ISTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY

QUALITY IMPROVEMENT FOR DOORS AND RELATED HARDWARE IN USA AND SOLUTIONS TO THE DOOR AND DOOR HARDWARE INDUSTRY IN TURKEY

MSc. Thesis by

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PREFACE

I am extremely grateful to my supervisor Assoc. Prof. Dr. Bilge IŞIK, for introducing and motivating me to the area that I have been working on. Her patience and optimism undoubtedly helped me to overcome many tough times. I also thank her for many fruitful discussions and suggestions pertinent to this work.

I would also like to thank my friend Hasan Ünver for his consistent support and his willingness to always listen and understanding.

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LIST OF ABBREVIATION

AAMA	: American Architectural Manufacturers Association
ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
AWI	: Architectural Woodwork Institute
BHMA	: Builders Hardware Manufacturers Association, Inc.
CEN	: The European Committee for Standardization
CENELEC	: The European Committee for Electrotechnical Standardization
DHI	: Door Hardware Institute
ETSI	: The European Telecommunications Standards Institute
ISO	: International Standards Organization
NFPA	: National Fire Protection Association
NWMA	: National Woodwork Manufacturers Association
SDI	: Steel Door Institute
TSE	: Turkish Standards Instutions
UL	: Underwriters Laboratories Inc.
WDMA	: Window and Door Manufacturers Association

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ÖZET

Üretimde kalite yükseltilmesi kavramı teknolojide, yönetimde, ve işletmelerdeki baş döndürücü gelişmelerin de neticesiyle hızla değişti. Kalite ve toplam kalite yönetimi kavramları artık belli bir zümrenin aşina olduğu kavramlar olmaktan çıkmış, bu tezin konusu olan kapı ve kapı aksamı üreten firmalarda da uygulanmaya başlanmıştır. Bu tez çalışmasındaki odak konusu kapılar ve kapı aksamlarının üretiminin yapılması, dağıtılması ve yerinde montajına yöneliktir. Toplam kalite yönetimi ve kaliteyi yükseltmeyi amaçlayan aktiviteler kapı ve kapı aksamı firmalarına, mimara ve mal sahibine kazandıracakları unsurlar açısından oldukça önemlidir.

Tezin ikinci bölümünde ise önce ahşap, metal ve alüminyum kapı türleri malzeme ve fonksiyonlarına göre; sonra da ahşap, metal ve alüminyum kasa türleri ve en sonunda kapı aksamları konusunda detaylı bir inceleme yapılmaktadır.

Tezin üçüncü bölümünde genel olarak uygulanmakta olan kurallar ve kalite standardları incelenmektedir. Sonra bu standardları uygulamakla yükümlü bölümlerin sorumlulukları anlatılmaktadır.

Tezin dördüncü bölümde ise Amerika Birleşik Devletleri'nde yer alan kapı, kapı kasası ve kapı aksamlarında kalite standardlarını belirleyen kuruluşların analizi yapılmaktadır. Bu bölümde ilk olarak bu kuruluşlar hakkında bilgi verildikten sonra bu kuruluşların kapılar, kapı kasaları ve kapı aksam malzemeleri için belirledikleri standardlar ve uygulamaları incelenmektedir.

Tezin beşinci bölümünde ise Türkiye'de yer alan kapı, kapı kasası ve kapı aksamlarında kalite standardlarını belirleyen kuruluşların analizi yapılmaktadır. Bu bölümde ilk olarak bu kuruluşlar hakkında bilgi verildikten sonra bu kuruluşların kapılar, kapı kasaları ve kapı aksam malzemeleri için belirledikleri standardlar ve uygulamaları incelenmektedir.

Altıncı bölümde ise Türkiye'deki kapı ve kapı aksamlarında kalite yükseltilmesi için diğer bölümlerde belirtilen bilgiler analiz edilmekte ve tablolar ile açıklanmaktadır.

Sonuç kısmında Türk kapı ve kapı aksamı firmalarının ulusal ve global alanda rekabet edebilmesi için kapı ve kapı aksamı standardlarının geliştirmesi, desteklemesi ve süreci sürekli gözlemlemesi gerektiği açıklanmaktadır. Bu hedefin gerçekleşmesi için de beşinci bölümde açıklanan tabloların kullanılması önerilmektedir.

SUMMARY

The rapid changes in technology, management, and processes have changed the way quality is provided for productivity improvement. The concept of quality and total quality management are applicable not only to some special sectors, but also to door companies as well. This thesis will focus mainly on the production, supply, and installation of doors and their related hardware. The benefits of total quality management activities are enormous to the door industry, architect, and owner.

The second part of the thesis presents information on door types based on materials and functions which include wood, metal, and aluminum doors. It also provides information on wood, metal, and aluminum doorframes; and concludes with information on the related door hardware.

The third part of the study starts with analyzing the general applicable standards and quality requirements, while determining the partakers' responsibilities to provide the required quality.

The fourth part of the thesis is focuses on the institutions in United States that determines the quality standards for doors, frames, and door hardware. This part starts with a brief on each institution that includes information about the quality standards that these institutions state for doors, door frames and related door hardware.

The fifth part of the thesis is focuses on the institutions in United States that determines the quality standards for doors, frames, and door hardware. This part starts with a brief on each institution that includes information about the quality standards that these institutions state for doors, door frames and related door hardware.

The sixth part analyses all the information presented in the previous parts in matrix tables in order to provide solutions to improve quality standards for doors and door hardware in Turkey.

The conclusion points out that in order for the Turkish door and door hardware companies to stay competitive in the national and global arena, they have to promote, develop, and monitor the performance standards for doors and door hardware. In order to achieve this goal, the matrix tables presented in part five are suggested.

1. INTRODUCTION:

1.1. Purpose of the Thesis:

For many progressive firms, quality is a given; a necessity in any business. Advancements in technology, management, and processes provide opportunities for productivity improvement all the time. Hence, the term "continuous improvement" applies as much to productivity as it does to quality (Harris, 2000). The concepts of quality and total quality management are applicable to all aspects of the business. However, this thesis will focus mainly on the production, supply, and installation of doors and their related hardware.

The beneficiary of all the total quality management activities is, of course, the owner of the construction. As a result, focus on the owner and the architect to ensure their satisfaction are critical goals for door production companies (Thomas, 2000). Owners not only benefit from improved quality but also from improved productivity of architectural outputs through lower prices.

Some door companies use Total Quality Management (TQM) as an approach to improving hardware and installation, thereby, enhancing the quality of their doors (Richardson, 1997). TQM also covers other performance factors and improvement activities including: productivity, flexibility, just-in-time operations, benchmarking, timeliness, reengineering, concurrent engineering, customer satisfaction, keeping up employee morale, and improving communication among employees, suppliers, and customers.

To produce quality doors, a quality process is required (Pegels, 1995). If implemented strategically, TQM can help the door company obtain:

- More appealing, less variable quality from the door
- Quicker, less variable response from design and development through supplier and sales channels

- Greater flexibility in adjusting to customers' shifting volume and mix requirements
- Lower cost through quality improvement, rework reduction, and non-value-adding waste elimination

International and domestic conditions have changed significantly since the Cold War. As it will be analyzed within the thesis, the social and financial conditions in Turkey make it very difficult for most Turkish companies to offer competitively priced, high-quality goods and services. There is also great global pressure; since the United States (U.S.) is no longer the only player in today's intensely competitive global economy. European companies have become important competitors in the market ever since the European Union's implementation of the custom union. New global powers are also emerging; it is conceivable that India and China will have an enormous effect on the world's political and economic future. The challenge for Turkish door companies will be to bring a higher level of quality into their organizations in order to produce premium products and services that customers want and demand. Producing topnotch goods and services is crucial to obtaining victory in this economic war.

Turkish institutions and door companies should be aware of various critical issues. It is very vital to know the U.S. quality standards when it comes to doors, door frames and door hardware because it may be useful to improve the quality standards of Turkish doors and door hardware which will help Turkish industry to stay competitive in the global world. The other issue is, when a Turkish customer, importer/exporter, testing agency or a law maker have the need to compare the quality standards of Turkey and USA. This will enable the partaker to understand the differences between those two countries when it comes to quality standards of doors and door hardware. This will also help them verify the door, door frame and door hardware that come from USA have the required standards set by US institutions. Knowing what US institutions specify will help them achieve this goal.

Also from a Turkish lawmaker or a testing agency point of view, it will help them see the difference between which will show whether what Turkey has is enough or could be improved or could be altered. It is also very vital for a Turkish importer/exporter to know what US institutions specify so that they can make sure

the doors, door frames and door hardware that are exported to Turkey have the required and specified quality standards or more.

1.2. Scope of the Thesis:

From a quality control and improvement point of view, doors and door hardware can be categorized in a number of options:

- Doors and hardware can be classified based on their materials. These include: wood, metal, aluminum or a customized material such as copper/alloy, glass, etc. Although door hardware can be produced from a variety of materials, the finish of the door hardware is its most important feature other than its function. Therefore, unlike doors and frames, door hardware should be classified based on their finishes more than their materials.
- Functionality can also be used to classify doors and hardware. Doors can be classified in two groups when it comes to functionality. The first group is interior versus exterior doors. The second group is the purpose of the door, which may include: doors serving as divider between two locations only, resistance doors (bullet-resistant, fire-resistant), sound-proof doors or maneuverable doors (sliding, folding, automatic swinging, bi-folding or revolving). Although the variety of door hardware is limitless, there are some hardware items that are commonly used worldwide which are: hinges, lock and latch sets, exit device, door closer, electric strike and threshold. There are three main categories to define if a door or a piece of hardware meets or exceeds the code or the quality standard, despite the distinction between these categories being unclear. They include: qualification data, report data and permit, and licenses and certification.
- There are several partakers that are responsible in ensuring the quality control of doors and hardware which are: fabricator, installer, testing agency, and architect and owner/owner's representative.
- Doors and hardware are classified based on quality standards setup by U.S. instructions. Although there are numerous institutions involved in setting up quality standards, the ones covered in this thesis are: Architectural Woodwork Institute (AWI), National Fire Protection Association (NFPA), Underwriters Laboratories Inc. (UL), Window and Door Manufacturers Association (WWDA),

Steel Door Institute (SDI), American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), Builders Hardware Manufacturers Association, Inc. (BHMA), Door Hardware Institute (DHI), American Architectural Manufacturers Association (AAMA), and National Woodwork Manufacturers Association (NWMA).

- Doors and door hardware are classified in Turkey based on quality standards set up by Turkish and European institutions which are: Turkish Standards Instructions (TSE), The European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI).

Although each of these categories can be a thesis on their own, given the variety of doors, door hardware, and quality standards, the scope of this thesis will be limited to the materials, functions, and quality assurances of door and door hardware by U.S. and Turkish institutions.

1.3. Methodology of the Thesis:

After determining the material and function of the door or door hardware, they will be categorized in a matrix based on quality standards. The matrix tables explained at the end of this thesis can be useful for Turkish door and door hardware companies. By defining the material, function, and quality assurance of a door or a door hardware, a door company can determine the quality improvements they have to use from U.S. and Turkish quality improvement point of views. There are two different types of matrix tables presented.

The first group of matrix tables show what each U.S. institutions specify for any kind of door, door frame and hardware. These tables help to understand the U.S. quality standards specified for doors and door hardware. They are also helpful if there is a need to conduct quality analysis to the doors, door frames and door hardware that are exported from USA.

The second group of matrix tables compare what Turkish and U.S. institutions specify for any kind of door, door frame and door hardware. These tables are useful to understand the differences between those two countries when it comes to quality standards of doors and door hardware.

2. DESCRIPTION OF DOORS AND DOOR HARDWARE:

2.1. General Description of Doors and Door Hardware:

A door is a structure made up of wood, metal, aluminum, glass, etc. in order to let people, animals, and objects to pass from one location to another (Figure 1).. Doors can be classified based on many features but the most common classifications are based on material and function.

The earliest records of doors are found in the paintings of the Egyptian tombs, in which they are shown as single of double wood doors. The most ancient doors that were recorded in history are the ones made for King Solomon's temple which were wood doors cased in silver or brass. The size, shape, material or decorative carving have changed from time to time but doors have been used almost since the beginning of civilization.

2.2. Classifying Doors Based on Their Material:

2.2.1. Wood Door:

Doors with wood, hardboard, or plastic face sheets bonded to a wood block or particle board core material with untreated wood edges fall into this category (Figure 1). It is essential to understand the attributes of wood as a material. Wood is the hard fibrous substance found between the pith and bark of a tree's branches and trunk. Wooden doors usually have a wood finishing that is can be achieved through planning, sanding and subsequently, staining, varnishing, waxing, or painting of the wood surface of the door. Because of its availability, easy workability, and insulating properties, wood is a very useful door material (Simmons, 2001). This is especially true due to the mass production of plywood that brought about the widespread use of flush doors, which now accounts for most wood doors used in all types of construction.

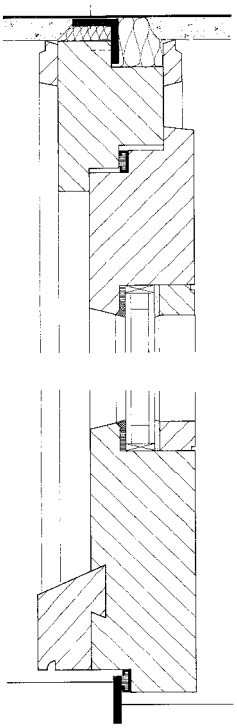

Figure 1 – Wood Door with Glazing

(Meyer-Bohe, 1987)

- Hollow Core Wood Door: Hollow core doors are flush wood doors consisting of wood, wood derivative, or class A insulation board (Figure 2). Flush doors with hollow cores are used for interior locations in residential and some light-commercial buildings. They are occasionally used as exterior doors in residential buildings and can serve satisfactorily in that use if bonded with waterproof adhesives and protected from the weather. They generally do not provide as much heat or sound insulation as solid core doors, but can be used where these factors are not critical (Simmons, 2001).

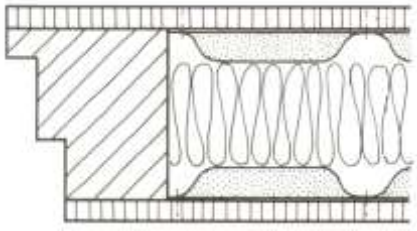

Figure 2 – Hollow Core Wood Door

(Meyer-Bohe, 1987)

- Solid Core Wood Door: Solid core doors are doors that have a core of solid wood or mineral composition (AWI, 1998). A solid core is a wood block, single specie, surfaced two sides, no spaces or defects impairing strength or visible through hardwood veneer facing. Solid-core construction increases the dimensional stability of a door, provides thermal insulation, and may add sound isolation and fire resistance. Solid-core doors are commonly used as entrance and other exterior doors, but may also be used where sound or fire ratings are required (Simmons, 2001).

2.2.2. Metal Door:

Metal doors are doors composed of flush or panel designs with a steel face of not less than 20-gauge steel. It is fabricated of sheet steel and reinforced by light metal channels; has either a hollow or solid core, and is sometimes filled with a light filler material for acoustical, fire-resistance or bullet-resistance purposes.

- Hollow Core Metal Door: Hollow core doors are flush metal doors of hollow-core construction. Hollow metal doors are available in steel gauges from 20 to 12; which gauges to use depends on where and how a door will be used. Hollow metal doors consist of a core, faces, tops, and bottoms. There are two types of core construction. In one type, cores are hollow and braced with steel stiffeners. Most of these cores are filled with the manufacturer's standard fireproof, rot-proof, and sound-deadening material. Insulated doors are filled with glass fiber or plastic foam insulation. In the second form of core construction, a door's face sheets are laminated to a core of impregnated kraft paper honeycomb, plastic foam insulation, or mineral fiber blocks (Simmons, 2001). The tops and bottoms of standard doors are finished with a recessed, welded-in closure. Exterior doors have tops and bottoms formed flush as an integral part of the door construction or are finished with a welded-in inverted channel. Bottoms may also be fitted with a recess for weatherstripping.

- Solid Core Metal Door: Solid core doors have a core of solid metal or mineral composition.

2.2.3. Aluminum Door:

Aluminum doors are doors that have aluminum stiles and rails, usually glazed. While analyzing an aluminum door, it is important to understand the attributes of aluminum as a material. Aluminum is a lustrous, silver-white, nonmagnetic, lightweight metal which is very malleable; and has good thermal and electrical conductivity. It is also a good reflector of both electric and light. In construction, most aluminum is used in alloy form because of added strength; further strengthened by heat treatment; used in extrusions, castings, and sheets. It has excellent resistance to oxidation; often anodized for better corrosion resistance, surface hardness, and architectural color requirements.

2.3. Classifying Doors Based on Their Resistance:

2.3.1. Bullet Resistant Door:

Bullet resistant doors are doors with an assembly consisting of specially stacked bullet resistant material with wood or other finishes on the exterior (AWI, 1998). The layers are bonded under heat and pressure (Figure 3).

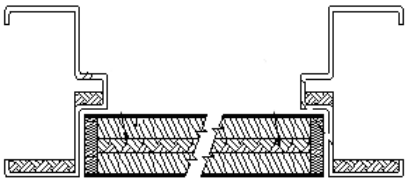

Figure 3 - Bullet Resistant Wood Door

(Ramsey, 2000)

2.3.2. Soundproof Door:

A soundproof door is an assembly especially constructed to provide greater sound attenuation than that provided by a conventional door; it usually carries a rating in terms of its sound transmission class. The interior part of the door has sound-insulating core, which has a sound transmission class rating of 36, 42, or 44. The barrier faces are separated by a void or damping compound to keep faces from

vibrating in unison. Sometimes the door may have special stops, gaskets, and threshold devices as well.

2.3.3. Fire Resistant Door:

Doors with fire-endurance ratings by the Underwriters' Laboratories, Inc., or other recognized and approved laboratories in United States are known as fire resistant doors (UL, 2000). The types of fire-ratings are:

- Class A: 3 hours: for doorways or other openings through a wall separating buildings or dividing a single building into fire areas.
- Class B: 1 or 1-½ hours: for doorways or other openings in enclosures of vertical transportation through buildings such as elevators, stairs, etc.
- Class C: ¾ hour; for doors in corridor and room partitions
- Class D: ½ hour; for doors and shutters in exterior walls which are subject to severe fire exposure from outside the buildings
- Class E and Class F: ¾ hour; for doors, shutters, or windows in exterior walls which are subject to moderate or light fire exposure respectively from outside the building.

2.3.4. Insulated Door:

Insulated doors are doors that have high resistance to heat flows. These doors have an inner core of plastic foam insulation; high R-values (R-8 to R-15), and are even more effective than the combination of prime and storm doors which reduce heat flow. Insulated doors are often installed with magnetic weather-strips that are relatively airtight and minimize heat loss by infiltration (Simmons, 2001).

2.4. Classifying Doors Based on Their Maneuver:

2.4.1. Sliding Door:

A sliding door is an assembly mounted on track, which slides in a horizontal direction, usually parallel to one wall (Figure 4 and 5). Sliding doors are a particular concern in securing a building (Ramsey, 2000). The locking devices should include vertical rod, or level bolts, at the top and bottom; the frame should be solid or reinforced at the locking points. The stile must also be reinforced at the locking

points. The operating panels should be designed so that they cannot be lifted out of their tracks when in the locked position. Glazing and other components should be installed from the inside so that entry cannot be gained by disassembly.

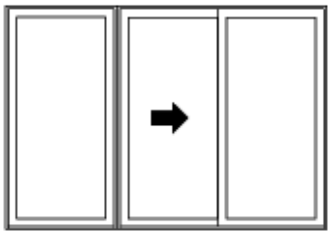

Figure 4 - Sliding Wood Door

(Ramsey, 2000)

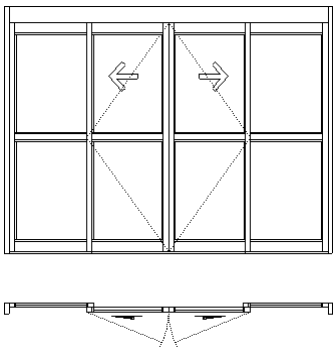

Figure 5 - Sliding Aluminum Door

(AAMA, 2001)

2.4.2. Folding Door:

Folding doors are one of two or more doors which are hinged together so that they can open and fold in a confined space (Figure 6). Folding doors are door pairs hinged together with pivots at the jamb. Track-guided hangers and trolleys allow the doors to fold against each other when they open. Folding doors require less floor space than other door types, but the thickness of the door panels reduces the clear opening. These doors are primarily visual screens, for locations such as closets, space dividers, residential laundry enclosures, and other areas where air circulation is desirable. They are not suitable where sound insulation or privacy is a prime requirement. The folding operation also makes them useful where door swings are objectionable (Simmons, 2001).

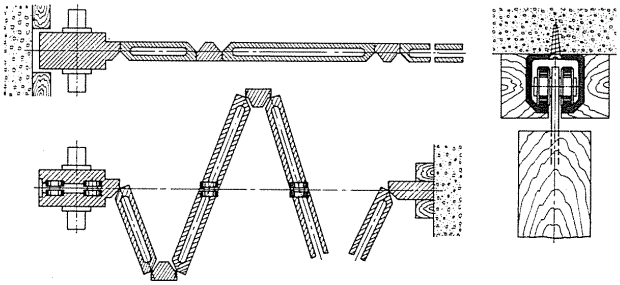

Figure 6 – Wood Folding Door

(Meyer-Bohe, 1987)

2.4.3. Automatic Swinging Door:

An automatic swinging door is equipped with hardware, permitting it to swing 90 degrees in either direction from the plane of its frame (Figure 7).

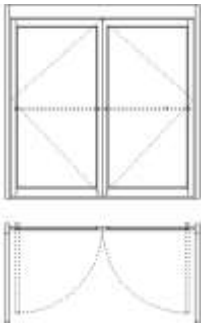

Figure 7- Automatic Swinging Door

(AAMA, 2001)

2.4.4. Bi-Folding Door:

A bi-folding door has two pairs of leaves, each pair consisting of an outer end and inner leaf which are hinged together; each inner leaf is hung from an overhead track; each outer leaf is pivoted at the jamb (Figure 8).

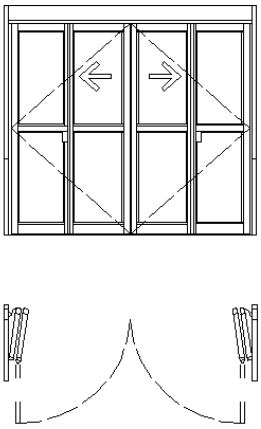

Figure 8 - Bi-Folding Door

(AAMA, 2001)

2.4.5. Revolving Door:

A revolving door is an exterior door consisting of four leaves, (at 90 degrees to each other) which pivot about a common vertical axis within a cylindrically shaped vestibule, preventing the direct passage of air through the vestibule, thereby eliminating the drafts from outside (Figure 9).

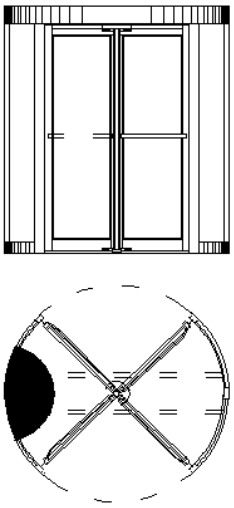

Figure 9 - Revolving Door

(AAMA, 2001)

2.5. Door Frame:

An assembly built into a wall consisting of two upright members (jambs) and a head (lintel) over the doorway; encloses the doorway and provides support on which to

hang the door. While analyzing the doorframe, it is essential to remember some design factors. A rigid frame and a sash are very important to resist prying and should be removable from inside if it is an exterior door. Also, the quality of the hardware–its placement and anchorage–are very critical issues while designing a door frame. Special attention must be given to the use of weather stripping, if it is an exterior door or if extreme interior physical conditions exist (Ramsey, 2000).

The finishing of the frame is also an important issue that should be considered while analyzing a door frame. Especially wood and metal door frames should receive at least on shop coat of rust-inhibitive primer before delivery to the job site. In very corrosive atmospheres, such as salt water beach locations, it is advisable to have doors and frames to be metal and hot-dipped galvanized for additional protection.

2.5.1. Wood Frame:

Head and jamb members can be framed with frames made of wood, hardboard, or plastic face sheets usually bonded to a wood block (Figure 10).

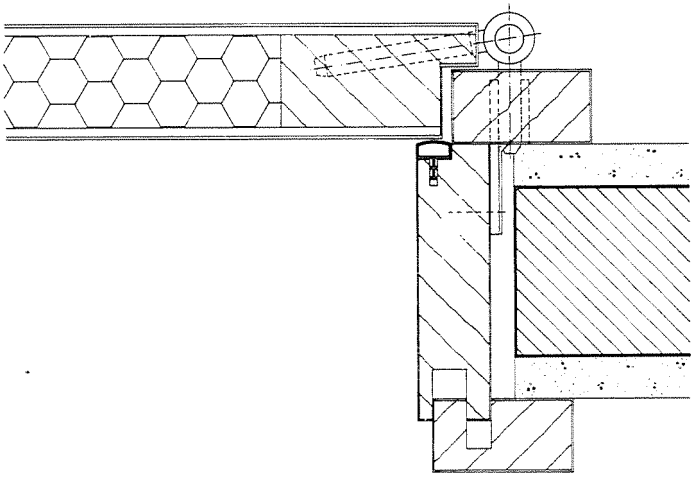

Figure 10 – Wood Frame

(Meyer-Bohe, 1987)

2.5.2. Light-Gauge Metal Frame:

Light-gauge metal frames have head and jamb members, with or without a transom panel or light-gauage steel. This type of frame is installed over finished wall.

2.5.3. Pressed Steel (Hollow Metal) Frame:

Pressed steal frames have head and jamb members, with or without solid or glazed transoms or sidelights of 18-gauge steel (1.5 hr maximum rating). This type of frame is required for most steel doors (Figure 11).

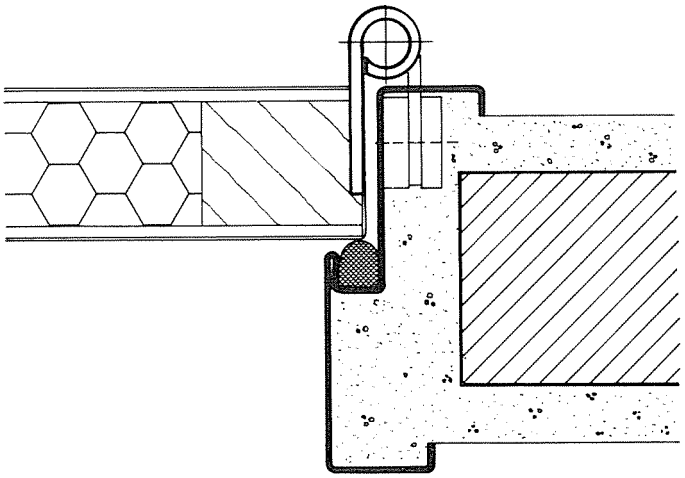

Figure 11 – Pressed Steel (Hollow Metal) Frame

(Meyer-Bohe, 1987)

2.5.4. Aluminum Frame:

Aluminum frames have head, jamb members, and aluminum. This type of frame is required for most aluminum and fiberglass reinforced doors.

2.6. Door Hardware:

Items that are used on doors and frames such as hinges, locks, catches, etc. have a finished appearance as well as a function, especially those used with doors, windows, and cabinets. These items are also known as finish hardware or architectural hardware. The door hardware may be considered part of the decorative treatment of a room or building, for this reason the quality analysis of door hardware is as important as the door itself. Today, the variety of door hardware is enormous, however, in this thesis the widely used hardware types were considered:

2.6.1. Hinge:

A hinge is designed to mortise into the edge of the door and into the rabbet of a doorframe (Figure 12). Door material, door weight, door dimensions, hinge weight, material finish and special features are very important while specifying what kind, how, and how many hinges should be used for a door. Also which type of the frame (metal, wood, aluminum), clearance, and conditions of usage (exterior or interior door) are crucial factors in determining what kind of hinges to use (Ramsey, 2000). Usually for a standard door, three hinges should suffice. There is another type of hinge called a continuous hinge, which is designed to be the same length as the moving part to which it is applied. An example is the lid covering the keys of a piano.

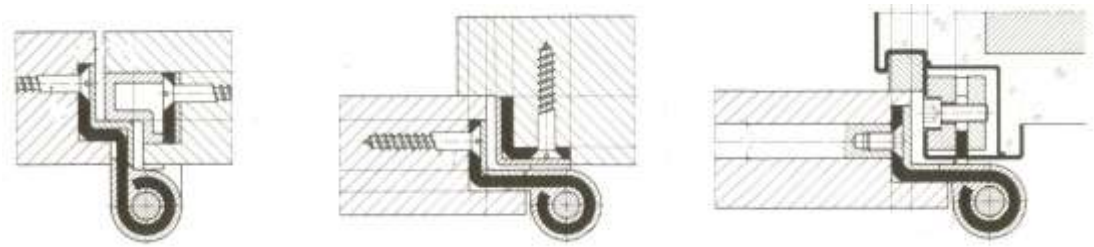

Figure 12 – Hinge Types

(Meyer-Bohe, 1987)

2.6.2. Lock and Latch Sets:

Locks and latches are intended for installation in holes bored in a door. Based on the characteristics of the door, there are four main types of latches and locks:

- Passage lock: Latches can be operated by a handle from either side at all times.
- Privacy lock: Outside handle is locked by a push-button inside (or if it's a deadbolt latch, by a turn) and unlocked by an emergency key outside.
- Entry lock: Outside entry is made inoperative by mechanical means, other than a key, on the inside; a latch bolt is operated by key in the outside handle or by manual means from the inside handle.
- Classroom lock: Outside handle is locked from the outside by key; when the outside handle is locked, a latch bolt may be retracted by key from the outside or by rotating the inside handle (Figure 13).

- Electro-magnetic lock: A lock that uses a magnet to hold the door closed.

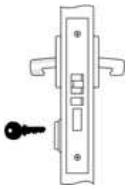

Figure 13 - Lock Set

(Ramsey, 2000)

2.6.3. Control and Security Devices:

- Exit Device: A door-locking device designed to grant instant exit by pressing on a cross bar that releases the locking bolt or latch. Exit devices consist of a bar across a door, which, when depressed, unlatches the door to permit easy exit even when the door is locked. Many styles and materials are available. Doors with exit devices are equipped with closers and automatically latch upon closing. Exit devices are required, by code, on exit doors in most public buildings (Simmons, 2001). There are three main types of exit devices: Rim Type (Surface), Mortise Type and Touch Bar (Figure 14).

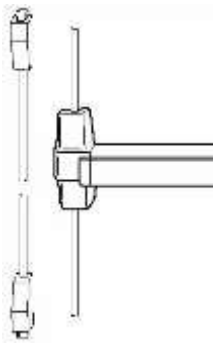

Figure 14 – Exit Device

(Ramsey, 2000)

- Door Control-Closer: A device needs to combine a spring for closing and a compression chamber into which the liquid or air escapes slowly, thus providing a means of controlling the speed of the closing action. There are four main types of door closer (Ramsey, 2000):

  The first one is surface mounted door closer/holder/detector: A combination device (closer/ holder/ detector) can have ionization, photoelectric, or heating

devices to detect smoke or any combustion products, and can hold open or close the door. Some combination devices are connected to the fire alarm system of the building, but may also be used merely to release and close the fire or smoke-barrier doors without such a connection.

The second one is surface mounted door closer/holder: A combination of closer and holder will hold in open position when incorporated with an independent detector or when wired into any type of fire detecting system (Figure 15).

The third one is surface mounted door closer: There are three ways to mount surface closers; hinge side, parallel arm, and top jamb. A wide variety of brackets, including corner and sofitt types is available to meet varying door and frame conditions.

The fourth one is concealed door closer: This is a type of closer that is concealed inside the doorframe.

Figure 15 – Door Closer

(DHI, 2001)

- High Security Cylinder: An auxiliary cylinder having a spring latch bolt and functioning independently of, and providing additional security to, the regular lock of the door.

- Electric Strike: An electrical device that permits releasing of the door from a remote control (Figure 16).

Figure 16 – Electric Strike

(DHI, 2001)

2.6.4. Threshold:

A strip fastened to the floor beneath a door, usually required to cover the joint where two types of floor material meet (Figure 17). Although the type, shape, and dimension of the thresholds vary, there are three types that are widely used. They are bronze, aluminum, and steel thresholds. Thresholds can be also categorized based on the assembly section, piece quantity, and the location to be used

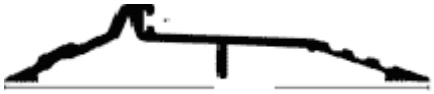

Figure 17 – Threshold

(DHI, 2001)

2.6.5. Material and Finish of Hardware:

Hardware has a finished appearance as well as a functional purpose and may be considered a part of the decorative treatment of a room or building. It is essential to provide quality of finish, including thickness of plates or coating (if any), composition, hardness and other qualities complying with manufacturer's standards but in no case less than specified by referenced standard for the applicable units of hardware. Although the types of finishes vary, the common ones that are being used in the US are: US26 (Bright Chrome), US26D (Satin Chrome), US28 (Satin Aluminum) and US32D (Stainless Steel).

3. GENERAL APPLICABLE STANDARDS AND QUALITY REQUIREMENTS:

3.1. Introduction:

The administrative and procedural requirements for quality assurance and quality control are one of the vital steps especially at the beginning of the construction. It is the manufacturers' or installers' responsibility to provide the materials or services that meet or exceed the specifically named code or standard. In order to prevent a rejection by the architect or the owner, it is very crucial to meet the quality standards.

3.2. General Definitions:

3.2.1. Quality-Assurance Services:

Activities, actions, and procedures performed before and during execution of the work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

3.2.2. Quality-Control Services:

Tests, inspections, procedures, and related actions during and after execution of the work to evaluate that completed construction comply with requirements (Liska, 1988). Services do not include contract enforcement activities performed by the architect, or other control fractions.

3.2.3. Testing Agency:

An entity engaged to perform specific test, inspections, or both. Testing laboratory means the same as testing agency.

3.3. Definitions of the Partakers that are Responsible for Quality Assurance of the Construction:

3.3.1. Fabricator's Qualifications:

A firm experienced in producing products similar to those indicated for the project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

3.3.2. Contractor's Qualifications:

A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for the project, whose work has resulted in construction with a record if successful in-service performance.

3.3.3. Testing Agency's Qualifications:

An agency with the experience and capability to conduct testing and inspecting as required by Turkish or US standards, and that specializes in types of tests and inspections to be performed.

3.3.4. Architect's Qualifications:

One who was trained and licensed by an architectural institute to design and supervise the construction of the buildings.

3.4. Submittal Documents:

There are some documents that the manufacturer or installer should provide to demonstrate their capabilities and experience.

3.4.1. Qualification Data:

An independent testing agency should submit a certified written report of each inspection, test or similar service, to the architect or owner.

3.4.2. Report Data:

A written report of each inspection, test or similar service that includes at least below-mentioned information (Liska, 1988).

- Date of issue
- Project title and number
- Name, address and telephone number of testing agency
- Dates and locations of samples and tests or inspections
- Names of individuals making the inspection or test
- Designation of the work and test method

- Identification of the product and specification section
- Complete inspection or test data
- Test results and an interpretation of test results
- Ambient conditions at the time of sample-taking and testing
- Comments or professional opinion as to whether inspected or tested work complies with the contract document requirements
- Name and signature of laboratory inspector
- Recommendations on retesting

3.4.3. Permit, Licenses, and Certificates:

For the owner's or architect's records, it is very essential to submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the work.

3.5. Responsibilities for Quality Control:

3.5.1. Manufacturer's Responsibilities for Quality Control:

Where indicated, it is the manufacturer's responsibility to engage a factory-authorized service representative to inspect the field-assembled components and equipment installation, including service connections. Submitting the report results in writing is also a part of the process.

3.5.2. Contractor's Responsibilities for Quality Control:

Providing quality control serviced required by authorities is a prerequisite of the contractor that supplies, furnishes, and installs the required construction item (Simmons, 2001). Wherever the services are indicated as contractors' responsibility such as the contract, addendums, memorandums, change orders; it is the contractor's responsibility to engage a qualified testing agency to perform these quality-control services. The other responsibilities of the contractor are:

- While providing these services contractors shouldn't employ the same entity engage by the architect or the owner to prevent a legal problem, unless it is agreed to in writing by two parties.
- It is very vital to notify the testing agencies in advance of time when the work that requires testing or inspecting to be performed
- Where quality control services are indicated as the contractors' responsibility, it is essential to submit a certified written report of each quality control service.
- It is also crucial to be aware of the quality control testing that aren't specified in the contract but are requested by the owner or the architect.
- In any stage of the quality control, it is important to submit the copies of each written report not only to the owner and the architect, but also to the authorities that have jurisdiction in order to prevent any misunderstanding or a legal clash.
- Regardless of whether original tests or inspections are contractor's responsibility, it is definitely the responsibility of the contractor to provide quality control services when a re-testing and/or re-inspecting is necessary for the construction that revised or replaced work that fails to comply with the requirements established by the contract documents.
- It is very vital for the contractor to coordinate sequence of activities to accommodate required quality-assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
- Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

3.5.3. Test Agency's Responsibilities for Quality Control:

One of the most important responsibilities of the test agency is cooperating with the architect, the owner and the contractor in performance of the duties (Simmons, 2001). It is a prerequisite for the test agency to provide qualified personnel to perform required tests and inspections. The other responsibilities of the test agency are:

- Notifying the architect, the owner and the contractor promptly of irregularities or deficiencies observed in the work during performance of its services
- Interpreting tests and inspections and state each report whether tested and inspected work complies with or deviates from requirements
- Submitting a certified written report of each test, inspection, and similar quality-control service through the contractor
- Not releasing, revoking, altering nor increasing requirements of the contract documents
- Not performing any duties of the owner, the architect or the contractor besides the requested task

3.5.4. Architect's Responsibilities for Quality Control:

An architect can be considered the most important figure to maintain quality control during the design and construction phases. In order to maintain the quality control during the design phase, an architect should be familiar with all codes and standards required for any type of construction details at any time. During the construction phase, an architect should make periodic site visits in order to stay familiar with the progress of work so that he/she can make sure the quality expected from that construction is fulfilled. Another responsibility of an architect is reviewing all shop drawings, product data and product samples to make sure they are up to codes and quality standards required by the owner, government and other institutions.

4. QUALITY ASSURANCE FOR DOOR COMPANIES IN USA:

The building construction industry is made up of so many diverse interest groups that it has not been possible to develop a single comprehensive set of criteria or standards acceptable to all concerned to provide an advanced quality to doors and their components.

It is necessary to clarify some terms, before beginning to identify some standards to improve the quality of doors, frames and door hardware. There is so much confusion in the industry about the use of the terms "specification, standards and codes". Unfortunately, the three are often erroneously used interchangeably, which can lead to some confusion.

In the sense that they are a detailed precise description of a product or practice, some construction industry standards could be called specifications, and some are so called by their producers. Some of the manufacturers' data that designers, builders, and owners rely on are also specifications in the dictionary sense, and those data are sometimes called specification by the manufactures. But calling either of them specifications sometimes leads to confusion. Therefore, referring to construction industry standards as "standards" and manufacturer's data as "product descriptions" or "product literature" will prevent any kind of confusion. Unless specifically modified in a legal contract, it is advised that the term "specification" is used in its narrow construction industry meaning.

When selecting materials or determining the suitability of materials and methods, specifiers and builders refer to a variety of industry standards. Some standards result from the efforts of manufacturers, professionals, and trades-people to simplify and increase the efficiency of their work or to ensure a minimum level of quality. Other standards are the work of governmental agencies and other groups interested in establishing minimum levels of safety and performance. Therefore, standards take a variety of forms depending on their source and purpose.

Construction standards have two basic objectives. The first objective is to establish levels of quality that may be recognized by a user, specifier, approver, or buyer of a material, product, or system. The second objective is to standardize or simplify such variables as dimensions, varieties, and other characteristics of specific products so as to minimize variations in manufacture and use.

While analyzing the above-mentioned issues, it must be noted that the standards that are being widely used in United States of America will be the main focus of this thesis.

4.1. General Quality Assurance for Door Companies in USA:

There are some basic rules that the door companies must be aware of; besides the detailed standards, local and general codes, architects' special requests for details, the companies should comply some qualification measures.

First of all the door, frame and door hardware companies specializing in manufacturing these components should have a minimum required year of documented experience. This experience range could vary from project to project. In general, a governmental project is likely to be more concerned about this issue than a small commercial project.

Also the door company specializing in performing the installation of doors, frames and door hardware should have a minimum required year of documented experience. And finally, complying with the requirements shown on the project drawings or specifications is a prerequisite for the door, frame and door hardware company. If complying with the project drawings to provide the specified doors, frames and door hardware is not possible, the company should provide a proposal indicating the substitute materials, equipment, or methods to be used in the work, in lieu of those specified in the drawings or specifications.

There are two types of formed door and frame units, which are standard and custom. Standard units are mass-produced and sold to retails outlets such as lumberyards and home centers. Standard units are also made for a particular project where they have been specified. Custom units are manufactured especially for a particular project to suit an owner's or an architect's design. Both types should meet the same standards

of quality. For example formed carbon steel, stainless steel, wood and aluminum doors may be either standard or custom. Copper-alloy doors and frames are custom.

There are so many standard setting and testing agencies determined various standards for doors, frames and door hardware. In addition to governmental agencies, these organizations have been established whose primary purposes are the setting standards or the testing of materials and products to ensure that they comply with established standards. When a material or product is compliance tested by its manufacturer, its trade association, or an independent testing agency, a testing standard produced by one of the agencies that are mentioned below is often used as the standard for testing procedure.

4.1.1. Architectural Woodwork Institute (AWI):

Established in 1953, The Architectural Woodwork Institute (AWI) has helped thousands of architectural woodwork professionals grow their businesses and take their careers to the next level. With more than 2,800 members in North America, AWI today is recognized as the premier source for networking, education and industry knowledge (AWI, 1998).

AWI promotes the value of architectural woodwork and educates the industry on the highest quality standards. AWI also provides opportunities for the education, training and network opportunities to ensure the promotion of quality standards.

The institute has three divisions. The first one is the manufacturer division specified by design professionals including all exposed wood, decorative laminates and other materials. The second on is the supplier division, focuses on primarily supplying raw materials, products or services to architectural woodwork manufacturers. The third on is the affiliate division for individuals who wish to support the objectives of the architectural woodwork industry and do not qualify as either manufacturer or supplier.

4.1.2. National Fire Protection Association (NFPA):

The National Fire Protection Association (NFPA) was organized in 1896 to promote the science and advance the methods of fire protection. NFPA is a nonprofit educational organization that publishes and distributes various publications on fire safety, including model codes, materials standards, and recommended practices.

These technical materials, aimed at minimizing losses of life and property by fire, and are prepared by NFPA Technical Committees and are adopted at the annual meeting of the Association. All are published as National Fire Codes, a 12-volume compilation of NFPA's official technical material (NFPA, 1999).

4.1.3. Underwriters Laboratories Inc. (UL):

Underwriters Laboratories Inc. (UL) is chartered as a nonprofit organization to establish, maintain, and operate laboratories for the examination and testing of devices, systems, and materials. The stated objectives of UL are to determine the relation of various devices, systems, and materials to life and property and to ascertain, define, and publish standards, classifications, and specifications for materials, devices, products, equipment, constructions, methods, and systems affecting hazards to life and property (UL, 2000).

UL, formed in 1894, was originally subsidized by stock insurance companies. Before the turn of the century, as new electrical devices and products came rapidly into the market, it became necessary to test and inspect them to ensure public safety. The National Board of Fire Underwriters (now the American Insurance Association) organized and sponsored UL to meet this demand.

UL became self-supporting in about 1916. To sustain its testing program, UL contracts with a product submitter for testing, reporting, and listing of devices, systems, or materials on a time and material basis. The cost of the inspection service is provided for either by an annual fee or by service charges for labels, depending on the type of the service. Materials and products carrying UL labels and certificates must meet published standards of performance and manufacture and are subjected to UL inspection during manufacture.

Although primarily interested in public safety, UL's policy is to list and label only products that perform their intended function. If a product does not perform with reasonable efficiency, even though it may be perfectly safe, it does not qualify for a UL label.

UL standards are designated by the initials UL, followed by a code number. No date of last revision is indicated by the number. For example, UL 70, "Septic Tanks, Bituminous Coated Metal," was issued in 1993.

4.1.4. Window and Door Manufacturers Association (WWDA):

The Association had its origin in 1927 with the formation of the National Door Manufacturers Association. In 1949, it changed its name to the National Woodwork Manufacturers Association to be more representative of the diversity of products made by its members. In 1945, the Association created a separate entity, Ponderosa Pine Woodwork, to carry out its promotional activities. This promotional arm was consolidated into National Woodwork Manufacturers Association in 1975 (WDMA, 2002).

In 1985, the name was changed to the National Wood Window & Door Association to provide an even better awareness of the products manufactured by its members. In 1998 the name was changed again to The Window and Door Manufacturers Association (WWDA) reflecting the increasing diversity of manufacturing materials.

WWDA is comprised of the country's leading producers of sash, frames, window units, skylights, flush doors, stile and rail doors, and sliding and swinging patio door units. Each of these product groups pursues their individual goals through separate divisions.

The Window Division represents producers of sash and frames, window units and sliding patio doors. The Door Division represents producers of panel doors, louver doors, combination doors, swinging patio doors, entryway systems, hollow core and solid core flush doors. In addition, a Council of Supplier Members represents the producers of glass, lumber, hardware, sealants, preservatives, weatherstripping, extrusions, and the numerous other materials required to manufacture the industry's products.

Through their membership in WDMA, participating companies demonstrate their commitment to high standards of design and construction so that end users receive the beauty, ease of operation, energy-saving performance, and ease of maintenance they expect from quality-made windows and doors.

4.1.5. Steel Door Institute (SDI):

The Steel Door Institute is a voluntary, unincorporated, non-profit business association established in 1954 to promote the use of steel doors and frames for the construction industry. Membership is open to all companies and corporations, or

other forms of enterprise located in the United States of America, who has been engaged for at least two years in the production for sale of swing steel doors and/or frames on a national basis. Products of the industry are manufactured in accordance with acceptable minimum standard requirements as established by the SDI.

One of the aims that SDI has is to assure production of quality products. The Steel Door Institute has promulgated minimum standard specifications for the manufacture of steel doors and frames to assure quality products for the construction industry.

SDI also aims to provide dependable service to the construction industry for its products. Members of the Steel Door Institute market their products throughout the world. Further, inventories are available through distributors in every trading area throughout the United States, thus assuring quick delivery and prompt service. The SDI members produce pre-engineered steel doors and frames utilizing the latest technological advancements. Products are designed to meet the needs of the construction industry.

The SDI also operates through committee action under the guidance of elected officers and By-Laws. Executive Committee meetings are held three times a year and the business affairs are managed by Wherry Associates, Cleveland, Ohio, USA.

The most active committee of the Steel Door Institute is the Technical Committee. This group is composed of representatives of all members of the Institute and meets three times a year for intensive 2-day sessions.

In addition, the Technical Committee or representatives of it meet regularly with organizations representing related products such as builders hardware. One of the major efforts of the Technical Committee is to work with Code Groups and Government Agencies to assure maximum safety and security for buildings and provide standards for quality performance. The Technical Committee since the year 1954 has been instrumental in establishing and promulgating a great number of publications helpful to the total construction industry including standardized specifications for metal doors and frames, standardized hardware locations and hardware preparations, building code improvements and establishment of performance specifications. The Technical Committee also helps the total construction industry by assuring a coordinated relationship of member products with those of allied building components.

4.1.6. American Society for Testing and Materials (ASTM):

The American Society for Testing and Materials (ASTM) is an international, privately financed, nonprofit, technical, scientific, and educational society. The objectives of the society are "the promotion of knowledge of the materials of engineering, and the standardization of specifications and methods of testing" (ASTM, 2003).

ASTM membership consists of individual engineers, scientists, and educators, as well as organizational members, including companies, government agencies, and universities. Technical comities formulate and recommend ASTM standards covering many types of materials: a number of administrative committees deal with publications, research activities. The society is supported mainly by membership dues, with some income from the sale of publications.

ASTM started in 1898 as the American Section of the International Society for Testing Materials. It was incorporated in 1902 and became the American Society for Testing Materials. In 1961, the name was changed to the American Society for Testing Materials to emphasize its interest in basic information about materials.

Two categories of information and publication are available form ASTM. The first one is ASTM standards, which include definitions of terms, materials, standards, workmanship standards, and methods of test standards used throughout the industry. And the second one is data dealing with research and testing of materials, including monthly and quarterly publications and technical publications that cover symposia and collections of data.

ASTM standards are designated by the initials ASTM, followed by a code number and the year of last revision. For example, ASTM C 55-99 refers to ASTM Document C55, "Standard Specification for Concrete Brick," as last revised in 1999.

4.1.7. American National Standards Institute (ANSI):

The American National Standards Institute (ANSI) is the name adopted by the United States of America Standards Institute (USASI) in October 1969. USASI was created in 1966 by the complete reorganization of the earlier standards organization, the American Standards Association (ASA). ASA was founded during World War I to prevent duplication and waste in war production. In 1918 five leading American

engineering societies including the American Society of Mechanical Engineers (ASME), the American Society of Civil Engineers (ASCE), and ASTM, and three departments of the federal government of United States, Commerce, War, and Navy, formed the American Engineering Standards Committee to coordinate the development of national standards. This committee was reorganized in 1928 into the American Standards Association, which was later incorporated into USASU and subsequently renamed ANSI (ANSI, 2002).

More than 3000 American National Standards have been developed and approved under ANSI procedures. These standards apply in the fields of engineering, industry, safety, and consumer goods.

An American National Standard is designated by code number and date of last revision; for example, ANSI A117.1-1998, "Guidelines for Accessible and Usable Buildings and Facilities."

Unlike ASTM, ANSI does not formulate its own standards or provide testing services. Instead, one part of ANSI, composed of national trade, professional, and scientific associations, establishes and maintains procedures for the approval of standards developed by other associations, agencies, or groups, as American National Standards. In this way, a standard developed by a trade association, such as the American Architectural Manufacturers Association (AAMA), can become an American National Standard.

A second part of ANSI consists of representatives of industrial firms, labor, and government. The two parts work closely together to recommend areas of standardization deemed essential and to review standards.

ANSI is privately financed by voluntary membership dues and from the sale of the published American National Standards. These national standards are available for voluntary use and often are incorporated in regulations and codes (ANSI, 2002).

4.1.8. Builders Hardware Manufacturers Association, Inc. (BHMA):

Builders Hardware Manufacturers Association, Inc. (BHMA) was founded in 1928 as the Hardware Manufacturers' Statistical Association. Although the Association continues to collect proprietary statistics for its member companies, BHMA today is

nationally recognized for its leadership role in ensuring the quality and performance of builders hardware.

More than 80 percent of all U.S. manufacturers of builders hardware are BHMA members. Together these companies produce the vast majority of the hardware items used in the nation's commercial and institutional buildings, from hinges and locks to door controls and exit devices. Any organization that manufactures and sells builders hardware in the United States is eligible for Association membership.

BHMA main goals are to develop and maintain performance standards for architectural hardware and to maintain its position as technical experts before key building code, fire, and life safety groups.

Every ANSI/BHMA standard contains an explanation of the BHMA product numbering code applicable for that particular category of hardware. BHMA product numbers utilize a five-digit number preceded by a prefix letter.

The prefix letter denotes the BHMA Product Section that produces the hardware. The first numeral designates the base material for the product. BHMA standards use the default number '0 to allow the manufacturer to use an optional material that meets the performance requirements of the applicable standard. The second number identifies the type of product. The third and fourth numerals identify the function of the specific item. The fifth number indicates the performance grade of the product. Every ANSI/BHMA standard contains an explanation of the BHMA product numbering code applicable for that particular category of hardware. For example B 5 2 1 3 1 is: B for Product Section for cabinet hardware hinges, 5\ for Stainless steel, 2 for Cabinet knob, 13 for Back mounted, 1 for Grade One (Thus the product is a Grade 1, back-mounted stainless steel cabinet knob).

4.1.9. Door Hardware Institute (DHI):

The Door and Hardware Institute (DHI) represents the architectural openings industry. With ancestry dating back to 1934, the Institute has more than 5,000 members in the United States, Canada and abroad. Membership consists of individuals and consultants involved in the architectural openings industry, representing distributors, manufacturers and sales representatives/agency firms, as well as architects, specifiers and contractors who rely on such professionals (DHI, 2001).

The purpose of DHI is to provide its members with the skills and competencies to compete successfully in the marketplace of today and tomorrow.

The Door and Hardware Institute is a professional organization that serves the North American marketplace as the advocate and primary resource for information, professional development and certification resource for the architectural openings industry with a focus on the channels of distribution.

DHI's aims are to establish the industry as the indispensable primary channel to furnish all total openings products and to serve as the primary resource for professional development in the industry.

4.1.10. American Architectural Manufacturers Association (AAMA):

American Architectural Manufacturers Association (AAMA) an organization that brings together the professionals of window, door, and skylight manufacturing companies, both large and small, from all across the U.S. and internationally, to represent the individual and shared concerns (AAMA, 2001).

AAMA proactively and effectively influences codes, construction and specification issues. In addition to its strong national voice, AAMA is active and influential in the Western and Southeastern regions of the U.S. and is developing additional regions for local focus. On both a regional and national basis, AAMA continuously monitors and reports legislative activities to keep the industry up-to-date on important developments.

AAMA has recently introduced a more stringent and comprehensive industry standard, the ANSI/AAMA/NWWDA 101/I.S.2. It encompasses not only the performance of vinyl, wood and aluminum windows and doors, but also the performance standards for window and door components like extrusions, glass, sealants and hardware. It defines these standards for windows and doors for residential, commercial (both light and heavy), and architectural applications.

4.2. Quality Assurance for Wood Doors and Frames:

Both standard and custom wood doors and frames should comply with the standards that are specified by various standard-setting and testing agencies standards.

4.2.1. Architectural Woodwork Institute (AWI):

The Architectural Woodwork Institute's (AWI) Quality Standards Guide was first developed in 1961 to provide architects, designers, building owners and woodworkers a common footing in specifying and building wood cabinetry. Since then, AWI Quality Standards have become one of the premier specification tools for wood doors. Intrinsic to the AWI Quality Standards is a series of tests for the standards (AWI, 1998). These tests require common, easily obtainable tools and devices that are easy to take to the job site:

a- Test For Smoothness:

- Look for a series of small ridges across the grain of the wood. These ridges represent knife cuts.
- If they are present, measure off one inch and count the ridges within that inch.
- If ridges are present but hard to count, rub a soft pencil over the top of the one-inch segment to highlight the tops of the ridges.
- A magnifying glass will provide greater accuracy and ease in counting.
- The number of ridges must meet the test(s) in the latest edition of the AWI Quality Standards.

b- Test For Door Warp and Thickness:

- Doors may be difficult to check for warping if only one person is present.
- However, by attaching a small clamp or piece of duct tape at one or both ends of a piece of string, holding it taut, you may avoid the need for help.
- Stretch the string across the door from top to bottom, from side to side and on the diagonal. Allowable warp in doors is 1/4-inch measured over any seven-foot straight line. This is equivalent to about 1/32-inch for every 10-1/2 inches of length.
- To check for equal thickness measure sides, top and bottom of door.
- The allowable margin is plus or minus 1/16-inch of specified thickness.

4.2.2. National Woodwork Manufacturers Association (NWMA), Industry Standard I.S. 1-73 "Wood Flush Doors:

The American National Standards Institute (ANSI) has approved the accreditation of NWWDA I.S.1A Industry Standard for Architectural Wood Flush Doors as an American National Standard in 2002 (WDMA, 2002).

4.2.3. National Fire Protection Association, NFPA 80, Standard for Fire Doors and Windows:

The aim of NFPA 80 is regulating the installation and maintenance of fire door, window, and shutter assemblies. The scope of this standard also covers the devices used to protect openings in floors and ceilings against the spread of fire (NFPA, 1999). Fire doors can only do their job if correctly installed and maintained.

4.2.4. Window and Door Manufacturers Association (WWDA), I.S. 1-A for Premium Grade Wood Doors:

The WWDA standard for wood doors is ANSI/NWWDA I.S 1-A (WDMA, 2002). Architectural wood flush doors offer the designer a wide variety of aesthetic for use in many applications including fire-rated and other special purpose doors. This standard provides quality levels for the grades, finishes, and construction of architectural wood flush doors.

4.3. Quality Assurance for Metal Doors and Frames:

Both standard and custom metal doors and frames should comply with the standards that are specified by various standard-setting and testing agencies standards.

4.3.1. Steel Door Institute (SDI):

The Steel Door Institute (SDI) specified some standards in order to ensure high quality of steel doors and frames. These standards include:

- SDI-100-91- Standard Steel Doors and Frames
- SDI-105-92- Erection Instructions for Steel Frames
- SDI-107-84- Hardware on Steel Doors
- SDI-109-88- Hardware for Standard Steel Doors and Frames

- SDI-110-84- Standard Steel Doors and Frames for Modular Masonry Construction
- SDI-107-84- Basic Fire Door Requirements

4.3.2. American Society for Testing and Material (ASTM):

a- ASTM A-1008/ A1008 M-02e1 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability:

- This specification covers cold rolled structural, high-strength low-alloy, and high-strength low-alloy with improved formability steel sheet, in coils and cut lengths.
- Cold rolled steel sheet is available in the designations as approved.
- This specification does not apply to steel strip as described in Specification A109.
- The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other (ASTM, 2003).

b- ASTM A1011/ A1011M-02 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability:

This specification covers hot-rolled structural, high strength-low alloy, and high-strength low-alloy with improved formability steel sheet and strip, in coils and cut lengths (ASTM, 2003).

c- ASTM A-653-97- Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Alloy Coated Galvannealed by the Hot-Dip Process:

- This specification covers steel sheet, zinc-coated (galvanized) or zinc-iron alloy-coated (galvannealed) by the hot-dip process in coils and cut lengths.
- The product is produced in various zinc or zinc-iron alloy-coating weights [masses] or coating designations.

- The product is produced in a number of designations, types, grades, and classes pertaining to chemical composition and typical mechanical properties of the steel sheet which are designed to be compatible with differing application requirements (ASTM, 2003).

d- ASTM B-209-96- Specification for Aluminum and Aluminum Alloy Sheet end Plates:

This specification covers aluminum and aluminum-alloy flat sheet, coiled sheet, and plate, in the alloys, plate in all alloys and sheet in heat-treatable alloys: mill finish, and sheet in nonheat-treatable alloys: mill finish, one-side bright mill finish, standard one-side bright finish, and standard two-sides bright finish (ASTM, 2003). Throughout this specification use of the term alloy in the general sense includes aluminum as well as aluminum alloy.

e- ASTM E-2074-00 Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies:

- This fire-test-response standard is applicable to door assemblies for use in walls to retard the passage of fire.
- This fire-test-response standard determines the ability of door assemblies to function as a fire-resistive barrier during a standard fire endurance test. Such a test meth shall not be construed as determining the suitability of door assemblies for continued use after their exposure to fire.
- This fire-test-response standard is intended to evaluate the ability of a door assembly to remain in an opening during a predetermined test exposure, which when required by is then followed by the application of a hose stream.
- The fire exposure is not representative of all fire conditions, which vary with changes in the amount, nature, and distribution of the fire loading, ventilation, compartment size and configuration, and heat characteristics of the compartment. It does, however, provide a relative measure of fire endurance of door assemblies under specified fire exposure conditions.
- A temperature limit on the unexposed surface of the door assembly, although the temperatures are measured and recorded.

- A limit on the number of openings allowed in glazed areas or of the number and size of lateral openings between the door and frame.
- A measurement of smoke or products of combustion that pass through the door assembly.
- A measurement of smoke, toxic gases, or other products of combustion generated by the door assembly (ASTM, 2003).

f- ASTM E-336-97- Measurement of Airborne Sound Insulation in Buildings:

- The aim of this test is measuring the Acoustical Insulation
- This test method covers procedures for determining the sound insulation between two rooms in a building. The evaluation may be made including all paths by which sound is transmitted or attention may be focused only on the dividing partition. The word "partition" in this test method includes all types of walls, floors, or any other boundaries separating two spaces. The boundaries may be permanent, operable, or movable.
- Sound Transmission Class or Transmission Loss Specifications: Building specifications may require that partitions have a certain minimum sound transmission class (STC) or transmission losses (TL). When it is required to demonstrate that a specific partition in a finished building complies with such specifications, a test satisfying the requirements will be required.
- Sound Isolation Specifications: where a building code specifies minimum values of noise isolation class (NIC) or normalized noise isolation class (NNIC), then only the procedures in the main body of the test method are necessary. Of the available single-number ratings, NNIC relates best to occupant satisfaction in an occupied building (ASTM, 2003).

4.3.3. American National Standards Institute (ANSI):

The American National Standards Institute (ANSI) specified some standards in order to ensure high quality of steel doors and frames (ANSI, 2002). These standards include:

- ANSI A115.1 – Series for Door and Frame Preparation

- ANSI A151.1 – Performance Test for Standard Steel Doors, Frames, Anchors, Hinge Reinforcing and Exit Device Reinforcing
- ANSI A2.2 – Fire Test for Door and Frame Assembly

4.3.4. National Fire Protection Association (NFPA):

The National Fire Protection Association (NFPA) specified some standards in order to ensure fire protection standards for public safety (NFPA, 1999). These standards include:

- NFPA 252 Fire Test Door and Frame Assemblies
- NFPA 80 Fire Test Door and Frame Assemblies

4.3.5. Underwriters Laboratories Inc., UL 10(b) Fire Test for Door and Frame Assemblies:

This method of fire test is applicable to door assemblies of various materials and types of construction for use in wall openings to retard the passage of fire. The methods are intended to evaluate the ability of a door assembly to remain in an opening during a predetermined test exposure. The tests expose a specimen to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period, followed by the application of a specified standard fire hose stream. Any variation from the construction or conditions that are tested is capable of substantially changing the performance characteristics of the assembly (UL, 2000). However the methods do not provide the following:

- Full information as to performance of all door assemblies in walls constructed of materials other than those tested.
- Evaluation of the degree by which the door assembly contributes to the risk of fire by generation of smoke, toxic gases, or other products of combustion.
- A temperature limit on the unexposed side of the door assembly.
- A limit on the number of openings intended in glazed areas or of the number and size of lateral openings between the door and frame.
- Measurement of the degree of control or limitation of the passage of smoke or products of combustion through the door assembly.

A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard.

A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard (Rains, 1990). Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

4.3.6. Door Hardware Institute (DHI):

a- DHI – The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware:

The procedures were designed specifically to provide a practical installation guide. Many recommendations are for the prevention of field problems due to improper hardware installation (DHI, 2001).

b- DHI A115 Series – Specifications for Steel Doors and Frame Preparation for Hardware:

The specification illustrates the recommended installation heights for various items of builders' hardware when used on standard steel doors and frames (DHI, 2001).

4.4. Quality Assurance for Aluminum Doors and Frames:

Both standard and custom aluminum doors and frames should comply with the standards that are specified by various standard-setting and testing agencies standards.

4.4.1. American Architectural Manufacturers Association (AAMA):

a- AAMA 501.1-94- Methods of Test for Exterior Walls:

Laboratory and field-test specifications for metal curtain walls including performance characteristics, test specimens, methods, recommended practices, test

apparatus and testing procedures. Includes 501.1, dynamic testing and 501.2, hose testing (AAMA, 2001).

b- AAMA 503-92 - Field Tests for Metal Storefronts, Curtain Walls, or Sloped Glazing:

Establishes the requirements for test specimens, apparatus, sampling, test procedures and reports used in evaluating product performance (AAMA, 2001).

c- AAMA 605.2-85 – Voluntary Specification for High Performance Organic Coatings on Architectural Aluminum Extrusions and Panels:

A standard which defines the performance requirements for superior organic coatings on aluminum extrusions and panels. The pretreatment requirements were derived from AAMA 605-98, which this standard and AAMA 2604 supercede (AAMA, 2001).

d- AAMA 1503-1.88 – Voluntary Test Method for Thermal Transmittance of Windows, Doors, and Glazed Wall Sections:

Describes test method parameters and equipment for determining thermal transmittance (U-value) and Condensation Resistance Factor (CRF) for windows, doors and glazed wall sections. Includes revisions to replicate NFRC thermal test conditions (AAMA, 2001).

4.4.2. American Society for Testing and Materials (ASTM):

a- ASTM A-36-96 – Standard Specification for Structural Steel:

This specification covers carbon steel shapes, plates, and bars of structural quality for use in riveted, bolted, or welded construction of bridges and buildings, and for general structural purposes (ASTM, 2003).

b- ASTM A-167-96 – Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip:

This specification covers stainless and heat-resisting chromium-nickel steel plate, sheet, and strip (ASTM, 2003).

c- ASTM B-209-96 – Specification for Aluminum and Aluminum Alloy Sheet and Plate:

- This specification covers several grades of minimum-wall-thickness, seamless, carbon-molybdenum alloy-steel, boiler and superheater tubes.
- This specification covers tubes 1/2 to 5 in. [12.7 to 127 mm] inclusive, in outside diameter and 0.035 to 0.500 in. [0.9 to 12.7 mm], inclusive, in minimum wall thickness (ASTM, 2003).

d- ASTM B-221-96 – Standard Specification for Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes:

This specification covers aluminum and aluminum-alloy extruded bar, rod, wire, profile, and tube in the aluminum alloys and tempers (ASTM, 2003).

e- ASTM B-633-85 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel:

This specification covers requirements for electrodeposited zinc coatings applied to iron or steel articles to protect them from corrosion. It does not cover electrodeposited zinc-coated steel wire or sheets (ASTM, 2003).

f- ASTM C-236-89 – Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box:

This test method covers the laboratory measurement of heat transfer through a specimen under controlled air temperature, air velocity, and thermal radiation conditions established in a metering chamber on one side and in a climatic chamber on the other side (ASTM, 2003).

g- ASTM E-283-91 – Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Wall, and Doors:

- This test method provides a standard laboratory procedure for determining the air leakage rates of exterior windows, curtain walls, and doors under specified differential pressure conditions across the specimen. The test method described is for tests with constant temperature and humidity across the specimen.

- This laboratory procedure is applicable to exterior windows, curtain walls, and doors and is intended to measure only such leakage associated with the assembly and not the installation. The test method can be adapted for the latter purpose.
- This test method is intended for laboratory use.
- Persons using this procedure should be knowledgeable in the areas of fluid mechanics, instrumentation practices, and shall have a general understanding of fenestration products and components (ASTM, 2003).

h- ASTM E-330-96 – Test for Structural Performance of Exterior Windows, Curtain Walls, and Doors:

- This test method describes the determination of the structural performance of exterior windows, doors, skylights, and curtain walls under uniform static air pressure differences, using a test chamber. This test method is applicable to curtain wall assemblies including, but not limited to, metal, glass, masonry, and stone components.
- This test method is intended only for evaluating the structural performance associated with the specified test specimen and not the structural performance of adjacent construction.
- The proper use of this test method requires knowledge of the principles of pressure and deflection measurement.
- This test method describes the apparatus and the procedure to be used for applying uniformly distributed test loads to a specimen (ASTM, 2003).

l- ASTM E-547-96 – Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors for Cyclic Air Pressure Differential Test:

- This test method covers the determination of the resistance of exterior windows, curtain walls, skylights, and doors to water penetration when water is applied to the outdoor face and exposed edges simultaneously with a cyclic static air pressure at the outdoor face higher than the pressure at the indoor face.
- This test method is applicable to any curtain-wall area or to windows, skylights, or doors alone.

- This test method addresses water penetration through a manufactured assembly. Water that penetrates the assembly, but does not result in a failure as defined herein, may have adverse effects on the performance of contained materials such as sealants and insulating or laminated glass. This test method does not address these issues (ASTM, 2003).

4.5. Quality Assurance for Door Hardware:

4.5.1. American National Standards Institute / Builders Hardware Manufacturers Association, Inc. (ANSI/BHMA):

a- ANSI/BHMA A156.1 Butts and Hinges:

This standard establishes requirements for light weight, standard weight, heavy weight, and detention hinges. Cycle tests, lateral and vertical wear tests, friction tests, strength tests, finish tests, and material and dimensional requirements are included (ANSI, 2002).

b- ANSI/BHMA A156.2 Bored and Preassembled Locks and Latches:

This standard establishes requirements for bored and preassembled locks and latches and includes performance tests, strength tests, finish tests, and dimensional criteria (ANSI, 2002).

c- ANSI/BHMA A156.3 Exit Devices:

This standard establishes requirements for exit devices and trim, automatic and self-latching flush bolts, removable mullions, coordinators and carry open bars. Performance criteria includes cycle, operational, strength, material evaluation, and finish tests (ANSI, 2002).

d- ANSI/BHMA A156.4 Door Controls-Closers:

This standard contains requirements for door closers surface mounted, concealed in the door, overhead concealed and concealed in the floor. Includes performance test requirements for closers and pivots including tests for such attributes as overload abuse, check for adjustable closing speed, cycle tests for closers with or without back check, closing force, door closer efficiency, checking cylinder test, test for adjustable

back check, test for factory pre set-back check, test for delayed action closers and finish durability tests (ANSI, 2002).

e- ANSI/BHMA A156.13 Mortise Locks and Latches:

This standard establishes requirements for mortise locks and latches and includes performance tests, strength tests, finish tests, and dimensional criteria (ANSI, 2002).

f- ANSI/BHMA A156.21 Thresholds:

This standard establishes requirements for thresholds and includes performance tests, strength tests, finish tests, and dimensional criteria (ANSI, 2002).

g- ANSI/BHMA A156.23 Electro-Magnetic Locks:

This standard establishes requirements for electro-magnetic locks and includes performance tests, strength tests, finish tests, and dimensional criteria (ANSI, 2002).

h- ANSI/BHMA A156.26 Continuous Hinges:

This standard establishes requirements for continuous hinges. Cycle tests, lateral and vertical wear tests, friction tests, strength tests, finish tests, and material and dimensional requirements are included (ANSI, 2002).

l- ANSI/BHMA A156.30 High Security Cylinders:

This standard establishes requirements for high security cylinders, and includes operational and finish tests (ANSI, 2002).

m- ANSI/BHMA A156.31 Electric Strikes:

This standard establishes requirements for electric strikes and frame-mounted actuators, and includes operational and finish tests (ANSI, 2002).

4.5.2 American National Standards Institute / Door Hardware Institute (ANSI/DHI):

ANSI/DHI A115.IG Installation Guide for Doors and Hardware states certain door hardware installation requirements. This guide was designed specifically to provide a practical installation guide. There are many recommendations for the elimination of field problems due to improper installation (DHI, 2001).

4.5.3. National Fire Protection Association (NFPA):

The National Fire Protection Association (NFPA) specified some standards in order to ensure fire protection standards for public safety (NFPA, 1999). These standards include:

- NFPA 80, Fire Doors and Windows
- NFPA 101, Life Safety Code
- NFPA 101, Life Safety Code Handbook
- NFPA 105, Installation of Smoke-Control Door Assemblies

5. QUALITY ASSURANCE FOR DOOR COMPANIES IN TURKEY:

5.1. General Quality Assurance for Door Companies in Turkey:

There are four institutions that are vital in Turkey when it comes to setting up quality standards. They are Turkish Standards Instructions (TSE), The European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI).

5.1.1. Turkish Standards Institutions (TSE):

Turkish Standards Institutions (TSE) has been established in 1960 for the purpose of preparing standards for every kind of item and products together with procedure and service. The Institute is a public founding which is conducted according to the special rules of law and has a juristic personality. Its abbreviation and trademark is TSE. This mark is represented in different ways. This mark can not be used without the permission of TSE in no way and under no condition. Only the standards that have been accepted by TSE get the name of Turkish Standards. These standards are voluntary and can be made compulsory by the approval of the ministry that the standard is relevant to. It is essential that a standard be a Turkish one so that it could be made compulsory. The standards made compulsory are published in Official Gazette. The tasks of TSE are as below:

- To prepare and to get every kind of standard prepared
- To inspect the standards which have been prepared within or out of the Institution and to accept them as Turkish Standards if approved
- To publish the standards which have been approved and to encourage their application as voluntary to submit the ones thought may be useful when made compulsory to come into force to the relevant ministry
- To prepare the standards or the projects of them and to declare its opinion upon request of public sector and private sector
- To perform the technical inspections and researches about standards, to follow up the resembling studies done in foreign countries, to establish relations with international and foreign companies of standard and to collaborate with them

- To collaborate with universities and other scientific and technical associations and institutions, to make publications on standardization, to constitute archives from national and international standards and to submit them to the ones whom they may concern who are concerned with.
- To conduct research on standards and to establish laboratories in order to check the application of voluntary standards, to perform technical studies requested by public or private sector and report about them.
- To train personnel in order to maintain and develop the standard works in the country and to open courses and arrange seminars for this purpose
- To perform studies which will encourage the quality production convenient to the standards and to prepare the documents about them.
- To perform studies on research and development about metrology and calibration and to establish necessary laboratories

The organization of these tasks of Turkish Standards Institution is determined according to the order of the distribution by General Assembly and announced to people who are interested in (TSE, 2006).

5.1.2. The European Committee for Standardization (CEN):

Funded in 1961, the European Committee for Standardization (CEN) was first based in Paris then moved to Brussels in 1975 acquired formal Statutes and was registered as a non profit-making, international, and scientific and technical institution. It is therefore an independent organization. In Europe, CEN works in partnership with the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI).

CEN's mission is to promote voluntary technical harmonization in Europe in conjunction with worldwide bodies and its partners in Europe. Harmonization diminishes trade barriers, promotes safety, allows interoperability of products, systems and services, and promotes common technical understanding (TSE, 2006).

Funded by European Union, there is a programme developed by CEN in 2002 to support to the quality infrastructure in Turkey. The name of the project is Turkey-MSTQ.

Since Turkey has been a recognized a candidate country for membership of the European Union in December 1999, the Turkish government is required to fully harmonize with the acquis communutaire. Therefore Turkey- MSTQ project is designed to support Turkey's private and public sectors in the process of technical harmonization and aligning of their quality infrastructure with that of the EU in the areas of direct relevance to the Customs Union Agreement, more specifically in the parts concerned with technical barriers to trade. The target groups for the project are officials and employees from the Turkish private and public sector involved in the harmonization process. The Turkish private sector will form the ultimate group of beneficiaries of the programme, as they will be able to profit from the enhanced quality infrastructure and the removal of technical barriers to trade.

5.1.3. The European Committee for Electrotechnical Standardization (CENELEC):

CENELEC is a non-profit technical organization set up under Belgian law and composed of the National Electrotechnical Committees of 23 European countries. In addition, 12 National Committees from Central and Eastern Europe are participating in CENELEC work with an Affiliate status including Turkey.

CENELEC members have been working together in the interests of European harmonization since the 1950s, creating both standards requested by the market and harmonized standards in support of European legislation and which have helped to shape the European Internal Market. CENELEC works with 35,000 technical experts from 22 European countries. Its work directly increases market potential, encourages technological development and guarantees the safety and health of consumers and workers.

CENELEC's mission is to prepare voluntary electro technical standards that help develop the Single European Market/European Economic Area for electrical and electronic goods and services removing barriers to trade, creating new markets and cutting compliance costs (TSE, 2006).

5.1.4. The European Telecommunications Standards Institute (ETSI):

As one of the three officially recognized European Standards Organizations (ESO), the European Telecommunications Standards Institute (ETSI) is actively

participating and supporting initiatives within collaborative frameworks such as the Information and Communications Technologies Standards Board (ICTSB), Global Standards Collaboration (GSC), and Global Radio Standardization (RAST).

Based on its extensive experience with fixed network standardization and its leading position in standardizing mobile communications, ETSI highlights the need for bridging the gap between different dimensions of traditional telecommunications, Internet Protocol (IP), and broadcasting environments by following the market trends and creating key synergies.

Recognizing its well-established role of fostering the convergence of emerging technologies, ETSI forges and strengthens the industry's collaboration in the development of future world-wide applicable standards. ETSI encourages the creation of a sound partnership climate dealing with the convergence of diverse markets and technologies building the future of the industry (ETSI, 2006).

5.1.5. Turkey, European Union and Standardization:

TSE is an affiliate member of CEN and CENELEC since 1991. Having started an initiative to become a full member of both organizations in the recent years, TSE is currently carrying out the task of harmonization of Turkish Standards with EU standards as part of Turkey's obligations within the context of the Turkey-EU relationship. In order to do this, TSE is actively following the standardization activities of CEN and CENELEC and about 85 percent of existing CEN and CENELEC standards have already been adopted as Turkish Standards and the unadopted standards, including the new ones, are being included in the standardization work programme of TSE.

It is very important that the representatives of the Turkish industry sector are contributing voluntarily to the Technical Committee work by giving their opinions about the related documentation in order that TSE is able to carry out its standardization activities parallel to those of CEN and CENELEC. TSE is also a part of the common certification system within the European Union such as CCA, HAR, KEYMARK. Thus, TSE is able to offer some convenience in this context for the Turkish industry sector by the mutual recognition of certificates (TSE, 2006).

5.2. Quality Assurance for Doors, Door Frames and Door Hardware:

5.2.1. Quality Assurance for Doors:

- **TS 11797 EN 947- Hinged and pivoted doors- Determination of the resistance to vertical load:** This standard applies to all vertically hinged or pivoted doors.
- **TS 12225- Door and windows- Unplasticized PVC- Manufacturing workshops- General rules:** This standard cover door and windows unplasticized PVC manufacturing workshops general rules.
- **TS 12558- The authorized maintenance and repair services- Furniture industry- Systems of door and window- Wood, metal and/or PVC- General rules:** This standard covers all wood, metal and/or PVC door and window of the authorized maintenance and repair services of general rules
- **TS 12655- Steel doors:** This standard covers steel doors which prohibit unauthorized entrance to buildings
- **TS 1905- Prefabricated Wooden Doors:** This standard specifies, classification, properties, sampling, testing and marking of wooden doors.
- **TS 2254- Symbolic Designation of Direction of Closing and Faces of Doors, Windows and Shutters:** This standard covers components the leavers of which move around one more vertical axes and does not apply to components the leaves of which move around horizontal axes or move by translation
- **TS 2255- Doors – Terminology:** This standard covers terminology for doors.
- **TS 4644 EN 12211 - Windows and doors - Resistance to windload - Test method:** This standard defines the method of the test to determine the resistance to windload for completely assembled windows and doors of any materials when submitted to positive and negative test pressures.
- **TS 538: Matchboarded Door Wings:** This standard specifies the classification, properties, sampling, testing and marking of matchboarded door wings.
- **TS 539 - Panelled, Glazed, Panelled and Glazed Wooden Door Wings:** This standard specifies the classification, properties, sampling, testing and marking of panelled, glazed panelled and glazed wooden door wings for buildings

- **TS 6007 EN 949 - Windows and curtain walling doors, blinds and shutters- Determination of the resistance to soft and heavy body impact for doors:** The standard specifies the method to be used to determine the damage caused by string with a soft and heavy body the face of a closed door leaf fixed in its own door frame as part of a doorset.
- **TS 675- Flush Wood Door Wings:** This standard specifies the classification, properties, sampling, testing and marking of flush wood door wings.
- **TS 7396- Fire Tests - Evaluation of Performance of Smoke Control Door Assemblies- Part 1: Ambient Temperature Test:** This standard includes a method for assessing the performance of door and shutter assemblies intended to act as barriers to smoke in a fire.
- **TS EN 1026- Windows and doors - Air permeability - Test method:** This standard defines the conventional method to be used to determine the air permeability of completely assembled windows and doors of any material, when submitted to positive or negative test pressures.
- **TS EN 1027- Windows and doors - Watertightness - Test method:** This standard defines the conventional method to be used to determine the watertightness of completely assembled windows and doors of any materials.
- **TS EN 1121- Doors – Behavior between two different climates – Test method:** This standard defines the test method to be used for determining the behavior of door leaves and doorsets between two different climates.
- **TS EN 1191- Windows and doors- Resistance to repeated opening and closing- Test method:** This standard specifies the method to be used to determine the mechanical durability of door sets and the opening parts of windows after a defined number of operating cycles
- **TS EN 1192- Doors- Classification of strength requirements:** This standard, provides a means of classifying where appropriate the performance of door leaves door frames door sets and door assemblies according to their strength in resisting vertical load static torsion soft and heavy body impact and hard body impact.

- **TS EN 12207- Windows and doors- Air permeability- Classification:** This standard defines the classification of test results for completely assembled windows and doors of any materials after testing in accordance with EN 1026
- **TS EN 12208- Windows and doors- Watertightness- Classification:** This standard defines the classification of test results for completely assembled windows and doors of any after testing in accordance with EN 1027 " Windows and doors - Watertightness - Test method".
- **TS EN 12210- Windows and doors - resistance to wind load – classification:** This standard defines the classification of test results for completely assembled windows and door of any materials after testing in accordance with EN 12211 " Windows and doors- Resistance to wind load – Test method".
- **TS EN 12217: Doors - Operating forces - Requirements and classification**
- **TS EN 12219: Doors - Climatic influences - Requirements and classification:** This standard applies to door leaves and doorsets tested in accordance wihit prEN 1121-2 and prEN 1294
- **TS EN 12400: Windows and pedestrian doors - Mechanical durability - Requirements and classification:** This standard specifies a means of classifying opening windows and pedestrian doors according to the performance when subjected to repeated opening and closing,
- **TS EN 12412-2- Thermal performance of windows, doors and shutters - Determination of thermal transmittance by hot box method - Part 2: Frames**
- **TS EN 12412-4- Thermal performance of windows, doors and shutters - Determination of thermal transmittance by hot box method - Part 4: Roller shutter boxes**
- **TS EN 12424-Industrial commercial and garage doors and gates- Resistance to windload- Classification:** This standard specifies the classifications for wind load for doors in a closed position.
- **TS EN 12425-Industrial commercial and garage doors and gates- Resistance to water penetration- Classification:** This standard specifies the classifications for resistance to water penetration for doors in a closed position when tested in accordance with EN 12489.

- **TS EN 12426: Industrial commercial and garage doors and gates- Air permeability- Test method:** This standard specifies the classifications for air permeability for doors in a closed position when tested in accordance with 12427.
- **TS EN 12427: Industrial commercial and garage doors and gates- Air permeability- Test method:** This standard specifies a test method for determining the air permeability for doors in a closed position.
- **TS EN 12428: Industrial commercial and garage doors and gates- Thermal transmittance- Requirements for the calculation:** This standard specifies the calculation requirements for the thermal transmittance for doors in a closed position.
- **TS EN 12433-1-Industrial, commercial and garage doors and gates- Terminology- Part 1: Types of doors:** This European Standard specifies the terminology for doors gates and barriers intended for installation in areas in the reach of people for which the main intended uses are giving safe access for goods and vehicles accompanied by persons in industrial and commercial premises and in residential garages.
- **TS EN 12433-2-Industrial, commercial and garage doors and gates- Terminology- Part 2: Parts of doors:** This standard specifies the terms for parts of most types of doors gates and barriers in common use. The terms used are also applicable for barriers.
- **TS EN 12444-Industrial commercial and garage doors and gates- Resistance to windload- Testing and calculation:** This standard specifies the test method and/or calculation of resistance to windload for doors in a closed position
- **TS EN 12489-Industrial, commercial and garage doors and gates - Resistance to water penetration - Test method:** This standard specifies the test method for determining the resistance to water penetration for doors in a closed position.
- **TS EN 12519- Windows and pedestrian doors - Terminology**
- **TS EN 129- Methods Of Testing Doors - Test For Deformation In Torsion of Door Leaves:** This standard specifies the method to be used to determine the residual deformation of a door after static stress in torsion.

- **TS EN 1294- Door leaves - Determination of the behavior under humidity variations in successive uniform climates:** This European Standard describes the method which is to be used to test the behavior under humidity variations of door leaves placed in successive uniform climates.
- **TS EN 130- Methods of Testing Doors; Test for the Change in Stiffness of the Door Leaves by Repeated Torsion:** This standard describes the method to be used to determine the change in stiffness of a door leaf after periodical stress in torsion.
- **TS EN 13123-1- Windows, doors and shutters - Explosion resistance; Requirements and classification - Part 1: Shock tube**
- **TS EN 13123-2- Windows, doors and shutters - Explosion resistance - Requirements and classification - Part 2: Range test**
- **TS EN 13124-1- Windows, doors and shutters - Explosion resistance; Test method - Part 1: Shock tube**
- **TS EN 13124-2- Windows, doors and shutters - Explosion resistance; Test method - Part 2: Range test**
- **TS EN 13241-1-Industrial, commercial and garage doors and gates - Product standard - Part 1: Products without fire resistance or smoke control characteristics:** This standard specifies the safety and performance requirements for doors, gates and barriers, intended for installation in areas in reach of persons, and for which the main intended uses are giving safe access for goods and vehicles accompanied or driven by persons in industrial, commercial or residential premises.
- **TS EN 1522- Windows, doors, shutters and blinds - Bullet resistance - Requirements and classification:** This standard defines the requirements and classification that windows, doors, shutters and blinds must satisfy when tested in accordance with EN 1523.
- **TS EN 1523- Windows, doors, shutters and blinds - Bullet resistance - Test method:** This standard defines attest procedure to permit classification of the bullet resistance of windows, doors, shutters and blinds (complete with their infillis)

- **TS EN 1529- Doors leaves- Height, width, thickness and squareness- Tolerance classes:** This standard, gives the tolerance limits for specified dimensions of height, width and thickness, and for squarenes of door leaves. It applies to door leaves which are supplied without and independent of, any frames. It does not apply to the leaves of door sets.
- **TS EN 1530: Door leaves- General and local flatness- Tolerance classes:** This standard gives the tolerances limits for general and local flatness of door leaves. It applies to door leaves which are supplied without and independent of any frames. It does not apply to the leaves of doorsets.
- **TS EN 1634-1- Fire resistance tests for door and shutter assemblies- Part 1: Fire doors and shutters:** This standard includes determination of fire resistance test methods of doors and shutters which are intended to use for assembling into vertical members gaps
- **TS EN 1634-3- Fire resistance tests for door and shutter assemblies - Part 3: Smoke control doors and shutters:** This part of EN 1634 specifies a method determining the leakage of cold smoke from one side of a door assembly to under the specified test conditions
- **TS EN 477- Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors- Determination of the resistance to impact of main profiles by the falling mass:** This standard, specifies a method for the determination of the resistance to impact by a falling mass at 10 C of unplasticized polyvinylchloride (PVC-U) main profiles for the fabrication of windows and doors for the assessment of the extrasion.
- **TS EN 477- Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors- Determination of the resistance to impact of main profiles by the falling mass**
- **TS EN 478: Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors- Appearance after exposure at 150 C- Test method:** This standard, specifies two methods for the determination of the effect of heat on unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors.

- **TS EN 479- Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors- Determination of heat reversion:** This standard specifies a method for the determination of the heat revesion of unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors by a test at 100 C. in an oven.
- **TS EN 513- Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors- Determination of the resistance to artificial weathering:** This European Standard specifies a method for exposing test pieces from an unplasticized polyvinylchloride (PVC-U) profile for the fabrication of windows and doors to a xenon arc laboratory light source in order to assess changes in impact strength and color. The method given on 8.10 (b) is the reference method of color measurement.
- **TS EN 514- Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors- Determination of the strength of welded corners and T-joints:** Unplasticized polyvinylcholoride (PVC-U) profiles for the fabrication of windows and doors- Determination of the strength of welded corners and T-joints.
- **TS EN 950- Door leaves - Determination of the resistance to hard body impact:** This standard specifies the method to be used to determine the damage caused to a door leaf by the impact of a hard body.
- **TS EN 951- Door leaves - Method for measurement of height, width, thickness and squareness:** This standard applies to all rectangular door leaves and the measurable parameters of doors of other shapes. This standard specifies the method to be used to measure the dimensions of height, width and thickness and defects of squareness of door leaves.
- **TS EN 952- Door leaves - General and local flatness - Measurement method:** This standard specifies the method to be used to measure the deviations in general and local flatness of door leaves
- **TS EN ISO 10077-1- Thermal performance of windows, doors and shutters Calculation of thermal transmittance- Part 1: Simplified method (ISO 10077-1: 2000)**

- **TS EN ISO 10077-2- Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (ISO 10077-2: 2003)**
- **TS EN ISO 12567-1- Thermal performance of windows and doors - Determination of thermal transmittance by hot box method - Part 1: Complete windows and doors:** This standard specifies a method measure the thermal transmittance of a door or window system.
- **TS ISO 7894 Partitions Made of Components- Test For Resistance to Wind (Static Pressure and Slamming Doors):** This standard defines the method to be used for testing the resistance to positive and negative static air pressure of complete partitions made of components.

5.2.2. Quality Assurance for Door Frames:

- **TS 1904- Door frames- Steel sheet:** This standard contains external and internal door frames fabricated form mild steel sheet
- **TS 806- Interior Wood Door Frames:** This standard specifies the classification, sampling, testing and marking of interior wood door frames.

5.2.3. Quality Assurance for Door Hardware:

- **TS 1229- Accessories for doors:** This standard covers the door handle, the door pivot and pin, the door latch, the door stopper, the door bumper and the safety chain for a door hardware
- **TS 179- Door locks:** This standard covers doors locks for building.
- **TS 2018- Modular Coordination- Coordinating Sizes for Doorsets- External and Internal:** This standard covers the coordinating sizes for doorsets of all materials to be used in buildings and which will fill coordinating spaces in dimensionally coordinated buildings.
- **TS 5884- Doorsets - Static loading test:** This standard comprises test of doorsets-static loading.
- **TS 5909- Doorsets - Determination of closing force:** This standard comprises determination of closing force of doors.

- **TS EN 1154- Building hardware – Controlled door closing devices – Requirements and test methods:** This standard specifies requirements for controlled door closing devices for swing doors, such devices being mounted on or in the frame, on or in the door, or in the floor.
- **TS EN 1155- Building hardware - Electrically powered hold-open devices for swing doors - Requirements and test methods:** This standard specifies requirements for separate hold-open devices and also for hold-open mechanisms incorporated in a door closer.
- **TS EN 1158- Building hardware - Door coordinator devices - Requirements and test methods:** This standard specifies requirements for the following door coordinator devices for use on double leaf swing doors: - separately mounted door coordinator devices; - Coordinator mechanisms incorporated in door closers; - coordinator mechanisms incorporated in door closers with electrically powered hold-open devices.
- **TS EN 12046-2- Operating forces - Test method- Part 2: Doors :** This standard is for hinged/pivoted and sliding doorsets with latches, for pedestrian use. It defines the test methods to determine the forces to open/close doors and to engage/release and lock/unlock the hardware using a key or handle.
- **TS EN 12051- Building hardware- Door and window bolts- Requirements and test methods**
- **TS EN 12365-1- Building hardware - Gasket and weatherstripping for doors, windows, shutters and curtain walling - Part 1: Performance requirements and classification**
- **TS EN 12365-2- Building hardware - Gasket and weatherstripping for doors, windows, shutters and curtain walling - Part 2: Linear compression force test methods**
- **TS EN 12365-3- Building hardware - Gasket and weatherstripping for doors, windows, shutters and curtain walling - Part 3: Deflection recovery test method**

- **TS EN 12365-4 - Building hardware - Gasket and weatherstripping for doors, windows, shutters and curtain walling - Part 4: Recovery after accelerated ageing test method**
- **TS EN 1527- Building hardware - Hardware for sliding doors and folding doors - Requirements and test methods**
- **TS EN 179- Building hardware - Emergency exit devices operated by a lever handle or push pad - Requirements and test methods**
- **TS EN 179/ AC+A1- Building hardware - Emergency exit devices operated by a lever handle or push pad - Requirements and test methods**
- **TS EN 60730-2-12/ A1- Automatic electrical controls for household and similar use part 2-12: particular requirements for electrically operated door locks (Amendment 1)**

6. ANALYSIS OF DOORS AND DOOR HARDWARE VERSUS QUALITY CONTROL:

6.1. Analysis of U.S. Quality Assurance:

6.1.1. Analysis of Doors versus Quality Assurance:

Based on descriptions made regarding doors and applicable quality requirements for doors in USA, the following matrix table may be used:

Table 1.1: Door Material versus Door Function Matrix

	Hollow Core Wood Door	Solid Core Wood Door	Hollow Core Metal Door	Solid Core Metal Door	Aluminum Door
Passage Door	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A ANSI A115.1	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A ANSI A115.1	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	ASTM B-209-96 ANSI A115.1 ASTM B-209-96 AAMA 501.1-94
Bullet Resistant Door					
Soundproof Door	ASTM E-336-97	ASTM E-336-97	ASTM E-336-97	ASTM E-336-97	ASTM B-209-96 ANSI A115.1 ASTM E-336-97
Fire Resistant Door	NFPA 80 ASTM E-2074-00 ANSI A2.2 NFPA 252 & NFPA 80	NFPA 80 ASTM E-2074-00 ANSI A2.2 NFPA 252 & NFPA 80	SDI-107-84 ASTM E-2074-00 ANSI A2.2 NFPA 252 & NFPA 80	SDI-107-84 ASTM E-2074-00 ANSI A2.2 NFPA 252 & NFPA 80	ASTM E-2074-00 ANSI A2.2 NFPA 252 & NFPA 80
Insulated Door					
Sliding Door	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	ASTM B-209-96 ANSI A115.1 ASTM B-209-96
Folding Door	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	ASTM B-209-96 ANSI A115.1 ASTM B-209-96
Automatic Swinging Door					ASTM B-209-96 ANSI A115.1 ASTM B-209-96
Bi-Folding Door					ASTM B-209-96 ANSI A115.1 ASTM B-209-96
Revolving Door					ASTM B-209-96 ANSI A115.1 ASTM B-209-96

6.1.2. Analysis of Door Frames versus Quality Assurance:

Based on descriptions made regarding door frames and applicable quality requirements for door frames in USA, the following matrix table may be used:

Table 1.2: Door Frame versus Door Matrix

	Wood Frame	**Light-Gauge Metal Frame**	**Pressed Steel (Hollow Metal) Frame**	**Aluminum Frame**
Hollow Core Wood Door	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S. 1-73 ANSI/WDMA I.S 1-A ANSI A115.1			-
Solid Core Wood Door	Test for Smoothness & Door Warp and Thickness (AW) NWMA I.S. 1-73 ANSI/WDMA I.S 1-A ANSI A115.1			-
Hollow Core Metal Door	-	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	-
Solid Core Metal Door	-	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	-
Aluminum Door	-	-	-	ASTM B-209-96 ANSI A115.1 ASTM B-209-96

6.1.3. Analysis of Door Hardware versus Quality Assurance:

Based on descriptions made regarding door hardware and applicable quality requirements for door hardware in USA, the following matrix table may be used:

Table 1.3: Door Hardware versus Quality Standard Matrix

	Quality Standard
Butt Hinges	ANSI/BHMA 1561.1 ANSI/DH 115.1G NFPA 80, 101, 105
Lock and Latch Sets	ANSI/BHMA 156.2 ANSI/BHMA 156.13 ANSI/DH 115.1G NFPA 80, 101, 105
Exit Device	ANSI/BHMA 156.3 ANSI/DH 115.1G NFPA 80, 101, 105
Door Closer	ANSI/BHMA 156.4 ANSI/DH 115.1G NFPA 80, 101, 105
Threshold	ANSI/BHMA 156.21 ANSI/DH 115.1G NFPA 80, 101, 105
Electro-Magnetic Lock	ANSI/BHMA 156.23 ANSI/DH 115.1G NFPA 80, 101, 105
Continuous Hinge	ANSI/BHMA 156.26 ANSI/DH 115.1G NFPA 80, 101, 105
High Security Cylinder	ANSI/BHMA 156.30 ANSI/DH 115.1G NFPA 80, 101, 105
Electric Strike	ANSI/BHMA 156.31 ANSI/DH 115.1G NFPA 80, 101, 105

6.2. Analysis of US versus Turkish Quality Assurance:

6.2.1. Analysis of US versus Turkish Quality Assurance for Doors:

In order to compare and understand the differences between USA and Turkey when it comes to quality standards of doors, the following matrix may be used:

Table 1.4: Matrix Table of US versus Turkish Quality Assurance for Doors

Category	USA Standards	Turkish Standards	Analysis
Passage Door	Test for Smoothness & Door Warp and Thickness (AW), NWMA I.S. 1-73, ANSI/WDMA I.S.1-A, ANSI A115.1, SDI-100-91, SDI-105-92, SDI-109-88, SDI-110-84, ASTM B-209-96, ANSI A115.1, ASTM B-209-96, AAMA 501.1-94	TS 11797 EN 947, TS 2254, TS 2255, TS 4644 EN 12211, TS 6007 EN 949, TS EN 1026, TS EN 1121, TS EN 1191, TS EN 1192, TS EN 12207, TS EN 12210, TS EN 12217 to TS EN 12519	Turkish standards categorize doors based on functionality or the action, however categorization based on material is not very common.
Bullet Resistant Door		TS EN 1522, TS EN 1523	No US data to compare
Soundproof Door	ASTM B-209-96 ANSI A115.1 ASTM E-336-97		No Turkish data to compare
Fire Resistant Door	NFPA 80 ASTM E-2074-00 ANSI A2.2 NFPA 252 & NFPA 80	TS 7396, TS EN 13241-1, TS EN 1634-1, TS EN 1634-3	Unlike US standards, Turkish fire-rating standards are not categorized based on materials.
Insulated Door		TS EN 12412-2, TS EN 12412-4, TS EN 12428, TS EN ISO 10077-1, TS EN ISO 10077-2, TS EN ISO 12567-1	No US data to compare
Sliding Door	Test for Smoothness & Door Warp and Thickness (AW), NWMA I.S. 1-73, ANSI/WDMA I.S.1-ASDI-100-91, SDI-105-92, SDI-109-88, SDI-110-84, ANSI A115.1, DHI A115, ASTM B-209-96, ANSI A115.1, ASTM B-209-96		No Turkish data to compare
Folding Door	Test for Smoothness & Door Warp and Thickness (AW), NWMA I.S. 1-73, ANSI/WDMA I.S.1-A, SDI-100-91, SDI-105-92, SDI-109-88, SDI-110-84, ANSI A115.1, DHI A115, ASTM B-209-96, ANSI A115.1, ASTM B-209-96		No Turkish data to compare
Automatic Swinging Door	ASTM B-209-96 ANSI A115.1 ASTM B-209-96		No Turkish data to compare
Bi-Folding Door	ASTM B-209-96 ANSI A115.1 ASTM B-209-96		No Turkish data to compare
Revolving Door	ASTM B-209-96 ANSI A115.1 ASTM B-209-96		No Turkish data to compare

6.2.2. Analysis of US versus Turkish Quality Assurance for Door Frames:

In order to compare and understand the differences between USA and Turkey when it comes to quality standards of door frames, the following matrix may be used:

Table 1.5: Matrix Table of US versus Turkish Quality Assurance for Door Frames

Category	USA Standards	Turkish Standards	Analysis
Wood Frame	Test for Smoothness & Door Warp and Thickness (AWI) NWMA I.S 1-73 ANSI/ WDMA I.S 1-A ANSI A115.1	TS 806	There is no standard by TSE regarding Light-Gauge and Aluminum Door Frames
Light-Gauge Metal Frame	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115		
Pressed Steel (Hollow Metal) Frame	SDI-100-91 SDI-105-92 SDI-109-88 SDI-110-84 ANSI A115.1 DHI A115	TS 1904	
Aluminum Frame	ASTM B-209-96 ANSI A115.1 ASTM B-209-96		

6.2.3. Analysis of US versus Turkish Quality Assurance for Door Hardware:

In order to compare and understand the differences between USA and Turkey when it comes to quality standards of door hardware, the following matrix may be used:

Table 1.6: Matrix Table of US versus Turkish Quality Assurance for Door Hardware

Category	USA Standards	Turkish Standards	Analysis
Butt Hinges	ANSI/BHMA 1561.1 ANSI/DH 115.1G NFPA 80, 101, 105		There is no standard by TSE regarding butt hinges, continuous hinges and security cylinder
Lock and Latch Sets	ANSI/BHMA 156.2 ANSI/BHMA 156.13 ANSI/DH 115.1G NFPA 80, 101, 105	TS 179 TS 2018 TS 5884 TS 5909	
Exit Device	ANSI/BHMA 156.3 ANSI/DH 115.1G NFPA 80, 101, 105	TS EN 179 TS EN 179/AC+A1	
Door Closer	ANSI/BHMA 156.4 ANSI/DH 115.1G NFPA 80, 101, 105	TS EN 1154	
Threshold	ANSI/BHMA 156.21 ANSI/DH 115.1G NFPA 80, 101, 105	TS EN 12365-1 TS EN 12365-2 TS EN 12365-3 TS EN 12365-4	
Electro-Magnetic Lock	ANSI/BHMA 156.23 ANSI/DH 115.1G NFPA 80, 101, 105	TS EN 1155	
Continuous Hing	ANSI/BHMA 156.26 ANSI/DH 115.1G NFPA 80, 101, 105		
High Security Cylinder	ANSI/BHMA 156.30 ANSI/DH 115.1G NFPA 80, 101, 105		
Electric Strike	ANSI/BHMA 156.31 ANSI/DH 115.1G NFPA 80, 101, 105	TS EN 60730-2-12/A1	

7. CONCLUSION:

The global pressure on the Turkish door and door hardware industry is increasing day by day. Most companies from the United States, European Union, and Asia (especially India and China) are challenging the Turkish door and door hardware companies by providing competitively priced, high-quality goods and services. In order to stay competitive, the Turkish counterparts should adopt new changes.

This thesis was prepared in order to shed light on how the American and Turkish door and door hardware industry functions from a quality improvement and standards from point of view so that it could present solutions to the Turkish door and door hardware industry, architects, testing agencies, importer/exporters, and lawmakers.

It is very vital for the Turkish door and door hardware industry to work closely together with government and self-acting agencies in order to advise or improve areas of standardization of the industry. The main goals should be developing and monitoring performance standards for doors and door hardware along with promoting the standardization of specifications and method of testing. Providing the industry with the quality standard will enable the Turkish door and door hardware companies to compete successfully in the national and global arena.

The matrix tables shown in Part 6 regarding door, door frame, and door hardware can be used for various reasons: The first matrix table groups are useful to understand the U.S. quality standards specified for doors and door hardware. They are also very vital when there is a need to conduct quality analysis to the doors, door frames and door hardware that are exported from USA.

The second group is useful to understand the differences between those two countries when it comes to quality standards of doors and door hardware. It is important for an architect or an owner to see what quality they are getting from USA. It is important for Turkish lawmakers or testing agencies to see the differences so that they could see what USA offers to improve the quality standards of doors and door hardware in Turkey. It is also important for the Turkish importer/exporter to see whether what USA sells to Turkey has the quality standards promised.

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ÖZGEÇMİŞ

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