AAMA QMSUG-1-21

Recommendations for Compliance with Minimum Quality Management System Requirements for AAMA Certification Programs Licensees

an FGIA certification document

American Architectural Manufacturers Association

FGIA
Fenestration & Glazing Industry Alliance

TABLE OF CONTENTS

AAMA QMSUG-1-21, as well as other AAMA documents available from FGIA, may be purchased from the online store.

This document was developed and maintained by representative members of FGIA as advisory information. FGIA DISCLAIMS ALL WARRANTIES WITH REGARD TO THIS INFORMATION, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS. IN NO EVENT SHALL FGIA BE LIABLE FOR ANY DAMAGES WHATSOEVER FROM THE USE, APPLICATION OR ADAPTATION OF MATERIALS PUBLISHED HEREIN. It is the sole responsibility of the user/purchaser to evaluate the accuracy, completeness or usefulness of any information, opinion, advice or other content published herein.

AAMA QMSUG-1-21, an FGIA Certification Document
Originally Published: 2016
Preceding Document: QMSUG-1-16
Published: 10/20

Fenstration and Glazing Industry Alliance
U.S. Headquarters: 1900 E. Golf Rd. Suite 1250, Schaumburg, IL 60173; Phone: (847) 303-5859

Canada Office: 1769 St. Laurent Blvd. Suite 104, Ottawa, ON, Canada K1G 5X7; Phone: (613) 233-1510

1.0 Introduction: AAMA/NFRC Certification – Role of the Quality Management System

Product certification has become a staple for enabling meaningful, objective appraisal of performance and compliance with codes and regulations for a wide range of products. A trusted Certification Label indicates that a product has been verified as conforming to regulatory or code-mandated standards through independent testing and assessment.

The FGIA's AAMA Window, Door and Skylight Certification Program indicates compliance with the North American Fenestration Standard (AAMA/WDMA/CSA 101/IS2/A440 NAFS), as mandated by the International Building Code (IBC), International Residential Code (IRC), and several state codes and federal agencies (e.g., Florida Building Code). The program operates as described in the current Procedural Guide (AAMA 103).

All new laboratory test reports submitted for review are eligible for an initial window, door or skylight certification term of five (5) years. In addition, all certifications that have not previously been extended are eligible for a five-year extension of the term of certification, provided, the product manufacturer complies with the enhanced Quality Management System (QMS) requirements outlined in Section 17 of **AAMA 103**).

The AAMA Manufactured Home Fenestration Products Certification Program is designed to allow AAMA manufacturer Licensees to comply with the requirements of the U.S. Department of Housing and Urban Development (HUD) Manufactured Housing Construction and Safety Standards 24 CFR 3280 – including, but not limited to, §3280.403, *Standard for Windows and Sliding Glass Doors Used in Manufactured Homes*; §3280.404, *Standard for Egress Windows and Devices for Use in Manufactured Homes*; and §3280.405, *Standard for Swinging Exterior Passage Doors for Use in Manufactured Homes*. These are addressed, respectively, by the current versions of the standards AAMA 1701.2, *Voluntary Standard for Utilization in Manufactured Housing for Primary Windows and Sliding Glass Doors*, AAMA 1704, *Voluntary Standard Egress Window Systems for Utilization in Manufactured Housing*, and AAMA 1702.2, *Swinging Exterior Passage Door Voluntary Standard for Utilization in Manufactured Housing*. Under the **AAMA 104** Procedural Guide protocols, these serve the same role as the NAFS does for certification of fenestration in site-built structures under AAMA 103.

The AAMA manufactured home fenestration product certification does not expire, adding annual testing of production line samples instead.

As a National Fenestration Rating Council (NFRC) Independent Certification and Inspection Agency (IA), the FGIA offers manufacturers the opportunity to certify product thermal performance to NFRC requirements (U-factor, Solar Heat Gain Coefficient and Visible Transmittance), separately or in addition to certification for basic structural, air and water performance requirements specified in NAFS. NFRC certification is valid for five years.

NFRC certification also requires a licensee to implement a QMS, as specified in Section 8.2 of NFRC 700. As many AAMA certification licensees are also NFRC licensees, this User Guide describes NFRC QMS requirements as well, noting where NFRC requirements are in addition to, or are more rigorous than, those required by FGIA. For simplicity, licensees participating in FGIA and NFRC programs will want to address all requirements within their QMS provisions.

Just because a product was made right one time for an initial certification test doesn't mean it is made that way every time. Accordingly, a major element of AAMA 103, AAMA 104 and NFRC 700 specifies minimum QMS requirements that licensees must follow in-house. These address QMS documentation, inspector qualifications and training, maintenance of inspection and test equipment, recordkeeping, handling of customer complaints and corrective action, in addition to inspection of incoming material, in-process assemblies and finished product. Certification thereby means that the certifying manufacturer has an effective quality control system in place to assure that every unit is made the same as that which passed the qualification testing, subject only to accumulated Waivers of Retest.

2.0 What is a QMS and why have it?

For a manufacturing company to function effectively, it has to identify and manage numerous linked activities that enable the transformation of material and components into finished products. In many firms, these pathways have evolved over time, often based on the accumulated personal preferences or experiences of a succession of individuals. Chances are, the internal practices so evolved are perfectly adequate – given that they are most likely the product of experience and common sense. The key is to apply them consistently and uniformly across all product lines, shifts and changing mixes of personnel.

A quality management system (QMS) is a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives.

In the context of AAMA and NFRC certification, this boils down to products that are consistently reliable reproductions of a representative sample unit that was designed and tested to comply with the applicable provisions of NAFS, one or more of AAMA 1701/1702/1704 for fenestration intended for use in manufactured housing, and/or NFRC, subject only to specified tolerances and accumulated Waivers of Retest.

A QMS helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve its effectiveness and efficiency on a continuous basis.

In a nutshell, sustainable quality is the purpose.

2.1 Why Bother?

By seeking certification of your product to NAFS or the Manufactured Home Fenestration Products Certification Program and/or NFRC thermal performance standards, you already know that a business must concentrate its attention, not only on costs, pricing and financial results, but also on the quality of what they deliver to attain the level of performance accepted by codes, specifiers or end-users. To meet the applicable product standard, you design certain physical and performance benchmarks into the product. The goal becomes uniformly and consistently achieving those benchmarks despite various changing conditions and employee turnover.

Those seeking product certification and who install the accompanying quality controls gain a competitive advantage over companies who do not. A third-party reviewed QMS provides confidence to buyers, specifiers and code authorities that successive units you make match the design that earned certification. This serves to enhance your reputation for consistency and dependability among your customers.

Additional reasons for adopting an effective QMS include:

- Internally, a well-thought out QMS lets you exert better control over manufacturing processes – reducing costs by reducing waste in the form of rework, scrap, warranty claims and customer complaints, and increasing productivity all along the manufacturing, distribution and installation pipeline.

- Trouble-shooting and tracing problems to track down their origin is easier.

- A QMS facilitates training, getting new hires up to speed faster with more consistent results.

- An effective QMS reduces risk. Consider, for example, the "what if" scenario posed by industry columnist Paul Gary of *Window & Door* magazine:

  "What if a homeowner or builder complains regarding [a certified] product performance [i.e., that it does not comply with the AAMA performance specifications] and is not satisfied by the manufacturer's response? Under either an (FGIA) investigation (as required per the Certification Program Procedural Guide) or by the methods of discovery in litigation, the process could easily expand into an investigation and evaluation of the manufacturer's satisfaction of any or all of the many requirements of AAMA 103 [or 104 if applicable], including testing and the required record-keeping.

  "If, through oversight or mistake, a manufacturer has not been in compliance, then what happens? Are the products sold within the period of the faulty record-keeping not qualified for certification? Could that extend further back in time? What would happen if you lost AAMA certification for product sold as being certified?

  "If everything went wrong and a decision was rendered that a year's worth of product was not entitled to AAMA certification, strict compliance with AAMA 103 [or104] and its documentation requirements would suddenly have been worth its weight in gold. Thinking this way, it seems more compelling to meet the requirements for the detail of AAMA 103 [or 104]."

Further, there is a trade-off for taking advantage of cost-saving long-term certification (5 years) and optional extended certification (5 years longer) for products that can be varied without limit under Waiver of Retest provisions. That trade-off is not necessarily greater effort at quality control than you are already doing, but may likely involve better availability of proof that you do so, so that third-party certifiers (and by extension your customers) can be confident that the units you produce from day-to-day match the one that was tested and earned certification one, two, five - even 10 years ago.

From the customer's point of view, it's a "trust but verify" world, especially when building inspectors and specifiers with Errors and Omissions (E&O) liability are looking over their shoulders.

Some may say: “We don’t need a QMS; our quality is built in.” Very likely so, but how is it built in? Does every worker – present and future – understand this vision and how it works? Having a documented (meaning “written-down”) system means employees will know what to do, when to do it and how to do it without relying totally on word of mouth or the varying training abilities of other staff members. A QMS that is visible to and understood by all concerned reduces the frequency of mistakes, which saves you both time and money.

Also, meeting production schedules doesn’t mean much if some of the product is suspect in terms of performing as designed or as certified. It is cheaper to do it right the first time.

2.2 Where did the FGIA/AAMA Requirements Come From?

The elements of 103 and 104 have evolved over many years of AAMA certification, which began in 1962. In many cases, they echo the evolution of the quality management discipline of many industries.

The FGIA and NFRC QMS requirements are very similar to other programs and overlap other QMS standards in many aspects. The elements of the program are derived from other standards, notably:

- ISO/IEC 17065, *Conformity Assessment: Requirements for Bodies Operating Product Certification Systems* (as enforced by accreditation bodies such as ANSI [American National Standards Institute]), which governs how all accredited certification programs are operated. Within this standard are certain requirements that the Certification Body (i.e., FGIA in this case, along with its Validator, Associated Laboratories, Inc. [ALI]) must enforce among program licensees. Some of these relate directly to the licensee’s QMS provisions.
- ICC-ES (AC10), *Acceptance Criteria for Quality Documentation, Product Certification Program*

3.0 An Overview of the AAMA 103/104/NFRC QMS Systems

Both AAMA 103 and AAMA 104 (Section 16.0 in both publications) as well as NFRC 700 (Section 8.2) set forth basic QMS requirements. These cover:

- Quality Manual and QMS documentation
- Role and training of quality inspectors
- Maintenance of Inspection and Test Equipment
- Inspection Records
- Production inspections:
  - Incoming Materials
  - In-process subassemblies
  - Finished Products
- Disposition of Nonconforming material or product
- Labeling
- Handling of customer complaints
- Corrective Action

The remainder of this User Guide will examine what is meant by each of these elements and offer guidance on working them into QMS documentation.

Unless otherwise noted, meeting 103/104 QMS requirements will also meet NFRC 700 requirements.

The basic QMS requirements and the relationships among its elements can be illustrated by the following diagram. References to specific requirements in FGIA and NFRC documents are indicated.

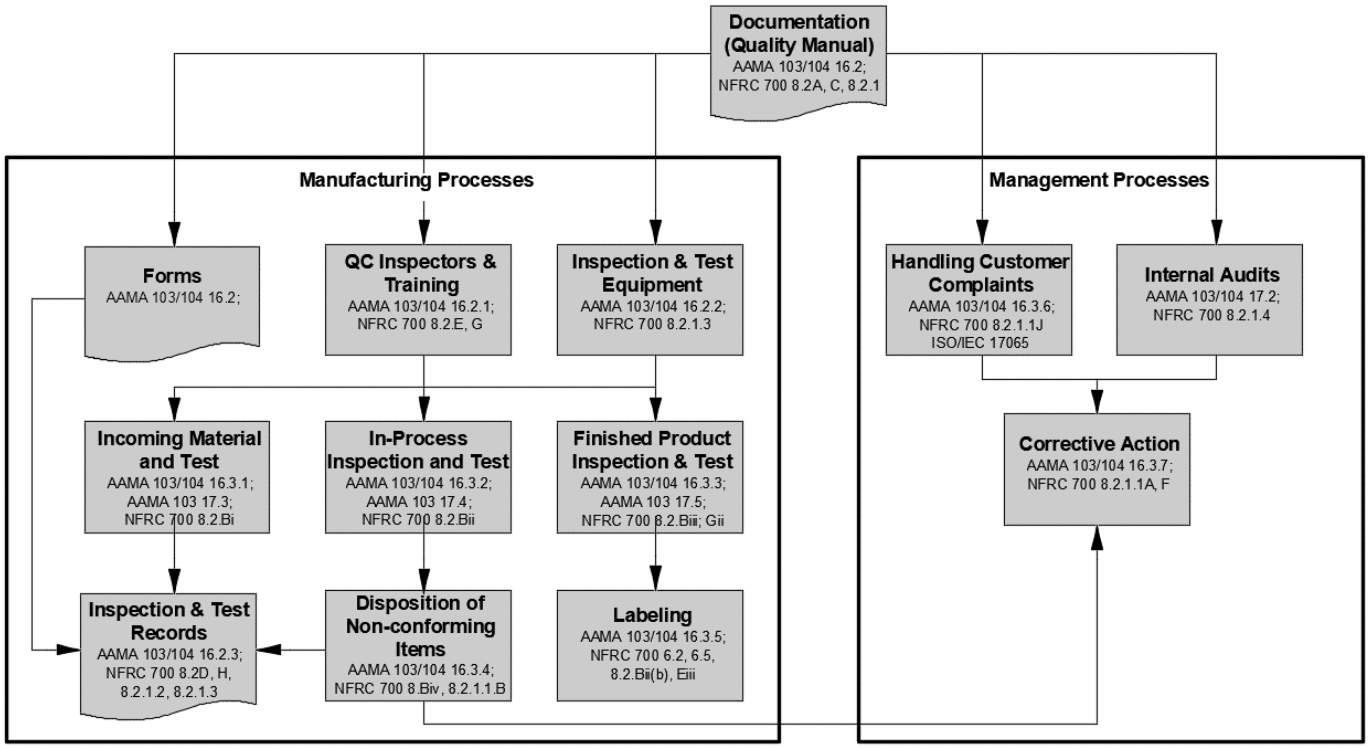

FIGURE 1: Quality Management System Flowchart

Of these, recent experience shows that inadequacies tend to focus on the following areas:

- Quality control (QC) inspector training
- Inspection recordkeeping
- Record of verification and calibration of inspection and test equipment
- Disposition of nonconforming material or product

3.1 How to address FGIA Requirements

Chances are, your company is already doing many if not all of the FGIA/NFRC required QMS elements in one form or another. If additional development is necessary, there may be no need to hire or appoint additional or specialized people to implement them.

Compare your current methods to the requirements and note where they are already addressed. Then, look at your current resources and spread additional or enhanced responsibilities (if any) among them. If a requirement seems onerous or particularly difficult to comply with, you are probably misinterpreting. Feel free to contact us to see if you have the right interpretation of the requirement. Contact information can be found on the FGIA website, www.fgiaonloine.org.

It is ***not*** the intent of AAMA 103 or 104 to imply uniformity in the structure of QMSs or uniformity of documentation among all licensees. There is no “one size fits all” template for all licensees. QMS requirements in 103/104 are intentionally vague; the licensee should design a process that is right for their processes and products, not be handcuffed by generic prescriptions. Each manufacturer must craft their QMS requirements around its own unique mix of products, facilities and human resources.

One way to look at the full context and where the 103/104 or NFRC requirements fit in is to take a high-altitude view of your existing system as a collection of linked processes. Define and describe each process so everyone working within the process has a shared understanding of how it operates. Identify all process inputs and outputs, along with the suppliers and customers, who may be internal or external. Inputs to a process are generally outputs of other processes (which gives rise to term “internal customer”). Identify process steps and flows. Many quality tools, such as block diagrams and flowcharts, are available to support these activities.

Exactly where you define the boundaries of a given process is up to you, based on your company's structure. When defining a process, keep in mind that every process:

- **Has an owner**. (Who is it? Does he/she have recognized authority and responsibility?)
- **Has linkages established**. (What are the inputs [there can be more than one!]; what other processes are linked to these inputs? What are the outputs [again, there can be more than one]; what other processes are linked to these outputs? Where do they go; who are the "internal customers"?)
- **Is monitored** (What result or information produced by the process is monitored? How often? How is it reported? Who gets the information?)
- **Generates records**. (What information is recorded? In what format are they recorded? [Forms often become records once they are filled in.] Where are they kept? How long are they maintained?)

4.0 Documentation

AAMA 103/104, 16.2 Quality Manual
Each Licensee must prepare a written description and explanation of the QMS procedures for each manufacturing location at which certified products are produced. This document or collection of documents, hereafter termed the "Quality Manual," irrespective of its precise documentation format, must be submitted to the Validator for acceptance. The Quality Manual is considered an integral part of the process by which the design of the product is transformed into finished goods. The Licensee is required to forward to the Validator updated copies of any revised sections of the Quality Manual – in whole or in part as applicable – within 30 days of the effective date of the revision.

…

It is recommended that each Licensee, when establishing quality control procedures include any other elements necessary to assure that products meet the Licensee's requirements and the requirements of the applicable specification(s). However, the Quality Manual must include, as a minimum, provisions for the following [*refers to the remaining clauses in Section 16.0*]

Documentation is one of the fundamentals of quality management systems that enables consistency of action. It helps achieve consistent conformity to product standards, enables effective training and helps ensure the repeatability of processes and traceability of product. The guiding principle is: "**Say what you do and do what you say**."

Note that there is a difference between documentation and records. In a nutshell,

- *Documentation* tells what to do;
- *Records* tell what has been done.

In the QMS vernacular, it is often said that "**if it's not documented, it doesn't exist**." Documentation is essentially the only proof you can offer that you have a uniform, stable and effective QMS in place and implemented. More importantly, written practices ensure that everyone is on the same page and minimizes the introduction of individual interpretations, which may differ from the original intent.

4.1 What should the documentation look like?

That's pretty much up to the company. But there are some established practices proven to make the job straightforward. Again, the 103/104/NFRC requirements only state what you have to do; exactly how is up to you.

How much documentation (level of detail) is required depends on the stability and education of the workforce, and the complexity and criticality of the process. Do what is necessary and useful to your company while meeting requirements. When it comes to QMS acceptability, you are not graded by the pound!

Your QMS documentation can be written in two ways: either based on the individual QC requirements as applied to all production lines in the plant (vertical), or for a single product line covering all activities and QC checks start-to-finish (horizontal). Either approach can introduce some redundancy, but this is acceptable if it facilitates understanding from the end users.

It can be written all in one book or as a series of stand-alone documents linked by a master list or key. If the latter, many quality management systems are organized in a hierarchy that can be depicted as follows:

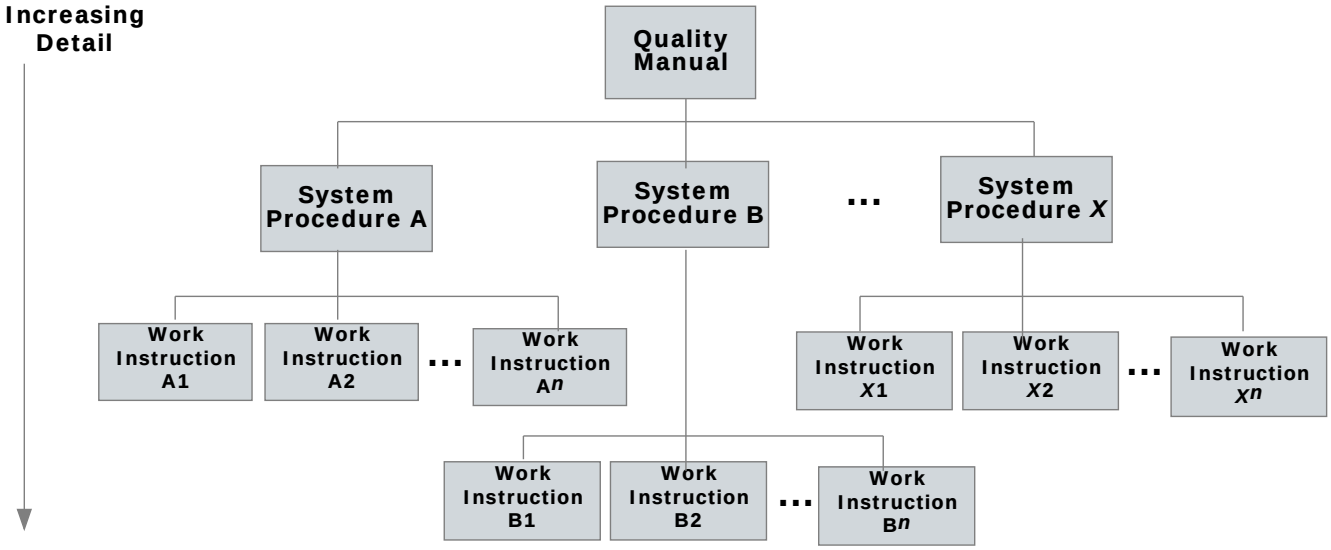

FIGURE 2: Quality Manual Flowchart

Procedures usually cover key elements of the system, such as "incoming material inspection."

Work Instructions cover detailed task-oriented information; those that might accompany the example incoming material inspection might detail "profile inspection," "hardware inspection" and "glass inspection."

Forms record findings and can be associated with any document at any level

Note that it is not necessary to generate separate procedural or work instruction documents just to mirror the diagrammed hierarchy. It depends on the level of detail you wish to cover, the number of different people who need to know the specifics, the complexity of the process, and how you want to organize it.

Note also that Work Instructions and forms are considered part of the QMS documentation/manual. If necessary, include instructions on how to fill out forms. Try to include example forms in the documentation.

A procedural document or work instruction should answer the basic questions of Who, What, Why, When, Where and How (including How much and How often).

A procedural or work instruction document is typically organized uniformly in sections or paragraphs to aid in quick reference, such as:

- **1.0 Purpose:** Relate to company policy, production objective or AAMA 103/104/NFRC element.
- **2.0 Scope:** What operations, products, department, etc, does it apply to?
- **3.0 Definitions:** What do certain terms, acronyms, etc., mean?
- **4.0 Responsibilities:** Who has the responsibility to ensure that this procedure is carried out?
- **5.0 Procedure:** What steps must be followed (sequence or "checklist")?
- **6.0 Related Documentation:** Provide a list of other procedures, forms or work instructions that relate to this procedure or are required to implement it**.**
- **7.0 Records:** What records are generated and where/how are they kept? What forms are used to record the information?
- **8.0 Revision Log:** Dates, nature and authors of subsequent changes. Note that NFRC, as of 2016, requires that revision logs be maintained, indicating the substance and date (and typically the author) of changes (NFRC 700, Section 8.2.C).

Numbering the paragraphs and subparagraphs within each document makes it easier to refer to specific details.

Your documents do not have to be written in this order. And, other elements can be added if it facilitates understanding and organization of the system.

4.2 Documentation Tips

- Use flowcharts to easily and visually describe processes. Consider a production flow-chart, which could include indications of which QMS documents apply at each step.
- You can include tests or inspections that are not required by 103/104 or NFRC, but are part of your protocol; in other words, feel free to merge the 103/104/NFRC requirements with what you are already doing. The whole program will be easier to follow that way.
- Make documentation (especially the QM) easy to update. Making it modular vs. monolithic lets you change sections vs. the entire document when there is an update.
- Make documents available for reference at convenient stages or locations, either as "read only" files on computer terminals via the company's intranet or by placing updated hard copies in repositories at previously defined locations throughout the plant. Be specific- avoid vague words or phrases that are open to interpretation (e.g., "properly," "as appropriate," "at specific intervals", etc.).
- If documents are all in computer files, add screen shots of referenced forms to your manual or relevant procedure to show examples and aid in understanding/training.

4.3 Keeping track: a documentation "system"

As noted above, the Quality Manual can be an array of documents that, together, meet the requirements – not necessarily a single volume. If the former, tracking of the individual elements becomes more important, as it is more difficult to train, refer to and update the documents if they are fragmented.

To create an easily referenced and tracked system:

- Give each document a unique identifier.
- Use these to set up an identification scheme for your own system so that the way in which documents are linked (and one process flows to another) is easily tracked. Specify the links among documents (cross-referencing).
- Indicate the current version (sequential number and issue date) of each document.
- Establish who is authorized to make changes to documents. That person or persons should have password-protected access to the documents while all others can view them as "read only."
- Develop a Document Index or Master List indicating the document titles, alphanumeric identifiers, original issue dates and the current revision dates. If you distribute hard copies of documents within the plant, this list can also be used to identify repository locations and which documents are maintained at each. Hard copies should be identified as "uncontrolled."
- Inform relevant people of document changes. Be sure to forward changed QMS documents to the Validator within 30 days of issue so everyone can stay "on the same page."

NOTE 1: *In-plant inspection of your QMS documents does not replace the desktop audit performed on your company's submitted manual and subsequent updates. The objective is to establish an approved baseline in one place vs. relying on references to prior plant inspections.*

5.0 Company Organization

AAMA 103/104, 16.2.1- Quality Control Inspectors
Organizational Role: It shall be preferable that the in-house quality control inspector not be responsible for production. The quality control inspector should report directly to management and should have an equal voice with production personnel. Recognizing the nature of the industry, this ideal may not be possible, but every attempt shall be made to assure that the person designated as responsible for quality control can get the attention of management at a level which is responsible for quality as well as production.

Inspectors examine incoming materials or components, subassemblies and/or finished product according to the governing QMS document to determine compliance with specifications.

NFRC 700 (Section 8.2.B.v) requires that you prepare a company organizational chart showing positions [and their interrelation] relevant to QMS requirements. Be sure to list who is responsible for conducting quality control checks, regardless of whatever title by which they are identified. Note that some assembly operators may be charged with performing certain inspections vs. a separate individual identified as an "inspector."

NFRC 700 specifically requires that the following be identified:

- Person responsible for maintaining the company QMS (8.2.E.i)
- Person responsible for ensuring that production meets labeled thermal performance ratings (8.2.E.ii and 8.2.G.i) (see also AAMA 103/104 section 16.3.5).
- Person trained and capable of supervising production (8.2.F)

6.0 Inspector Training

AAMA 104, 16.2.1 Training: …

Quality inspectors must have an effective knowledge of all specification requirements and the ability to perform all tests required by the Licensee's QMS. They and other persons performing quality control functions must be properly trained and records must be maintained to demonstrate the training and the inspector's competence.

All QMS system standards require that workers, especially quality inspectors, receive appropriate training that, together with experience, qualifies them to perform the job. Frequency of training should be documented in the QMS, and records of inspector training must be maintained.

Quality inspector training elements should include such topics as:

- Overview of the company QMS; detailed review of aspects governing the specific job
- Overall product description, detailed description of parts/assemblies and work activity involved in the particular fabrication step(s) encompassed by the job scope
- Role and scope of AAMA and NFRC product performance standards and how they relate to the fabrication step(s) involved in the job scope
- Role of AAMA certification and labeling – how it works and how it impacts the specific fabrication step(s) involved in the job scope. Explain the meaning of the language on the label, and the importance of proper placement on the proper product.
- Product features and design elements that are to be inspected, how they function, and the acceptance criteria (e.g., tolerance ranges, operating force, etc.) that must be met in order to pass inspection
- Procedure for handling products or materials that fail inspections and for notifying appropriate people
- How frequently to perform the inspection
- How to perform measurements or tests; what acceptance criteria to look for. Consider posting at the workstation written and/or visual reference displays for each inspection or test performed.
- Proper use and care of measuring devices – how to perform verification checks
- Data to be recorded, forms to use and what to do with them
- General inspection guidelines – techniques and expectations

Most companies task appropriate department managers or supervisors with identifying training intervals, training needs, establishing training methods (with the aid of the Quality Manger) and keep records of training for employees within their respective areas.

Training can be in the form of formal "classes" or "on the job" training, requiring sign-off of a supervisor when satisfactorily completed and the requisite skills are demonstrated.

Training records (in the form of training session attendance logs, and entries in individual personnel files) provide proof that training is done, that it is sufficient and/or that a particular individual is qualified and competent to perform their assigned job. If internal "sign-offs" are required, be sure they are part of the record.

It may be useful to develop an affidavit form that, when signed by the trainee, attests that he/she has read and understands the relevant company QMS (and other) job requirements as documented for the position. In the case of QC Inspectors, it could be advisable to add the most current AAMA 103 and/or 104 Procedural Guide, the current AAMA Verified Components List (see Incoming Material Inspection) and how to access it. Those who serve as internal auditors (see AAMA 103 Section 17.2) should understand process auditing techniques, the company's fabrication processes, applicable product standards, and quality acceptance criteria.

Be sure to include assembly operators in the quality inspection training as applicable. Any QC inspections that they perform should be included in job descriptions (if relevant).

7.0 Inspection and Test Equipment

AAMA 103/104, 16.2.2 Inspection and Test Equipment
The Quality Manual must list equipment used in quality control inspection, measuring or testing activities. Equipment listed shall be calibrated, verified or replaced at regular intervals to maintain accuracy. Checks shall be recorded in a manner suitable to indicate frequency of regular periodic verification and calibration and acceptable accuracy against user defined tolerances.

The purpose of this requirement is to ensure that the facility is furnished with all items of sampling, measurement and test equipment required to correctly perform all required inspections or tests. Also, suitable checks of measuring devices used must be performed at regular intervals to confirm that the measurement output remains accurate. Common devices used are measuring tapes or rules, calipers, micrometers, portable hardness testers (e.g., "webster gauge"), thermometers, weight scales, force gauges (to confirm operating force), and protractors. A system for controlling such equipment typically encompasses checks at regular intervals, identification of current calibration status, due date of the next calibration (per the calibration frequency that you determine, based on use and tolerances or the device manufacturer's recommendations), and disposition of devices that cannot be verified.

Note that there is a difference between "verification" and "calibration."

- ***Verification*** is checking the measuring device against a known reference (such as a gauge block) prior to use (such as at the start of a shift or production day) or after it has been subjected to possible damage (such as by being dropped) to see if it has the necessary accuracy. Before being placed into service, new, reconditioned or repaired equipment is similarly verified.
- ***Calibration*** is checking the measuring device against a known reference and adjusting the instrument to achieve the necessary accuracy. Your company will likely have qualified equipment and personnel to perform verification checks; it may or may not have the capability to perform calibrations depending on the instrument involved. In the latter case, devices might be sent to accredited calibration service or to the device manufacturer to be calibrated.

To the extent deemed necessary, detailed step-by-step verification or calibration instructions can be provided within easy access of inspectors or operators, depending on to whom the responsibility is assigned. Note that NFRC 700 (Section 8.2.1.3B) requires that written instructions be readily available for the use of test equipment used in quality inspections/checks (see also 103/104 Section 16.2.3).

Typical procedural elements should include:

- What is the needed accuracy (determined per profile or fabrication drawings, prescribed tolerances, etc.)?
- Who has the responsibility to perform specific checks/verifications?
- Who has the authority to perform calibrations and make determinations regarding disposition of out-of-calibration devices?
- How often is calibration required? (In most cases, this is at least annually, or in the event of damage. Depending on the production environment and intensity of use, many companies call for recalibration more often, such as monthly.)
- Set-up and maintenance of a Master List of all measuring equipment and gauges as required to implement documented inspection and test procedures. It should include a list of major equipment, their use, location, unique identification and appropriate performance parameters to be maintained.
- How is each item of equipment uniquely identified, such as by serial number, property number, or other appropriate distinctive means?
- Note which devices are calibrated in-house and the reference standard used, and which are calibrated outside and have a certificate on file.
- Create a Calibration Record form. The Calibration Records should indicate the device name, identification number, date originally placed into service, frequency of checks, check method, acceptance criteria, calibration results and action taken per results.
- If employee-owned measuring equipment is permitted (e.g. tape measures), they should be included on the Master List and checked for accuracy and calibrated in the same manner as company-owned equipment.
- To establish traceability to National Institute of Standards and Technology (NIST) reference standards, master gauges and reference standards (e.g., gauge blocks) used to calibrate inspection equipment should be verified periodically (such as once every year) by a qualified calibration laboratory.
- Where practical, the calibration status of a gauge or measuring device should be identified by the use of a status label or sticker applied to the gauge or device, indicating the initials of who performed the check, the date the check was performed, and the due date of the next check. Where the use of a sticker is not practical, the record of calibration can be the Calibration Record, referencing the serial number or other permanent identification of the device.
- Product(s) inspected using measuring equipment subsequently found to be out of calibration tolerance should be rechecked to verify conformance. The corrective action process (103/104 Section 16.3.7) may need to be implemented to accomplish this.

7.1 Instrument maintenance tips:

- Equipment should be operated only by appropriately trained and authorized personnel as indicated by job descriptions. Current instructions on the use and maintenance of equipment, including any relevant manuals published by the manufacturer, should be readily available for reference by those tasked with calibration.
- Measuring equipment should be safeguarded from unauthorized adjustment that would invalidate test results by means of tamperproof seals placed over all adjustment points; if these seals show signs of tampering, it will invalidate the calibration and the equipment must be calibrated again before it can be used for client's work.
- Follow manufacturers' instruction manuals for the maintenance and the proper storage, transport and handling of measuring and test equipment, to ensure proper function and prevent contamination or deterioration.
- Suspect, malfunctioning or damaged equipment should be removed from service, isolated and clearly marked as out of service until replaced, repaired, recalibrated or otherwise verified as suitable for service.
- Some companies set up strategically-located verification and/or calibration "stations" within the plant to enable fast turnaround. Instructions can be provided on how to conduct the verifications/calibrations by type of instrument, how and where to record results, and what to do if the device is found to be out of tolerance and further assistance is in order. Include in the instructions how to record that the verification/calibration has been performed.

8.0 Inspection and Test Records

AAMA 103/104, 16.2.3 Quality Control Inspection Records
All quality control inspection records shall be maintained by the Licensee for all shifts and available for Validator review. It is acceptable for these records to be one comprehensive sheet or several report forms as selected by the Licensee.

These records shall, at a minimum, indicate that required inspections were performed on all products qualified for certification labeling and the results obtained. Each entry should have provisions for initialing and dating by the person performing the inspection or test and responsible for rejecting or releasing the product to the next manufacturing step or for shipment. Should any products be found in noncompliance, an entry shall be made denoting its disposition (see also 16.3.4). Whenever practical, records should provide traceability (by batch or lot number or other suitable means) to link received material and components to finished product and indicate the disposition of rejected materials or products. All quality control records must be retained for a minimum of twelve months.

NOTE 2*: the NFRC requires that all records be maintained for 5 years.*

Records provide objective evidence of activities performed or results achieved, and enable traceability to help solve problems. They also provide a reservoir of data on which to base improvements by analyzing processes; this works to increase productivity and reduce costs.

To comply with the AAMA 103/104/NFRC QMS requirements, the following records must be maintained:

- Training of quality inspectors (103/104 Section 16.2.1)
- Measuring equipment checks and calibration/verification (AAMA 103/104 section 16.2.2)
- Receiving inspection/ incoming materials inspection (AAMA 103/104 section 16.3.1.1)
- In-process inspection and tests (AAMA 103/104 section 16.3.2.1)
- Finished product inspection and tests (AAMA 103/104 16.3.3)
- Disposition of nonconforming product or materials (AAMA 103/104 16.3.4)
- Handling of customer complaints (AAMA 103/104 16.3.6)
- Corrective actions (AAMA 103/104 16.3.7)
- Internal audits (AAMA 103 Section 17.2 extended requirement only)

Specific requirements for the content of records in each of these areas are listed within the QMS requirements in Section 16.0 of AAMA 103 and AAMA 104. These requirements also cover those of NFRC. Be sure that these elements are included in the requisite records!

Typically, forms become records when filled in. It is a good idea to include sample blank forms in an appendix to the quality manual or appropriate procedural document. Remember to update these examples if the form is changed.

Note that whenever practical, records involving product should provide traceability by including lot #, batch #, work order #, or other identifier as typically used in your company. Such traceability helps solve problems and can assist in determining root causes as part of the corrective action process.

Records are to be maintained in an accessible and protected manner. Note that NFRC 700 says that they are to be kept at a "central location" (Section 8.2H). In general, AAMA 103/104 require that identified records be kept for one year; NFRC (Section 8.2.D) required five years. If your company certifies through both programs, obviously the longer retention time should be observed. Consider adding a "record retention end-date" to records to help ensure they will not be disposed of prematurely.

9.0 Material & Product Quality Inspection

AAMA 103/104, 16.3 Quality Control System
The following shall be the minimum requirements necessary to create an acceptable Quality Control System:

In general, inspections work as depicted in the following process flowchart:

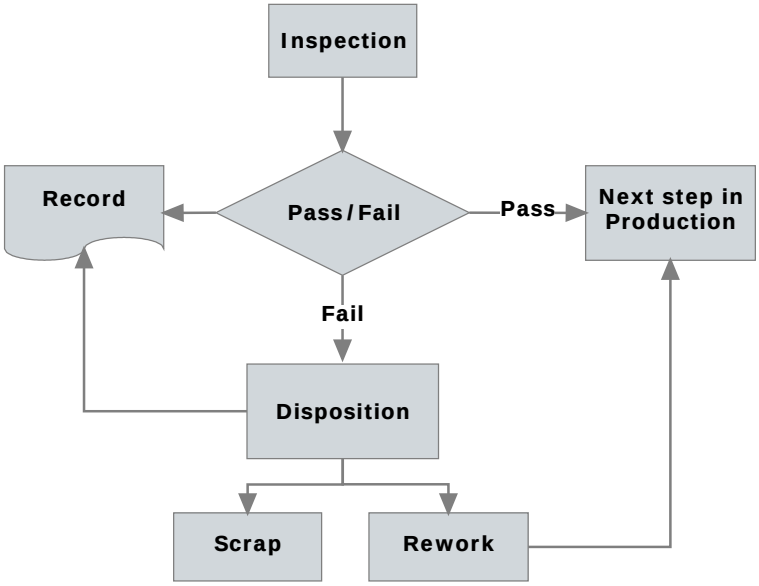

FIGURE 3: Quality Control System Flowchart

Inspection procedure documentation should indicate at a minimum:

- What checks are to be performed? What product attributes apply? What are items covered in "specs" for the items to be inspected?
- Who performs the checks? How often? At what point in the manufacturing process flow? Many companies assign each line operator with the responsibility for checking his/her own work and of that of their co-workers according to a control plan, job description and/ or work instructions.
- How the inspection is performed (observation, measurement, etc.)?
- What are the acceptance criteria, or where to find them (should include acceptable tolerances)?
- What forms are used to generate a record of inspection data and results? A good inspection form serves as a checklist to perform the inspection.

Be sure to include a review of the documented inspection procedures or work instructions and associated forms in inspector training.

Remember, the goal of the program is to have a robust QMS that allows you, the manufacturer, to fabricate a quality product that inspires customer confidence, builds your brand, and reduces or eliminates call-back and field service. To this end, also include in the documented inspection procedures or work instructions any tests or observations that are not required by AAMA 103/104 or NFRC but part of your company's protocol. It will be easier to understand your system that way, vs. calling them out separately. Just be sure to treat these additional inspections or tests the same in terms of training, records, non-conforming product dispositions, etc.

Some companies refer to product inspections of this sort as "audits." Do not confuse this term with Internal Audits as required by AAMA 103, Section 17.2; the former are product-oriented, while the latter is process-oriented.

9.1 Incoming Materials Inspection

AAMA 103/104, 16.3.1.1 The Licensee shall establish and implement inspection, testing or other monitoring activities necessary for ensuring that purchased materials and components meet the manufacturer's specifications and the specified program requirements (per the AAMA Component Verification Program or the AAMA Profile Certification Program).

Incoming inspection must be based on your company's specifications for purchased materials and subject to the minimum requirements of the governing product standard, such as NAFS. These specifications, which often accompany purchase order records, must be available for verification of inspection records. Inspection records should state positively that the item inspected meets the relevant specification or contract requirement.

Be sure that records enable traceability, including such information as receipt date, vendor, bundle/part number, in-house tag number, quantity, color, etc.

Incoming materials inspection varies somewhat depending on whether the items are components, profiles (extrusions) or glass.

9.1.1. Components

AAMA 103/104, Section 16.3.1.1 … Purchased components from categories of the VCL are to be used in the manufacture of certified products. Licensees shall provide the inspector valid component test reports from an AAMA accredited laboratory for those components in categories eligible for listing but are not listed in the AAMA VCL. These component test reports shall be valid for the time period listed in the appropriate version of the Component Verification Program Manual (CVPM).

For components from categories not listed on the VCL, the components shall comply with the appropriate AAMA referenced standards or specifications where applicable.

The Licensee shall provide specifications for incoming materials (including raw materials or components) used for the manufacture of finished products. Details shall be provided of inspections or tests that are conducted on incoming materials, or other means used to determine that the materials meet specifications. The Licensee shall indicate that the supplied materials and components meet licensee requirements, AAMA standards (or existing AAMA certification requirements) and assembly/project requirements if applicable. The licensee should ensure that component suppliers, through test reports, affidavits, or other methods that no substantial changes have been made.

To have a component listed, the component manufacturer fills out an application, form VCL-01. The component is then submitted to an AAMA accredited lab for testing to the appropriate standard, and the resulting test report is submitted to FGIA's validator, ALI, for review. After review of the report, the component is listed on the Verified Components List (VCL) for one year from the test completion date. Each report can be extended twice in one-year increments, for a total report life of 3 years. At the end of the 3 year cycle the component must either be tested again, or it will be removed from the VCL.

Note that components listed on the VCL are not "**certified"** as performing to AAMA specifications. This is not true as this is a **verification** program vs. a certification program, in that the component manufacturer's plant is not subject to inspection and its quality management system is not subject to audit.

Listing on the AAMA VCL is not required. However, if not listed on the VCL, your company must acquire and be able to show test reports from an AAMA-accredited laboratory (provided either by the component manufacturer or directly by the laboratory working on behalf of the licensee) and keep them available along with incoming inspection records

If the licensee makes its own components, they must be separately tested by an AAMA approved laboratory; again, test reports from the laboratory must be available to prove conformance. Note that you should also be able to produce test reports or affidavits from the component supplier that changes that could affect the component's acceptability have not been made over the course of successive shipments under the same specification.

Guidelines for the conduct of the AAMA Component Verification Program are published in four separate manuals depending on component type:

- **Sealants**: See Component Verification Manual CVPM-S.
- **Hardware**: See Component Verification Manual CVPM-H.
- **Weatherstripping:** See Component Verification Manual CVPM-W
- **Finish Applicators** (references standards for laminates, anodizing, and organic coatings). Note that paints and coatings comprise a special case in component verification in that the VCL lists applicators, not the paint itself. Finish applicators should have a copy of the finish manufacturer's tech data sheets and test reports per the applicable AAMA specification. See Component Verification Manual CVPM-FA

9.1.1.1 Hardware

FGIA hardware standards referenced in NAFS or 1701.2 and 1702.2 cover basic components such as:

- **Sash Balances (AAMA 902) and Friction Based Sash Balances (AAMA 908).** This covers block-and-tackle, constant force, spiral and gas shock sash balances as used in hung windows, rating them for travel range, minimum and maximum sash weight carrying capacity and the force required to initiate and maintain sash movement.
- **Gear-type Rotary and Linear Operators (AAMA 901).** This standard covers gear type rotary and linear operating devices used for opening and closing casement, awning, jalousie and other similar types of windows.
- **Multi-Bar Hinges (AAMA 904).** This standard provides maximum weight, height and width ratings for the multi-part hinges as used in casement, project-out, parallel-opening and project-in configurations.
- **Sliding Glass Door Roller Assemblies (AAMA 906).** The required testing includes 10,000 full-open/full-close cycles without the roller "jumping" its track or causing the door sash to become more difficult to operate.

Performance tests prescribed by the standards determine durability after accelerated open/close cycling and shock loads, ability to support sash weight and corrosion resistance. These types of components have a three-year test life before re-verification testing is required.

Standards also exist that govern hardware performance for exterior side-hinged doors (SHD). These cover lever handle sets designed for use with multipoint hardware (AAMA 903), multipoint locking hardware (AAMA 909), open/close cycling (AAMA 920), vertical cantilevered loading on the door edge opposite the hinges (AAMA 925) and water penetration of locking/latching hardware (AAMA 930).

Applicable to all steel hardware is AAMA 907, which requires hardware made of carbon steel to have a corrosion-resistant coating of cadmium, zinc or nickel-and-chrome plating.

AAMA 1704 describes test procedures to determine the maximum force required to operate manufactured housing fenestration intended to function as emergency egress devices. The force required to open the sash until the minimum clear opening dimensions have been attained, the force to operate each lock and latch on an operable sash, as well as the force required to operate each swivel or pivot type lock on removable screens cannot exceed 90 N (20 ft lb).

9.1.1.2 Weatherstrip

Weatherstripping must meet minimum requirements for two primary attributes: weatherability and compression set (shrinkage under accelerated weathering). Those requirements, and test methods for determining if they are met, are spelled out in AAMA 701/702, a dual standard covering the performance and testing of pile weatherstripping (701) and replaceable fenestration weatherseals (702) such as bulb-type rubber stripping applied to window and door products by means of kerfs, t-slots, pockets or other similar retaining profiles, including integrally attached, co-extruded weatherseals. These types of components have a three year test life before needing to be re-approved.

In the FGIA's AAMA Certification Program, manufacturers may substitute weatherstripping differing in nominal height from that used in the tested sample by maxim of + 0.5 mm (0.02 in) or – 0.3 mm (0.01 in) without retest by obtaining a waiver of retest.

9.1.1.3 Sealants and Tapes

Specifying the right sealant for a given application involves a number of factors. It must provide a weather-tight seal that remains intact despite movement of the frame joint. Meanwhile, it must withstand the environmental onslaughts of water and ultraviolet radiation and retain its properties as it ages. Consideration must be given to the type of substrate to which the sealant must adhere (a primer coat being necessary for some), the type and expected movement of the joint to be sealed, and the compatibility of the sealant with other materials.

The list of criteria a sealant must meet includes:

- Adhesion to all exposed substrates
- Cohesion or ability to hold together as a mass
- Hardness (for sealants not intended to remain pliable)
- Elasticity, in either elongation or compression, and elastic recovery vs. permanent extension set or compression set
- Compatibility with surrounding materials, including lack of staining
- Effects of environmental conditions
- Appearance
- Durability

Sealant products used in fenestration manufacturing must comply with:

- AAMA 800, *Voluntary Specifications and Test Methods for Sealants*
- AAMA 813, *Voluntary Specification and Test Methods for Adhesives Used in Simulated Divided Lites*

AAMA 800 is a compilation of standards, specifications and test methods for determining the performance of compounds, sealants, and tapes used in the manufacture and/or installation of windows, sliding glass doors and curtain walls. It lists performance requirements and associated test protocols for seven different types of sealants, most of which are relevant to fenestration manufacturing. It specifies ASTM test methods to verify adhesion, low-temperature flexibility, water resistance and other key parameters, in several cases modifying the test method and describing test procedures of its own. The manufacturing-related sealants covered, which are listed on the VCL, are:

- Back-bedding glazing compound, used to bed glass to the surrounding substrate. (AAMA 800, Sections 802.3 and 805.2)
- Back Bedding Mastic Type Glazing Tapes (804.3, 806.3 and 807.3)
- Narrow-Joint Seam Sealer designed to seal narrow joints that are mechanically restricted from movement (803.3)
- Expanded Cellular Glazing Tape – closed-cell products considered to be compression sealants (810.1)

These types of components have a three-year test life before re-verification testing is required.

AAMA 813 establishes minimum performance requirements for tape or liquid adhesive systems used to attach simulated divided lites (externally-applied muntin bars).

9.1.2. Glass

Received glass is typically inspected for breakage and thickness. In particular, your company is responsible for ensuring that the glass thickness is appropriate per ASTM E1300, *Standard Practice for Determining Load Resistance of Glass in Buildings,* for the size of the labeled product and the Performance Grade on the AAMA certification label.

Note also that the NAFS section on glass requires that glass meets several standards as applicable to fenestration products.

In almost all cases the glass manufacturer will have records indicating compliance with these standards.

Insulating Glass Units

Insulating Glass Units (IGUs) present something of a special case. They can be obtained from on outside supplier or made in-house in a special fabrication operation. Please refer to Section 9.3.a for specific IGU inspection requirements.

9.1.3. Profiles

AAMA 103/104, Section 16.3.1.1 …

Extrusions and profiles shall be checked to determine that they:

a. Have the wall thickness and dimensions specified on the product manufacturer's drawings and are within approved drawing tolerances
b. Have the required physical properties.

NOTE 10: *When checking extrusions or profiles, it shall not be necessary to verify each and every thickness or dimension, but only those critical dimensions which the extruder and Licensee have agreed upon. Upon request from the Licensee, the extruder shall provide a statement which will indicate compliance with this section. When such a statement is not presented, the Licensee shall provide data in paragraphs "a" and "b" above.*

To be deemed as conforming to NAFS or the AAMA 1701.2/1702.2/1704 manufactured housing fenestration standards and therefore certifiable under the FGIA's AAMA Certification Program, fenestration made with polymeric frame and sash profiles (vinyl, fiberglass, ABS, or composite) must demonstrate independent certification with specifications for those materials. The requirements include such properties as impact resistance, dimensional stability, heat resistance, weight tolerance, lead content and color retention as determined from years of actual outdoor weathering tests.

As with component verification, profile certification qualifies extruders or pultruders as pre-approved resources for fenestration manufacturers.

Applicable specifications as referenced in NAFS for polymeric profile certification, which defer to ASTM test methods for determining the actual performance data or pass/fail status, are listed as follows:

- AAMA 303, *Voluntary Specification for Rigid Poly (Vinyl Chloride) (PVC) Exterior Profiles*.
  - AAMA 303 defers to AAMA 613/614/615 for the performance of painted vinyl profiles.
- AAMA 304, *Voluntary Specification for Acrylonitrile-Butadiene-Styrene (ABS) Exterior Profiles Capped with ASA or ASA/PVC Blends.*
- AAMA 305, *Voluntary Specification for Fiber Reinforced Thermoset Profiles*
  - AAMA 305 defers to AAMA 623, AAMA 624 or AAMA 625 for the performance of painted fiberglass profiles.
- AAMA 307, *Voluntary Specification for Laminates Intended for Use on AAMA Certified Profiles*
- AAMA 308, *Voluntary Specification for Cellular Polyvinyl Chloride (PVC) Exterior Profiles*
- AAMA 309, *Standard Specification for Classification of Rigid Thermoplastic/Cellulosic Composite Materials*
- AAMA 310, *Voluntary Specification for Reinforced Thermoplastic Fenestration Exterior Profile Extrusions*
- AAMA 311, *Voluntary Specification for Rigid Thermoplastic Cellulosic Composite Fenestration Exterior Profiles*
- AAMA 312, *Voluntary Specification for the Lamination of Wood and Cellulosic Composite Materials Intended for Use on AAMA Certified Profiles*
- AAMA 313, *Voluntary Specification for Molded Aliphatic Polyurethane Elastomer Frame Materials*

Each of these standards establishes minimum requirements for dimensional stability, impact resistance, weatherability, heat resistance, weight tolerance, heat build-up and lead content, as verified by independent laboratory testing of samples randomly-selected by the AAMA inspector at the profile producer's plant.

Wood and aluminum profiles must meet specific requirements listed in NAFS-11, Sections 10.3.2 and 10.3.6, respectively.

Painted coatings on wood or cellulosic composites are governed by AAMA 653.

Painted coatings on aluminum are governed by the AAMA 2603, 2604, 2605 series.

All profiles, regardless of material, are to be inspected for:

1) Wall thickness and dimensions as specified on the product manufacturer's drawings within approved drawing tolerances. Per NAFS, the maximum allowable deviation from the nominal wall thickness is ± 10% or ~0.010 in (0.3 mm), whichever is greater, for open die walls and ± 15% or ~0.016 in (0.4 mm), whichever is greater, for closed die walls. Manufacturing tolerances for the cross-sectional dimensions of wood rails, stiles, heads, jambs, and sills shall not exceed ~0.031 in (±0.8 mm) for dimensions up to ~3.94 in (100 mm) or ~0.060 in (±1.5 mm) for dimensions of 3.94 in or greater.

   AAMA 103/104 note that only "critical" dimensions need to be checked; these dimensions are determined by the licensee and should be specified in the QMS documentation or on drawings, and be included in inspection procedures and record forms, along with acceptance criteria.

2) "Required physical properties," which refers to whatever your company feels is critical with regard to dimensions and features. For aluminum, this could include the temper (T5, T6, etc.). For vinyl, critical properties could include gloss or color match.

Provide an accessible summary of required profile dimensions and associated tolerances (or an acceptable measurement range, e.g., "Critical Dimension Log") for each profile type and/or by product line, showing dimensions such as overall width, overall height, glazing pocket depth, sliding product glider track depth and width for roller clearance, etc. as deemed necessary.

Detailed instructions on how to conduct the measurements using the proper device can be prepared and made available either as part of the quality manual inspection procedure or as a separate referenced document ("work instruction"). Consider including instructions of what to do next if the product either passes or fails inspection and what information to record and where. Appearance criteria (absence of dents, bows, twists, scratches, paint blisters or other blemishes, etc. and freedom from contamination) can also be specified and described.

Sometimes, after checking for form, fit and function, the determination can be made that the material can be used as is despite imperfections. The process and acceptance criteria limits for these determinations should be made clear.

AAMA 103/104, 16.3.1.2 A record of acceptance of incoming material used in certified products shall be kept on file for a period of one year.

NOTE 3: *Required document retention for NFRC is five years.*

9.2 In-Process Quality Control

AAMA 103/104, 16.3.2.1 Fabricated parts of each different product manufactured during each shift on which it is processed shall be checked for the following:

a. Length
b. Application of weather strip
c. Application of back-bedding compound and other sealants

16.3.2.2 A record of these inspections shall be kept on file for a period of one year. The record shall indicate the disposition of all items not determined satisfactory for the labeling of the product.

As noted earlier, in-process inspections and/or tests are intended to ensure that errors are not magnified through subsequent processing. Recall the concept of the "internal customer," in which we think of the next processing step in the fabrication sequence as in effect a "customer" for the output of the previous step. In short, "do not pass a defect along to the next workstation."

As part of this effort, make it easy to identify items as approved for release to the next stage and specify how this is done in the documentation.

Of course, document what checks are to be performed and indicate the associated acceptance criteria. At a minimum, follow 103/104, Section 16.3.2.1 and verify appropriate length, application of weather strip and application of back bedding compound and other sealants. Obtain "critical dimensions" from approved drawings and include them (at a minimum) on the inspection record form. Be sure that accumulated Waivers of Retest (AAMA 103/104, Section 11) have not changed the acceptance criteria and that record forms are appropriately updated.

Other criteria might include proper fabrication of weep holes, installation of proper hardware and fasteners, correct length of parts, proper taping, proper in-process labeling, etc.

Include inspections or tests that are not required by AAMA 103/104 but are part of your company's quality assurance protocol. Be sure to treat these additional requirements the same in terms of documenting training, records, dispositions, etc.

As with incoming inspections, consider providing detailed instructions on how to conduct the measurements using the proper device(s) can be prepared and made available if considered advisable. Many companies include instructions of what to do next if the product either passes or fails inspection and what information to record and where. Example in-process inspections that can be conducted at appropriate workstations or production stages can include profile saw operation, cut length tolerance and safety aspects.

9.3 Finished Product Quality Control

AAMA 103/104, 16.3.3 Finished Product Inspection (comprehensive inspection of finished products)

16.3.3.1 Finished products shall be examined on a regular basis (at least daily) in accordance with the following schedule:

Production	Number Examined
Up to 150	2
151-500	3
Greater than 500	5

16.3.3.2 The examinations of completed fenestration products shall include, at a minimum, the:

a. Size
b. Hardware application
c. Weather strip contact
d. Corner seal applications
e. Squareness
f. Glazing appropriateness
g. Operation
h. Label application (placement and correct label)

Finished product inspection or testing serves one essential purpose: ensuring that product is not delivered until it meets requirements.

Note that the specified **daily** sampling rate is applicable to each production line. Be sure to include in QMS documentation how production volume is tracked so that the inspection sampling rate is observed.

Document what checks are to be performed and indicate the acceptance criteria. Checklists for the final inspection (which become records when completed) can be prepared by production line or by the window/door type.

Each product or line will have its own list of critical characteristics depending on operator type, frame material and type of glass. As always, acceptance criteria should be provided as part of the inspection record/log sheet and/or QMS procedural documents or work instructions.

To amplify the Section 16.3.3.2 requirements above, examples of parameters to check, depending on product type, might include:

- Frame and sash size within tolerances
- Integral mullion proper length and straightness (if applicable)
- Screen features, such as tautness and screen spline hold
- Sash and accessory operation
- Alignment and operation of hardware for the product type
- Glazing setting blocks, back-bedding, bead or tape application
- Glazing corner seal applications
- Proper installation of weatherstripping; proper contact with frame and sash
- Unit squareness (compare diagonal measurements)
- Meeting rail, jamb, sill and other frame or sash joinery
- Visual inspection (appearance criteria), such as grid alignment, cleanliness, absence of blemishes, excess sealant, weld cleaning, overall fit/finish, weep hole positioning, hardware placement, correct color or finish
- Packaging and shipping preparation properly accomplished

When possible include in the pass/fail record traceability information, such as order number, batch number, line number, inspector name/initials, date, product name, etc.

9.3.1. Insulating Glass Units (IGU)

AAMA 103/104, 16.3.3.3 At a minimum, the following attributes of finished [IGU] products must be verified:

a. Glass Thickness
b. Size
c. Spacer setback
d. Whetting to glass
e. Corner sealant application
f. Glass overlap

If applicable:

g. Gas fill identification
h. Low-e glass identification
i. Grid assembly joinery
j. Grid attachment to spacer

IGUs present something of a special case. They can be obtained from on outside supplier or made in-house in a special fabrication operation. Either way, ASTM E2190, *Standard Specification for Insulating Glass Unit Performance and Evaluation*, (or CAN/CGSB 12.8) figures heavily.

NAFS requires that IGU assemblies must meet ASTM E2190, which provides the basis for evaluating the durability of IGUs. The test method also establishes proof of gas fill (other than air) content to an average minimum initial 90% gas fill content and an average minimum of 80% gas fill content following completion of insulating glass durability testing.

Inspection of IGU may be done as incoming material when outsourced (see Section 9.1.2 of this guide), as finished checks at the IGU assembly line if manufactured in-house, or as finished checks on the assembled window.

When manufactured in-house, the IGU fabrication operation must have its own set (or sub-set) of QMS procedural documents and records as listed in NFRC 706 and/or as required by the accredited third-party IGU certifying organization.

9.3.1.1. Insulating Glass Unit Certification

Note that NFRC certification and the FGIA requirements for a five-year certification extension (see AAMA 103 section 17.3 both require third-party IGU certification. And, because the program is based on NFRC ratings, the ENERGY STAR® program also requires IGU certification. This can be accomplished through a third-party IGU certification program separately offered by FGIA's Validator, ALI of Dallas, Texas.

To obtain IG certification through AAMA/ALI, the IGU manufacturer assembles 12 identical IGU test units, 14" X 20" in size, each with the same spacer and sealant combination for which certification is desired. The test samples and supporting data are forwarded to an approved independent test laboratory of the manufacturer's choice for testing per ASTM E2190 and its referenced test methods. The program also prescribes minimum QMS requirements for the IG fabrication process, and inspects the manufacturing facility twice annually to ensure that all certified IGs are being properly fabricated.

Upon receipt of a passing test report and documentation of an approved QMS, Notice of Certification Authorization (NCA) is issued and the Licensee may begin applying the AAMA/ALI IG Certification Mark to each unit of that product family and list the product in the AAMA/ALI Certified Products Directory. IGU certifications are valid for 24 months from the date of the completion of seal durability testing.

9.3.1.2. Receiving Inspection of IGUs (Internally Fabricated or Outsourced)

Regardless of where they are fabricated, IGUs are typically inspected for breakage, proper sealant width, and proper 4th corner sealant application. A prescribed number of random samples taken from a shipment may be additionally tested for argon gas fill, grid straightness and joinery (if applicable), and presence of an acceptable quality low-e coating on the correct surface. Such checks should be included on a record sheet and initialed and dated by the inspector. Easily accessible work instructions can be provided to explain the details, including data recording and what to do in the event of inspection failure.

Note that outsourcing IG units does not relieve manufacturer of responsibility for these QC checks as set forth in "Finished Product Inspection" (AAMA 103/104 Section 16.3.3). This can be accomplished as part of in-coming inspection or as in-process inspection.

Regardless of source and whether the IGU is certified or not, an incoming inspection of IGU assemblies must be performed. These inspections are listed as Finished Process Inspections per AAMA 103/104 Section 16.3.3.3, namely:

a. Glass Thickness
b. Size
c. Spacer setback
d. Whetting to glass
e. Corner sealant application
f. Glass overlap

Plus, if applicable:

g. Gas fill identification
h. Low-e glass identification
i. Grid assembly joinery
j. Grid attachment to spacer

Note that the thickness test (16.3.3.3a) means checking the glass lite, specifically for conformance to ASTM E1300 for size and design pressure as listed on the AAMA certification label. However, **IGU overall thickness** may be critical to the final assembly of the product, and therefore may be critical to your company's in-process or finished product QC check. If overall thickness is a critical dimension, then adding it to the IGU QMS is a good idea.

Size and glass overlap affect fit into the frame or sash, setback can affect the visual aesthetics of the finished product, poor whetting or corner seal application can lead to premature seal failure.

Also, include any tests or checks recommended by component suppliers (spacers, internal muntins, etc.)

Equipment used for these checks should be included in equipment lists (103/104, Section 16.2.2).

When outsourced, you should request your IGU supplier to provide documentation of these checks, but note again that AAMA 103/104 still requires checks per Section 16.3.3.3 for licensees who purchase IGU from an outside supplier.

For those participating in the NFRC thermal certification program, the IGU QMS requirements listed in NFRC 706 are adequately addressed by meeting the QMS requirements of AAMA 103/104 and the AAMA/ALI insulating glass certification program. Specifically, the NFRC 706 requirements, and the AAMA 103/104 requirements that address them, are:

- Verify the quality and effectiveness of the various components of the products and confirm that you or the IG fabricator's records (as applicable) identify its component, verification method, success/failure, and the frequency of its inspections. (AAMA 103/104, Section 16.3.1)
- Per prescribed sample rates, conduct inspections of final products and indicate frequency of rejection and inspection of products. (AAMA 103/104, Section 16.3.3)
- Verify and calibrate the equipment used in quality control testing (AAMA 103/104, Section 16.2.2)
- Maintain a method of controlling non-conforming product (AAMA 103/104, Section 16.3.4)
- Create, retain, and maintain training records (AAMA 103/104, Section 16.2.1).

9.3.2 Record Retention

AAMA 103/104, 16.3.3.4 A record of finished product inspections shall be kept on file for a period of one year. The record shall indicate the frequency of inspection and rejection, and disposition of all items not determined satisfactory for the marking of the product.

NOTE 4: *While FGIA only requires one year, the required document retention for NFRC certification is five years. Licensees of the thermal certification program should retain records according to the NFRC guidelines.*

Records for finished product inspections should, as with all inspection record sheets, list the product identity, batch/line/shift and other identification information, inspections performed, the pass/fail status of each and/or actual measurement data as appropriate, the inspector's initials and the inspection date. Nonconforming product (i.e., that which failed inspection) should be linked to disposition records, or the latter can be included on the inspection record form if space is available. Such forms can be called different things according to company tradition, such as "product audit sheet."

9.3.3 Production Line Sample Testing for the Manufactured Housing Certification Program

AAMA 104, Section 17.0, provides for production unit testing, applicable to manufactured housing fenestration products only.

At one of the two semi-annual inspection visits, the Inspector randomly selects at least one production sample from the list of certified manufactured housing fenestration products for laboratory evaluation to the pass/fail criteria of AAMA 1701.2, AAMA 1702.2, or AAMA 1704, as applicable.

Testing can be performed by a third-party AAMA Accredited Testing Laboratory of the company's choice, or at the manufacturer's in-house testing facility if witnessed by a representative of a third-party AAMA Accredited Testing laboratory, provided that the facilities comply with AAMA 205, *In-Plant Testing Guidelines for Manufacturers and Independent Laboratories*.

If a failure occurs during a production sample performance test, or if an approved emergency exit window or device does not meet the operability or clear opening dimensional requirements of AAMA 1704, such failure is evaluated under two categories, i.e., Correctable Workmanship Category and Design Deficiency Category. It is then submitted to appropriate corrective action as described in AAMA 104, Section 17.2.

10.0 Disposition of Nonconforming Materials or Products

AAMA 103/104, 16.3.4 Disposition of Nonconforming Material or Product
The Licensee shall establish a procedure for identifying the pass/fail inspection status of received nonconforming material, in-process sub-assemblies and completed products and a means for isolating, handling and determining a disposition of items that are not in compliance. All items not complying with the company's design criteria, or that cannot be reworked to meet the requirements, shall be scrapped. Records of such items and disposition must be maintained.

The point of this requirement is to make sure that products and materials that do not meet the minimum requirements set forth in the manufacturer's QMS are identified and segregated to prevent unintended use or delivery. The controls, related responsibilities, and authorities for dealing with nonconforming product must be defined in your company's QMS documentation.

Many companies use highly visible color-coded tags or stickers to indicate pass/fail status, indicate that a failed product should be isolated to prevent unintended release, and the product should be reworked/repaired, scrapped, or otherwise dispositioned.

Dispositions are recorded on an appropriate form, which may be part of the inspection record or a separate form. If rework is involved, precise instructions should be recorded as well as the means to verify the rework and return the item to production.

In addition to identifying the product itself, some record should be kept to indicate the incident and what was done to resolve it (e.g., a Rejection Ticket). If rework is to be performed, a Rework Ticket might be generated to describe the work and follow-up verification to be done.

Some companies use a rejection code system similar to the defect code approached under customer complaints. This will help focus on the most pressing problems, improve corrective action and aid improvement.

Copies of this information (disposition record/ticket) may be made for placement on the material and for distribution to responsible parties such as the area/line supervisor, QC manager or plant manager for processing in the manner that the company deems best.

10.1 Disposition Types

Disposition may be one of the following:

- Return of the nonconforming item to the vendor (used for purchased components, profiles, glass, etc.),
- Rework or repair of the product
- Regrade the product or material for alternative use (e.g. incorrectly fabricated jamb material can be reused and refabricated for a shorter frame member
- Scrap the product or material

The person or group deciding on the disposition must determine which of these alternatives costs less in terms of time, disruption or money and have the authority to implement the decision.

QMS documentation should describe the process to determine dispositions and indicate the responsible parties. Some companies rely on individuals; others appoint a committee or “material review board” or a similar group composed of internal stakeholders.

The documentation should describe the means by which the nonconforming item is physically identified, such as by tags, stamps, physical location, etc.

Traceability to component parts and subassemblies, vendors and batch/work order should be preserved throughout. Most companies assign an order number and line item number (or equivalent) at the time of order. The order number can provide unique identification and traceability throughout the production process. A more detailed approach involves applying a series of labels to the product at various in-process stages to aid in identifying products that have passed quality inspections at those points and enable tracing back to inspection records. These labels indicate the product and/or customer name, job number, and certain relevant size specifications which the QC staff and production workers can use to check during the production process.

11.0 Labeling

AAMA 103/104, 16.3.5 Labeling
The Licensee shall designate an individual responsible for handling all aspects of the labeling program including issuing instructions on the procurement, handling and application of certification marks or labels and specifying the format, content, location and method of application

This requirement is important, as the AAMA Certification Label is often the only proof in the field that the product meets project specifications or code requirements. FGIA offers three options for the purchase of permanent certification labels:

- Pre-printed labels from the official printer contracted by FGIA and sold by the Validator. This is the most commonly used option.
- Label kits, used by the licensee to print rolls of gold or silver labels in-house as demand necessitates. Label kits and the database used to print them are available from the Validator.
- Labels printed using print stock and a database generated in-house. To be approved for this option, the label stock must pass durability testing, and the label database must be audited by the Validator to ensure it complies with all the requirements of the program.

Both AAMA 103/104 and NFRC 700 (Section 6.2) specifically require that the QMS designate a person responsible for all aspect of the label programs. This person is responsible for:

- Procurement and/or printing of all temporary and permanent labels
- Specifying the format, content, location, and methods of application of labels
- Handling and application of certification labels or marks
- Monitoring through quality checks that all certification labels or marks are properly used

Note that the content and layout of certification labels are described in detail in:

- AAMA 103/104, Section 8.0 for windows, doors and skylights
- NFRC 700 Section 6.4 describes permanent label requirements, Section 6.5 describes temporary label requirements. Appendix A provides examples of temporary labels of all fenestration products.

Label Control Tips

- Consider ways to positively link a particular label with the appropriate production line/batch, etc. to avoid labeling errors.
- Consider posting diagrams in the shop or work instructions showing proper label placement.
- Include a picture of the proper label in the production line work instructions. FGIA can provide high-quality electronic images of all AAMA gold, silver, and manufactured housing labels
- Proper label placement should be part of finished product inspection.
- Be sure proper labeling is included in training and described in the QMS.

12.0 Handling of Customer Complaints

AAMA 103/104, 16.3.6 Handling of Customer Complaints
The Licensee shall establish and implement a process for handling all customer complaints (see Section 12.0) and satisfactorily reaching a disposition thereof, and maintain records of such incidents.

NOTE 5: *Need written practices for the recording of performance and compliance complaints, and the response and resolution of such complaints.*

AAMA 103/104, Section 12.2 is also included by reference in QMS requirements for Handling of Customer Complaints.

AAMA 103/104, 12.2 Complaints to the Licensee
The Licensee shall include in its quality manual a full description of how complaints are resolved and how record keeping is performed. Records of the actions taken by the Licensee to address complaints must be maintained and are subject to the review of the Validator's surveillance inspectors.

NOTE 7*: The licensee's existing warranty program may address this requirement.*

Most frequently overlooked in a licensee's QMS documentation is a process to handle customer complaints. Record-keeping and complaint resolution must be described and the records are subject to review during the in-plant Validator inspections and (if applicable) internal audits.

This is a broad-based requirement. In fact, it is the only manufacturer QMS requirement specifically mentioned in ISO/IEC 17065 (4.1.2.2j), the standard that governs the operation and accreditation of Certification Bodies such as FGIA/ALI.

The process should focus on product performance complaints, returned products, and other issues that may affect product certification. ***Routine field service claims and issues stemming from installation errors do not have to be part of the formal process.***

Tracking complaints can lead to actions that improve both the product and the company's performance and may provide insight on ways to eliminate certain complaints entirely, minimizing ongoing risk while improving customer relations.

A means to capture complaints, track their resolution and provide a record is to develop and use a Complaints form. Anyone in the company, including sales and marketing, should have access to the form. The procedure should delineate how the form is communicated and processed internally.

Typical content for a Complaint form might include:

- Date, and "case number" if useful for tracking
- Complainant (who originated the complaint)
- Complaint received by (name, title and office location of person originally receiving the complaint, including date of receipt) Acknowledgment returned to complainant?
- Nature of complaint
- Evidence presented
- Resolution requested by complainant or recipient
- Investigation (name of responsible individual or team leader and due date for conclusions; link to any Corrective Action case initiated)
- Action taken
- Resolution and communication to the complainant
- Close date

Some companies keep track of complaints by product line and/or assign a defect code that can be sorted to indicate the type of complaints or returns reported most frequently for each product line and enable more effective corrective action. Examples of conditions to which a defect code might be assigned include damaged in shipment, vent not latching, leaks, non-functional weep system, sash balance loose or maladjusted, bowed frame, bad corner joint, blemished glass or paint finish, etc.

Complaint resolution can and often should involve formal Corrective Action (see AAMA 103/104 Section 16.3.7). In fact, the last four items in the above list actually mirrors the Corrective Action process. If formal Corrective Action is utilized, it might be a good idea to link it with the complaint in your records by case number or other suitable means. To initiate a Corrective Action effort in response to a complaint, it might be more straightforward to open a Nonconformity Report (NCR) of the sort used in Internal Auditing (see AAMA 103 Section 17.2).

13.0 Corrective Action

AAMA 103/104, 16.3.7 Corrective Action
The Licensee shall establish and implement internal corrective action procedures to be taken to investigate and correct the cause(s) of product non-conformities as identified during implementation of 16.3.1, 16.3.2, 16.3.3 and 16.3.6 above.

NOTE 11: *The internal Corrective Action process may be patterned after the process described in Section 13.0 at the Licensee's option. The corrective action should include determining the root cause of the problem (root cause analysis) and permanent changes made to prevent recurrence (corrective actions).*

Findings of non-compliance with the Licensee's QMS or its documentation are discussed with the appropriately responsible authority, and corrective actions initiated per Section 12.0. Continued noncompliance with the QMS requirements can result in suspension or termination of the product line or the Licensee as described in Section 14.0.

Corrective Action as described in quality management lexicon is sometimes a poorly-understood process. It requires a commitment to look beyond treating symptoms and instead confront the underlying condition. Its purpose is to eliminate the cause of nonconformities in order to prevent recurrence and associated waste.

Defining the seriousness of the problem that initiates formal corrective action is up to you.

Items that can trigger the corrective action process are:

- Customer complaints and returns (16.3.6)
- Nonconformities reported during internal audits (per 103, Section 17.0) when applicable, or
- Rejected products due to failed in-process or final inspections
- Label misuse (16.3.1, 16.3.2 and 16.3.3).

Once the corrective action process is implemented, it is wise to establish a routine due-date for the initial milestones so that the problem doesn't get lost in day-to-day work.

The Corrective Action process is already ingrained in many industries, and can be depicted by the following flowchart:

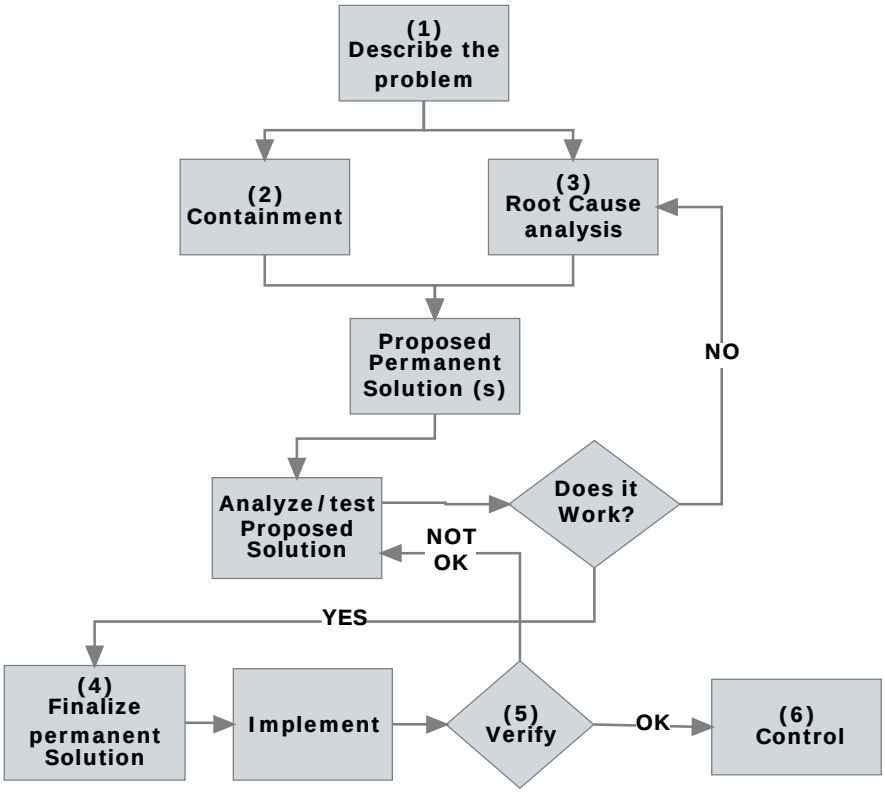

FIGURE 4: Corrective Action Process

1. Problem Description (describe the problem with sufficient information to pursue a meaningful solution)
2. Interim Action/Containment (this is the "Band-Aid" you might use to figuratively stop the "bleeding" and/or stop nonconforming product from reaching the customer; this is not the end-point, however. Don't confuse Containment or Immediate Disposition with real solutions; treat the cause, not just the symptoms. Don't settle for Band-Aids.
3. Root Cause Analysis (the most important step of Corrective Action; see next section)
4. Permanent Corrective Action (the solution to prevent recurrence of the problem; be sure to identify responsibilities and completion dates for these actions)
5. Verification (how will you know when and if the solution has been implemented? Often accomplished via future Internal Audits, if applicable [see 17.2])
6. Control (may involve revision to a QMS procedural document or form, as well as an update to the training of involved personnel and revision to future internal audit checklists [see 17.2]).

These steps may be captured for the record using a Corrective Action form, such as the following example:

INTERNAL CORRECTIVE ACTION REPORT

INITIATED BY: _____ INITIATION DATE _____ SOURCE: ❑ INTERNAL AUDIT ❑ CUSTOMER COMPLAINT ❑ RMA ❑ FAILED INSPECTION/TEST	
NONCONFORMITY: Audit/NCR #: _____ Date: _____	
IMMEDIATE DISPOSITION OR CONTAINMENT:	
ROOT CAUSE:	
PROPOSED CORRECTIVE ACTION: PROPOSED IMPLEMENTATION DATE: _____ APPROVED: _____	
FINAL CORRECTIVE ACTION: APPROVED: _____ Date: _____	
VERIFIED BY:	DATE:

FIGURE 5: Internal Corrective Action Report

Root Cause Analysis

The essential element of the corrective action process is to determine and eliminate the Root Cause of the nonconformity.

When a problem is identified, there is a natural tendency to simply fix the result or effect (symptom) of the problem and deem this as corrective action. In the workplace it's very tempting to focus on recovering from a problem as quickly as possible and to get back to productive business as usual. However, the costs associated with running a solid root cause analysis program are far less than the costs of not supporting one. These include:

- Risk
- Quality breaches, where sub-standard product makes it into the marketplace
- Money wasted by implementing ineffective solutions
- Damage to customer relationships due to the fabrication of sub-standard products

Correctly implemented, root cause analysis shifts the mind-set from fixing the effects of problems to eliminating, changing, or controlling the causes of problems

First, consider two levels of root cause analysis use depending on the importance of the problem and its current and potential impact.

- First, an *ad hoc* approach at lower managerial levels for minor problems that occur day-to-day and week-to-week. This process can be implemented "on the spot." Just be careful that you don't use this option as a means to short-circuit the process in the interest of saving time at the expense of eliminating waste over the longer term or across other company operations. Clearly define or categorize problems that can use this expedited approach.
- Second, a formal approach for more systemic or impactful problems, using:
    - Pre-established triggers,
    - Goals of the analysis
    - Documented recommendations with follow-ups enforced by deadlines to monitor solution results

To get at and fix the root cause, corrective action practitioners follow several basic principles:

- Focus on identifying the causes of problems rather than on assigning blame; remember that "it's the process; not the person." Avoid the easy way out. "Employee error" is not a root cause- if the employee failed, then the system allowed them to do so.
- Try to foster an atmosphere where employees trust that any root cause analysis or incident investigation aims to find the facts about all causes—human and conditional—not to place blame.
- Teams should be multi-disciplinary. Choose a team representing the areas that have an effect on the process that experienced the problem. Pick a leader with no bias toward any particular department or subgroup. "Protecting turf" is not as important as fixing problems that affect overall welfare.
- Use disciplined problem solving. Whenever possible avoid corrective actions that are based solely on intuition and opinion. Use published analysis tools and methods to jog your thinking and help find a root cause. Don't be impatient. Problems will recur as a result of ineffective solutions.
    - As a starting point, practice the "five whys," which means to ask "why" five times to trace cause and effect through several levels. Here is an example:

    Problem: Received a speeding ticket on the way to work.
    1. **Why**? I was driving fast because I was late for work.
    2. **Why**? I did not wake up on time.
    3. **Why**? My alarm did not work properly.
    4. **Why**? There was a power outage, and the batteries in the alarm were dead.
    5. **Why**? I forgot to check and replace the batteries.

    In this case, the root cause of receiving a speeding ticket was failing to replace the batteries in your alarm clock. To put this in manufacturing terms, **a substandard product was fabricated because routine maintenance on an essential piece of equipment was neglected**.

Consider all inputs to the process to help identify where the problem may lie. A favorite tool to do this is the "fishbone diagram." Back up your identified causes with evidence, so you're not just brainstorming problems.

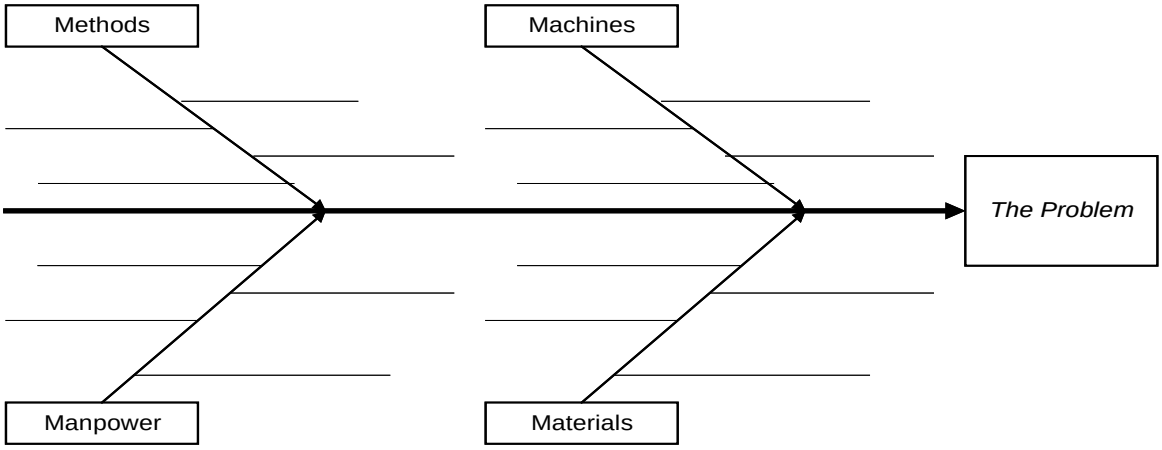

FIGURE 6: Fishbone Diagram
Each blank would be filled in with the appropriate inputs to the process

- A major criterion for getting to the root cause is that the solutions devised should save money. Be prepared with data and projections for cost-benefit analysis that demonstrate the value of the proposed corrective action to management. Cost-benefit criteria can help prioritize the best solutions and identify those that minimize or eliminate other problems.
- A big-picture, long-term view is needed. What other processes or product lines can benefit from the proposed corrective action? Note that a root cause might reveal a systemic cause, which can lead to future, more serious incidents if not addressed. ***A single solution that addresses a common cause can eliminate multiple problems.***
- Avoid excuses!
    - We don't have time to think long-term. We need to get product out the door.
    - We've got to get these orders shipped. We'll get to root-cause analysis later and really resolve the problems then.
    - Fixing this problem is too expensive. Just make it work.

    Sound vaguely familiar? Under this regime, nothing really happens. Mistakes are repeated and the costs accepted by default. This type of thinking can be summed up by the following phrase: ***"There's never time to do it right, but there's always time to do it over."***

Some additional practitioner tips for corrective action implementation

- Appoint people and deadlines to report back or to implement an agreed-to action. Requirements such as instructing the process owner to determine the solution (based on root cause determination) and communicate the implementation date within a prescribed deadline, plus built-in escalation to the process owner's supervisor in the event of non-response, will help ensure that corrective action happens. Some require reporting of the proposed corrective action to a decision-making authority for approval prior to implementation.
- Consider tracking corrective actions in a logbook or spreadsheet that links to individual corrective action forms or files.
- Follow up with assigned deadlines. Are the solutions proving effective? Are the results of the solutions actually changing, controlling, or eliminating causes, or are they only reducing the probability?
- Communicate the solution and associated changes. Does everyone understand what is to be done and why? As previously noted, revise QMS documentation and forms, update training content for affected personnel, and update the Internal Audit checklist (if applicable)
- Remove the temporary "containment" fix (if applicable) once the corrective action has been implemented.
- Set a date to reevaluate whether the solutions have been effective, or whether the problem has recurred. A good rule of thumb is to look between three months and one year after the close of a root cause analysis. Determine who will follow up to verify the effectiveness of the corrective action (if the nonconformity was issued by an internal auditor [per 17.2], many assign this task to the internal auditor). If solutions have been ineffective, decide how you will revisit the problem.

14.0 Additional QMS Requirements for AAMA AWS Certification Extension

For the air-water-structural program, FGIA also offers 5-year extensions of certification for all products currently authorized for certification. To be eligible for this extension, manufacturers must create an enhanced QMS that goes beyond the minimum requirements defined in section 16 of AAMA 103. These additional requirements are defined in Section 17 of AAMA 103.

AAMA 103, 17.1 Scope

The requirements in this Section are in addition to those stated in Section 16.0.

This section sets forth requirements for In-Plant Quality Management System (QMS) which Licensees in the Program shall follow when manufacturing certified products and requesting five-year certification extension beyond initial certification per Section 6.7. Extension is not applicable to the NFRC or IGU Certification Programs.

Where QMS elements herein are similar to those in Section 16.0, the requirements of this Section shall be substituted.

14.1 Internal Audits

AAMA 103, 17.2 Quality Control Internal Audit

The Licensee shall implement a documented internal audit program. The documentation shall be contained in the Quality Manual. The internal audits shall be conducted with corrective action system that addresses any concerns found during the inspections. The Validator shall review the results of internal audits during inspections.

NOTE 6: *NFRC 700 section 8.2.1.4 specifies that certifying manufacturers must conduct and internal audit of their QMS at least annually using a company representative trained for this function, have "documented evidence of internal quality audits," but this does not refer to the same type of audit described in AAMA 103, 17.2. The NFRC requirement refers to quality control inspections and inspection record-keeping.* At least annually, a company representative trained to perform audits shall perform and document an internal audit of the licensee's quality management system. The audit shall review the licensee's forms used and the records kept of the licensee's ongoing compliance with Section 8.2, 8.2.1.1, 8.2.1.2, and 8.2.1.3 of this document. Documented Evidence of External Quality Audits

Athletes and runners monitor their heart rate, blood pressure, blood oxygenation, respiration rate and other physical parameters to determine if their activity is serving their fitness goals. Internal auditing serves much the same purpose in the business and manufacturing environment, telling if defined procedures adequately address requirements and are being followed (i.e., if your company is properly "saying what you do and doing what you say").

In this case, the internal audit verifies:

- If the documented QMS meets the requirements specified both by the company and by FGIA;
- If the responsibilities documented in the QMS have been assigned to appropriate personnel; and
- If the QMS is being properly implemented.

Internal audits do *not* refer to product inspections.

For those participating in the thermal certification program, NFRC 700 (Section 8.2.1.4) also requires a complete annual review of company QMS documentation by a company representative trained to perform audits to ensure that it continues to address minimum requirements, and if improvements, clarifications or other revisions to the QMS should be made.

For both the air-water-structural and thermal certification programs, the company decides and defines the frequency of such reviews (although annually is a typical approach). Such a review is often included in what is termed a formal "Management Review" (as in ISO 9001), but it can be considered part of the Internal Audit protocol.

It's important to note that what is being audited are ***processes,*** not ***people!*** This is not an adversarial procedure, and has nothing to do with personnel performance reviews. The operating assumption of the auditor must be that "if people frequently make similar mistakes, it's the system's fault."

The Internal audit procedure within your documented QMS should contain the responsibilities and requirements for planning and conducting the audits, reporting the results, and maintaining records. The procedure should also tie into the corrective action processes used in responding to the occasional nonconformity reports stemming from the audits, and describe how follow-up, verification, and related records are accomplished.

Internal audits can be performed across a given product line from start to finish, encompassing all relevant QC inspections and requirements at each production stage. Alternatively, audits can be conducted across all product lines for each specific QC requirement. Either is acceptable and up to your company to determine. Think of it as a matrix of management and production stages vs. quality requirements. As long as all of the squares are filled in, however you go about doing so, you are good to go.

The basic audit process, defined for all industries in ISO 19011, *Guidelines for auditing management systems*, can be depicted by the following flowchart:

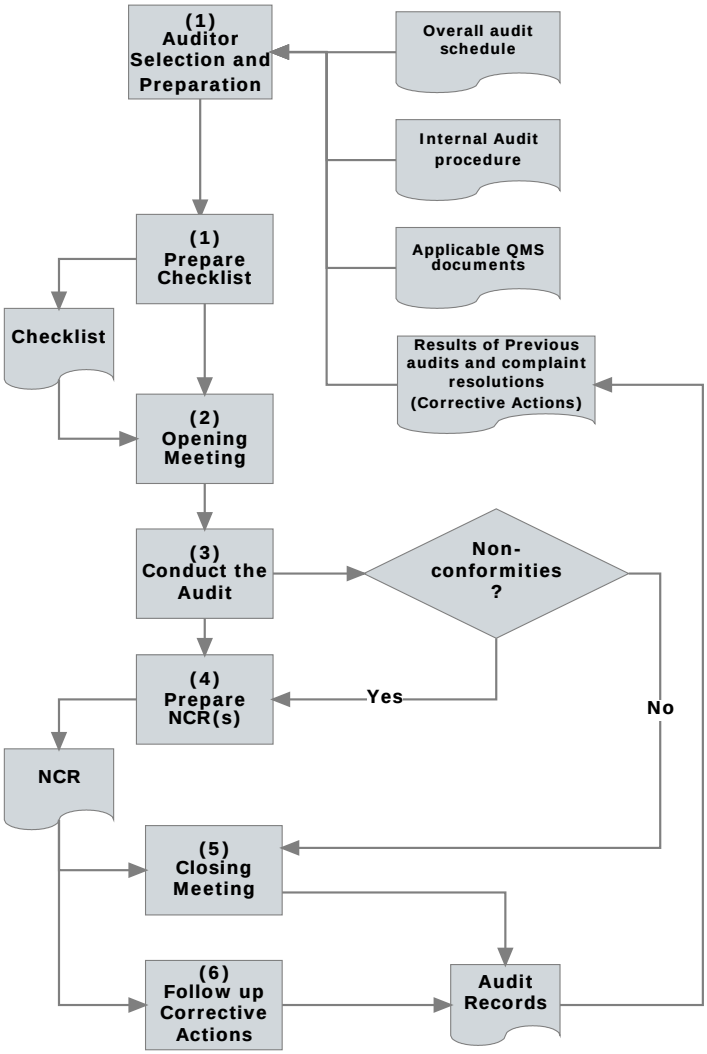

FIGURE 7: Internal Audit Flowchart

Looking at each step in the process:

(1) Auditor Selection and Preparation

Note that no one can be put in the position of auditing his/her own work, as would be the case if someone from Quality Control or Production conducts the audit. Someone from another department, such as sales, engineering or accounting, who does not have any responsibilities in the area being audited, should be appointed and trained to conduct the audit. Alternatively, an independent auditor from outside the organization can be engaged to conduct the audit.

Most companies schedule internal audits at least once every year. The entire operation can be audited in a single event (which may take a couple of days), or segments can be audited (requiring, say, two or three hours each) such that the entire system will have been audited over the course of a year. The actual frequency (in excess of once per year) and depth of audits is a decision that rests with the company.

The auditor must understand the process and governing QMS documents that are being audited. A good idea is to first perform a "desk audit" review of the relevant documentation. The auditor should be able to answer the questions:

- Is the process identified and correctly described? Does it meet certification requirements?
- Are the QMS responsibilities and roles defined and assigned to appropriate personnel?
- Are the output requirements for the process being audited and the acceptance criteria understood? Are the means to measure conformance with the program defined? Is the required content of inspection/test records understood?
- Be aware of the resources needed to conduct process activities (equipment, people, info, material, etc.)

- Include a plan for collecting specific evidence needed to answer checklist questions (What do you want to see? How many items [product, documents, etc.] are to be sampled?)
- Look at Corrective Action records from previous audits, as part of the job will be to verify that the correction is in place and functioning effectively.

Audit Planning and Scheduling

You may not need a separate plan for each audit. If the entire system is audited at a time, the plan can be built into the internal audit procedural document within the QMS. If audits are done separately, a brief plan for each may be in order. Stated audit plans should include:

- Overall schedule - A master schedule of separate audits will help keep track of the program.
- Scope (activities to be covered by each audit)
- List of standards, procedures against which each function is to be audited
- Organizational units affected

The audit checklist

Develop a checklist to help ensure your audits are thorough and complete. A standard checklist can be developed for use as an established QMS form when any audit is conducted. The following is a typical checklist format, patterned after that used by ANSI auditors in assessing the ongoing accreditation of FGIA/ALI as a Certification Body.

XYZ COMPANY INTERNAL AUDIT CHECKLIST

Audit date:_____ Auditor:_____

Areas audited (plant, department/product line, shift, etc.)_____

Requirement		Company QMS documents		Meets requirements?		Comments
103/104 reference number	Text from Requirement	Reference number	Text (company-specific implementation details)	Yes	No	

FIGURE 8: Internal Audit Checklist

In addition, for each audit, note any specific points to be examined based on past problems, nonconformity notices issued and Corrective Actions processed since the preceding audit.

(2) Opening Meeting

These are usually quite informal. The purpose is to simply inform the supervisor of the area being audited that the audit is underway and what you will be accomplishing. In many companies, this is old hat to manufacturing personnel. In others, especially where internal auditing is being introduced for the first time, it is important to explain what it is and what it isn't (process check vs. personnel performance assessment) and how the system works. Explain that it is a requirement for the product certification and labeling program.

At this point, a person (preferably the supervisor) from the area being audited is designated to accompany the auditor. This person can help in identifying responsible parties, describing the process details and locating appropriate records.

(3) Conducting the Audit

First and foremost, follow the checklist!
Explain your purpose; show auditees a copy of your blank checklist. Be sure they understand this is not a personnel function that could affect their pay or tenure.

Check the following:

- Are the relevant quality procedures being implemented and records maintained?
- Do the workers understand the process as documented and the use of associated forms? How are details of the activities communicated (instructions, procedures, and methods/tools)?
- What must be delivered to the external or internal customer (process outputs)?
- Are the resources necessary to support the process (skilled personnel, technology, equipment, infrastructure, information) provided adequately?

Assess the proficiency of the personnel. Are their abilities (talent/education) and skills (training) commensurate with the task? Watch the process being performed and/or examine process records.

Record any discrepancies or nonconformities using your checklist. Document all observations and describe any evidence for your conclusion in the "Comments" section.
Obtain copies of records or any other documents that might serve as evidence of the nonconformity. In some cases, a cell phone picture can help.

Check that all log books are being properly filled out and are up to date.

If what is going on isn't obviously observable, ask the operators "Who/What/Why/When/Where/How" questions, not yes-or-no type questions. For example:

- What do you do when…?
- Where do you record the information? Is it current? Are any prescribed sampling rates being followed?

Keep in mind:

- You aren't after right or wrong answers, just facts; no “Gotcha” moments. You aren't seeking to place blame but to check the system.
- Walk in under the assumption that if people frequently make similar mistakes, it's the system's fault.

(4) Preparing Nonconformity Reports (NCRs)

An NCR should be issued if:

- The process as documented does not meet FGIA, NFRC or company requirements
- The process is not being followed on the plant floor
- Records are not being kept as described in the documentation

A typical NCR form might look like the following:

XYZ COMPANY
INTERNAL QMS AUDIT NONCONFORMITY REPORT

PLANT: *(e.g., Centerville, Kansas)*	AREA UNDER REVIEW: *(Operation(s), product line, shift, etc.)*	ISSUE DATE: AUDIT DATE:)
APPLICABLE CERTIFICATION STANDARD: *(e.g., AAMA 103, 16.2.8)*	COMPANY DOCUMENTATION REFERENCE: *(e.g., XYZ QMS Manual A, Procedure A-3)*	AUDIT/NCR#: *(TRACKING NUMBER)*
NONCONFORMITY: (Complete nonconformity statement).		
AUDITOR:	AUDITOR SIGNATURE:	
ACKNOWLEDGED BY: *(Supervisor of area receiving the nonconformity)*		DATE:

FIGURE 9: Internal Audit NCR Form

Note that such a form should include:

- Unique identification of the audit (name, number, etc.) and specific area/function being audited
- Identification of reference documents against which the audit was conducted (QS9000 element, Quality Manual, procedures, etc.)
- A good nonconformity statement

The nonconformity statement

The nonconformity statement is an important part of the internal auditing process. To be useful to the company in analyzing and fixing problems, nonconformity statements need to be clear, complete and concise.

Clearly state the problem – avoid reaction based on past experience or trial-and-error fixes.
As newspaper reporters are trained, be sure to adequately answer those same "Five W's" you asked the operators:

WHAT was found
WHERE was it found
WHO was there
WHEN was it found
WHY it's a nonconformance

Ask and assess:

- What are they having a problem with?
- Where is the problem? (line, process, part)
- Has it occurred before? How often?
- Why is this a problem?
- How many units have the problem (occurrences?)
- How big a problem is it (implications)?

Nonconformity statements must:

- Be based on written procedure or standard requirements – *not* assumptions, personal experience or opinion!
- Give clear reference to the job situation (Location, line #, job #, part #, etc.).
- Give reference to the controlling procedure or clause of the governing standard or Certification Program requirement

Keep in mind the "Five-Cs" for well-written Nonconformance Statements:

- ☑ Complete – include the specific requirement and objective evidence
- ☑ Correct – accurately convey the information
- ☑ Concise – be as brief and succinct as possible
- ☑ Clear – use easily understood & familiar terminology
- ☑ Confirmed – verify that the information needed for corrective action is stated.

Not sure whether to "write up" an observation as a nonconformity? Consider its relevance to the company and ask yourself:

- What could go wrong if the discrepancy isn't corrected?
  - Excessive scrap?
  - Injuries?
  - Regulatory fines?
  - Suspension or loss of certification?
  - Miscommunications?
  - Excessive overtime?
  - Missed deliveries?

- What is the likelihood of it going wrong?

Note that the Nonconformity Reports should be issued within an agreed period of time (typically on the order of one to two business days after the audit).

Some companies require a separate audit report that simply summarizes what was done, what nonconformities were issued, along with copies of the nonconformity reports and your completed checklist. Include a conclusionary statement on the degree to which the audit criteria have been fulfilled. The exact content of such reports, which serve as records that the audits were done, and the timing of their release, is up to the discretion of the company.

Also include attachments (supporting facts for each nonconformity found).

(5) Closing Meeting

Like the opening meeting, this is scarcely a formal affair in the context of an internal audit. Its main purpose is to confirm that the audit is over and summarize the results, including letting the process owner(s) know what follow-up actions are required of them.

Some guidelines:

- Don't place blame. Remember: "It's the system's fault."
- Don't use actual employee names; use position titles instead (e.g., "operator," "technician," "supervisor," etc.)
- Be professional in tone; don't put people on the defensive.
- Include an overall summary statement: The "bottom line" performance evaluation must answer the two basic questions:
  1. Are control systems in place?
  2. Do they work?
- Present findings in terms of specific requirements against which the audit was conducted.

- Obtain departmental supervisor's acknowledgement that the audit evidence is accurate, and that the nonconformities are understood. Have them sign off on the NCR form(s) as a simple acknowledgment that the form was received (not as an admission of "guilt.") Clarify, correct and explain any fuzzy areas.
- Satisfy needs. Make a contribution. Try to show how the facts affect the product, service, or customer satisfaction.
- However, as an internal auditor, don't own any of the problems by recommending or prescribing solutions and future actions! It's the auditees' job to come up with corrective actions.
- Explain follow-up and Corrective Action process and timing if problems were identified (30 days is a typical turnaround period for a Corrective Action to progress as far as the Root Cause analysis and proposed corrective action. See 16.3.7.).

Note that some audit regimes also allow for the auditor to file "observations" or "opportunities for improvement." These do not require corrective action response as do nonconformities and are simply suggestions for improving operational conformance with requirements or operational efficiency. These have often proven useful if you wish to institute this option.

Some companies encourage auditors to include noteworthy accomplishments (positive practices) in their audit reports. It can serve as a confirmation of proper performance and a morale booster.

(6) Follow-up of Corrective Actions

Responsible parties (process owners) must determine and eliminate the root cause of any nonconformities noted by auditors using the previously described Corrective Action process (see AAMA 1.3/104 Section 16.3.7). It is the auditor's role to check back to see if the solution works, either in a special visit if so instructed by the Corrective Action, or at the next regularly scheduled audit.

Consider using a calendar or spreadsheet tool to track NCRs for Corrective Action responses. Procedural documentation should specify a length of time in which the CAR is to be submitted.

NOTE 7: *The initial CAR response does not have to be complete; at the least, it should indicate who is responsible for root cause analysis and devising a corrective action plan, indicating when the plan is expected to be finalized. Depending on the complexity of the problem, this can take days or months. Using the expected corrective action implementation date as a guide, the actual implementation should be followed up to ensure that it goes into place as predicted and that it is operational and effective.*

14.2 Incoming Material Inspection

AAMA 103, 17.3 In-Coming Material
In addition to the requirements listed in 16.3.1, when Insulating Glass units are used in the production of Certified Units, participation in an IG certification program certifying conformance to ASTM E2190 is required. These certifications shall be kept on file for verification by the auditor during the semi-annual plant audits.

For the Air-Water-Structural (AWS) certification extension program, as well as the NFRC certification program, the manufacturer must participate in an accredited 3rd-party insulating glass certification program. All IGUs installed into certified units must be certified for conformance to ASTM E2190. If more than one spacer type is used in the plant, then all spacer types used in AAMA or NFRC certified products must be certified. Evidence must be available to the FGIA auditors in the form of current IGU certification certificates.

14.3 In-Process Inspection

AAMA 103, 17.4 In-Process Quality Control

17.4.1 Fabricated parts of each different product manufactured during each shift on which it is processed shall be checked per Section 16.0 and for Corner Assembly Structural Integrity.

NOTE 12: *This may be demonstrated by testing, such as the Thermoplastic Corner Weld Test*

17.4.2 A record of these inspections and tests shall be kept on file for a period of no less than one year. The record shall indicate the disposition of all items determined to be unsatisfactory for the labeling of the product.

In-process subassemblies must be inspected in the same manner as indicated in AAMA 103/104 Section 16.3.2; however, inspections must be performed and records maintained for each shift.

Also, corner assembly structural integrity must be confirmed by testing. For thermoplastic (vinyl) products, this may be accomplished through the Thermoplastic Corner Weld Test outlined in Section 9.3.6.2 of NAFS-11. It is recommended that testing be performed on the output of each corner welding machine of each production line at strategic points throughout the day, usually at the beginning of each shift. The purpose of this requirement is to ensure that the welder is operating within acceptable tolerances before a run of production units are fabricated and sent to the customer.

The test protocol in NAFS outlines the following procedure:

- The corner samples must be of sufficient size to be accommodated in the test fixture (an example might be to cut an "L" piece with 20" legs)
- The corner sample must be mounted in the test fixture as indicated in the diagram below.
- A load is gradually applied until breakage of the corner occurs.
- Assess the corner breakage. Except for cellulosic composite materials (cellular vinyl), when loaded to failure, the break cannot extend along the entire weld line. When breakage occurs away from the corner, or if breakage starts along the weld line but extends no more than ¼ inch of the length of the weld from a corner but the fracture runs away from the weld, the corner passes the test.
- Record results on a defined log sheet or similar document. Indicate steps to take in the event of failure (temperature adjusted, weld plate sleeves changed, etc.); a failure is often considered serious enough that all welding at the welder producing the failed test is stopped until corrective action is taken and a series of repeated tests (say, five samples) all pass.
- Cellulosic composite materials do not break in the same manner as vinyl, so if the corner weld test is used the manufacturer must define the pass/failure criteria. NAFS indicates the following test results must be reported:
  (a) description of the break;
  (b) location of the break; and
  (c) weight of the applied load that caused breakage.

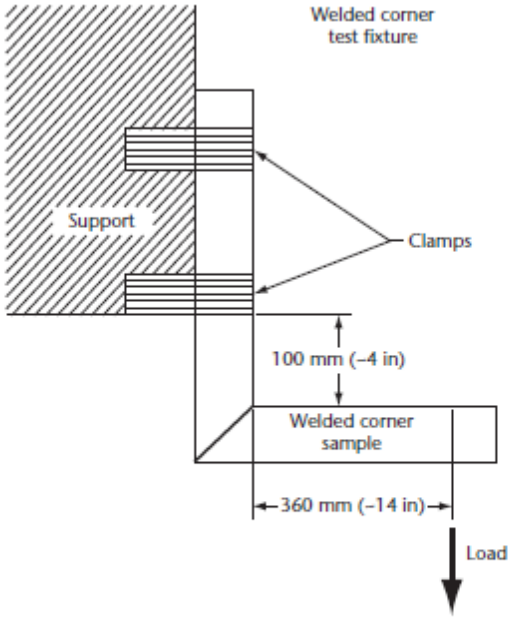

FIGURE 10: Vinyl Corner Weld Test Fixture

The test description above is a recommendation only. Use your manufacturing experience to determine the best pass/fail criteria for your products.

Please note, employing the corner weld test is not mandatory to satisfy the requirements of this section for welded vinyl products. Other methods may be acceptable as long as they are properly documented and verify the structural integrity of the corner joinery. Many products, such as fiberglass, wood, aluminum, and even some vinyl frames are mechanically fastened. Mechanically fastened corners can be verified through inspections (e.g., use of proper materials, fasteners, torque settings, sealants, etc.), or can be checked by applying a designated weight to the loose end of an L-shaped corner sample. Again, please use your experience to design a test and pass/fail criteria that best meets the needs of the products you manufacture.

14.4 Finished Product Inspection

AAMA 103, 17.5 Finished Product Inspection and Testing

17.5.1 Finished products shall be examined on a regular basis (at least daily) in accordance with the following schedule:

Production	Number Examined
Up to 150	4
151-500	6
Greater than 500	10

Note that this sampling rate is twice that of the final inspection under 16.3.3.

AAMA 103, 17.5.2 The examinations of completed fenestration products shall include the attributes described in Section 16.0 plus the following:

17.5.2.1 Sill Corner Assembly and Drainage Test

17.5.2.1.1 For all fenestration products, material and joining types, a quality control (QC) procedure that physically tests the integrity of the sill corners and proper drainage of the weep system shall be added to the licensee's published quality control manual. The sill corner assembly and drainage QC tests shall be conducted at least weekly across a representative sampling of product lines.

NOTE 13: *It is recommended that the quantity of water introduced at the sill corner assembly be determined using Clause 9.3.3 of NAFS-11. Alternate QC tests, such as full static water penetration resistance testing, may be acceptable but they must be validated by the Licensee and described in the QC manual.*

17.5.2.1.2 A log of test dates and results shall be maintained by the licensee for review by the Validator during plant inspections. Records of testing and test results shall be maintained for a minimum of 12 months.

The purpose of this test is to verify the water-tightness of the sill corners and proper drainage of the weep system. Water is introduced into the jamb/sill assembly and observed for two things:

- The integrity of the sill/jamb junction (no leakage)
- Proper drainage of the weep system at the conclusion of the test.

A process description or work instruction should be prepared detailing how to conduct the test.
It should define:

- Testing frequency per product line (e.g., weekly or per sampling chart above depending on production volume)
- The testing process, such as the following sequence:
  1. Tape off or plug exterior weep holes
  2. Stand the unit vertically as if installed.
  3. Fill sill with water to top of interior sill leg. Some product designs, such as those using a sloped sill, might require addition of a temporary water dam element to form a dam equivalent to the sill dam height.
  4. Let water stand for a defined amount of time
  5. Check for leaks at the corner joinery (leaks anywhere other than taped locations would be a failure). If there are no leaks, remove the weep hole tape/plugs and check for proper function of the weep system.
- Record results and failure dispositions on the appropriate log sheet or other documents; drain test water, dry, and return the passed units to the finished goods section.

AAMA 103, 17.5.2.2 Operational Check for Unit Opening and Closing, Locking and Unlocking

17.5.2.2.1 A quality control (QC) procedure shall be developed to confirm that certified products operate properly in the opening and closing directions without the application of excessive force [operational force], remain in the open or closed position without assistance, and that they lock and unlock as intended (where applicable).

17.5.2.2.2 A log of test dates and results shall be maintained by the licensee for review by the Validator during plant inspections. Records of testing and test results shall be maintained for a minimum of 12 months.

This test is performed to confirm that the product operates properly in the opening and closing directions without the application of excessive force, remains in the open or closed position without assistance, and that it locks and unlocks as intended. The frequency of testing should be defined according to the minimum sampling rate noted above.

A force gauge can be used to ascertain the actual operating force but is not required. Maximum allowable operating forces should be defined by the manufacturer.

15.0 Referenced Documents

All standards or test methods referenced herein are intended to be the most current revision level unless specifically indicated otherwise. As of the date of publication of this User Guide, these are:

15.1 AAMA, Fenestration and Glazing Industry Alliance (FGIA) Standards

AAMA 103-19, Procedural Guide for Certification of Window, Door and Skylight Assemblies
AAMA 104-17, Procedural Guide for Certification of Manufactured Home Fenestration Products: Windows/Sliding Doors, Emergency Exit Windows and Devices, Swinging Exterior Passage Doors
AAMA 303-2019, Voluntary Specification for Rigid Polyvinyl Chloride (PVC) Exterior Profiles
AAMA 305-18, Voluntary Specification for Fiber Reinforced Thermoset Profiles
AAMA 307-16, Voluntary Specification for Laminates Intended for Use on AAMA Certified Profiles
AAMA 308-16, Specification for Cellular Polyvinyl Chloride (PVC) Exterior Profiles
AAMA 309-13, Standard Specification for Classification of Rigid Thermoplastic/Cellulosic Composite Materials
AAMA 310-12, Voluntary Specification for Reinforced Thermoplastic Fenestration Exterior Profile Extrusions
AAMA 311-13, Voluntary Specification for Rigid Thermoplastic Cellulosic Composite Fenestration Exterior Profiles
AAMA 312-14, Voluntary Specification for the Lamination of Wood and Cellulosic Composite Materials Intended for Use on AAMA Certified Profiles
AAMA 313-10, Voluntary Specification for Molded Aliphatic Polyurethane Elastomer Frame Materials
AAMA 701/702-11, Voluntary Specification for Pile Weatherstripping & Replaceable Fenestration Weatherseals
AAMA 800-16, Voluntary Specifications and Test Methods for Sealants
AAMA 813-19, Voluntary Specification and Test Methods for Adhesives Used in Simulated Divided Lites
AAMA 901-16, Voluntary Specification for Rotary & Linear Operators in Window Applications
AAMA 902-16, Voluntary Specification for Sash Balances
AAMA 904-14, Voluntary Specification for Multi-Bar Hinges in Window Applications
AAMA 906-21, Voluntary Specification for Sliding Door and Lift and Slide Roller Assemblies
AAMA 907-15, Voluntary Specification for Corrosion Resistant Coatings on Carbon Steel Components Used in Windows, Doors and Skylights
AAMA 908-16a, Voluntary Specification for Friction Based Sash Balances
AAMA 1701.2-17, Voluntary Standard for Utilization in Manufactured Housing for Primary Windows and Sliding Glass Doors
AAMA 1702.2-17, Swinging Exterior Passage Door Voluntary Standard for Utilization in Man. Housing
AAMA 1704-17, Voluntary Standard Egress Window Systems for Utilization in Manufactured Housing
AAMA CVPM-FA-18, AAMA Component Verification Program Manual: Finishes Applicators
AAMA CVPM-H-18, AAMA Component Verification Program Manual: Hardware
AAMA CVPM-S-18, AAMA Component Verification Program Manual: Sealants
AAMA CVPM-W-18a, AAMA Component Verification Program Manual: Weatherstripping

15.2 American National Standards Institute (ANSI)

ANSI Z97.1-09, Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

15.3 ASTM International (ASTM)

ASTM C1036-16, Standard Specification for Flat Glass
ASTM C1048-18, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1172-19, Standard Specification for Laminated Architectural Flat Glass
ASTM E546-14 (2020), Standard Test Method for Frost/Dew Point of Sealed Insulating Glass Units
ASTM E1300-16, Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E2188-19, Standard Test Method for Insulating Glass Unit Performance
ASTM E2189-19, Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units
ASTM E2190-19, Standard Specification for Insulating Glass Unit Performance and Evaluation
ASTM E2649-20, Standard Test Method for Determining Argon Concentration in Sealed Insulating Glass Units Using Spark Emission Spectroscopy

15.4 Consumer Product Safety Commission (CPSC)

16 CFR 1201 (current as of 4/2021), Safety Standard For Architectural Glazing Materials
24 CFR 3280 (current as of 2/2021), Manufactured Home Construction And Safety Standards

15.5 Canadian Government Specifications Board (CGSB)

CAN/CGSB-12.1-M90, Tempered or Laminated Safety Glass
CAN/CGSB-12.3-M91, Flat, Clear Float Glass
CAN/CGSB-12.4-M91, Heat Absorbing Glass
CAN/CGSB-12.9-M91, Spandrel Glass
CAN/CGSB-12.10-M89, Light and Heat Reflecting Glass
CAN/CGSB-12.11-M90, Wired Safety Glass
CAN/CGSB-12.12-M90, Plastic Safety Glazing Sheets

15.6 International Code Council (ICC)

ICC-ES AC10-14, Acceptance Criteria for Quality Documentation

15.7 International Organization for Standardization (ISO)

ISO 9001-15, Quality Management Systems – Requirements
ISO/IEC 17065-12, Conformity assessment -- Requirements for bodies certifying products, processes and services

15.8 National Fenestration Rating Council (NFRC)

NFRC 700-21, Product Certification Program
NFRC 706-19, Requirements for Participating Insulating Glass Certification Programs

16.0 Referenced Acronyms

16. 1 The following is a list of quality related acronyms found in this document and elsewhere:

AAMA – American Architectural Manufacturers Association
ALI – Associated Laboratories, Inc.
ANSI – American National Standards Institute
ASQ – American Society for Quality
AWS – Air-Water-Structural
ASTM – ASTM (American Society for Testing and Materials) International
CAR – Certification Authorization Report
CPD – Certified Products Directory
CPSC – Consumer Products Safety Commission
E&O – Errors and Omissions
FGIA- Fenestration and Glazing and Industry Alliance
HUD – U.S. Department of Housing and Urban Development
IA – Inspection Agency
IBC – International Building Code
IEC – International Electrotechnical Commission
IGU – Insulating Glass Unit
IRC – International Residential Code
ISO – International Organization for Standardization
RMA
SHD – Side-Hinged Doors
SIG – Sealed Insulating Glass
VCL – Verified Components List
WDMA – Window and Door Manufacturers Association

Appendix A: AAMA and NFRC Minimum QMS Requirements Cross Reference Table

Requirement	AAMA 103	AAMA 104	NFRC 700	Notes
Manufacturing Processes				
Forms	16.2	16.2		Forms to be used along with test methods and any other pertinent information desired by the manufacturer
QC Inspectors & Training	16.2.1	16.2.1		Quality inspectors shall have an effective knowledge of all specification requirements and the ability to perform all tests required by the Licensee's QMS. They and other persons performing quality control functions shall be properly trained and records maintained to demonstrate the training and the inspector's competence.
			8.2.E	An NFRC Licensee shall designate properly trained and experienced personnel to ensure quality control;
			8.2.G	An NFRC Licensee shall designate no less than one properly trained employee to the task of quality control auditor at each manufacturing facility.
Plant Personnel			8.2.B.v	Current organizational chart by position applicable to their NFRC License Agreement.
			8.2.F	An NFRC Licensee shall designate properly trained and experienced personnel to supervise production at each manufacturing facility. The Licensee's quality control system shall identify this role.
Inspection and Test Equipment	16.2.2	16.2.2		The Quality Manual shall list equipment used in quality control inspection,measuring or testing activities. All equipment listed shall be calibrated, verified or replaced at regular intervals to maintain accuracy. Checks shall be recorded in a manner suitable to indicate frequency of regular periodic verification and calibration and acceptable accuracy against user defined tolerances.
			8.2.1.3	The Licensee shall establish and maintain documented procedures to control, calibrate, and maintain inspection, measuring and testing equipment used by personnel to demonstrate the conformance of products to the Licensee's specified requirements.
Incoming Material Inspection and test	16.3.1	16.3.1		The Licensee shall establish and implement inspection, testing or other monitoring activities necessary for ensuring that purchased materials and components meet the manufacturer's specifications and the specified program requirements (per the AAMA Component Verification Program or the AAMA Profile Certification Program).
	17.3			Participation in an IG certification program certifying conformance to ASTM E2190 is required. These certifications shall be kept on file for verification by the auditor during the semi-annual plant audits.
			8.2.B.ii	The documented in-plant quality control system shall contain… Audit of incoming material;
In-process Inspection and Test	16.3.2	16.3.2		Fabricated parts of each different product manufactured during each shift on which it is processed shall be checked for: a. Length; b. Application of Weather strip; c. Application of Backbedding Compound and Other Sealants
	17.4			Fabricated parts of each different product manufactured during each shift during which it is processed shall be checked per Section 16.0, including Corner Assembly Structural Integrity.
			8.2.B.ii	The documented in-plant quality control system shall contain… Audit of in-process material;
Finished Product Inspection and Test	16.3.3	16.3.3		Finished products shall be examined on a regular basis (at least daily) in accordance with the schedule in 16.3.3.1. They shall include all items from 16.3.3.2 and 16.3.3.3
	17.5.1			Finished products shall be examined on a regular basis (at least daily) in accordance with the schedule in 17.5.1.
	17.5.2.1			Sill corner assembly and drainage testing
	17.5.2.2			Operational check for opening, closing, locking, and unlocking
		17.0		Production Model testing requirements form Manufactured Housing Certification Program
			8.2.B.iii	Identify critical in-house inspection requirements including but not limited to the following periodic inspection of a fully assembled product: (a) Proper labeling; (b) Product is built in accordance with certification authorization.
			8.2.1.2	The Licensee shall perform inspection and testing of NFRC-certified products as required by the quality control plan. The Licensee shall define and establish records that provide evidence of inspection and testing according to the Licensee's defined acceptance criteria.

Requirement	AAMA 103	AAMA 104	NFRC 700	Notes
Manufacturing Processes				
Inspection and Test Records	16.2.3	16.2.3		All quality control inspection records shall be maintained by the Licensee for all shifts and available for Validator review. It is acceptable for these records to be one comprehensive sheet or several report forms as selected by the Licensee. Record shall comply with all the requirements of 16.2.3 paragraph 2 and be retained for 12 months
			8.2.C	The Licensee's documented quality control system shall be kept current including all modifications and revision dates.
			8.2.D	An NFRC Licensee shall establish, document, and maintain a quality system to ensure product conformance to the Licensee's specified design requirements. An NFRC Licensee shall retain all quality control records in Section 8.2.B for a minimum of five years.
			8.2.H	All quality control records shall be filed in a Licensee-designated central location, and shall be made available to the IA and to the Licensee's quality control auditor as needed.
			8.2.1.2	The Licensee shall perform inspection and testing of NFRC-certified products as required by the quality control plan. The Licensee shall define and establish records that provide evidence of inspection and testing according to the Licensee's defined acceptance criteria.
			8.2.1.5	An NFRC Licensee shall establish and maintain a system of records containing the following information: A. Evidence that the product has been inspected or tested according to the quality control plan, B. Evidence to show whether the product passed or failed the Licensee-specified inspection or test, and C. Identification of the inspection authority responsible for release of the product.
Disposition of Nonconforming Items	16.3.4	16.3.4		The Licensee shall establish a procedure for identifying the pass/fail inspection status of received nonconforming material,in-process subassemblies and completed products and a means for isolating, handling and determining a disposition of itemsthat are not in compliance. All items not complying with the company's design criteria, or that cannot be reworked to meetthe requirements, shall be scrapped. Records of such items and disposition shall be maintained.
			8.2.B.iv	The documented in-plant quality control system shall contain the minimum following requirements: Method for identifying, isolating, and disposition of material or products with non-conformities
			8.2.1.1.A	The Licensee's quality control plan shall define and document procedures to be taken to investigate and correct the cause of product non-conformities.
			8.2.1.1.B-E	B. An NFRC Licensee shall establish, perform, and maintain procedures for the control of non-conforming products. The procedures shall define criteria for action taken for all non-conforming products. The action taken on non-conforming products may be: C. Re-work to meet the Licensee's specified requirements, D. Re-grade for alternative applications, or E. Reject or scrap.
			8.2.1.1.F-J	F. An NFRC Licensee shall establish and maintain documented procedures for implementing corrective procedures in the event of non-conforming products including: G. Investigating the cause of non-conformities and recording the results; H. Determining corrective action needed to eliminate the cause(s) of non- conformities; I. Application(s) of controls ensuring corrective action has been effectively taken; and J. Effective handling of customer complaints and reports of product non-conformities.
Labeling	16.3.5	16.3.5		The Licensee shall designate an individual responsible for handling all aspects of the labeling program including issuing instructions on the procurement, handling and application of certification marks or labels and specifying the format, content, location and method of application.
			8.2.E.iii	An NFRC Licensee shall designate properly trained and experienced personnel to ensure quality control; such duties include: ...Provide direction to ensure products are properly labeled as NFRC-certified

Requirement	AAMA 103	AAMA 104	NFRC 700	
Management Processes				
Customer Complaints	16.3.6/12.2	16.3.6/12.2		The Licensee shall establish and implement a process for handling all customer complaints (see Section 12.0) and satisfactorily reaching a disposition thereof, and maintain records of such incidents.
Internal Audits	17.2			The Licensee shall implement a documented internal audit program. The documentation shall be included in the Quality Manual. The internal audits shall be conducted with a corrective action system that addresses any concerns found during the inspections. The Validator shall review the results of internal audits during inspections.
			8.2.1.4	At least annually, a company representative trained to perform audits shall perform and document an internal audit of the licensee's quality management system. The audit shall review the licensee's forms used and the records kept of the licensee's ongoing compliance with Section 8.2, 8.2.1.1, 8.2.1.2, and 8.2.1.3 of NFRC 700.
Corrective Action	16.3.7/13.0	16.3.7/13.0		The Licensee shall establish and implement internal corrective action procedures to be taken to investigate and correct the cause(s) of product non-conformities as identified during implementation of 16.3.1, 16.3.2, 16.3.3 and 16.3.6.
			8.2.1.1.A	The Licensee's quality control plan shall define and document procedures to be taken to investigate and correct the cause of product non-conformities.
			8.2.1.1.F-J	F. An NFRC Licensee shall establish and maintain documented procedures for implementing corrective procedures in the event of non-conforming products including: G. Investigating the cause of non-conformities and recording the results; H. Determining corrective action needed to eliminate the cause(s) of non- conformities; I. Application(s) of controls ensuring corrective action has been effectively taken; and J. Effective handling of customer complaints and reports of product non-conformities.

Changes from AAMA QMSUG-1-16 to AAMA QMSUG-1-21

- Various editorial changes were made
- Updated AAMA to FGIA where appropriate
- Updated Fig. 1 with new NFRC requirements
- Updated references to NFRC 700 sections
- Section 14.1- added NFRC internal audit requirements
- Updated Appendix A to new NFRC 700 sections and requirements

American Architectural Manufacturers Association

FGIA
Fenestration & Glazing Industry Alliance

AAMA QMSUG-1-21

To purchase publications, visit **store.FGIAonline.org**.