan based on the defined product life cycle model. The plan must include project organizational structure; project roles, responsibilities and accountabilities of the project team and related teams and individuals; interfaces within or outside of the organization; means for scheduling, tracking, issue resolution, and management reporting; budgets, staffing, and schedules associated with project activities; method(s), standards, documented procedure(s), and tools to be used; references to related plans, such as development, testing, configuration management and quality; project-specific development or service delivery environment and physical resource considerations, such as development, user documentation, testing and operation; customer, user and supplier involvement during the product life cycle, such as joint reviews, informal meetings, and approvals; management of project quality including appropriate process quality measures; Design For x plans as appropriate to the product life cycle. Examples of x are Manufacturability, Reliability, Regulatory, or Testability; risk management and contingency plans, such as technical, cost and schedules; lessons learned from previous post-project analyses; project-specific training requirements; required certifications; proprietary, usage, ownership, warranty and licensing rights; and post-project analysis.*

7.3.1.C.2 Requirements Traceability, *requires the organization to establish and maintain a method to trace documented requirements through design and test.*

7.3.1.C.3 Test Planning, *requires test plans to be documented and should include scope of testing; types of tests to be performed; traceability to requirements; test environment; test coverage; expected results; data definition and database requirements; set of tests, repeatable test cases and documented test procedures; use of external testing; and method of reporting and resolving defects, and customer test requirements.*

7.3.1.C.4 **_Risk Management Plan,_** *requires the organization to develop and document a plan for the identification, analysis, and control of risks to the project that can impact cost, schedule or product performance.*

7.3.1.C.5 **_Integration Planning_**, *requires the organization to develop and document a plan to integrate software components into the product. The plan must include methods and documented procedure(s), responsibilities, schedule for integration, and test requirements.*

7.3.1.C.6 **_Estimation_**, *requires the organization to establish and maintain a method for estimating and tracking project factors against the project plan throughout the project life cycle including during project planning, execution, and change management.*

7.3.1.HS.1 **_Migration Planning_**, *requires the organization to develop and document a migration plan when a system or software product is planned to be migrated from an old to a new. If the old environment will no longer be supported, users shall be given notification of migration plans and activities which shall include a description of the new environment with its date of availability, and description of other support options available. The plan should include requirements analysis and definition of migration, development of migration tools, conversion of product and data, migration execution, migration verification, and support for the old environment in the future.*

7.3.1.HS.2 **_Design and Development Process Quality Measurement Planning and Implementation_**, *requires during the design and development planning phase, establishment and maintenance of methods for selecting and reporting appropriate design process quality measures for the project. As recommended during this phase, this measurement system is required to be appropriate to the project. At a minimum, the measures should cover the areas of project schedule (life cycle phase transition or milestone monitoring), test execution, and test phase defect monitoring." at the end of the adder.*

7.3.1.S.1 **_Computer Resources_**, *requires the organization to establish and maintain methods for estimating and tracking critical computer resources for the target computer, the computer on which the software is intended to operate.*

7.3.1.S.2 **_Regression Test Planning_**, *requires, if regression testing is to be performed, test plans that specify what tests are regression and what features and functions are covered by these regression tests.*

7.3.2 **Design and Development Inputs**, requires inputs relating to product requirements to be determined and reviewed for adequacy, with records maintained. These include functional, performance, and applicable statutory and regulatory requirements; applicable information derived from previous similar designs; and other essential design and development requirements. Requirements must be complete, unambiguous and not in conflict with each other.

7.3.2.C.1 *Customer and Supplier Input, requires the organization to establish and maintain methods for soliciting and using customer and subcontractor input during the development of new or revised product requirements.*

7.3.2.C.2 *Design and Development Requirements, requires design requirements to be defined and documented, and should include quality and reliability requirements; product functions and capabilities; business, organizational and user requirements; safety, environmental and security requirements; manufacturability, installability, usability and maintainability requirements; design constraints; testing requirements; computer resources for the target computer; and lessons learned from previous projects.*

7.3.2.C.3 *Requirements Allocation, requires the organization to document the allocation of the product requirements to the product architecture.*

7.3.2.H.1 *Content of Requirements, requires product requirements to include, but not be limited to, nominal values and tolerances, maintainability needs, and end item packaging requirements.*

7.3.2.S.1 *Identification of Software Requirements, requires the organization to determine, analyze and document the software requirements of the system.*

7.3.3 **Design and Development Outputs**, requires design and development outputs to be in a form suitable for verification against input requirements, and to be approved before release. Outputs must meet input requirements; provide appropriate information for purchasing, production and service provision; contain or reference product acceptance criteria; and specify product characteristics that are essential for its safe and proper use.

7.3.3.HS.1 *Design and Development Output, requires design and development outputs to include, but not be limited to, system architecture, system detailed design, source code and user documentation.*

> **7.3.3.V.1** *Services Design and Development Output, requires output from the services design and development to contain a complete and precise statement of the service to be provided. Design and development outputs must include, but are not limited to, service delivery procedures, resource and skill requirements, reliance on suppliers, service characteristics subject to customer evaluation, and standards of acceptability for each service characteristic.*

7.3.4 **Design and Development Review**, requires systematic reviews of design and development at suitable stages in accordance with planned arrangements to evaluate the ability of design and development results to meet requirements, identify problems and propose necessary actions. Representatives of functions concerned with the design and development stage(s) being reviewed must participate, and records of review results and any necessary actions must be maintained.

7.3.5 **Design and Development Verification**, requires performing design and development verification in accordance with planned arrangements to ensure the design and development outputs have met the input requirements. Records of verification results and any necessary actions must be maintained.

> **7.3.5.C.1** *Verification of Documentation, requires the organization to verify the customer and/or user documentation prior to product delivery.*

> **7.3.5.HS.1** *Stress Testing, requires the organization to test the product under stress conditions, including, but not limited to, out-of-boundary and invalid input conditions, high volume and peak load simulations, and operational errors.*

> **7.3.5.HS.2** *Abnormal Conditions, requires the organization to test product under abnormal conditions, which shall include, as appropriate Hardware errors, Software errors, Operations, administration, maintenance and provisioning (OAM&P) errors, Overload traffic, Invalid user input, System recovery from a total outage.*

> **7.3.5.S.1** *System Testing, requires each software release to be subjected to a system test in accordance with a documented system test plan.*

7.3.6 **Design and Development Validation**, requires performing design and development validation in accordance with planned arrangements to ensure that the resulting product is capable of meeting specified application or intended use requirements, where known. Validation must be completed before product delivery or implementation wherever practicable. Records of validation results and any necessary actions must be maintained.

7.3.6.S.1 ***Release Management****, requires the organization to establish and maintain methods to ensure that the release and delivery of software products and related documentation are carried out under controlled conditions. Methods should provide for delivery to the customer of release planning information in advance of the release, product introduction and release schedules, detailed descriptions of product features delivered, including changes incorporated in new software products or releases, and advisories of current or planned changes to contractual terms.*

7.3.7 **Control of Design and Development Changes**, requires design and development changes to be identified, recorded, reviewed; verified and validated, as appropriate; and approved before implementation. This review of changes includes evaluation of the effect of the changes on constituent parts and product already delivered. Records of change review results and any necessary actions must be maintained.

7.3.7.C.1 ***Change Management Process****, requires the organization to establish and maintain a documented procedure to ensure that all requirements and design changes, which may arise at any time during the product life cycle, are managed and tracked in a manner which is systematic and timely manner appropriate to the life cycle stage, and requires that changes which adversely affect mutually agreed conditions for quality, reliability and functional intent, are reviewed with the customer prior to approval. Management of changes should include impact analysis, including impact on resources and schedule, planning, implementation, testing, documentation, communication, and review and approval.*

7.3.7.C.2 ***Informing Customers****, requires the organization to establish and maintain a documented procedure(s) to ensure that customers are informed when design changes affect contractual commitments.*

7.3.7.C.3 ***Problem Resolution Configuration Management****, requires the organization to ensure that its configuration management system tracks fixes to problems and incorporates those fixes in future revisions.*

7.3.7.H.1 ***Component Changes****, requires the organization to have a documented procedure(s) in place to ensure that material or component substitutions or changes do not adversely affect product quality or performance. The documented procedure(s) should include functional testing, qualification testing, stress testing, approved parts listing, and/or critical parts listing.*

7.4 Purchasing

7.4.1 Purchasing Process, requires the organization to ensure that purchased product conforms to specified requirements, with the type and extent of control applied to the supplier and the purchased product dependent upon the effect on subsequent product realization or the final product. Suppliers must be evaluated and selected based on their ability to supply product in accordance with the organization's requirements, with the criteria for selection, evaluation and re-evaluation established. Records of evaluation results and any necessary actions must be maintained.

7.4.1.C.1 Purchasing Procedure(s), requires the organization to establish and maintain documented purchasing procedure(s) that ensure product requirements are clearly defined; risks are understood and managed; qualification and acceptance criteria are established; contracts are defined; proprietary, usage, ownership, warranty and licensing rights are satisfied; future support for the product is planned; ongoing supply-base management and monitoring is in place; supplier selection criteria are defined; suppliers are re-evaluated based on defined criteria; and feedback is provided to key suppliers based on data analysis of supplier performance.

7.4.1.C.2 Supplier Performance Management, requires the organization to plan and perform supplier performance management and development activities so that suppliers are qualified to established criteria, ongoing supply-based management and monitoring is in place, suppliers are periodically re-evaluated using established criteria, evaluation results are considered during supplier selection activities, feedback is pro-actively provided to suppliers for continuous improvement, supplier quality performance is tracked and enhanced, and alignment towards conformity to TL 9000 requirements and measurements occurs.

7.4.2 Purchasing Information, requires purchasing information describing the product to be purchased, including where appropriate, requirements for approval of product, procedures, processes and equipment; qualification of personnel; and the QMS. The organization must ensure the adequacy of specified purchase requirements before communicating them to the supplier.

7.4.3 Verification of Purchased Product, requires the organization to establish and implement the inspection or other activities necessary to ensure that purchased product meets specified purchase requirements. Where the organization or its customer proposes to perform verification at the supplier's premises, the organization must state the intended verification arrangements and product release method in the purchasing information.

7.5 Production and Service Provision

7.5.1 Control of Production and Service Provision, requires the organization to plan and carry out production and service provision under controlled conditions, which include, as applicable, the availability of product characteristics information; the availability of work instructions; using suitable equipment; the availability and use of monitoring and measuring equipment; the implementation of monitoring and measurement; and the implementation of product release, delivery and post-delivery activities.

7.5.1.C.1 *Service Resources*, *requires the organization to provide customer contact employees with appropriate tools, training, and resources necessary to provide effective and timely customer service.*

7.5.1.C.2 *Product Delivery*, *requires the organization to establish and maintain methods to minimize interference with the customer's normal site operation and service during product delivery and installation.*

7.5.1.HS.1 *Emergency Service*, *requires the organization to ensure that services and resources are available to support recovery from emergency failures of product in the field throughout its expected life, and to identify potential situations that can have an impact on its ability to provide the emergency service, and to have response plans to address these situations, where these plans are required to be based on risk and periodically assessed.*

7.5.1.HS.2 *Installation Plan*, *requires the organization to establish and maintain a documented installation plan. The installation plan must identify the resources, the information required, and list the sequence of events, and any necessary records.*

7.5.1.HV.1 *Operational Changes*, *requires, each time a significant change is made in the established operation, a critical examination to be made of the first units/services processed after the change.*

7.5.1.S.1 *Patching Procedure(s)*, *requires the organization to establish and maintain a documented patching procedure(s) that guides the decision to solve problems by patching, addresses patch development procedures, propagation (forward and backward) and resolution, that are consistent with customer needs or contractual requirements for maintenance support, and that ensures the organization provides the customer with a statement of impact on the customer's operation for each patch.*

7.5.1.S.2 *Patch Documentation*, *requires the organization to establish and maintain methods to ensure that all documentation required to describe, test, install and apply a patch has been verified and delivered with the patch.*

7.5.1.S.3 ***Replication****, requires the organization to establish and maintain a documented procedure(s) for replication, which should include identification of the master copy and replicate copies for delivery; quantity of replicates to deliver; type of media; labeling; identification and packaging of required documentation, such as user guides; and control of environment to ensure repeatable replication.*

7.5.1.V.1 ***Software Used in Service Delivery****, requires organizations to establish and maintain a documented procedure for the maintenance and control of software used in service delivery to ensure continued process capability and integrity.*

7.5.1.V.2 ***Tool Changes****, requires the organization to establish and maintain documented procedure(s) in place to ensure that substitutions or changes to tools used in performing the service do not adversely affect the service quality.*

7.5.2 **Validation of Processes for Production and Service Provision**, requires the organization to validate production and service provision where the resulting output cannot be verified by subsequent monitoring or measurement, including as a consequence any processes where deficiencies become apparent only after the product is in use or the service has been delivered. Validation must demonstrate the ability of these processes to achieve planned results, and must include, as applicable, defined criteria for process review and approval, approval of equipment and qualification of personnel, use of specific methods and procedures, requirements for records, and revalidation.

7.5.3 **Identification and Traceability**, requires the organization, where appropriate, to identify the product by suitable means throughout product realization, and the product status with respect to monitoring and measurement requirements throughout product realization. The organization must control and record the product's unique identification where traceability is required, and maintain records.

7.5.3.H.1 ***Traceability for Recall****, requires Field Replaceable Units (FRU) to be traceable throughout the product life cycle in a way that helps organizations and their customers to identify products being recalled, or needing to be replaced or modified.*

7.5.3.H.2 ***Traceability of Design Changes****, requires the organization to define and implement methods necessary to provide traceability of design changes to identifiable manufacturing dates, lots or serial numbers.*

7.5.3.HS.1 ***Product Identification****, requires the organization to establish and maintain a process for the identification of each product and the level of required control. For each product and its versions, the following must be identified where they exist: product documentation, development or production tools essential to repeat product creation, interfaces to other products, and software and hardware environment.*

7.5.4 **Customer Property**, requires the organization to exercise care with customer property while it is under the organization's control or being used by the organization. Customer property provided for use or incorporation into the product must be identified, verified, protected and safeguarded. Lost, damaged or otherwise unsuitable customer property must be recorded and reported to the customer.

7.5.5 **Preservation of Product**, requires the organization to preserve product during internal processing and delivery to the intended destination in order to maintain conformity to requirements, including as applicable identification, handling, packaging, storage and protection. Preservation also applies to a product's constituent parts.

7.5.5.C.1 *Electrostatic Discharge (ESD) Damage Protection, where applicable, electrostatic discharge (ESD) protection requires protection be employed for components and products susceptible to ESD damage.*

7.5.5.HS.1 *Packaging and Labeling Verification, requires the organization to establish and maintain methods to ensure that packaging and labeling of products and components conform to specified requirements.*

7.5.5.HV.1 *Deterioration, requires where the possibility of deterioration exists, the organization shall establish and maintain methods to determine when materials that may impact product quality have deteriorated or exceeded their expiration dates, and assess any subsequent action required.*

7.5.5.S.1 *Software Virus Protection, requires the organization to establish and maintain methods for software virus prevention, detection and removal from the deliverable product.*

7.6 **Control of Monitoring and Measuring Devices**, requires the organization to determine the monitoring and measurements to be undertaken, and the monitoring and measuring equipment needed to provide evidence of product conformity to determined requirements. The organization must establish processes to ensure that monitoring and measurement can be carried out and in a manner that is consistent with monitoring and measurement requirements. Where necessary to ensure valid results, measuring equipment must be calibrated or verified, or both, at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards, or under a recorded basis where no such standards exist; adjusted or re-adjusted as necessary; have identification in order to determine the calibration status; safeguarded from adjustments that would invalidate the measurement result; and protected from damage and deterioration during handling, maintenance and storage. The organization must re-assess and record the validity of previous measuring results when the equipment is found not to conform to requirements, with appropriate action taken on the affected equipment and product. Records of calibration and verification results must be maintained. Confirmation of the ability of computer software to satisfy the intended application would typically include its verification and configuration management to maintain its suitability for use.

7.6.C.1 Equipment Identification*, requires monitoring and measuring devices that are either inactive or unsuitable for use to be visibly identified and not used. All monitoring and measuring devices that do not require calibration must be identified.*

8 Measurement, Analysis and Improvement

8.1 General, requires the organization to plan and implement the monitoring, measurement, analysis and improvement processes needed to demonstrate conformity to product requirements, ensure QMS conformity and continually improve QMS effectiveness, including determining applicable methods, such as statistical techniques, and the extent of their use.

8.2 Monitoring and Measurement

8.2.1 Customer Satisfaction, requires the organization to monitor information relating to customer perception of the organization meeting customer requirements as one of the QMS performance measurements, while determining methods for obtaining and using this information.

*   ***8.2.1.C.1 Customer Satisfaction Data****, requires the organization to establish and maintain a method to collect data directly from customers concerning their satisfaction with provided products. The organization must also collect customer data on how well the organization meets commitments and its responsiveness to customer feedback and needs. This data must be collected and analyzed, and data trends must be kept.*

8.2.2 Internal Audit, requires the organization to conduct periodic internal audits to determine if the QMS conforms to planned arrangements, ISO 9001 requirements and the organization's QMS requirements; and has been effectively implemented and maintained. Audit program planning must take into consideration the status and importance of processes and areas to be audited, as well as the results of previous audits. The audit criteria, scope, frequency and methods must be defined. Auditor selection and audit conduct must ensure that the audit process is objective and impartial. Auditors must not audit their own work. A documented procedure must define responsibilities and requirements for planning and conducting audits, reporting results and maintaining records. The management responsible for the area being audited must ensure that any necessary corrections and corrective actions are taken without undue delay to eliminate detected nonconformities and their causes. Follow-up activities must include verification of actions taken and the reporting of verification results. Records of the audits and their results shall be maintained.

8.2.3 Monitoring and Measurement of Processes, requires the organization to apply suitable methods to monitor and, where applicable, measure the QMS processes. These methods must demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, correction and corrective action must be taken, as appropriate.

8.2.3.C.1 ***Process Measurement***, *requires process measurements to be identified, documented and monitored at appropriate points to ensure suitability and promote increased effectiveness of processes. This includes the establishment of appropriate design process measurements. Key process measurements that impact product quality are required to have specific performance targets or control limits established.*

8.2.4 **Monitoring and Measurement of Product**, requires the organization to monitor and measure product characteristics at appropriate product realization process stages, in accordance with planned arrangements, to verify that product requirements have been met. Evidence of conformity to the acceptance criteria must be maintained, with records indicating the person(s) authorizing product release to the customer. Product release and service delivery to the customer cannot proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by a relevant authority and, where applicable, the customer.

8.2.4.H.1 ***Periodic Retesting***, *requires the organization to establish and maintain a documented procedure(s) that ensures products are periodically retested to assess their ability to continue to meet design requirements. When determining the depth of the retest, the organization should consider the conditions in 8.2.4.H.3.*

8.2.4.H.2 ***Content of Testing***, *requires the initial test and periodic retest to be more extensive than the routine quality tests. The initial test must include those that are contained in the customer's and/or organization's product specifications and/or contracts. The results of these tests must be documented.*

8.2.4.H.3 ***Frequency of Testing***, *requires the organization to establish and document the frequency of tests and periodic retests. When determining the test frequency, the organization must include product complexity and service criticality; number of design, engineering and/or manufacturing changes made to the product and whether the change(s) affect form fit and/or function; changes to the manufacturing process; manufacturing variations, such as tooling wear; material and/or component substitutions and failure rates; and the field performance record of the product.*

8.2.4.H.4 ***Testing of Repair and Return Products***, *requires repair and return products to be subjected to appropriate evaluation(s) and/or test(s) to ensure functionality to product specification.*

8.2.4.HV.1 ***Inspection and Test Documentation***, *requires each inspection or testing activity to have detailed documentation. Details should include parameters to be checked with acceptable tolerances; the use of statistical techniques, control charts and similar methods; a sampling*

> *plan, including frequency, sample size, and acceptance criteria; handling of nonconformances; data to be recorded; a defect classification scheme; a method for designating an inspection item or lot; and electrical, functional and feature testing.*

> **8.2.4.HV.2** **Inspection and Test Records**, *requires inspection and test records to include product identification; quantity of product inspected; documented procedure(s) followed; person performing the test and inspection; calibrated equipment used; date performed; and number, type and severity of defects found.*

> **8.2.4.S.1** **Test Documentation**, *requires software tests to be conducted per the test plan according to documented procedure(s). Records of testing must include test results, analysis of test results, conformity to expected results and problem reporting for nonconforming items.*

8.3 Control of Nonconforming Product, requires the organization to ensure that product which does not conform to requirements is identified and controlled to prevent its unintended use or delivery. A documented procedure must be established to define the controls and authorities for dealing with nonconforming product. The organization must deal with nonconforming product, where applicable, by either taking action to eliminate the detected nonconformity; authorizing its use, release or acceptance under concession by a relevant authority and, where applicable, the customer; taking action to preclude its original intended use or application; or some combination of these methods. Records of the nature of nonconformities and any subsequent actions taken, including concessions obtained, must be maintained. When nonconforming product is corrected, it must be subject to re-verification to demonstrate conformity to requirements. When nonconforming product is detected after delivery or use has started, the organization must take action appropriate to the effects, or potential effects, of the nonconformity.

8.4 Analysis of Data, requires the organization to determine, collect and analyze appropriate data to demonstrate the suitability and effectiveness of the QMS, and to evaluate where continual improvement of QMS effectiveness can be made. This includes data generated by monitoring and measuring, and from other relevant sources. The data analysis must provide information relating to customer satisfaction; conformance to product requirements; characteristics and trends of processes and products, including opportunities for preventive action; and suppliers.

> **8.4.C.1** **Trend Analysis of Nonconforming Product**, *requires trend analysis of discrepancies found in nonconforming product to be performed on a defined, regular basis and results used as input for corrective and preventive action.*

> **8.4.HS.1** **Field Performance Data**, *requires the quality management system to include the collection and analysis of field performance data, which can be used to help identify the cause and frequency of equipment failure. In addition, no trouble found (NTF) data must also be maintained. This information must be provided to the appropriate organizations to foster continual improvement.*

8.4.V.1 ***Service Performance Data****, requires the quality management system to include the collection and analysis of service performance data, which can be used to identify the cause and frequency of service failure. This information must be provided to the appropriate organizations to foster continual improvement of the service.*

8.5 Improvement

8.5.1 **Continual Improvement**, requires the organization to continually improve the effectiveness of the QMS through the use of the quality policy, objectives, audit results, analysis of data, corrective and preventive actions, and management review.

8.5.1.C.1 ***Continual Improvement Program****(s), requires the organization to establish and maintain a continual improvement program that includes a focus to improve customer satisfaction; quality and reliability of the product; and other processes, products and services used within the organization.*

8.5.1.C.2 ***Employee Participation****, requires the organization to implement methods for encouraging employee participation in the continual improvement process.*

8.5.2 **Corrective Action**, requires the organization to take action to eliminate the causes of nonconformities in order to prevent recurrence. Corrective actions must be appropriate to the effects of the encountered nonconformities. A documented procedure must be established to define requirements for reviewing nonconformities, including customer complaints; determining the causes of nonconformities; evaluating the need for action to prevent the recurrence of nonconformities; determining and implementing needed actions; recording the results of actions taken; and reviewing the effectiveness of corrective actions taken.

8.5.2.S.1 ***Problem Resolution****, requires the organization to establish and maintain a documented procedure(s) to initiate corrective action once a reported trouble is diagnosed as a problem. The documented procedure(s) should provide guidelines for distinguishing among potential solutions such as patching; immediate source code corrections; deferring solutions to a planned release; and providing documented "work-around" operational procedure(s) and resolution within a designated timeframe based on the severity of the issue.*

8.5.3 **Preventive Action**, requires the organization to determine action to eliminate the causes of potential nonconformities in order to prevent their occurrence. Preventive actions must be appropriate to the effects of the potential problems. A documented procedure must be established to define requirements for determining potential nonconformities and their causes, evaluating the need for action to prevent nonconformity occurrence, determining and implementing needed action, recording the results of actions taken, and reviewing the effectiveness of preventive actions taken.

CONCLUSION

TL 9000 represents progress, harmony and perseverance, for before it came on the scene, there were numerous telecommunications quality and reliability standards, resulting in a confusing maze of overlapping requirements and audits. This problem has all been eliminated with the streamlining of these separate requirements into one commonly used standard. TL 9000 has ended varying demands and the wastefulness that accompanied them.

TL 9000 enables telecommunications firms to improve the overall quality of their hardware, software and services, while realizing considerable returns on investment. Its continual improvement philosophy defines specific quality needs, and sets clear goals and objectives.

TL 9000 is unique in establishing cost and performance based measurements on the reliability and quality performance of hardware, software and services. These measurements are an important part of the continual improvement approach, and are expected to significantly reduce the amount of time and money spent addressing product and service failures.

TL 9000, the telecommunications industry's solution for better quality, is having an enormous impact on thousands of suppliers around the world and is pointing them to registration.

As registration typically takes 12 to 18 months to complete, companies are advised to start moving now. Companies should not delay registration, but should take full advantage of the competitive edge such status carries.

There are many benefits to be derived from implementing a well-structured TL 9000 quality management system, and the registration process is rigorous and timely. For this reason, not to mention the high rate of failure that afflicts companies seeking registration for the first time, it is a good idea to seek the services of an outside professional consulting firm.

A competent quality consultant can walk your company through the TL 9000 requirements, interpret and implement the standard to your specific situation and the scope of your business, and identify any problems that may halt the registration process.