Glass Jars:

Container Structure:

Glass container:
There are 3 basic parts to a glass container:

1 . Finish: The finish is the very top part of the jar that contains threads or lugs that contact and hold the cap or closure. Specific areas identified in the "finish" are sealing surface, glass lug, continuous thread, transfer bead, vertical neck ring seam and the neck ring parting line.

2. Body: The body of the container is that portion which is made in the "body mold". It is the largest part of the container and lies between the finish and the bottom. The characteristic parts of the "body" are the shoulder, heel, side wall, and mold seam.

3. Bottom: The bottom of the container is made in the "bottom plate" part of the glass-container mold. The designated parts of the bottom area are normally the bottom plate parting line and the bearing surface.

Glass closures:
Among the terms commonly used for describing parts of metal vacuum closures are the following:
Panel: The flat center area in the top of the cap.
Radius/Shoulder: The rounded area at the outer edge of the panel connecting the panel and skirt.
Skirt: The flat side of the cap. The skirt may be smooth, knurled, or fluted and serves as the gripping surface.
Face: The outside of the cap
Reverse: The inside of the cap
Curl: The rounded portion at the bottom of the skirt that adds rigidity to the cap and serves to protect the cut edge of the metal.
Lug: A horizontal inward protrusion from the curl that seat under the thread or lug on the finish of the glass container and holds the cap in position.
Coatings: Coatings and inks used on the inner and outer surfaces of the cap to protect the metal from attack, adhere gasket materials, and decorate the closure.
Gasket: The actual sealing member of the cap which must make intimate contact with the glass finish at the proper point to form an effective seal. Gaskets are made of either rubber or plastisols.
Safety Button or Flip Panel: A raised, circular area in the center of the panel which is used only for vacuum packed products and serves two principle purposes which are detection of low or no vacuum packages and an indicator to the consumer of a properly sealed package.

Vacuum Formation:
Almost all low-acid foods packaged in glass containers are sealed with vacuum-type closures. The vacuum within the package and the overpressure in the retort on the outside of the cap play an important role in forming and maintaining a good seal. There are two basic types of cappers which apply caps while forming a vacuum in the container:

1. Mechanical Vacuum Capper: applies the cap to the jar in an evacuated chamber (usually used on dry products and rarely on low-acid processed foods).

2. Steam Flow Capper: the container is subjected to a controlled steam flow that displaces the headspace gases from the jar by a flushing action. The steam is trapped in the headspace as the cap is applied, then condenses to form a vacuum which helps hold the closure in place.

The method of cold-water vacuum check requires a series of jars to be filled with cold tap water to the approximate headspace that will be maintained with the product to be run. A series means 4 to 6 containers for a straight-line capper, and 1 container for each capping head on a rotary capper. The capper is allowed to warm up to operating temperature and normal steam setting and these jars are then sealed in the capper. The jars are then opened and re-run through the capper and then checked for vacuum. By running the jars through the capper the first time the water is de-aerated, and thus a truer vacuum reading is obtained after the second run. Vacuum is measured using a standard vacuum gage. The range of vacuum is recommended by the container manufacturer, but typically should be 22 inches or more.

Vacuum Closures:
There are four primary factors that affect vacuum formation (however, 1-3 are considered critical factors only if designated critical by the process authority):

1. Headspace: There must be sufficient void or headspace at the top of the container to allow adequate steam to be trapped in the container for forming a vacuum, and to accommodate product expansion during retorting. The correct amount of headspace varies with products, processes, and package design, but a rule-of-thumb in the industry is that it should be not less than 6% of the container volume. Inadequate headspace can result in displacement or deformation of the closure during retorting.

2. Product fill/sealing temperature: Product filling temperature affects the final vacuum in the container (due to product contraction upon cooling). The higher the product temperature at the time of sealing, the higher the final package vacuum. Higher filling temperatures also result in less air being entrapped in the product.

3. Residual air in the product: Air can have a direct effect on the final package vacuum and should be kept at a minimum for good sealing. The more air that is trapped in the product, the lower the vacuum. Expansion of residual air in the container during processing can exert pressure against the closure and adversely affect seal integrity. Air in the container can also impede heat penetration into the container during retorting.

4. Capper vacuum efficiency: Capper vacuum efficiency refers to the ability of a steam flow capper to produce a vacuum in sealed glass containers. The most convenient, routine check on the vacuum efficiency of a steam-flow capper is the "cold-water vacuum check."

Currently, two primary types of vacuum closures are used on low-acid food products:
1. Lug type closure: This closure is the predominate vacuum-cap type. It is a convenient closure because it can be removed without a tool and forms a good reseal for storage. Structurally, the lug cap consists of a steel shell and can have four, six, or eight metal lugs depending on its diameter. Normally it contains a flowed-in plastisol gasket. During closure application the headspace is swept by steam and lug caps are secured to the glass finish by turning or twisting the cap onto the finish to seat the lugs of the cap under the threads on the glass finish.

With this lug type of closure the top of the glass finish makes contact with the gasket on the inside of the lid. In most instances the lids are heated with steam to soften the compound and facilitate sealing. Both the lugs and vacuum hold the cap in place on the glass finish, but vacuum is the most important.

2. Press on-Twist off (PT) closures: This closure is in widespread use on baby foods as well as other products. Structurally, the PT cap consists of a steel shell with no lugs. The gasket is molded plastisol on the inside vertical wall and covers a sealing area extending from the outer edge of the top panel to the curl of the cap. These closures typically have a safety button or flip panel.

The cap is first heated to soften the plastisol. It is then pushed directly down on the glass finish after air is swept from the headspace with steam. The glass threads form impressions in the skirt of the cap gasket and allow the cap to be cammed-off and on. The PT closure is held in place on the finish primarily by vacuum, with some assistance from the thread impressions in the gasket wall when the cap is cooled.

3. Plastisol-Lined Continuous Thread (PLCT) Cap: The PLCT cap consists of a metal shell with a threaded skirt curled at the end. It contains a flowed-in plastisol gasket on the inside that makes intimate contact with the top of the finish when the cap is screwed onto the jar finish. The PLCT cap may be used in both steam and non-steam applications. Security measurements on this type of container closure can be performed. However, pull-up cannot be determined. An example would be the "mason jar."

Closure Evaluation Requirements:
Generally, closure application inspections are performed either visually (non-destructive), or by cap removal (destructive). It is important to know the tests and observations on the different types of closures as well as the defects that can occur.

Visual Examinations (Non-Destructive):
As with metal cans, requirements for visual examination of closures for glass containers include regular observations for gross closure defects of at least one container from each capper head by a closure technician. According to 9 CFR 431.2(c)(1), a closure technician must visually assess the adequacy of the closures formed by each closing machine. Visual examinations must be done at sufficient frequency to ensure proper closure and must be performed at least every 30 minutes of continuous closing machine operation. The entire container must also be examined for defects. When there are defects, corrective actions must be taken. All these procedures must be documented.

Additional visual examination must be performed at the beginning of production, immediately following a container jam, and after every machine adjustment. This includes when there is a change in container size, per 9 CFR 431.2(c)(1). At least one container from each closure machine must be examined during each regular examination period, either before or after thermal processing at intervals of at least every 4 hours of continuous machine operation.

Equipment can assist in non-destructive examinations, including mechanical headspacers (which control headspace limits in the container) cocked-cap detectors and ejectors, and dud detectors (which detect low vacuums) are commonly found on glass-container closing lines and can affect sealing of the container. For example, if a headspacer is incorporated in the processing line, it is imperative that it is set properly. A headspacer can contribute to product overhanging the finish by dripping liquid and product on the glass finish, which may affect good sealing. Cocked-cap detectors/ejectors and dud detectors, if used, maintained, and set properly, can serve as useful tools in the evaluation of defective seals and sealing problems.

Physical Examination (Destructive):
The regulation requires that physical or destructive testing be performed by a trained closure technician at intervals of sufficient frequency to ensure proper closure, and in a manner provided

as guidance by the manufacturer. Sufficient frequency is defined as either before or after thermal processing at intervals not to exceed 4 hours of continuous closing machine operation. Specification guidelines for closure integrity must be on file and available for review, per 9 CFR 431.2(c)(2). Additional visual examination should be performed at the beginning of production, immediately following a container jam, and after every machine adjustment.

Security: Security values (lug tension of an applied closure) are the most reliable measurement of proper lug cap application. Security value ranges are supplied by the closure manufacturer to the processor. Generally, if measured values are always higher that the range specified, it indicates a secure package with some degree of over-application. If measured values are always lower than the range specified usually indicate under-application. Some factors that may affect the measured values are, type of plate, compound, and glass surface treatment applied by the container manufacturer.

Security measurement is a destructive test. There is no requirement as to the number of containers that should be tested; however, being a destructive test there are practical limits to the number of containers that one would test. A security test is performed as follows:
-Mark a vertical line on the cap and a corresponding line on the container.
-Turn cap counter-clockwise until the vacuum is broken.
-Reapply the cap until the closure is finger- tight.
-Measure the distance between the marked vertical lines in 1/16 inch increments.

Security is considered positive if the line on the cap is to the right of the line on the container and negative if the line on the cap is to the left of the line on the container. A high positive security can indicate under application; a negative security value can indicate over application. The cause of negative security should be determined, and corrective action taken immediately.

Security can be measured at the capper and after processing and cooling. The range of measurement, however, should be lower after processing due to compound sink that occurs with heat and high pressure.