OPERATING PRACTICES FOR FISHERY PRODUCTS IN HERMETICALLY SEALED CONTAINERS

SCOPE

This Operating Practice for Fishery Products in Hermetically Sealed Containers is used for approval of processing establishments that process low acid fishery products packed in hermetically sealed containers. This criterion covers the necessary practices and controls required for processing of such products, from the step of packing, sterilization and post-process handling, to ensure product safety. Besides, the operation of fishery products in hermetically sealed containers is required to follow the Good Manufacturing Practices of Fishery Products which is the basic requirements for all fish processing.

DEFINITIONS

1. **Fishery products in hermetically sealed containers** means fishery products which mostly have pH more than 4.6 and water activity more than 0.85 packed in containers that are able to prevent entry of microorganisms and spores after retorting. Such containers include cans, glass jars, retort pouches, semi-rigid containers, and etc.
2. **Container integrity** means the ability of the container to maintain hermeticity.
3. **Heat penetration test** means the scientific experiments conducted to determine the time required for the slowest hating point in a container to reach a specified temperature.
4. **Temperature distribution test** means the test conducted to locate the cold or slow heating zones in preparation for heat penetration test and to determine that the time and temperature requirements for venting are adequate to eliminate any cold spots in the retort.
5. **Scheduled process** means the process selected by the processor as adequate under the conditions of manufacture for a given product to achieve commercial sterility.
6. **Head space** means the vertical distance between the level of the product (generally the liquid surface) in the upright rigid container and the inside surface of the lid.
7. **Critical factor** means any property, characteristic, condition, aspect, or other parameter, variation of which may affect the validated scheduled process and the attainment of commercial sterility.
8. **Bleeder** means opening used to remove air that enters with steam from retorts and steam chambers and to promote circulation of steam in such retorts and steam chambers. Bleeders may serve as a means of removing condensate.
9. **Come-up time** means the time, including venting time which elapses between the introduction of the heating medium into the closed retort and the time when the temperature in the retort reaches the required sterilization temperature.
10. **Initial temperature** means the product temperature of the coldest container to be processed at the time the sterilization cycle begins.

REQUIREMENTS

1. Empty product containers

1.1 Product containers e.g. cans, glass jars and caps, and flexible containers including retort pouches and semi-rigid container should be made of sound material and able to maintain product quality as well as provide appropriate protection from contamination throughout the expected conditions of storage.

1.2 The product containers should be sufficiently durable to withstand the mechanical, e.g. seaming and sealing machine, and thermal stresses encountered during thermal

processing. With laminates particular attention should be paid to ensure that thermal process applied to the product does not cause delamination.

2. Inspection empty product containers

2.1 All lots of cans and lids brought into the cannery are inspected according to predetermined standards and procedures by the well trained personnel. Appropriate sampling and inspection schemes are in accordance with the international accepted or can manufacturer standard.

2.2 As a minimum an inspection and measurement should include :

2.2.1 Empty cans
1) Can integrity from both outside and inside containers
2) Double seam quality from both visual and tear-down inspection
3) Inside enamel or coating in the cans, and out side coating of the cans
4) General cleanliness

2.2.2 can ends
1) Sealing compound at end curl
2) General quality of ends
3) Cans of easy open type, the scoring is even and deep enough for the container to be opened easily, but not so deep that the end will tear after container closure.

2.2.3 Retort pouches and semi-rigid containers
1) General cleanliness
2) Defects such as delamination, improper tear notches, improper side or bottom seals.
3) Solvent or other off-odors from the interior of the pouch.

2.2.4 Glass containers
1) Breakage of glass
2) Scratches or hairline fractures
3) Deformed diameter of glass containers resulting in incomplete closures
4) Incorrect container heights and shapes resulting in incomplete closures

2.2.5 Caps for glass containers
1) Enamel faults, absence of enamel, scratches, weak adhesion of the enamel
2) Complete absence or poor distribution of the gasket compound or the use of the wrong type of material

2.3 Each pallet of empty cans and ends that are inspected and meets the set specification should have tag identifying its approval. Tag details include container manufacturer, date of receipt, quantity and container size.

2.4 All defective containers should be clearly identified and controlled to prevent unintentional use of such containers.

3. Proper use of product containers

3.1 Containers are handled and conveyed so as to prevent any damage or contamination before use. Records of container use are required to include container manufacturer, container size, and date of receipt and use.

3.2 During palletizing cans are periodically inspected for obvious defects by removing a random sample of cans form each pallet and visually inspecting for defects. Faulty rigid containers, e.g. those that have been dented or pierced, having severe scratches or deformed flanges, with defective seam, etc., should not be used.

3.3 All empty rigid containers are air or steam cleaned or washed with clean water prior to filling. Cleaned cans should be conveyed in such a position to prevent recontamination to containers. Rails for conveying cans to the filling lines should be of smooth with no any sharp portion which can damage the can bodies.

3.4 As each tube of can lids is put into seamer, it is to be inspected in the holder by rotating the tube for evidence of damage. Lids showing evidence of damage is to be removed and discarded.

3.5 Empty cans should be removed from the conveying rails which lead to the filling machines before production lines are washed down. It not practicable they may be shielded or located so that they will not become contaminated or obstruct clean-up operations.

4. Packing media

4.1 All ingredients added to products should be food grade quality and inspected upon receipt.

4.2 Mixing and application of packing media should follow the plant's established procedures and heat penetration study.

4.3 Equipment used in ingredient preparation, including dispenser on the lines, should be clean. Ingredient containers should be properly covered to prevent them from falling of foreign material.

5. Filling

5.1 Prior to can filling, fish is visually inspected for defects including off-colors, foreign matter, etc. Any defective material found is removed from the processing line and re-worked or rejected as required. For retort pouches, all products to be filled is examined to ensure that there are no projecting bones or other sharp objects that could pierce the pouch when the vacuum is drawn.

5.2 During Filling of containers, bones, skin, or product lying on flange or sealing area are removed. Such debris left on the flange or sealing area may cause incomplete formation of a double seam or seal when closing is applied. Periodical inspection should be carried out.

5.3 Fish fill, either by hand or by machine, and net content specifications for each style of pack is adhered to by plant employees engaged in can filling operations. Calibrated balance scales or other suitable weighing devices are available at the filling area to ensure that minimum fish fill weight and net weight requirements are met. Can filling monitoring is done on line inspection station by quality control staff. Accurate inspection records of fill weight and net weight are made and maintained.

5.4 Weighing scales, either automatic or manual, should be calibrated at the beginning of each shift.

5.5 Fill weight and net weight of product should meet the filling requirement as specified in the scheduled process.

5.6 For retort pouches the thickness of the filled container should not exceed the maximum thickness specified in the filed process. Measurement should be carried out by appropriate equipment.

5.7 The head space in rigid container or air content in flexible container should be controlled so as to meet the requirement as specified in the scheduled process.

5.8 The exhausting of containers for the removal of air, if affect to heat penetration of product during thermal process, should be controlled so as to meet the conditions for which the scheduled process was designed.

6. Closing operations

6.1 Sealing and seaming machines are maintained in good repair and kept cleaned before and after operation. Adjustment of such equipment should be routinely performed for each type of container.

6.2 Daily testing of double-seam or seal forming of the machine is performed before the routine operation starting up or when the lengthy shut down occur. Such testing should include visual and tear-down inspection from each seaming, sealing or closure head. All inspections are recorded and maintained.

6.3 Closing machine of product container should produce double-seams or seals with good integrity, and retain a proper vacuum, either obtained by hot filling, exhausting, vacuum closing or steam-flow closing. Vacuum in product container should be measured and recorded at intervals of sufficient frequency.

6.4 Duration between containers are filled and closed should be performed in an appropriated time without any delay. Control and prevention of such delay should be carried out during canning operation.

7. Inspection of container integrity

7.1 Visual examinations of the containers coming from the closing machine should be made at frequent intervals to detect any abnormalities. At a minimum, visual seam inspections of three containers from each closure head or seal inspection from each sealing bar for retort pouches and semi-rigid containers should be made at 30 minutes. When defects which may affect the integrity of the container are observed, immediate corrective action should be taken and recorded.

Defects to look for during external examination of double-seams are:

- Broken chuck
- Cut-over
- Cut-down flange (CDF)
- Droop
- False seam
- Fractured seam
- Knocked-down curl (KDC)
- Knocked-down end (KDE)
- Loose seam
- Spinner (skidder)
- Vee

Examples of defects for retort pouches and semi-rigid containers are:

- Blister
- Channel leaker
- Compress seal
- Crooked seal
- Delamination
- Misaligned seal
- Seal creep
- Uneven seal juncture
- Wrinkle

Examples of defects for glass containers are:

- Crushed lug
- Chipped glass finish
- Cut through
- Cocked cap
- Stripped cap
- Cracked glass finish

7.2 Complete double-seam inspections are done at least every four hours during production periods on a minimum of one can from each seaming head of every

operation line. When defects which may affect the integrity of the container are observed, immediate corrective action should be taken and recorded.

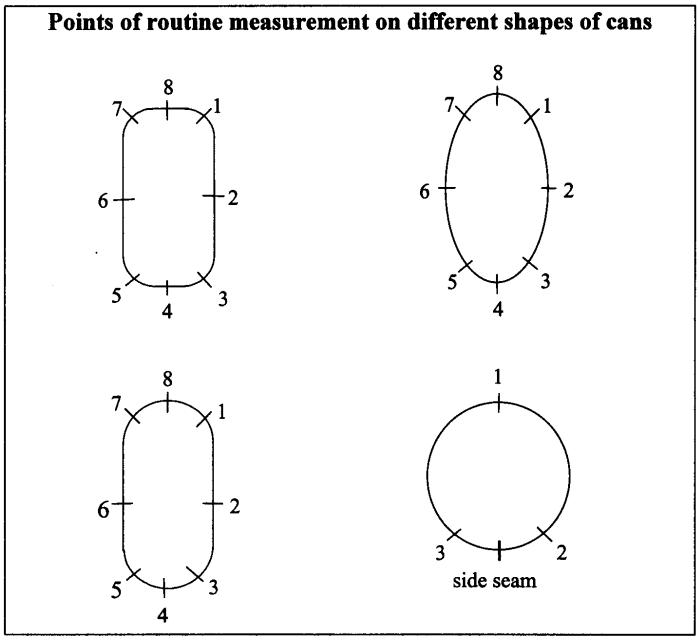
7.3 Tear-down inspection should follow international accepted method. Seam measurements on round cans are made at three points around the circumference of the can approximately 120 degrees apart and at least one-half inch away from the side seam crossover of a three piece can. Inspection includes:

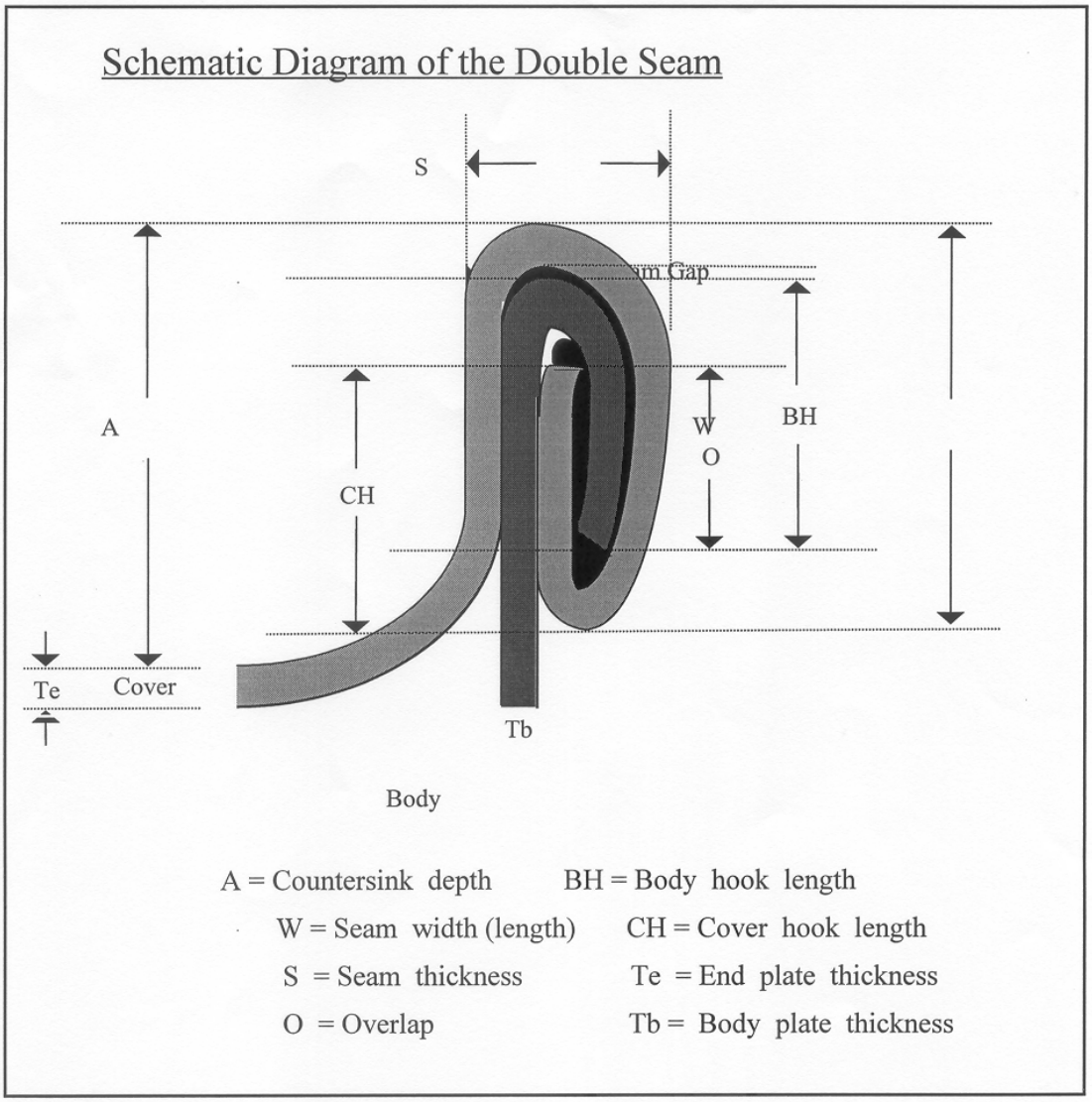
7.3.1 Seam width, seam thickness and countersink depth

7.3.2 Body hood and cover hook 9end hook)

7.3.3 Seam tightness (or wrinkle free) and pressure ridge

Points of routine measurement on different shapes of cans





$$O = CH + BH + Te - W$$

$$\% \text{ overlap} = \frac{O}{W - (2\,Te + Tb)} \times 100$$

$$\% \text{ Body hook butting} = \frac{BH - 1.1\,Tb}{W - 1.1\,(2\,Te + Tb)} \times 100$$

$$\text{Free space} = S - (2\,Tb + 3\,Te)$$

7.4 When using the micrometer, the zero gradation mark on the rotatable barrel should match exactly with the index line on the stationary body member.

7.5 For retort pouches and semi-rigid containers, seal inspection should include examination of seal strength either by tensile inspection or burst test at the frequency of approximately every 4 hours. Sampling should be of 1 pouch for each position on the sealing bar.

7.6 If can integrity defective are found, the closure machine should be stopped and all container sealed or closed between the discovery of the fault and the last approved container inspection should be isolated, identified and held for further testing.

8. Practices after container closure

8.1 All sealed cans should be thoroughly washed prior to retorting to remove grease, dirt and product from the outside of the cans. Food approved detergents should be used for can washing. The chosen detergent and any brushes used must not react with or affect the can enamel or palate, or cause physically damage to the cans.

8.2 When loading products in to the retort basket, care is taken to ensure that product containers, particularly flexible containers, are not damaged or defective to result in container integrity.

8.3 When loading the retort basket, cans are arranged so that the flow of steam is not impeded. The loose edges of the pouches may overlap but the product inside the pouch must not overlap.

8.4 Records of basket loading are made. Basket loading records indicate approximate number of containers, container size, code, and time on the clock when loading of the basket was started and completed.

8.5 A traffic control system such as a double ended retort, a barrier, gate of a device is installed or closing retort only when the retort operator is ready to start the process, to ensure that no retort baskets, trucks, cars or crates of uncooked containers can by-pass the retorts.

8.6 Each retort basket is marked with a heat-sensitive indicator which will undergo a change in appearance only after exposure to processing temperatures, or by other effective means. Such mark should be kept to indicate whether or not those units have been retorted.

9. Product code

All containers are legibly embossed or permanently inked at the time of can closing, with a product code indicating the establishment, date of processing and product type, and does not adversely affect the container integrity.

10. Thermal process operation

10.1 The time between seaming the first container of the lot and the commencement of thermal processing should not exceed two hours.

10.2 The initial temperature of the contents of the coldest containers to be processed should be determined and recorded with sufficient frequency to ensure that temperature of the products is not lower than the minimum initial temperature specified in the scheduled process.

10.3 If products are sterilized in steam still retort, venting procedures used shall be applied from the established schedule which demonstrates that all air is completely removed from the retorts. At the time steam is turned on, the drain should be opened for a time sufficient to remove steam condensate from the retort walls, retort baskets or product container surroundings.

10.4 Scheduled processes shall be established by qualified persons having expert knowledge of thermal processing requirements for low-acid foods in hermetically sealed containers and having adequate facilities for making such determinations. Complete records shall be prepared and cover all critical factors that may affect the scheduled process, such as

- packing type and product formulation,
- container size,
- maximum fill-in-weights,
- minimum headspace,

- pH of product,
- air contents in product container,
- initial temperature
- process temperature and time

10.5 Thermal process to be used shall be strictly followed in accordance with the established scheduled process. If steam still retorts are used, controls shall include venting schedule, process temperature and time, and cooling after processing.

11. Process control

11.1 Schedules of approved heat processes for each can size, for each type and style of product must be posted near the retort operator's station or made readily available to the retort operator, so that there is no misunderstanding of the proper process to be followed.

11.2 Heat processing and associated processing operations shall be performed and supervised only by properly trained personnel.

11.3 All areas around the retorts, particularly those where retort baskets of processed product are handled, transported through, or removed from the retort, are kept in a clean and sanitary condition. Floors do not have areas of standing water which result in splashing of contaminated water from the wheels of the retort baskets.

11.4 Commercial sterility must be accomplished using such equipment and instruments as are needed to ensure that the scheduled process is achieved. Checks should be made to such equipment as a proper interval.

11.5 The thermal process must be continuously monitored using the instruments as described in 12.1.1 and 12.1.2, or 12.2.1 and 12.2.2

11.6 Timing devices used in recording thermal process time information shall be accurate to the extent needed to ensure that the processing time and venting time specified in the scheduled process are achieved. Pocket or wrist watches are not considered satisfactory for timing purposes. Where two or more clocks or other timing devices are used in a heat processing room they shall be synchronized. Clock shall be positioned in such a manner that it is clearly visible from the retort operator's station.

11.7 The steam supply to the thermal processing system shall be adequate to the extent needed to ensure that sufficient steam pressure is maintained during thermal processing, regardless of other demands of steam by the plant. The steam header pressure must maintain a minimum pressure of 90 p.s.i. during maximum utilization-prior to venting commencement. Where lower pressure is applied, proof shall be able to demonstrate an adequacy of thermal process.

12. Retort equipment

12.1 Steam still retort

12.1.1 Mercury-in-glass thermometer (MIG)

1) Each retort shall be equipped with mercury-in-glass thermometer and in a position where they can be accurately and easily read by retort operators. Thermometer's divisions are easily readable to 0.5◦C and temperature range does not exceed 4◦C per centimeter of graduated scale.
2) Thermometers shall be tested for accuracy against a known accurate standard thermometer upon installation and at least once a year thereafter, or more frequently if necessary, to ensure their accuracy. Records of thermometer accuracy checks that specify date, standard used, method used, and person performing the test should be

maintained. A thermometer that has a divided mercury column or that cannot be adjusted to the standard shall be repaired or replaced before further use of the retort.

3) Each thermometer should have a tag, seal, or other means of identity that includes the date on which it was last tested for accuracy and the next calibration date.
4) Bulbs of indicating thermometers shall be installed either within the retort shell or in external wells attached to the retort. External well or pipes shall be connected to the retort through at least a 3/4 inch diameter opening equipped with a 1/16 inch or larger bleeder opening so located as to provide a full flow of steam past the length of the thermometer bulb.
5) The mercury thermometer – not the recorder chart – shall be the reference instrument for indicating the processing temperature.

12.1.2 Temperature recording device

1) Each retort shall have a temperature recording device with graduations not exceed 1◦ C within a range of 5◦ C of the processing temperature. The temperature chart shall be adjusted to agree as nearly as possible with, but to be in no event higher than, the known accurate mercury-in-glass thermometer during the process time.
2) Recorder adjustment shall be made only by an authorized person. A means of preventing unauthorized changes in adjustment shall be provided, such as a notice or a lock. The recorder may be combined with the steam controller and may be a recording controlling instrument. Air-operated temperature controllers should have adequate filter systems to ensure a supply of clean, dry air.
3) If the temperature recorder bulb is installed in an external well attached to the shell, the well shall have a 1/16 inch or larger bleeder which emits steam continuously during the processing period.
4) The temperature recording device shall be accurate, reliable and checked regularly.

12.1.3 Pressure gauge

1) Each retort should be equipped with a pressure gauge which has a range from zero such that the safe working pressure of the retort is about two-thirds of the full scale and be graduated in divisions not greater than two psi (0.14 kg/cm^2). The gauge dial should not be less than four inches (102 mm) in diameter.
2) The gauge should be checked for accuracy at least once a year. Each gauge should have a tag, seal, or other means of identity that includes the date on which it was last tested for accuracy. Pressure gauge and MIG thermometer which have tested for accuracy shall give a corresponding pressure and temperature at the same sea level.

Corresponding gauge pressure (psi) and process temperatures

Temp (°F)	Sea level	Feet Above Sea Level 500	1000	2000	3000	4000	5000	6000	Temp (°C)
200	–	–	–	–	–	–	–	–	93.3
205	–	–	–	–	–	–	0.5	0.9	96.1
210	–	–	–	0.4	0.9	1.4	1.8	2.3	98.9
212	0.0	0.2	0.5	1.0	1.5	2.0	2.4	2.9	100.0
215	0.9	1.1	1.4	1.9	2.4	2.9	3.3	3.8	101.7
220	2.5	2.7	3.0	3.4	3.9	4.4	4.9	5.3	104.4
225	4.2	4.5	4.7	5.2	5.7	6.2	6.6	7.1	107.2
230	6.1	6.3	6.6	7.1	7.6	8.0	8.5	9.0	110.0
235	8.1	8.3	8.6	9.1	9.6	10.0	10.5	11.0	112.8
240	10.3	10.5	10.8	11.3	11.7	12.2	12.7	13.1	115.6
242	11.2	11.4	11.7	12.2	12.7	13.1	13.6	14.1	116.7
245	12.6	12.9	13.1	13.6	14.1	14.6	15.0	15.5	118.3
248	14.1	14.3	14.6	15.1	15.6	16.0	16.5	17.0	120.0
250	15.1	15.4	15.6	16.1	16.6	17.1	17.5	18.0	121.1
252	16.2	16.4	16.7	17.2	17.7	18.1	18.6	19.1	122.2
255	17.8	18.1	18.3	18.8	19.3	19.8	20.2	20.7	123.9
260	20.7	21.0	21.2	21.7	22.2	22.7	23.1	23.6	126.7
265	23.8	24.0	24.3	24.8	25.3	25.8	26.3	26.8	129.4
270	27.3	27.5	27.8	28.3	28.8	29.3	29.8	30.3	132.2
275	30.9	31.2	31.5	32.0	32.5	33.0	33.5	34.0	135.0

12.1.4 Steam controller

Each retort shall be equipped with an automatic steam controller to maintain the retort temperature. This may be a recording-controlling instrument when combined with a recording thermometer. The steam controller may be air-operated and actuated by a temperature sensor positioned near the mercury-in-glass thermometer in the retort

12.1.5 Steam inlet

The steam inlet to each retort shall be large enough to provide sufficient steam for proper operation of the retort. Steam may enter either the top portion or the bottom portion of the retort but, in any case, shall enter the portion of the retort opposite the vent.

12.1.6 Steam spreader

1) Steam spreaders are continuations of the steam inlet line inside the retort. Horizontal still retorts shall be equipped with steam spreaders that extend the length of the retort. Horizontal still retorts over 30 feet long should have two steam inlets connected to the spreader.
2) For steam spreaders along the bottom of the retort, the perforations should be along the top 90◦ of this pipe, that is, within 45◦on either side of the top center as shown in the following figure.

3) Size of steam spreader holes should not be smaller than 3/16 inch. Numbers of the holes should correspond with the size of steam inlet which should be such that the total

cross-sectional area of the holes is equal to $1^{1/2}$ to 2 times the cross-sectional area of the smallest restriction in the steam inlet line.

4) Steam spreaders should be constructed with a rust-resistant material. Spreader holes should not be clogged with scale and kept in good repair to provide a complete steam distribution in the retort.

Corresponding the numbers of holes and the steam inlet size

Size of holes inches	Numbers of holes; Steam inlet size standard pipe				
	1 inch	1 ¼ inches	1 ½ inches	2 inches	2 ½ inches
3/16	47-62	81-108	11-148	183-244	260-346
7/32	35-56	60-80	71-108	135-180	190-254
1/4	27-36	45-60	63-84	102-137	147-196
5/16	-	30-40	40-54	66-88	93-124
3/8	-	21-28	28-37	45-60	66-88
7/16	-	-	21-28	33-45	48-64
1/2	-	-	15-20	26-36	36-48

12.1.7 Bleeders

1) Bleeders, except those for thermometer wells, shall be one-eighth inch or larger. For horizontal still retorts, bleeders shall be located within approximately one foot of the outermost locations of containers at each end along the top of the retort; additional bleeders shall be located not more than eight feet apart along the top. Bleeders maybe installed at positions other than those specified above, as long as there is evidence in the form of heat distribution data that they accomplish adequate removal of air and circulation of steam within the retort.
2) All bleeders shall be arranged in such a way that the operator can observe that they are functioning properly. They should be wide open during the entire process, including the come-up-time.
3) In retorts having top steam inlet and bottom venting, a bleeder or other suitable device shall be installed in the bottom of the retort to continuously remove condensate.

12.1.8 Stacking equipment

1) Retort baskets for holding product containers shall be so constructed that steam can adequately be circulated around the containers during venting, coming-up and sterilization times, e.g. strap iron. All retort baskets shall be free of sharp edges, welding slag, rough of damaged slats on the side-walls.

2) When the divider plates are used, the perforations should be approximately the equivalent of one- inch holes diameter on two inch centers. The dividers used shall fit the baskets adequately in order to prevent can nesting.
3) Only single dividers are used between layers in retort baskets. The positioning of containers in the retort, when specified in the scheduled process, shall be in accordance with that process.

12.1.9 Vents

1) Vents shall be installed in such a way that air is removed from the retort before timing of the process is started. They should be located in that portion of the retort opposite the steam inlet; for example, steam inlet in bottom portion and vent in top portion. Vent shall be of a size that the cross-sectional area of the pipe is larger than that of steam inlet. Vents shall not be connected directly to a closed drain system without an atmospheric break in the line.
2) Vents shall be controlled by gate, plug cock, ball, or other adequate type valves which shall be fully open to permit rapid discharge of air from the retort during the venting period.
3) Where a retort manifold connects several vent pipes from a single still retort, it shall be controlled by a single suitable valve (as mentioned above). For horizontal still retort, each vent pipe shall be located not more than 5 feet apart along the top and approximately two and half feel from each retort end. The retort manifold shall be of a size that the cross-sectional area of the pipe is larger than the total cross-sectional area of all connecting vents.
4) A manifold header connecting vents or manifolds from several still retorts shall lead to the atmosphere. The manifold header shall not be controlled by a valve and should be of a size such that the cross-sectional area is at least equal to the total cross-sectional area of all connecting retort manifold pipes from all retorts venting simultaneously.

12.1.10 Safety valve

1) All retorts are equipped with safety valves to release excessive steam may enter into the retorts and cause over pressure exceeding the safe working level. Such valves shall be of a type and installed in a manner that in accordance with the specifications of manufacturers.
2) Safety valve should be checked regularly for proper operations and set-point as required. Their outlet should be installed in such a direction that not harmful to the retort operators when the excessive steam pressure is release.

12.1.11 Air inlet

Retorts using air for pressure cooling shall be equipped with an adequate tight closing valve and piping arrangement on air line to prevent leakage of air into the retort during processing.

12.2 Pressure water in still retort

12.2.1 Mercury-in-glass thermometer (MIG)

1) Each retort shall be equipped with mercury-in-glass thermometer and where they can be accurately and easily read. Thermometer's divisions are easily readable to 0.5◦C and temperature range does not exceed 4◦C per centimeter of graduated scale.
2) Thermometers shall be tested for accuracy against a known accurate standard thermometer upon installation and at least once a year thereafter, or more frequently if necessary, to ensure their accuracy. Records of thermometer accuracy checks that specify date, standard used, method used, and person performing the test should be maintained. A thermometer that has a divided mercury column or that cannot be adjusted to the standard shall be repaired or replaced before further use of the retort.
3) Each thermometer should have a tag, seal, or other means of identity that includes the date on which it was last tested for accuracy and the next calibration date.

4) Bulbs of indicating thermometers shall be located in such a position that they are beneath the surface of the water throughout the process at least 2 inches without a separable well or sleeve. On horizontal retorts, this entry should be made in the side at the center, and the thermometer bulbs shall be inserted directly into the retort shell.
5) The mercury thermometer – not the recorder chart – shall be the reference instrument for indicating the processing temperature.

12.2.2 Temperature recording device

1) Each retort shall have a temperature recording device with graduations not exceed 1◦ C within a range of 5◦ C of the processing temperature. The temperature chart shall be adjusted to agree as nearly as possible with, but to be in no event higher than, the known accurate mercury-in-glass thermometer during the process time.
2) Recorder adjustment shall be made only by an authorized person. A means of preventing unauthorized changes in adjustment shall be provided, such as a notice or a lock. The recorder may be combined with the steam controller and may be a recording controlling instrument.
3) The recording thermometer bulb should be located adjacent to the bulb of the mercury-in-glass thermometer or at the lowest temperature in the retort where there is no opportunity for direct steam impingement on the control bulb.
4) The temperature recording device shall be accurate, reliable and checked regularly.

12.2.3 Pressure gauge

1) Each retort should be equipped with a pressure gauge which has a range from zero such that the safe working pressure of the retort is about two-thirds of the full scale and be graduated in divisions not greater than two psi (0.14 kg/cm^2). The gauge dial should not be less than four inches (102 mm) in diameter.
2) The gauge should be checked for accuracy at least once a year. Each gauge should have a tag, seal, or other means of identity that includes the date on which it was last tested for accuracy. Pressure gauge and MIG thermometer which have tested for accuracy shall give a corresponding pressure and temperature at the same sea level.

12.2.4 Safety valve

1) All retorts are equipped with safety valves to release excessive steam may enter into the retorts and cause over pressure exceeding the safe working level. Such valves shall be of a type and installed in a manner that in accordance with the specifications of manufacturers.
2) Safety valve should be checked regularly for proper operations and set-point as required. Their outlet should be installed in such a direction that not harmful to the retort operators when the excessive steam pressure is release.

12.2.5 Pressure control valve

In addition to the pressure safety valve an adjustable pressure control valve of a capacity sufficient to prevent undesired increases in retort pressure should be installed in the overflow line. This valve also controls the maximum water level in the retort. The valve should be suitable screened to prevent blockage by floating containers or debris.

12.2.6 Steam controller

Each retort shall be equipped with an automatic steam controller to maintain the retort temperature. This may be a recording-controlling instrument when combined with a recording thermometer. The steam controller may be air-operated and actuated by a temperature sensor positioned near the mercury-in-glass thermometer in the retort

12.2.7 Steam inlet

The steam inlet to each retort shall be large enough to provide sufficient steam for proper operation of the retort and that create a proper heat distribution throughout the retort.

12.2.8 Stacking equipment

Retort baskets for holding product containers shall be so constructed that steam can adequately be circulated around the containers during venting, coming-up and sterilization times, e.g. strap iron. All retort baskets shall be free of sharp edges, welding slag, rough of damaged slats on the side-walls. Special equipment will be required to ensure that the thickness of filled flexible containers will not exceed that specified in the scheduled process and that they will not become displaced and overlap one another during the thermal process.

12.2.9 Drain valve

A screened, non-clogging, water-tight valve should be used.

12.2.10 Water level

There should be a means of determining the water level in the retort during operation, e.g. by using a water gauge glass or petcock. Water should adequately cover the top layer of containers during the entire coming-up, sterilizing and cooling periods. This water level should be at least 15 cm or 6 inches over the top layer of product containers in the retort.

12.2.11 Air supply and controls

1) In still retorts for pressure processing in water, a means should be provided for introducing compressed air at the proper pressure and rate. The retort pressure should be controlled by an automatic pressure control unit. A non-return valve should be provided in the air supply line to prevent water from entering the system.
2) Air or water circulation should be maintained continuously during the coming-up-time, processing and cooling periods. If air is used to promote circulation it should be introduced into the steam line at a point between the retort and the steam control valve at the bottom of the retort.

12.2.12 Cooling water entry

In retorts processing glass jars the cooling water should be introduced in a manner which avoids direct impingement on the jars, in order to prevent breakage by thermal shock.

12.2.13 Retort head space

The head space necessary to control the air pressure should be maintained between the water level and the top of the retort shell.

12.2.14 Water circulation

All water circulation systems used for heat distribution should be installed in such a manner that an even temperature distribution throughout the retort is maintained. Checks for correct operation should be made during each processing cycle, for example, alarm systems to indicate malfunction of water circulation.

12.3 Water spray retort

12.3.1 Temperature distribution must be tested appropriately for each retort model, type of product, packaging and stacking equipment.

12.3.2 Mercury-in-glass thermometer and temperature recording device should be positioned in such a manner that the retort temperature can be read accurately.

12.3.3 There should be a means of determining the water flow in the retort. This water flow rate should comply with the heat distribution study performed in such retort.

12.3.4 Water spreader should be kept in good repair. Holes should not be clogged with scale and regular maintenance program be carried out.

12.4 Steam-air mixture retort

12.4.1 System used for circulating the steam-air mixtures should provide acceptable heat distribution as established by adequate tests. There should not be any portion of retort that holds a low temperature pocket.

12.4.2 The operation of the heat processing system should be the same as that required by the scheduled process and instruction manual of the retort manufacturer. Examples of process controls are monitoring of the fan speed, control of pressure of air mixing with steam.

13. Deviation in thermal processing

Whenever any process is less than the scheduled process or when critical factors are out of control, the following actions should be taken.

13.1 Segregate and fully reprocess that portion of the production involved. Full records of the reprocessing conditions shall be kept for further evaluation.

13.2 Set aside that portion of the product involved for further evaluation as to any potential public health significance. Such evaluation shall be made by a competent processing authority and shall be in accordance with procedures recognized by competent processing authorities as being adequate to detect any potential hazard to public health.

14. Cooling

14.1 After thermal process the containers shall be cooled as rapidly as possible. Water used for cooling shall be of potable water quality. In steam still retort water shall be chlorinated and a measurable level of free chlorine residues is required in the cooling water at the discharge end of retort. Residual chlorine shall be measured at least twice per packing shift.

14.2 Cooling water should be stored in sanitary condition with proper cover. When cooling water is chlorinated, there should be a sufficient contact time of at least 20 minutes to reduce the microbial content of the water to a level which will minimize the risk of contamination in the can contents during cooling.

14.3 Where water is recirculated any insoluble organic matter shall be separated. A suitable treatment system shall be commenced to achieve potable water quality before use.
14.4 Where an alternative method of treatment is used, it must be equivalent to the use of chlorine.

15. Post-process handling

15.1 After water-cooling of the products in the retorts, the retort baskets should be properly tilted to allow any water to drain from the can surface before place in air cool area.
15.2 There shall be no handling of hot and wet cans. The processed containers shall be handled with sanitizing gloves (hand dips should be provided in the restricted areas).
15.3 The post-process area shall be restricted to those employees working in this area. It shall be separated from other areas in such a way that neither unauthorized people nor unprocessed product can easily enter the area. Facilities must be constructed and maintained so that cooling cans are not exposed to dust, dirt, other debris, condensed water, or outside environment. If fans are used, ensure they are cleaned regularly.
15.4 Cans which are ready for palletizing or cartooning shall be of cool and dry. Rough handling causing damage to can bodies, seam and ends, such as dents, malformed seams shall be avoided.

16. Product inspection before and after labeling

The filled and sealed cans shall be examined to remove defective, swollen, rusty, dirty, or damaged cans before and after labeling. Production lots in which defective or swollen cans have been found shall be isolated and clearly identified from other finished products for further testing of destroyed.

17. Product warehouse

17.1 Warehouse shall be kept in good repair. All finished product is stored with good ventilation and humidity, sufficient to prevent overheating or moist. A sanitation program shall be implemented to protect products from dust, dirt, and other debris.
17.2 Products shall be stored in an orderly manner. An appropriate gap shall be maintained between the products and the walls for inspection and cleaning purposes.
17.3 Warehouse shall be insect and rodent-free. Pest control program shall be maintained in the establishment.

18. Processing records

18.1 Permanent process records are prepared clearly and promptly as the various step of the retorting process are complete. Record forms identify all necessary information including dates and name of person who made the record.
18.2 Retort logs of all retorting systems must include the following information:

- Retort number
- product, including packing style
- product code
- can size
- approximate number of cans
- initial temperature
- the scheduled and actual processing time
- temperatures from mercury thermometer and recording thermometer readings
- pressure in retort

For steam still retort, the following additional information is required:

- time steam on
- venting time and temperature
- temperature and time sterilization start
- time steam off

For pressure water in still retort, the following additional information is required:

- time steam on
- come-up time
- time sterilization start
- process temperature
- water level, if water immersion type of process is applied
- water circulation and pressure maintained, if water immersion type of process is applied
- flow rate, if water spray is applied
- time steam off

For steam-air mixture retort, the following additional information is required:

- time steam on
- come-up time
- time sterilization start
- maintenance of circulation of steam-air mixture
- process temperature
- time steam off

18.3 All the monitoring records shall be reviewed by designated person to ensure that such records are complete and the production is in control not later than 24 hrs from the production day. All records shall be kept at least for 3 years.