A Guide to Can Defects and Basic Components of Double Seam Containers

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Introduction

Canned foods are among the safest food processed today. Approximately 60% of food consumed in the United States is thermally processed and packaged in hermetically sealed containers. However, regardless of the safety assured in canned foods, any damaged or defective canned products are a potential public health problem. Defective cans may leak and allow microorganisms to enter that may cause food poisoning or other significant threat and a potential public health problem to consider when dealing with serious defective/damaged canned food containers requiring inspection, evaluation and sampling. It is imperative that canned food products with visual and/or external defects be recognized. Those containers with "critical defects" should not be sold, distributed or consumed. Those containers with "major defects" may become a public health concern and should not be marketed without testing before sale. However, canned food with "minor defects" normally represent no public health hazard, i.e. if the hermetic seal on the can has not been jeopardized, these products are generally considered safe and, when properly labeled, such products are acceptable for distribution and sale.

Purpose of Guide

This guide is intended in part to help resolve the question which frequently arises concerning the evaluation and safety of canned food products: When does the can defect or damage become severe enough to represent a public health concern or hazard?

This simplified guide shows in color some of the major types of can defects which may be commonly found by visual observation. It categorizes the defects/damages according to their degree of potential hazard, and shows what to look for in the routine visual inspection of the finished product. These classifications may change after laboratory examination. It is essential that prior to sale, samples of each defect suspected of causing loss of hermetic seal be collected for laboratory examination, i.e. measurement and integrity of can seams, microbiological analysis of contents, etc. Note that a “hermetically sealed” container for canned food and/or beverages is considered as one that is appropriately constructed/designed and intended to assure no entry of bacterial microorganism and thus maintain the commercial sterility of its contents after thermal processing. Other definitions commonly and frequently used in the visual evaluation of can defects are included as part of this guide for a quick and simple reference and for use in the field.

Classification for Defective/Damaged Canned Goods

The extent of a defective/damaged canned foods container will determine its classification. Classification is as follows:

Class I -- Critical Defects: Defects which provide evidence that the container has lost its hermetic seal (i.e. holes, fracture, punctures, product leakage, etc.) or evidence that there is, or has been, microbial growth in the can contents.

This is a critical defect rating which would be considered a potential public health problem. Any lot which is found to have a defect must be set aside and thoroughly inspected and sorted to ensure that no containers that have lost their hermetic seal are distributed.

Class II -- Major Defects: Defects that result in cans which do not show visible signs of having lost their hermetic seal, but are of such magnitude that they may have lost their hermetic seal.

This is a major defect rating which may result in the loss of the hermetic seal and become a public health problem. Even though a Class II defect may not be health threatening by itself, a large number of cans with Class II defects necessitates more extensive sampling of such lots before sale. Evidence of a significant number of Class II defects may be considered a potential public health problem.

Class III -- Minor Defects: Defects which have had no adverse effect on the hermetic seal.

This is a defect rating a minor significance from a public health standpoint. This guide is not concerned with defects that only affect commercial sale. For example, dented cans which will not stack on shelves may be rated as a Class III when neither the double seam, side seam nor the body has been adversely affected. If the effect on the hermetic seal cannot be determined, sampling and examination would be appropriate.

Photographs of Defective Canned Foods
Class I - Critical Defects

Body/End Defects

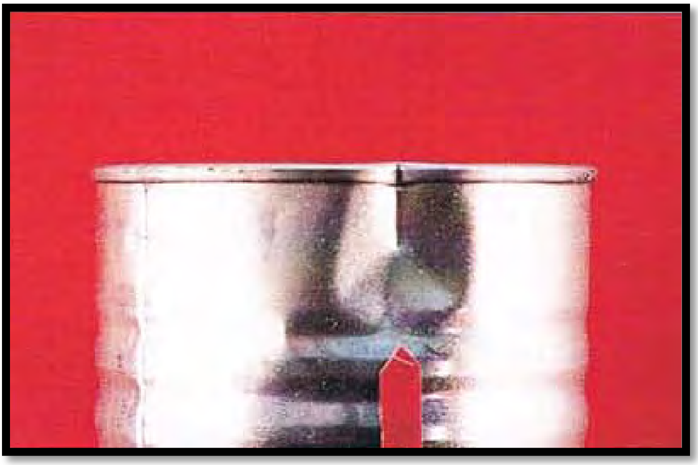
Photo 1: *Bulged and/or swollen ends from gas formation in can which causes one or both ends to swell producing a flipper, soft swell, hard swell, or blown can.*

Photo 2: *Can with likely loss of hermetic seal and normally a leader due to the mislocked side seam.*

Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 3: *An opening below the double seam or plate fracture.*

Photo 4: *Plate fracture in double seam or can body. Note position of red pointer.*



Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 5: *Severe double seam dent plate fracture.*

Photo 6: *Puncture in can body. Pinholes in can body plate also cause loss of hermetic seal.*

Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 7: *Closure on end of can reflects incomplete double seam (Double seaming operation not completed by manufacturer).*

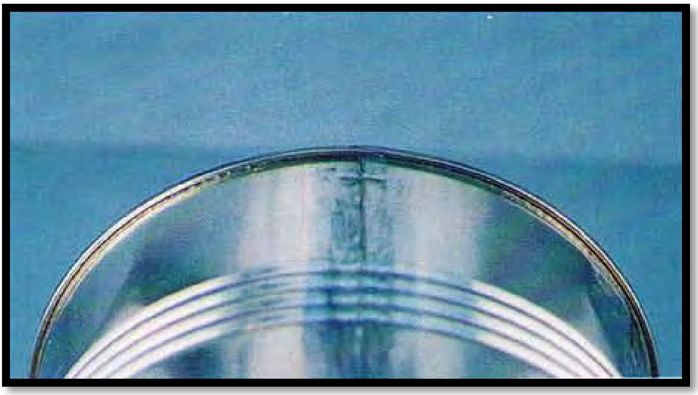


Photo 8: *Defect in end of closure on can (torn flange). Note arrow pointer.*

Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 9: *Depicts a **false seam** with loss of hermetic seal. Seam is formed buy not engaged properly. Note knocked down flange.*

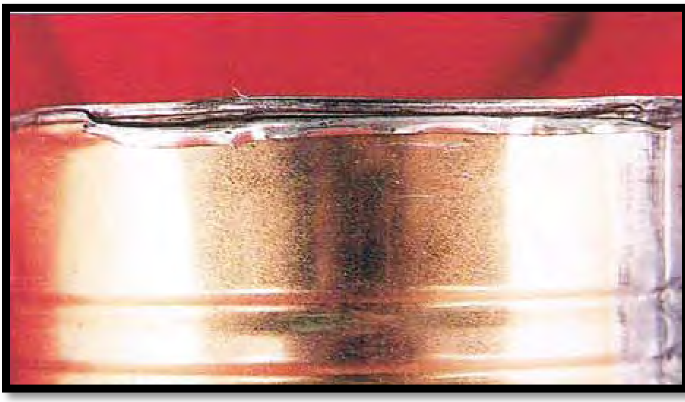
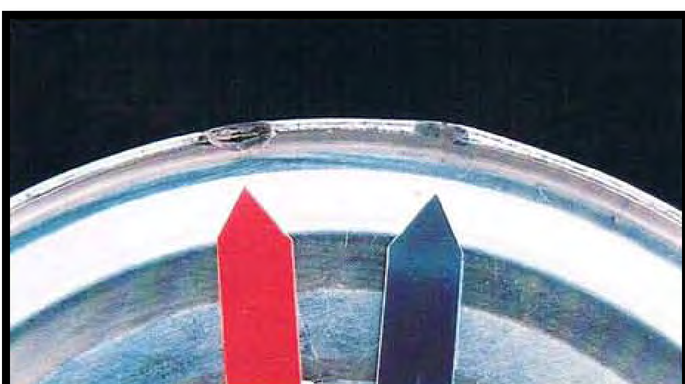


Photo 10: *Example of a **cable cut** on can end. Red pointer shows "significant defect," i.e., cut through double seam. Blue pointer depicts cut/abrasion not through double seam.*

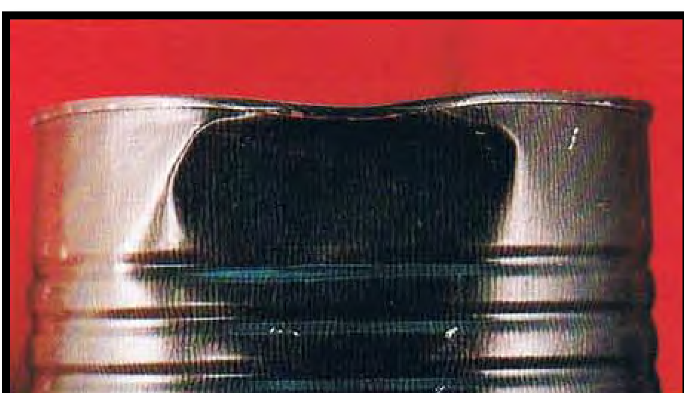


Photographs of Defective Canned Foods
Class II – Major Defects

Body Dents, End/Closure, and Rust Defects

Photo 11: *Severely rusted with deep pits near point of perforation.*

Photo 12: *Major body dent which has impacted on double seam. (Plate may be fractured with loss of hermetic seal.)*



Photographs of Defective Canned Foods
Class II – Major Defects

Photo 13: *Major dent in center of can body. (Plate may be fractured with loss of hermetic seal.)*

Photo 14: *"Cut-over" depicting sharp seam. (Observe for potential plate fracture or loss of hermetic seal).*

Photographs of Defective Canned Foods
Class II – Major Defects

Photo 15: *Defect shown termed a "vee" or "spur" with end curl knocked down. Can is a potential leaker.*

Photo 16: *Pointer indicates "knocked down flange."*

Photographs of Defective Canned Foods
Class II – Major Defects

Photo 17: *Cans that are buckled during retorting may leak during the cooling operation because the double seam has been strained.*

Photo 18: *Cans exhibiting severe paneling of the side walls.*

Photographs of Defective Canned Foods
Class III – Minor Defects

Body/End Defects

Photo 19: *Surface rust and residue food cooked on end of can. (Minor external rust and light superficial pitting easily removable by light buffing is considered an insignificant defect).*

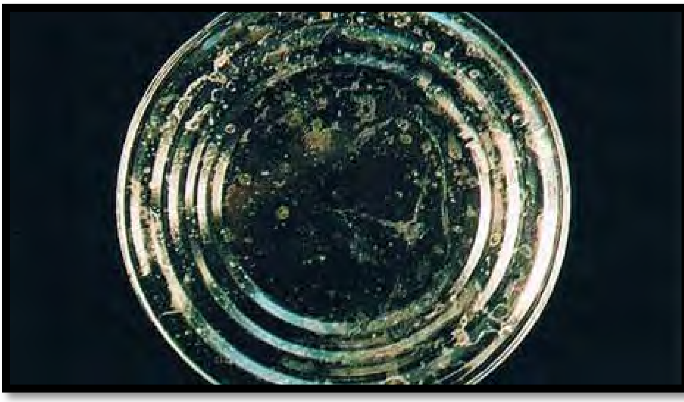


Photo 20: *Paneled container without visible signs of loss of integrity, i.e., no plate fractures.*

Photographs of Defective Canned Foods
Class III – Minor Defects

Photo 21: *Obvious body dent on side of container body. Side seam and/or double seams appear not significantly affected.*

Photo 22: *Minor dent to double seam on end of can body, i.e., it does not appear creased or sharp.*

Photographs of Defective Canned Foods
Class III – Minor Defects

Photo 23: *Minor "buckle" just extending into double seam on end of can body. (Double seam does not appear significantly affected).*

Basic Components of Double Seam Containers

Metal for Can Manufacturing

The "tin" can was originally manufactured from steel sheets that had been dipped in molten tin. This "hot dipped" method was gradually replaced by electroplating the tin coating onto the base steel. This new method allowed for the application of lower and more uniform weights of tin as well as different weights of tin on each side of the sheet. Also, electrolytically coated plate is produced in a continuous coil rather than from individual sheets.

Today enamel coated tin-free steel -- steel sheet with a light chromium surface treatment but no tin coating -- is used extensively for applications where tin is not required to protect against corrosion or to facilitate the side seam welding process. For instance, tin-free steel is widely used for ends and for the manufacture of drawn two-piece cans.

Certain characteristics of the plate used in can manufacture affect the characteristics of the finished double seams. Depending on the can's size and strength requirements, different thicknesses of metal can be used. For steel containers the thickness of the metal is indicated by specifying the theoretical weight in pounds per base box; this is known as the base weight. When dealing with other materials, such as aluminum or plastic, thickness is specified directly in inches or millimeters. The temper of tinplate or tin-free steel, usually designated by a number such as Tl, T2, T3, etc, indicates the forming properties or hardness of tinplate (Tl = dead-soft; TS = very hard). Double cold-reduced (2CR) or double-reduced (DR) tinplate or tin-free steel are steel-tin mill products that are given a partial cold reduction to near final gauge and then given another cold reduction to final gauge. The resulting plate is stiffer, harder and stronger than conventional tinplate and enables the use, wherever applicable, of lower base weights for container components. Neither plate thickness nor tempers can be attained in tinplate without some variation. Those characteristics can only be controlled within a range, with the nominal value somewhere in the middle of that range. Obviously, with some variability in the basic materials used in can manufacture, double seam characteristics can also reflect similar degrees of variability.

Metal Can Body

The **three-piece can** is made from a formed body with a welded side seam and two ends. One end is placed on the can by the can manufacturer while the other is attached after the food is placed in the can. All three-piece cans used in the United States have welded side seams. Initially side seams were soldered with lead solder, but FDA has since banned the use of lead solder to manufacture food cans. In 1991, food can manufacturers terminated their use of lead in solder; however without the lead in the solder, the formation of the soldered side seam was unsatisfactory. Since that time, can manufacturers turned to welded side seams to replace the soldered side seams. The welded side seam has alleviated several defects that were inherent with soldered side seams; these differences will be addressed in later sections of this guide. There may be some countries where soldered side seams are still produced using lead in the solder; however, products placed in these cans are not allowed into the United States.

The **two-piece can** is formed in one of two ways – drawing and redrawing (DRD) or drawing and ironing (D&I). DRD produces cans with thicker metal to withstand pressure during thermal processing and vacuum formation upon cooling. This type of container is formed by punching a piece of metal through various dies until the final can shape is attained. D&I is used mainly for aluminum cans where the gas pressure from the beverage production maintains the shape of the can. This type of process produces thinner metal in the can walls than does the DRD method due to the ironing of the walls to form the final container.

Body beads are the concentric depressions or ridges placed on cans between the top and bottom of the can; they provide more physical strength to the can to withstand the pressurization and maintain integrity during thermal processing.

The **flange** is the edge of the body cylinder that is flared outward resulting in a rim or ledge and is an integral part of the double seam. The flange is formed into the body hook during double seaming and becomes interlocked with the cover hook. The width and radius of the flange are determined by can manufacturers to meet the requirements of forming a proper body hook during the double seaming operation *(Figure 1).*

Figure 1

Can End or Cover

The **end curl** -- sometimes referred to as cover curl -- is designed to provide sufficient metal to form a good cover hook. Important in the design are proper curl, a proper base for sealing compound application, and easy feeding of end units into the closing machine *(Figure 2).*

Figure 2

Sealing Compound -- To aid in forming a sound double seam, a rubber-based gasket or sealing material called sealing compound is necessary. Can manufacturers apply the sealing compound into the annular groove of the can ends. The amount of compound used depends upon the type of compound, the can diameter, the type of sterilization method used, and the style of the container. The type of compound depends upon the product and the method of sterilization. Lack of compatibility between compound and product can cause softening, smearing and oozing, resulting in reduced sealing efficiency. Although the application of sealing compound to the ends is a relatively precise operation, equipment capability may provide variances in the placement and amount of sealing compound. As in the case of tinplate variability, the amount of sealing compound in the ends must also fan within a range of acceptability.

The Double Seam

A double seam is that part of the can formed by joining the body of the can and the end (sometimes referred to as the cover). The body flange and the curl of the end interlock during the double seaming operation to form a strong mechanical structure. Each double seam consists of three thicknesses of the can end and two thicknesses of the can body with an appropriate sealing compound distributed through the folded metal to form a hermetic seal *(Figure 3).*

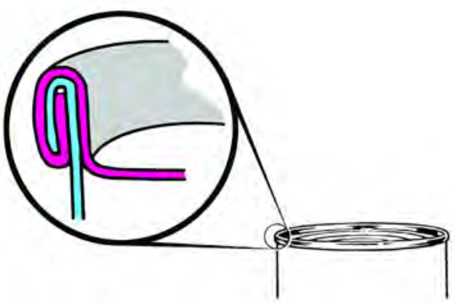


Figure 3

The double seam is generally formed in two operations, referred to as first operation and second operation -- hence the name double seam. Each station of the closing machine has a base plate, a seaming chuck, at least one first operation roll and one second operation roll. The base plate of the machine supports the can body. The snug fitting seaming chuck holds the can end in place and acts as a support surface for the double seaming roll pressure.

First Operation

In the first operation, the curl of the end is interlocked (sometimes referred to as engaged) with the flange of the can body. The actual interlocking is performed with a roll having a specially contoured groove. The first operation seam should not be too loose or too tight, since there is no way to correct a faulty first operation seam during the remaining seaming steps. A good quality first operation seam has the body hook approximately parallel to the cover hook, the edge of the flange of the body (which becomes the body hook) well tucked down in the cover hook radius, and the curl of the cover adjacent to, if not actually touching, the body wall of the can. The first operation seam will usually be made properly if the following conditions are met:

- Correct pin gauge height (the distance between the bottom of the seaming chuck lip and the top surface of the base plate);
- Correct base plate pressure;
- Correct seaming rolls and chuck being used;
- Correct alignment of seaming rolls to seaming chuck; and
- Correct tightness of the first operation roll.

When the first operation seam is completed, the first operation roll is retracted and no longer contacts the can end.

Second Operation

The second operation roll has a flatter groove profile than the first operation roll. The flatter profile is designed to press the preformed hooks together, to iron out wrinkles in the cover hook, to distribute sealing compound in the seam, and, specifically, to develop double seam tightness.

The tightness or compactness of the finished double seam is a function of the adjustment of the second operation roll, its profile and its condition. The second operation roll can be adjusted to tighten the finished double seam. If the correct roll profiles are not used, or the rolls are worn excessively, the desired seam structure and tightness cannot be achieved.

During the double seaming operation, considerable pressure is exerted on the can end, the can body and the sealing compound. The compound should be enclosed by the double seam. The compression by the seaming rolls will cause the sealing compound to flow and fill voids in the seam, thereby blocking potential leakage paths.

The Hermetic Seal

The sealing compound and the mechanically interlocked can end and body work together to make the double seam a hermetic seal. Neither the sealing compound nor the interlocked can body and end alone are able to form a hermetic seal; they must complement each other. The double seam must be correctly formed. The compound, notwithstanding its resilience and ability to fill voids in the double seam, cannot compensate for an improperly formed seam.

Double Seam Structure

The quality of a double seam is judged by measuring and evaluating the specific structures comprising the seam. These measurements are based on seam dimension guidelines provided by the can body and end manufacturer. Two sets of dimensions may be provided for each structure measured. Set-up dimensions are used for establishing the first and second seaming operations of the closing machine. Operating dimensions provide the adjustment tolerance or range of operating dimensions for good practice. When the operating or adjustment limits are exceeded for critical dimensions, corrective action must be taken.

It is extremely important to understand that seam measurements by themselves cannot be used for determining the quality of a double seam. The seam dimension guidelines are provided for use in setting up the double seam initially and to assist in maintaining acceptable seams during production. The final judgment of the double seam can only be made by a visual inspection of the torn down seam in conjunction with measurements taken from the double seam component parts.

Some of the dimensions provided in the seam dimension guidelines are determined by the plate weight or thickness. For instance, the thickness of either the first operation or second operation seam will depend to a great extent on the thickness of the can body and end being used. Body hook and cover hook lengths, on the other hand, are not affected by plate thickness unless extreme variations are encountered.

Seam dimensions suggested for given can sizes take into account the fact that the body plate and end plate are subject to inherent variations in thickness and hardness (temper). Consequently, the suggested seam dimensions reflect the thickness and tightness necessary for optimum seam integrity.

Seam Components

Countersink Depth -- The countersink depth is the distance measured from the top of the double seam to the end panel adjacent to the inside wall of the double seam *(Figure 4).*

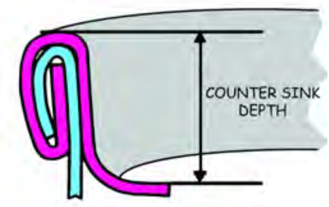


Figure 4

Seam Thickness – Seam thickness is the maximum distance measured across or perpendicular to the layers of material in the seam. As previously mentioned, there are three layers of the end metal and two of the body metal (or plastic) in the double seam.

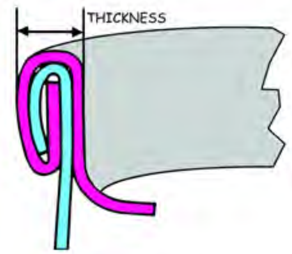


Figure 5

Thickness is an indication of double seam tightness; however, it should be emphasized that it is only one indication of seam tightness *(Figure 5).*

Seam Width (Length or Height) -- Seam width, also referred to as seam length or height, is the dimension measured parallel to the hooks of the seam *(Figure 6*). This dimension is somewhat dependent upon the groove contour of the second operation seaming roll.

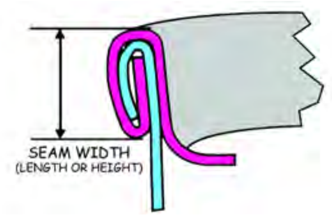


Figure 6

Body Hook and Cover Hook -- The body hook, whose origin was the body flange, and the cover hook, which was formed during the double seaming operation from the, end curl, reflect the internal aspects of the double seam. These two structures observed in a cross-section appear in an interlocking relationship to each other *(Figure 7).*

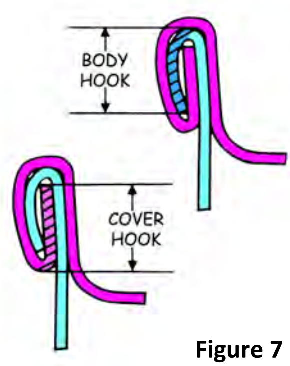


Figure 7

Overlap -- The degree of interlock between the body hook and cover hook is known as overlap *(Figure 8).*

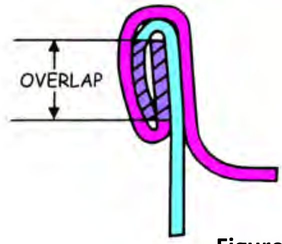


Figure 8

Tightness -- Seam tightness is judged by the degree of wrinkling of the cover hook. During the first operation, the end curl is guided around and up under the body flange. This process crowds the cut edge of the curl into a smaller circumference, resulting in a wavy cut edge with accompanying wrinkles around the seam. The function of the second operation roll is to press the preformed first operation cover book and body hook together to such a degree that the wrinkles may be ironed out sufficiently to ensure a hermetic seal.

In a completed double seam, wrinkles may extend from the end curl cut edge downward on the face of the cover hook. The wrinkles help to indicate double seam tightness. Tightness ratio is a numerical designation which indicates the relative freedom from wrinkles -- the percentage of smoothness of the cover hook.

Juncture Area -- On a three-piece can, the juncture is where the double seam meets and crosses over the side seam area of the can body. On welded side seam cans, the thickness of the weld is only slightly greater (about 1.4 times as great) than the thickness of the body metal. While a slight impression of the weld is apparent on the face of the cover hook, there is minimal change to the double seam at this point. Some welded cans that are made using a thicker coating over the inside surface of the weld may exhibit slight droops at the juncture. Two-piece containers have no side seam; therefore, they have no side seam juncture. The juncture area was a particularly troublesome spot when the side seams were soldered rather than welded. For soldered side seam cans, there were two additional thicknesses of metal at this point.

Critical Evaluation of the Double Seam

The variability of can-making materials, closing machine adjustments, and/or wear on the rolls may cause significant variations in the double seam. The shape and conformation of the finished double seam are determined by the contour of the seaming rolls and the taper of the chuck. Roll contours may be changed to accommodate different plate thicknesses. The roll profiles and the pressure adjustments of the rolls and the base plate on the closing machine are the factors that finally determine the shape and integrity of the double seam and its dimensions. Along with visual appearance, the measurements of seam thickness, seam width and countersink depth are quick and easy signals to indicate proper double seam formation.

Although the external shape and conformation of the double seam may appear to be satisfactory, one or more critical internal structures may not be acceptable; as a result, a hermetic seal will not be achieved.

During the examination of double seams, measurements that are outside the recommended guidelines or visual defects may be found. Assessing the seriousness of these out-of-normal conditions requires experienced judgment. Whether or not immediate corrective action is taken depends upon the effect of the seam condition and on the soundness of the container seal.

A discussion of seam defects and their possible causes follows.

Excessive Countersink Depth

Excessive countersink depth occurs when the dimension exceeds operating limits and results in shortened cover hooks and overlap *(Figure 9).* Possible causes are:

- Excessive baseplate pressure;
- Insufficient (short) pin gauge height;
- Chuck not fully seated in the end unit;
- Improper seaming chuck lip height; and/or
- Improper relation of first operation roll to lip of chuck.

Figure 9

Loose First Operation Seam

When the first operation is too loose, the cover hook will not be in contact with the can body, and there may not be sufficient "tuck up" of the end curl to form a good cover hook and overlap (*Figure 10*). Possible cause of a loose first operation seam may be:

- First operation seaming roll setting too loose;
- Worn first operation seaming roll;
- Worn seaming roll cam, roll pins, bearings or plunger; and/or
- First operation seaming roll groove profile too wide.
- Worn seaming roll cam, roll pins, bearings or plunger; and/or
- First operation seaming roll groove profile too wide.

Figure 10

Excessively Tight First Operation Seam

An excessively tight first operation seam will have the bottom of the seam slightly flattened throughout its length, sharp seams and poorly formed cover hooks (*Figure 11*). Possible causes are:

- First operation seaming roll setting is too tight; and/or
- First operation seaming roll groove is too narrow.

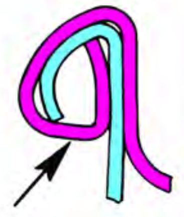


Figure 11

Short Body Hooks

When the body hook length is less than the recommended guidelines, the double seam is said to have a short body hook (*Figure 12*). Possible causes of this condition are:

- Insufficient lifter pressure;
- Incorrect pin height setting (seaming chuck set too high in relation to lifter baseplate);
- First operation seaming roll set too tightly;
- Second operation seaming roll set too loosely; and/or
- Improperly formed can flange length or flange radius.

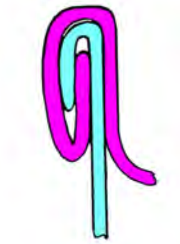


Figure 12

Long Body Hooks

Long body hooks occur when the body hook length is in excess of recommended guidelines (*Figure 13*). Possible causes are:

- Excessive lifter pressure;
- Incorrect pin height (pin gauge) setting (chuck too low in relation to lifter baseplate); and/or
- Improperly formed can flange length, flange radius or mushroomed can flange.

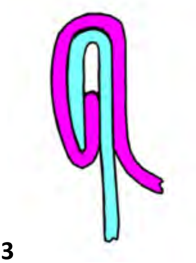


Figure 13

Loose Second Operation Seam

A loose second operation may produce a double seam that leaks because the folds of metal have not been pressed together tightly enough and the compound has not been compressed and distributed to fill the voids in the seam (*Figure 14*).

Possible causes of a loose seam are:

- Improper setting of second operation seaming roll;
- Worn second operation seaming roll;
- Worn seaming roll cam, roll pins or bearings; and/or
- Second operation seaming roll groove too wide.

Figure 14

Excessively Tight Second Operation Seam

Excessive pressure in the second operation does not produce a good seam and may stretch the metal, causing an increase in the width (height or length) of the seam and an unhooking or reduction of the overlap (*Figure 15*). An excessively tight second operation seam may also cause sharp seams, as well as compound squeezing out of the seam. A tight seam is more likely to leak than one made with normal pressures. This condition was more pronounced at the side seam lap of soldered cans. Possible causes of an excessively tight second operation double seam are:

- Improper setting of second operation seaming roll; and/or
- Body and/or end plate abnormally thick.

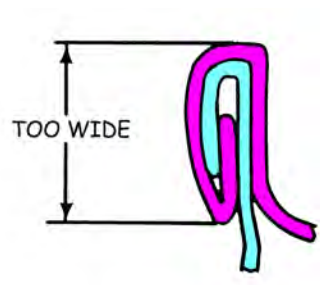


Figure 15

Short Cover Hook

A cover hook length less than recommended guidelines is known as a short cover hook (*Figure 16*). Possible causes of this condition are:

- Poorly formed end curls;
- First operation seaming roll set too loosely;
- Excessive lifter pressure;
- Worn first operation seaming roll groove; and/or
- Excessive countersink depth.

Figure 16

Long Cover Hook

Cover hook length in excess of recommended guidelines indicates a long cover hook condition (Figure 17). Possible causes of a long cover hook are:

- First operation roll set too tightly; and/or
- Poorly formed end curls.

Figure 17

Insufficient Overlap

Insufficient overlap exists when the interlock between body hook and cover hook is less than recommended guidelines (*Figure 18*). Sufficient overlap is necessary to form a satisfactory hermetic seal. Possible causes are:

- Can body flanges out of specifications;
- Cover end curls out of specifications; and/or
- Poor adjustment of the closing machine.

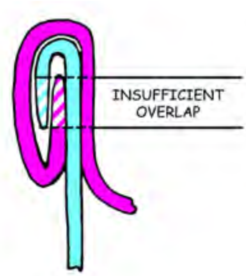


Figure 18

Structural Defects

Structural defects are seam abnormalities that are generally serious in nature and may result in loss of the hermetic seal. Observation of any of the following structural defects requires experienced judgment with appropriate corrective action.

Droop

A smooth projection of a double seam below the bottom of a normal seam is identified as a droop. This may occur at any point around the seam (*Figure 19*). Possible causes of droop are:

- Excessive body hook;
- First operation too loose;
- Worn first operation rolls or roll bearings;
- Cocked can bodies;
- Product trapped in steam;
- Excessive amount or unequal distribution of end seaming compound; and/or
- Can flange or end curl defect.

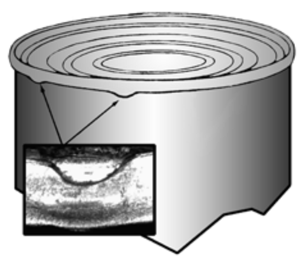


Figure 19

Vee

Vees are irregularities in the double seam due to insufficient and sometimes no overlap of the cover hook with the body hook, usually in small areas of the seam. The cover hook metal protrudes below the seam at the cover hook radius in one or more' 'V" shapes.

Sharp Seam

A sharp seam refers to a sharp edge at the top inside portion of the seam at any point around the seam. The condition results from a portion of the cover being forced over the top of the seaming chuck lip during double seaming. A sharp seam usually can be felt more easily than it can be seen. This condition can be the first indication of a further complication known as a cut-over.

Cut-Over

A cut-over is a seam that is sharp enough to fracture the metal at the top inside portion of the seam. Possible causes of both sharp seams and cut-overs are:

- Worn seaming chuck;
- First or second operation seaming rolls set too tight;
- Worn seaming roll grooves;
- Product in the seam;
- Vertical play in seaming head assembly;
- Incorrect alignment of first operation seaming roll to seaming chuck;
- Excessive vertical play of first operation seaming roll; and/or
- Excessive base plate pressure.

Jumped Seam or Jump-Over

A jumped seam is a portion of a double seam adjacent to the juncture area of a soldered side seam can that is not rolled tight enough. It is caused by the jumping of the seaming rolls after passing over the lap. This situation does not occur with welded or two-piece cans.

Seam Bumps

Seam bumps are most often found on the packer's end of two-piece cans and three-piece welded side seam cans. The defect is found in a relatively small area of the double seam up to one and one-quarter inches (31.8 millimeters) long where seam thickness suddenly increases by 0.003 inch (0.08 millimeter) to 0.004 inch (0.1 millimeter) or more. The increase in thickness is accompanied by a cover hook that is pulled away from the body wall and, when viewed in cross-section, a distorted body hook. Possible causes of seam bumps include:

- Excessively tight finished seams;
- long body hooks; and/or
- Excessive end sealing compound application.

Deadhead or Spinner

A deadhead is an incomplete seam caused by the chuck spinning in the countersink of the end during the seaming operation (*Figure 20*). This seam defect is also known as a "spinner," "skidder "or "slip." Possible causes include:

- Incorrect baseplate pressure;
- Improper end-fit with seaming chuck;
- Worn seaming chuck;
- Seaming rolls binding (not freely rotating);
- Oil or grease on chuck;
- Excessive vertical play of seaming chuck spindle;
- Incorrect pin-gauge setting (seaming chuck too high in relation to baseplate); and/or
- Lifters not rotating freely.

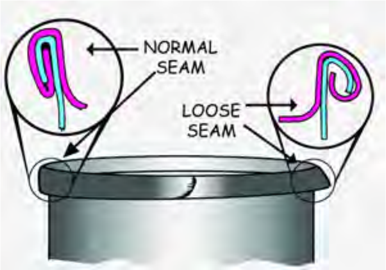


Figure 20

False Seam

A false seam is a seam or portion of a seam that is entirely unhooked and in which the folded cover hook is compressed against the folded body hook. A false seam is not always detectable in an external visual examination; therefore, a seam section or teardown may be necessary to reveal this defect. Possible causes of false seams are:

- Bent can flange;
- Mushroomed flange;
- Damaged or bent end curls;
- Misassembly of can and cover; and/or
- Can not centering on seam chuck.

Other terms may more specifically describe a false seam condition. A knocked down flange is usually caused by a body flange being bent before double seaming.

Possible causes of knocked down flanges include:

- Improper can handling; and/or
- Out of time end feed and/or can feed settings of the closing machine.

Damaged end curls result when the end curl is flattened in one or more spots, causing the curl to fold back on itself. Possible causes of damaged end curls are:

- Damage due to improper handling of end units; and/or
- Improper cover feed or end guide settings.

Can Body Buckling

Can body buckling is a condition found directly under the finished seam where the can appears to have a buckled or twisted condition. Possible causes of body buckling are:

- Excessive baseplate pressure; and/or
- Improper pin-gauge setting (chuck too low).

Cocked Body

A cocked body occurs when the can body blank was out of square at the time of manufacturing causing an unevenness at the lap or juncture. This is a can manufacturing defect that could result in double seam dimensions that vary excessively around the circumference of the can.

Misassembly

A misassembly, sometimes referred to as a misplaced cover, is the result of the can body and end being improperly aligned in the closing machine. Therefore, the seam is completely disconnected partway around the can. Possible causes are:

- Closing machine settings or timing incorrect; and/or
- Sluggish seaming roll levers.

Cut Seam

A cut seam is a fractured double seam wherein the outer layer of the seam is fractured. Possible causes are:

- Excessively tight seam;
- Excessive sealing compound; and/or
- Defective end plate.

This was a common problem with soldered side seams at the juncture area where the double seam crossed the side seam and there was excess solder at the side seam lap.

Mushroomed Flange

A mushroomed flange is a can flange that is overformed, resulting in a long body hook. It may not be possible to see this condition until a cross-section of the seam is cut and examined. Possible causes of mushroomed flanges are:

- Poor can handling practices;
- Over-flanging; and/or
- Damage by can filler.

Fractured Embossed/Debossed Codes

Fractured embossed/debossed codes result when the metal of the end has been cut through at the code mark. Fractured embossed/ debossed codes may possibly be caused by:

- Misalignment of male and female type characters;
- Misalignment of type holders;
- Intermixing of new and old types;
- Improper matching of male and female type; and/or
- Excessive coder pressure or improper coder setting giving too deep a code mark.

The use of an ink jet coding system will eliminate concerns with fractured embossed/debossed codes.

Broken Chuck

Broken chuck defects occur when a portion of the chuck lip has broke. This results in an excessively loose seam at this point due to lack of support for the seaming roll pressure. Often, an impression of the damaged area of the chuck is made on the end countersink wall. Possible causes for a broken chuck are:

- Severe jam in the closing machine;
- Seaming rolls binding on chuck;
- Improper metal used for chuck or metal fatigue in chuck lip; and/or
- Prying against chuck to clear a jam.

Selected Definitions Container (CAN) Assessment

1. **BUCKLE AND/OR BUCKLING:** Permanent distortion of the can end caused by excessive internal pressure. *(Photos 17 and 23)*

2. **CORROSION:** Any deterioration of the surface of the container due to a chemical reaction.

3. **CUT-OVER:** A sharp break or bend in the can end metal at the seaming panel radius. *(Photo 14)*

4. **FALSE SEAM:** A significant defect in the double seam in which the cover and body hooks are not overlapped or engaged. Defect is not always detectable by simple external examination, i.e., a complete can tear down inspection may be necessary to reveal the false seam. *(Photo 9)*

5. **FIRST OPERATION:** The double seaming operation in which the curl of the end is tucked under the flange of the can body to form the cover hook and body hook, respectively.

6. **FLIPPERS:** Only one end is slack or slightly bulged. That end will remain flat if pressed in. Cans which bulge when sharply and squarely struck end-down on a flat surface are flippers, provided that the bulged end remains flat when pressed. Flippers result from a lack of vacuum. *(Photo 1)*

7. **HARD SWELL:** A can bulged so tightly at both ends that no indentation can be made with thumb pressure. *(Photo 1)*

8. **HERMETIC SEAL: "**Hermetic" means air tight. A "hermetically sealed container" is one that is suitably designed to maintain the commercial sterility of its contents after processing, i.e., preclude the entrance of bacteria and also maintain the desired vacuum or pressure in the can. Food and beverage cans (tin and steel) normally have three hermetic seals—one along the side seam and one each at the top and bottom ends of the can.

9. **HYDROGEN SWELL:** A bulged, closed metal can caused by hydrogen produced therein by reaction of the metal with the content of the can. *(Photo 1)*

10. **KNOCKED DOWN FLANGE:** A common term for a false seam where a portion of the body flange is bent back against the body without being engaged with the cover hook.

11. **LEAKERS:** Containers which have leaked.

12. **PANELING:** Flat sides on can body and/or permanent distortion (collapsing) of the can body caused by internal vacuum and excessive eternal pressure developed during processing or cooling. *(Photos 18 and 20)*

13. **PIN HOLES:** Minute opening in the base plate metal due to corrosion.

14. **PITTING:** Depressions in a metal surface caused by corrosion. *(Photo 11)*

15. **RUST:** Iron oxide produced by moisture in contact with unprotected base plate metal. *(Photos 11 and 19)*

16. **SECOND OPERATION:** The finishing operation in double seaming where the hooks formed in the first operation are rolled tightly against each other.

17. **SHARP SEAM:** A sharp edge at the top inside portion of the seam. Condition can be first indication of a further complication known as a "cut-over." This defect can usually be felt more easily than it can be seen. *(Photo 14)*

18. **SOFT SWELL:** A can bulged at both ends, but not so tightly that the ends cannot be pushed in somewhat with thumb pressure. *(Photo 1)*

19. SPRINGER: One end of a can bulges. Manual pressure on the bulged end forces the opposite end out or the same end will spring out with release of pressure. If both ends bulge but only one will remain flat when pressed, the can is a Springer. Springers result from moderate positive pressure in the can. *(Photo 1)*

20. **SWELLS:** Both ends of the can are bulged. Neither end will remain flat without pressure. Soft swells yield to manual pressure, but no impression can be made manually on hard swells. Swells result from positive pressure in the can usually because of spoilage of the contents. Some swells, especially in acid products, may result from chemical reaction between the contents and the container. *(Photo 1)*

21. VEE OR SPUR: Small metal irregularities in the double seam in one or more "V" shapes. *(Photo 15)*

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Canned Foods: Principles of Thermal Process Control, Acidification and Container Closure Evaluation, Seventh Edition, 2007
GMA Science and Education Foundation®
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Other AFDO Publications

- Apple Cider Processing Operations Requirements & Guidelines (February 2003, 2nd Print)
- Cured, Salted & Smoked Fish Est. GMPs Including Listeria Manual (May 2004)
- Food Code: Pocket Guide for Regulators (December 2006; August 2011, Printed)
- Food Emergency Pocket Guide (January 2007, Revised; September 2011, Revised)
- Guidelines for Exempt Slaughter and Processing Operations (June 2011)
- Guidelines for Exempt Slaughter and Processing Operations Training Manual
- Guidelines for the Transportation of Food Products (June 2005)
- Guidelines: Inspection & Enforcement of GMP Regulations for Packaged Ice
- Guidelines: Handling and Producing Packaged Ice within Foodservice and Retail Establishments
- Meat and Poultry Processing at Retail Training Manual
- Model Code for Produce Safety (November 2009)
- Model Consumer Commodity Salvage Code (February 2008)
- Model Water Vending Machine Regulation (June 1997, Revised; December 2002, Printed)
- Retail Meat and Poultry Processing Guidelines (June 2011)
- Retail Guidelines for Refrigerated Foods in Reduced Oxygen Packages
- State Food Safety Resource Survey

A Guide to Can Defects
and
Basic Components of Double Seam Containers

November 2011

Association of Food & Drug Officials

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Introduction

Canned foods are among the safest food processed today. Approximately 60% of food consumed in the United States is thermally processed and packaged in hermetically sealed containers. However, regardless of the safety assured in canned foods, any damaged or defective canned products are a potential public health problem. Defective cans may leak and allow microorganisms to enter that may cause food poisoning or other significant threat and a potential public health problem to consider when dealing with serious defective/damaged canned food containers requiring inspection, evaluation and sampling. It is imperative that canned food products with visual and/or external defects be recognized. Those containers with “critical defects” should not be sold, distributed or consumed. Those containers with “major defects” may become a public health concern and should not be marketed without testing before sale. However, canned food with “minor defects” normally represent no public health hazard, i.e. if the hermetic seal on the can has not been jeopardized, these products are generally considered safe and, when properly labeled, such products are acceptable for distribution and sale.

Purpose of Guide

This guide is intended in part to help resolve the question which frequently arises concerning the evaluation and safety of canned food products: When does the can defect or damage become severe enough to represent a public health concern or hazard?

This simplified guide shows in color some of the major types of can defects which may be commonly found by visual observation. It categorizes the defects/damages according to their degree of potential hazard, and shows what to look for in the routine visual inspection of the finished product. These classifications may change after laboratory examination. It is essential that prior to sale, samples of each defect suspected of causing loss of hermetic seal be collected for laboratory examination, i.e. measurement and integrity of can seams, microbiological analysis of contents, etc. Note that a “hermetically sealed” container for canned food and/or beverages is considered as one that is appropriately constructed/designed and intended to assure no entry of bacterial microorganism and thus maintain the commercial sterility of its contents after thermal processing. Other definitions commonly and frequently used in the visual evaluation of can defects are included as part of this guide for a quick and simple reference and for use in the field.

Classification for Defective/Damaged Canned Goods

The extent of a defective/damaged canned foods container will determine its classification. Classification is as follows:

Class I -- Critical Defects: Defects which provide evidence that the container has lost its hermetic seal (i.e. holes, fracture, punctures, product leakage, etc.) or evidence that there is, or has been, microbial growth in the can contents.

This is a critical defect rating which would be considered a potential public health problem. Any lot which is found to have a defect must be set aside and thoroughly inspected and sorted to ensure that no containers that have lost their hermetic seal are distributed.

Class II -- Major Defects: Defects that result in cans which do not show visible signs of having lost their hermetic seal, but are of such magnitude that they may have lost their hermetic seal.

This is a major defect rating which may result in the loss of the hermetic seal and become a public health problem. Even though a Class II defect may not be health threatening by itself, a large number of cans with Class II defects necessitates more extensive sampling of such lots before sale. Evidence of a significant number of Class II defects may be considered a potential public health problem.

Class III -- Minor Defects: Defects which have had no adverse effect on the hermetic seal.

This is a defect rating a minor significance from a public health standpoint. This guide is not concerned with defects that only affect commercial sale. For example, dented cans which will not stack on shelves may be rated as a Class III when neither the double seam, side seam nor the body has been adversely affected. If the effect on the hermetic seal cannot be determined, sampling and examination would be appropriate.

Photographs of Defective Canned Foods
Class I - Critical Defects

Body/End Defects

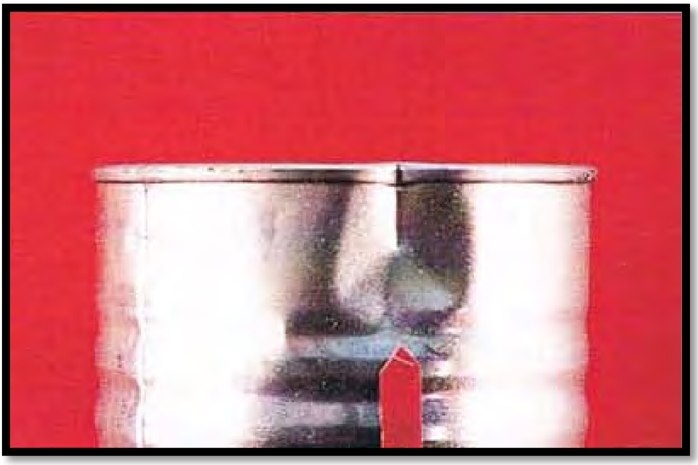
Photo 1: *Bulged and/or swollen ends from gas formation in can which causes one or both ends to swell producing a flipper, soft swell, hard swell, or blown can.*

Photo 2: *Can with likely loss of hermetic seal and normally a leader due to the mislocked side seam.*

Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 3: *An opening below the double seam or plate fracture.*

Photo 4: *Plate fracture in double seam or can body. Note position of red pointer.*



Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 5: *Severe double seam dent plate fracture.*

Photo 6: *Puncture in can body. Pinholes in can body plate also cause loss of hermetic seal.*

Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 7: *Closure on end of can reflects incomplete double seam (Double seaming operation not completed by manufacturer).*

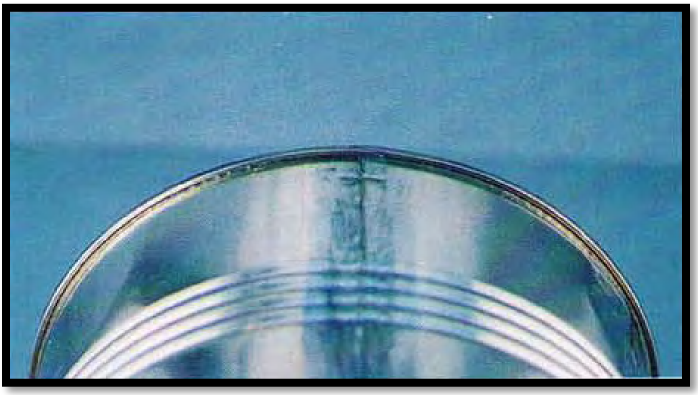


Photo 8: *Defect in end of closure on can (torn flange). Note arrow pointer.*

Photographs of Defective Canned Foods
Class I - Critical Defects

Photo 9: *Depicts a **false seam** with loss of hermetic seal. Seam is formed buy not engaged properly. Note knocked down flange.*

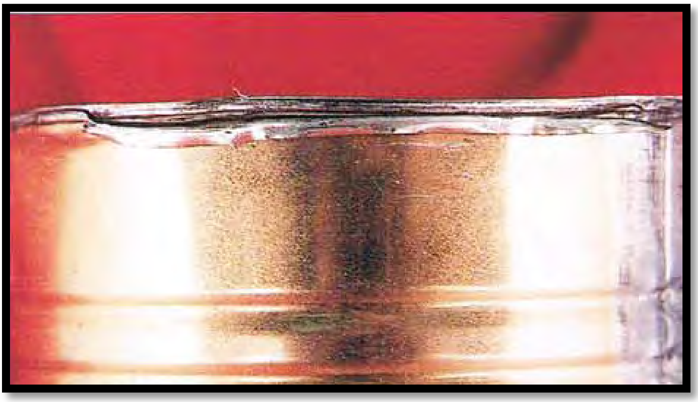
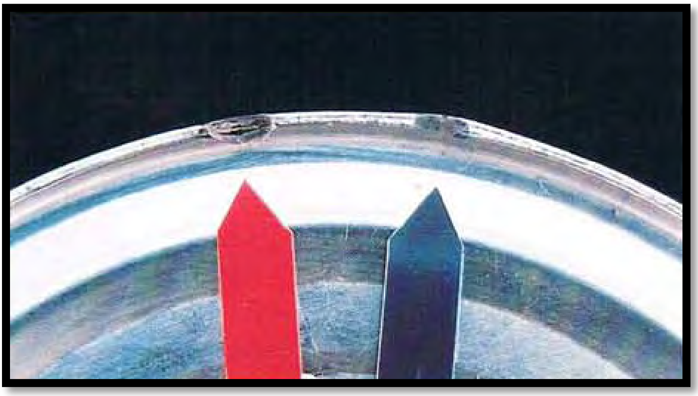


Photo 10: *Example of a **cable cut** on can end. Red pointer shows "significant defect," i.e., cut through double seam. Blue pointer depicts cut/abrasion not through double seam.*

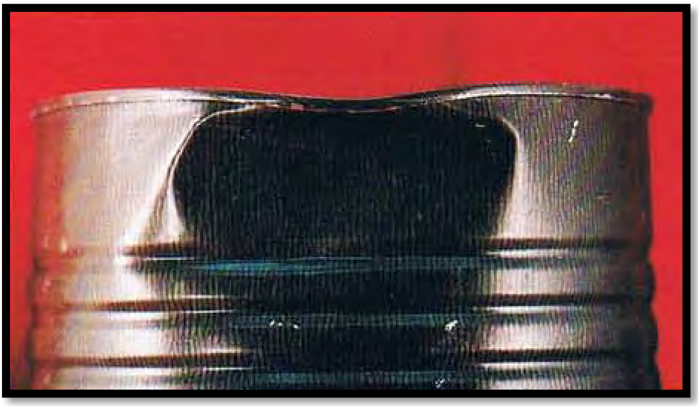


Photographs of Defective Canned Foods
Class II – Major Defects

Body Dents, End/Closure, and Rust Defects

Photo 11: *Severely rusted with deep pits near point of perforation.*

Photo 12: *Major body dent which has impacted on double seam. (Plate may be fractured with loss of hermetic seal.)*



Photographs of Defective Canned Foods
Class II – Major Defects

Photo 13: *Major dent in center of can body. (Plate may be fractured with loss of hermetic seal.)*

Photo 14: *"Cut-over" depicting sharp seam. (Observe for potential plate fracture or loss of hermetic seal).*

Photographs of Defective Canned Foods
Class II – Major Defects

Photo 15: *Defect shown termed a "vee" or "spur" with end curl knocked down. Can is a potential leaker.*

Photo 16: *Pointer indicates "knocked down flange."*

Photographs of Defective Canned Foods
Class II – Major Defects

Photo 17: *Cans that are buckled during retorting may leak during the cooling operation because the double seam has been strained.*

Photo 18: *Cans exhibiting severe paneling of the side walls.*

Photographs of Defective Canned Foods
Class III – Minor Defects

Body/End Defects

Photo 19: *Surface rust and residue food cooked on end of can. (Minor external rust and light superficial pitting easily removable by light buffing is considered an insignificant defect).*

Photo 20: *Paneled container without visible signs of loss of integrity, i.e., no plate fractures.*

Photographs of Defective Canned Foods
Class III – Minor Defects

Photo 21: *Obvious body dent on side of container body. Side seam and/or double seams appear not significantly affected.*

Photo 22: *Minor dent to double seam on end of can body, i.e., it does not appear creased or sharp.*

Photographs of Defective Canned Foods
Class III – Minor Defects

Photo 23: *Minor "buckle" just extending into double seam on end of can body. (Double seam does not appear significantly affected).*

Basic Components of Double Seam Containers

Metal for Can Manufacturing

The "tin" can was originally manufactured from steel sheets that had been dipped in molten tin. This "hot dipped" method was gradually replaced by electroplating the tin coating onto the base steel. This new method allowed for the application of lower and more uniform weights of tin as well as different weights of tin on each side of the sheet. Also, electrolytically coated plate is produced in a continuous coil rather than from individual sheets.

Today enamel coated tin-free steel -- steel sheet with a light chromium surface treatment but no tin coating -- is used extensively for applications where tin is not required to protect against corrosion or to facilitate the side seam welding process. For instance, tin-free steel is widely used for ends and for the manufacture of drawn two-piece cans.

Certain characteristics of the plate used in can manufacture affect the characteristics of the finished double seams. Depending on the can's size and strength requirements, different thicknesses of metal can be used. For steel containers the thickness of the metal is indicated by specifying the theoretical weight in pounds per base box; this is known as the base weight. When dealing with other materials, such as aluminum or plastic, thickness is specified directly in inches or millimeters. The temper of tinplate or tin-free steel, usually designated by a number such as Tl, T2, T3, etc, indicates the forming properties or hardness of tinplate (Tl = dead-soft; TS = very hard). Double cold-reduced (2CR) or double-reduced (DR) tinplate or tin-free steel are steel-tin mill products that are given a partial cold reduction to near final gauge and then given another cold reduction to final gauge. The resulting plate is stiffer, harder and stronger than conventional tinplate and enables the use, wherever applicable, of lower base weights for container components. Neither plate thickness nor tempers can be attained in tinplate without some variation. Those characteristics can only be controlled within a range, with the nominal value somewhere in the middle of that range. Obviously, with some variability in the basic materials used in can manufacture, double seam characteristics can also reflect similar degrees of variability.

Metal Can Body

The **three-piece can** is made from a formed body with a welded side seam and two ends. One end is placed on the can by the can manufacturer while the other is attached after the food is placed in the can. All three-piece cans used in the United States have welded side seams. Initially side seams were soldered with lead solder, but FDA has since banned the use of lead solder to manufacture food cans. In 1991, food can manufacturers terminated their use of lead in solder; however without the lead in the solder, the formation of the soldered side seam was unsatisfactory. Since that time, can manufacturers turned to welded side seams to replace the soldered side seams. The welded side seam has alleviated several defects that were inherent with soldered side seams; these differences will be addressed in later sections of this guide. There may be some countries where soldered side seams are still produced using lead in the solder; however, products placed in these cans are not allowed into the United States.

The **two-piece can** is formed in one of two ways – drawing and redrawing (DRD) or drawing and ironing (D&I). DRD produces cans with thicker metal to withstand pressure during thermal processing and vacuum formation upon cooling. This type of container is formed by punching a piece of metal through various dies until the final can shape is attained. D&I is used mainly for aluminum cans where the gas pressure from the beverage production maintains the shape of the can. This type of process produces thinner metal in the can walls than does the DRD method due to the ironing of the walls to form the final container.

Body beads are the concentric depressions or ridges placed on cans between the top and bottom of the can; they provide more physical strength to the can to withstand the pressurization and maintain integrity during thermal processing.

The **flange** is the edge of the body cylinder that is flared outward resulting in a rim or ledge and is an integral part of the double seam. The flange is formed into the body hook during double seaming and becomes interlocked with the cover hook. The width and radius of the flange are determined by can manufacturers to meet the requirements of forming a proper body hook during the double seaming operation *(Figure 1).*

Figure 1

Can End or Cover

The **end curl** -- sometimes referred to as cover curl -- is designed to provide sufficient metal to form a good cover hook. Important in the design are proper curl, a proper base for sealing compound application, and easy feeding of end units into the closing machine *(Figure 2).*

Figure 2

Sealing Compound -- To aid in forming a sound double seam, a rubber-based gasket or sealing material called sealing compound is necessary. Can manufacturers apply the sealing compound into the annular groove of the can ends. The amount of compound used depends upon the type of compound, the can diameter, the type of sterilization method used, and the style of the container. The type of compound depends upon the product and the method of sterilization. Lack of compatibility between compound and product can cause softening, smearing and oozing, resulting in reduced sealing efficiency. Although the application of sealing compound to the ends is a relatively precise operation, equipment capability may provide variances in the placement and amount of sealing compound. As in the case of tinplate variability, the amount of sealing compound in the ends must also fan within a range of acceptability.

The Double Seam

A double seam is that part of the can formed by joining the body of the can and the end (sometimes referred to as the cover). The body flange and the curl of the end interlock during the double seaming operation to form a strong mechanical structure. Each double seam consists of three thicknesses of the can end and two thicknesses of the can body with an appropriate sealing compound distributed through the folded metal to form a hermetic seal *(Figure 3).*

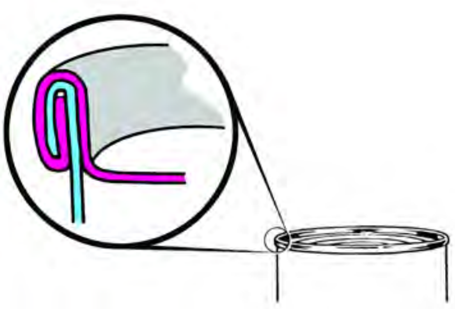


Figure 3

The double seam is generally formed in two operations, referred to as first operation and second operation -- hence the name double seam. Each station of the closing machine has a base plate, a seaming chuck, at least one first operation roll and one second operation roll. The base plate of the machine supports the can body. The snug fitting seaming chuck holds the can end in place and acts as a support surface for the double seaming roll pressure.

First Operation

In the first operation, the curl of the end is interlocked (sometimes referred to as engaged) with the flange of the can body. The actual interlocking is performed with a roll having a specially contoured groove. The first operation seam should not be too loose or too tight, since there is no way to correct a faulty first operation seam during the remaining seaming steps. A good quality first operation seam has the body hook approximately parallel to the cover hook, the edge of the flange of the body (which becomes the body hook) well tucked down in the cover hook radius, and the curl of the cover adjacent to, if not actually touching, the body wall of the can. The first operation seam will usually be made properly if the following conditions are met:

- Correct pin gauge height (the distance between the bottom of the seaming chuck lip and the top surface of the base plate);
- Correct base plate pressure;
- Correct seaming rolls and chuck being used;
- Correct alignment of seaming rolls to seaming chuck; and
- Correct tightness of the first operation roll.

When the first operation seam is completed, the first operation roll is retracted and no longer contacts the can end.

Second Operation

The second operation roll has a flatter groove profile than the first operation roll. The flatter profile is designed to press the preformed hooks together, to iron out wrinkles in the cover hook, to distribute sealing compound in the seam, and, specifically, to develop double seam tightness.

The tightness or compactness of the finished double seam is a function of the adjustment of the second operation roll, its profile and its condition. The second operation roll can be adjusted to tighten the finished double seam. If the correct roll profiles are not used, or the rolls are worn excessively, the desired seam structure and tightness cannot be achieved.

During the double seaming operation, considerable pressure is exerted on the can end, the can body and the sealing compound. The compound should be enclosed by the double seam. The compression by the seaming rolls will cause the sealing compound to flow and fill voids in the seam, thereby blocking potential leakage paths.

The Hermetic Seal

The sealing compound and the mechanically interlocked can end and body work together to make the double seam a hermetic seal. Neither the sealing compound nor the interlocked can body and end alone are able to form a hermetic seal; they must complement each other. The double seam must be correctly formed. The compound, notwithstanding its resilience and ability to fill voids in the double seam, cannot compensate for an improperly formed seam.

Double Seam Structure

The quality of a double seam is judged by measuring and evaluating the specific structures comprising the seam. These measurements are based on seam dimension guidelines provided by the can body and end manufacturer. Two sets of dimensions may be provided for each structure measured. Set-up dimensions are used for establishing the first and second seaming operations of the closing machine. Operating dimensions provide the adjustment tolerance or range of operating dimensions for good practice. When the operating or adjustment limits are exceeded for critical dimensions, corrective action must be taken.

It is extremely important to understand that seam measurements by themselves cannot be used for determining the quality of a double seam. The seam dimension guidelines are provided for use in setting up the double seam initially and to assist in maintaining acceptable seams during production. The final judgment of the double seam can only be made by a visual inspection of the torn down seam in conjunction with measurements taken from the double seam component parts.

Some of the dimensions provided in the seam dimension guidelines are determined by the plate weight or thickness. For instance, the thickness of either the first operation or second operation seam will depend to a great extent on the thickness of the can body and end being used. Body hook and cover hook lengths, on the other hand, are not affected by plate thickness unless extreme variations are encountered.

Seam dimensions suggested for given can sizes take into account the fact that the body plate and end plate are subject to inherent variations in thickness and hardness (temper). Consequently, the suggested seam dimensions reflect the thickness and tightness necessary for optimum seam integrity.

Seam Components

Countersink Depth -- The countersink depth is the distance measured from the top of the double seam to the end panel adjacent to the inside wall of the double seam *(Figure 4).*

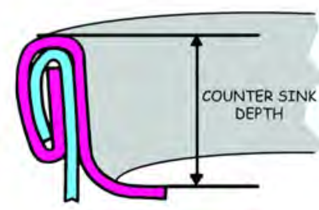


Figure 4

Seam Thickness – Seam thickness is the maximum distance measured across or perpendicular to the layers of material in the seam. As previously mentioned, there are three layers of the end metal and two of the body metal (or plastic) in the double seam.

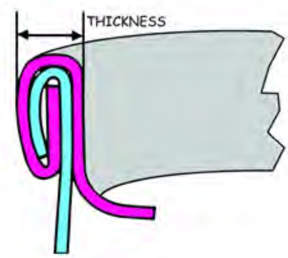


Figure 5

Thickness is an indication of double seam tightness; however, it should be emphasized that it is only one indication of seam tightness *(Figure 5).*

Seam Width (Length or Height) -- Seam width, also referred to as seam length or height, is the dimension measured parallel to the hooks of the seam *(Figure 6*). This dimension is somewhat dependent upon the groove contour of the second operation seaming roll.

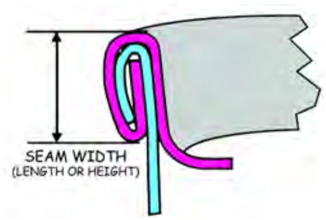


Figure 6

Body Hook and Cover Hook -- The body hook, whose origin was the body flange, and the cover hook, which was formed during the double seaming operation from the, end curl, reflect the internal aspects of the double seam. These two structures observed in a cross-section appear in an interlocking relationship to each other *(Figure 7).*

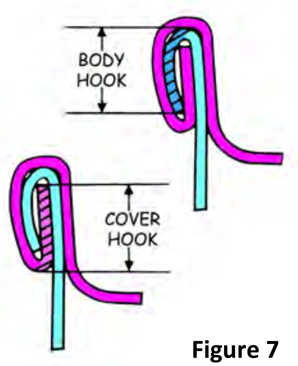


Figure 7

Overlap -- The degree of interlock between the body hook and cover hook is known as overlap *(Figure 8).*

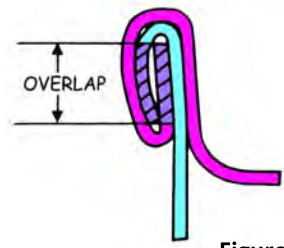


Figure 8

Tightness -- Seam tightness is judged by the degree of wrinkling of the cover hook. During the first operation, the end curl is guided around and up under the body flange. This process crowds the cut edge of the curl into a smaller circumference, resulting in a wavy cut edge with accompanying wrinkles around the seam. The function of the second operation roll is to press the preformed first operation cover book and body hook together to such a degree that the wrinkles may be ironed out sufficiently to ensure a hermetic seal.

In a completed double seam, wrinkles may extend from the end curl cut edge downward on the face of the cover hook. The wrinkles help to indicate double seam tightness. Tightness ratio is a numerical designation which indicates the relative freedom from wrinkles -- the percentage of smoothness of the cover hook.

Juncture Area -- On a three-piece can, the juncture is where the double seam meets and crosses over the side seam area of the can body. On welded side seam cans, the thickness of the weld is only slightly greater (about 1.4 times as great) than the thickness of the body metal. While a slight impression of the weld is apparent on the face of the cover hook, there is minimal change to the double seam at this point. Some welded cans that are made using a thicker coating over the inside surface of the weld may exhibit slight droops at the juncture. Two-piece containers have no side seam; therefore, they have no side seam juncture. The juncture area was a particularly troublesome spot when the side seams were soldered rather than welded. For soldered side seam cans, there were two additional thicknesses of metal at this point.

Critical Evaluation of the Double Seam

The variability of can-making materials, closing machine adjustments, and/or wear on the rolls may cause significant variations in the double seam. The shape and conformation of the finished double seam are determined by the contour of the seaming rolls and the taper of the chuck. Roll contours may be changed to accommodate different plate thicknesses. The roll profiles and the pressure adjustments of the rolls and the base plate on the closing machine are the factors that finally determine the shape and integrity of the double seam and its dimensions. Along with visual appearance, the measurements of seam thickness, seam width and countersink depth are quick and easy signals to indicate proper double seam formation.

Although the external shape and conformation of the double seam may appear to be satisfactory, one or more critical internal structures may not be acceptable; as a result, a hermetic seal will not be achieved.

During the examination of double seams, measurements that are outside the recommended guidelines or visual defects may be found. Assessing the seriousness of these out-of-normal conditions requires experienced judgment. Whether or not immediate corrective action is taken depends upon the effect of the seam condition and on the soundness of the container seal.

A discussion of seam defects and their possible causes follows.

Excessive Countersink Depth

Excessive countersink depth occurs when the dimension exceeds operating limits and results in shortened cover hooks and overlap *(Figure 9).* Possible causes are:

- Excessive baseplate pressure;
- Insufficient (short) pin gauge height;
- Chuck not fully seated in the end unit;
- Improper seaming chuck lip height; and/or
- Improper relation of first operation roll to lip of chuck.

Figure 9

Loose First Operation Seam

When the first operation is too loose, the cover hook will not be in contact with the can body, and there may not be sufficient "tuck up" of the end curl to form a good cover hook and overlap (*Figure 10*). Possible cause of a loose first operation seam may be:

Figure 10

- First operation seaming roll setting too loose;
- Worn first operation seaming roll;
- Worn seaming roll cam, roll pins, bearings or plunger; and/or
- First operation seaming roll groove profile too wide.
- Worn seaming roll cam, roll pins, bearings or plunger; and/or
- First operation seaming roll groove profile too wide.

Excessively Tight First Operation Seam

An excessively tight first operation seam will have the bottom of the seam slightly flattened throughout its length, sharp seams and poorly formed cover hooks (*Figure 11*). Possible causes are:

- First operation seaming roll setting is too tight; and/or
- First operation seaming roll groove is too narrow.

Figure 11

Short Body Hooks

When the body hook length is less than the recommended guidelines, the double seam is said to have a short body hook (*Figure 12*). Possible causes of this condition are:

- Insufficient lifter pressure;
- Incorrect pin height setting (seaming chuck set too high in relation to lifter baseplate);
- First operation seaming roll set too tightly;
- Second operation seaming roll set too loosely; and/or
- Improperly formed can flange length or flange radius.

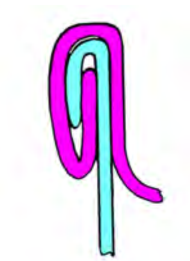


Figure 12

Long Body Hooks

Long body hooks occur when the body hook length is in excess of recommended guidelines (*Figure 13*). Possible causes are:

- Excessive lifter pressure;
- Incorrect pin height (pin gauge) setting (chuck too low in relation to lifter baseplate); and/or
- Improperly formed can flange length, flange radius or mushroomed can flange.

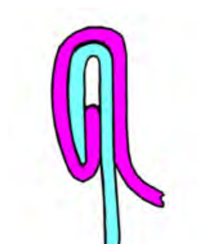


Figure 13

Loose Second Operation Seam

A loose second operation may produce a double seam that leaks because the folds of metal have not been pressed together tightly enough and the compound has not been compressed and distributed to fill the voids in the seam (*Figure 14*).

Possible causes of a loose seam are:

- Improper setting of second operation seaming roll;
- Worn second operation seaming roll;
- Worn seaming roll cam, roll pins or bearings; and/or
- Second operation seaming roll groove too wide.

Figure 14

Excessively Tight Second Operation Seam

Excessive pressure in the second operation does not produce a good seam and may stretch the metal, causing an increase in the width (height or length) of the seam and an unhooking or reduction of the overlap (*Figure 15*). An excessively tight second operation seam may also cause sharp seams, as well as compound squeezing out of the seam. A tight seam is more likely to leak than one made with normal pressures. This condition was more pronounced at the side seam lap of soldered cans. Possible causes of an excessively tight second operation double seam are:

- Improper setting of second operation seaming roll; and/or
- Body and/or end plate abnormally thick.

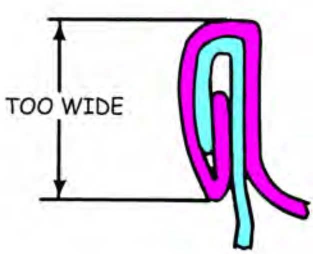


Figure 15

Short Cover Hook

A cover hook length less than recommended guidelines is known as a short cover hook (*Figure 16*). Possible causes of this condition are:

- Poorly formed end curls;
- First operation seaming roll set too loosely;
- Excessive lifter pressure;
- Worn first operation seaming roll groove; and/or
- Excessive countersink depth.

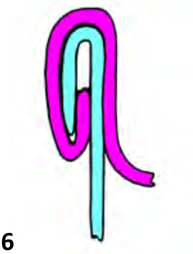


Figure 16

Long Cover Hook

Cover hook length in excess of recommended guidelines indicates a long cover hook condition (Figure 17). Possible causes of a long cover hook are:

- First operation roll set too tightly; and/or
- Poorly formed end curls.

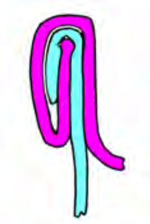


Figure 17

Insufficient Overlap

Insufficient overlap exists when the interlock between body hook and cover hook is less than recommended guidelines (*Figure 18*). Sufficient overlap is necessary to form a satisfactory hermetic seal. Possible causes are:

- Can body flanges out of specifications;
- Cover end curls out of specifications; and/or
- Poor adjustment of the closing machine.

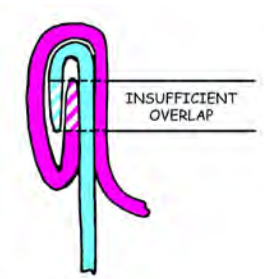


Figure 18

Structural Defects

Structural defects are seam abnormalities that are generally serious in nature and may result in loss of the hermetic seal. Observation of any of the following structural defects requires experienced judgment with appropriate corrective action.

Droop

A smooth projection of a double seam below the bottom of a normal seam is identified as a droop. This may occur at any point around the seam (*Figure 19*). Possible causes of droop are:

- Excessive body hook;
- First operation too loose;
- Worn first operation rolls or roll bearings;
- Cocked can bodies;
- Product trapped in steam;
- Excessive amount or unequal distribution of end seaming compound; and/or
- Can flange or end curl defect.

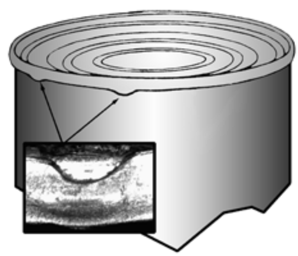


Figure 19

Vee

Vees are irregularities in the double seam due to insufficient and sometimes no overlap of the cover hook with the body hook, usually in small areas of the seam. The cover hook metal protrudes below the seam at the cover hook radius in one or more' 'V" shapes.

Sharp Seam

A sharp seam refers to a sharp edge at the top inside portion of the seam at any point around the seam. The condition results from a portion of the cover being forced over the top of the seaming chuck lip during double seaming. A sharp seam usually can be felt more easily than it can be seen. This condition can be the first indication of a further complication known as a cut-over.

Cut-Over

A cut-over is a seam that is sharp enough to fracture the metal at the top inside portion of the seam. Possible causes of both sharp seams and cut-overs are:

- Worn seaming chuck;
- First or second operation seaming rolls set too tight;
- Worn seaming roll grooves;
- Product in the seam;
- Vertical play in seaming head assembly;
- Incorrect alignment of first operation seaming roll to seaming chuck;
- Excessive vertical play of first operation seaming roll; and/or
- Excessive base plate pressure.

Jumped Seam or Jump-Over

A jumped seam is a portion of a double seam adjacent to the juncture area of a soldered side seam can that is not rolled tight enough. It is caused by the jumping of the seaming rolls after passing over the lap. This situation does not occur with welded or two-piece cans.

Seam Bumps

Seam bumps are most often found on the packer's end of two-piece cans and three-piece welded side seam cans. The defect is found in a relatively small area of the double seam up to one and one-quarter inches (31.8 millimeters) long where seam thickness suddenly increases by 0.003 inch (0.08 millimeter) to 0.004 inch (0.1 millimeter) or more. The increase in thickness is accompanied by a cover hook that is pulled away from the body wall and, when viewed in cross-section, a distorted body hook. Possible causes of seam bumps include:

- Excessively tight finished seams;
- long body hooks; and/or
- Excessive end sealing compound application.

Deadhead or Spinner

A deadhead is an incomplete seam caused by the chuck spinning in the countersink of the end during the seaming operation (*Figure 20*). This seam defect is also known as a "spinner," "skidder "or "slip." Possible causes include:

- Incorrect baseplate pressure;
- Improper end-fit with seaming chuck;
- Worn seaming chuck;
- Seaming rolls binding (not freely rotating);
- Oil or grease on chuck;
- Excessive vertical play of seaming chuck spindle;
- Incorrect pin-gauge setting (seaming chuck too high in relation to baseplate); and/or
- Lifters not rotating freely.

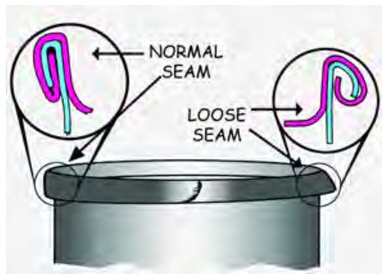


Figure 20

False Seam

A false seam is a seam or portion of a seam that is entirely unhooked and in which the folded cover hook is compressed against the folded body hook. A false seam is not always detectable in an external visual examination; therefore, a seam section or teardown may be necessary to reveal this defect. Possible causes of false seams are:

- Bent can flange;
- Mushroomed flange;
- Damaged or bent end curls;
- Misassembly of can and cover; and/or
- Can not centering on seam chuck.

Other terms may more specifically describe a false seam condition. A knocked down flange is usually caused by a body flange being bent before double seaming.

Possible causes of knocked down flanges include:

- Improper can handling; and/or
- Out of time end feed and/or can feed settings of the closing machine.

Damaged end curls result when the end curl is flattened in one or more spots, causing the curl to fold back on itself. Possible causes of damaged end curls are:

- Damage due to improper handling of end units; and/or
- Improper cover feed or end guide settings.

Can Body Buckling

Can body buckling is a condition found directly under the finished seam where the can appears to have a buckled or twisted condition. Possible causes of body buckling are:

- Excessive baseplate pressure; and/or
- Improper pin-gauge setting (chuck too low).

Cocked Body

A cocked body occurs when the can body blank was out of square at the time of manufacturing causing an unevenness at the lap or juncture. This is a can manufacturing defect that could result in double seam dimensions that vary excessively around the circumference of the can.

Misassembly

A misassembly, sometimes referred to as a misplaced cover, is the result of the can body and end being improperly aligned in the closing machine. Therefore, the seam is completely disconnected partway around the can. Possible causes are:

- Closing machine settings or timing incorrect; and/or
- Sluggish seaming roll levers.

Cut Seam

A cut seam is a fractured double seam wherein the outer layer of the seam is fractured. Possible causes are:

- Excessively tight seam;
- Excessive sealing compound; and/or
- Defective end plate.

This was a common problem with soldered side seams at the juncture area where the double seam crossed the side seam and there was excess solder at the side seam lap.

Mushroomed Flange

A mushroomed flange is a can flange that is overformed, resulting in a long body hook. It may not be possible to see this condition until a cross-section of the seam is cut and examined. Possible causes of mushroomed flanges are:

- Poor can handling practices;
- Over-flanging; and/or
- Damage by can filler.

Fractured Embossed/Debossed Codes

Fractured embossed/debossed codes result when the metal of the end has been cut through at the code mark. Fractured embossed/ debossed codes may possibly be caused by:

- Misalignment of male and female type characters;
- Misalignment of type holders;
- Intermixing of new and old types;
- Improper matching of male and female type; and/or
- Excessive coder pressure or improper coder setting giving too deep a code mark.

The use of an ink jet coding system will eliminate concerns with fractured embossed/debossed codes.

Broken Chuck

Broken chuck defects occur when a portion of the chuck lip has broke. This results in an excessively loose seam at this point due to lack of support for the seaming roll pressure. Often, an impression of the damaged area of the chuck is made on the end countersink wall. Possible causes for a broken chuck are:

- Severe jam in the closing machine;
- Seaming rolls binding on chuck;
- Improper metal used for chuck or metal fatigue in chuck lip; and/or
- Prying against chuck to clear a jam.

Selected Definitions Container (CAN) Assessment

1. **BUCKLE AND/OR BUCKLING:** Permanent distortion of the can end caused by excessive internal pressure. *(Photos 17 and 23)*

2. **CORROSION:** Any deterioration of the surface of the container due to a chemical reaction.

3. **CUT-OVER:** A sharp break or bend in the can end metal at the seaming panel radius. *(Photo 14)*

4. **FALSE SEAM:** A significant defect in the double seam in which the cover and body hooks are not overlapped or engaged. Defect is not always detectable by simple external examination, i.e., a complete can tear down inspection may be necessary to reveal the false seam. *(Photo 9)*

5. **FIRST OPERATION:** The double seaming operation in which the curl of the end is tucked under the flange of the can body to form the cover hook and body hook, respectively.

6. **FLIPPERS:** Only one end is slack or slightly bulged. That end will remain flat if pressed in. Cans which bulge when sharply and squarely struck end-down on a flat surface are flippers, provided that the bulged end remains flat when pressed. Flippers result from a lack of vacuum. *(Photo 1)*

7. **HARD SWELL:** A can bulged so tightly at both ends that no indentation can be made with thumb pressure. *(Photo 1)*

8. **HERMETIC SEAL: "**Hermetic" means air tight. A "hermetically sealed container" is one that is suitably designed to maintain the commercial sterility of its contents after processing, i.e., preclude the entrance of bacteria and also maintain the desired vacuum or pressure in the can. Food and beverage cans (tin and steel) normally have three hermetic seals—one along the side seam and one each at the top and bottom ends of the can.

9. **HYDROGEN SWELL:** A bulged, closed metal can caused by hydrogen produced therein by reaction of the metal with the content of the can. *(Photo 1)*

10. **KNOCKED DOWN FLANGE:** A common term for a false seam where a portion of the body flange is bent back against the body without being engaged with the cover hook.

11. **LEAKERS:** Containers which have leaked.

12. **PANELING:** Flat sides on can body and/or permanent distortion (collapsing) of the can body caused by internal vacuum and excessive eternal pressure developed during processing or cooling. *(Photos 18 and 20)*

13. **PIN HOLES:** Minute opening in the base plate metal due to corrosion.

14. **PITTING:** Depressions in a metal surface caused by corrosion. *(Photo 11)*

15. **RUST:** Iron oxide produced by moisture in contact with unprotected base plate metal. *(Photos 11 and 19)*

16. **SECOND OPERATION:** The finishing operation in double seaming where the hooks formed in the first operation are rolled tightly against each other.

17. **SHARP SEAM:** A sharp edge at the top inside portion of the seam. Condition can be first indication of a further complication known as a "cut-over." This defect can usually be felt more easily than it can be seen. *(Photo 14)*

18. **SOFT SWELL:** A can bulged at both ends, but not so tightly that the ends cannot be pushed in somewhat with thumb pressure. *(Photo 1)*

19. SPRINGER: One end of a can bulges. Manual pressure on the bulged end forces the opposite end out or the same end will spring out with release of pressure. If both ends bulge but only one will remain flat when pressed, the can is a Springer. Springers result from moderate positive pressure in the can. *(Photo 1)*

20. **SWELLS:** Both ends of the can are bulged. Neither end will remain flat without pressure. Soft swells yield to manual pressure, but no impression can be made manually on hard swells. Swells result from positive pressure in the can usually because of spoilage of the contents. Some swells, especially in acid products, may result from chemical reaction between the contents and the container. *(Photo 1)*

21. VEE OR SPUR: Small metal irregularities in the double seam in one or more “V” shapes. *(Photo 15)*

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GMA Science and Education Foundation®
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Other AFDO Publications

- Apple Cider Processing Operations Requirements & Guidelines (February 2003, 2nd Print)
- Cured, Salted & Smoked Fish Est. GMPs Including Listeria Manual (May 2004)
- Food Code: Pocket Guide for Regulators (December 2006; August 2011, Printed)
- Food Emergency Pocket Guide (January 2007, Revised; September 2011, Revised)
- Guidelines for Exempt Slaughter and Processing Operations (June 2011)
- Guidelines for Exempt Slaughter and Processing Operations Training Manual
- Guidelines for the Transportation of Food Products (June 2005)
- Guidelines: Inspection & Enforcement of GMP Regulations for Packaged Ice
- Guidelines: Handling and Producing Packaged Ice within Foodservice and Retail Establishments
- Meat and Poultry Processing at Retail Training Manual
- Model Code for Produce Safety (November 2009)
- Model Consumer Commodity Salvage Code (February 2008)
- Model Water Vending Machine Regulation (June 1997, Revised; December 2002, Printed)
- Retail Meat and Poultry Processing Guidelines (June 2011)
- Retail Guidelines for Refrigerated Foods in Reduced Oxygen Packages
- State Food Safety Resource Survey

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