Gasket Fabricators Association

Technical Handbook

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Table of Contents

INTRODUCTION

Gasket Fabricator Defined

Gaskets are an integral component of any device which requires the confinement of a gas or liquid. They compensate for the unconformity of mating surfaces. These surface irregularities may be minute or large depending on the purpose of the device but in all cases, the gasket is required to compensate for the difference while limiting the flow of fluid in either direction.

Gaskets differ from seals in that gaskets are normally cut from sheets or rolls while seals are formed individually in their own configuration. A flat cut gasket is derived from material of specific thickness and to a configuration that is designed for a specific application.

Organizations which convert material in sheet or roll form to functional gaskets are designated as "gasket fabricators," gasket cutters," or simply "converters." "Gasket fabricators" are generally perceived to be those organizations which have dedicated their assets toward optimal accuracy and efficiency in their gasket fabricating activities. They have made major investments in sophisticated fabricating equipment. Gasket fabrication for original equipment production line applications requires consistency and precision on an ever-improving scale. Organizations that are sensitive to these needs, invest in the required equipment and process controls.

Members of the Gasket Fabricators Association are professionals dedicated to the continuous improvement of these activities.

Types of Material Fabricated—Processing Equipment

If the gasket material is in sheet or roll form, a gasket fabricator can convert it into parts. However, the material characteristics will determine the personality of the end product. Gasket materials that are hard and thin can be fabricated to tighter dimensional tolerances than gasket materials that are soft and thick. Accordingly, 90 durometer rubber 1/32 inch thick can be cut to more precise requirements than 30 durometer rubber 1/8 inch thick.

Some gasket fabricators specialize in certain types of material. One fabricator may have unique capabilities in the processing of sponge rubber products where another fabricator may have acquired equipment more suitable for elastomeric rubber.

Another specialization is the ability to process sheets rather than roll goods. One fabricator may be heavily invested in platen presses while another may specialize in slitters and punch presses with continuous feed and takeoff.

Typical gasket fabricating equipment utilized by gasket fabricators are:

1. Steel Rule Dies— Most commonly used for moderate volume parts. Tooling is economical and can be used in platen presses, roll presses, mechanical presses or rotary die machines.

2. Male and Female Blanking Dies—Generally used in high volume production where very close tolerances are required. Tooling is more costly but generally longer lasting.

3. Laser Cutting Machines—Laser technology offers excellent tolerance control with essentially no tooling wear. Equipment is expensive and used primarily in very specific applications.

4. Water Jet Cutting Machines—New technology with limited use, except in reinforced fiberglass composite cutting. Offers excellent tolerances.

5. Wire Electrical Discharge Machines (EDM)—For small volume or prototype work. Very good for intricate designs.

In summary, all gasket fabricators are not alike. They differ in their converting capabilities and accordingly, they differ in the types and forms of materials processed.

STANDARD PRACTICES

DIMENSIONAL CHARACTERISTICS

General

The objective of the following specifications and capabilities for cut gaskets is to acquaint the user of gasketing products with acceptable methods, procedures and dimensional characteristics used in the industry. The enclosed information and data is offered as a guide to the designer of gaskets as well as an aid to the purchasing facility using cut gaskets.

The specifications outlined herein were developed from the present state of the art with respect to known manufacturing techniques. Depending upon materials, product design and/or individual manufacturing techniques, the dimensional specifications outlined in the report may vary.

Application

In general, a gasket is used to seal two imperfect mating surfaces. In any part designed as a gasket, only the designer knows which dimensions are critical. If all are critical, this should be clearly indicated. In gasket designs, the bolt hole location and hole size are normally the most important. Port hole position and size may also be of prime concern. Thickness of the gasket as well as the material physical characteristics play an important part in gasket design and capability. The essential design elements should always be specified on drawings. In examining a gasket drawing the producer of a gasket frequently questions if corners must be as sharp as shown or whether radii are acceptable; do all holes and ports actually require the same close tolerances; and does the title block tolerance properly reflect actual gasket requirements versus standards for machined parts? The designer should be certain he needs everything he specifies. Unnecessary requirements can result in needless costs in producing the parts. Consultation with the gasket fabricator will often lead to cost saving in tooling or production of the part.

Methods

Although cutting methods for individual gaskets can vary widely, the most conventional cutting tools used are: Steel rule dies, solid steel dies, or a combination of both. The most widely used is the steel rule die. Steel rule dies have been described as “glorified cookie cutters.” A steel rule die consists of a base material such as high grade plywood or phenolic composition which becomes the holder for a strip of hard thin steel sharpened on one edge known as “steel rule.” Sharpened hole punches known as “tubes” are incorporated along with rubber stripper pads to complete the tool. Depending upon the dimensional aspects of the part, different procedures can be used in the construction of the cutting tool. These various methods greatly dictate the accuracy of the cut part.

The illustrations on page 7 and 8 outline steel rule construction methods.

Tooling Types

The two most common types of tooling used are steel rule dies and all steel dies. Volume, quantity, tolerance, and cost are the variables that help determine the type of tooling used.

Steel Rule Dies

There are multiple ways to construct a steel rule die. However, the objective of any method is to cut a pattern of the part into the base material, and then insert a steel rule that has been bent into the same pattern, into the base material.

The various methods used to make a steel rule die are:

- To obtain the pattern cut into the dieboard, the customer's print or part pattern can be either hand or machine drafted onto the dieboard. The dieboard is then hand cut with a jigsaw.
- Another method is to program the customer's print into a computer controlled laser cutting machine and laser cut the pattern into the dieboard.
- Once the pattern is cut into the dieboard, the steel rule is bent into the same pattern and inserted into the board. The bending of the steel rule can be done either by hand or by using a computer driven rule bending machine.

As shown in the chart on the following page, these methods have different tolerances associated with them.

All Steel Tooling

Depending upon the complexity of the design, the type of material and the volume of the part, all steel male and female tooling is often used to produce a gasket. Unlike blanking or cutting ferrous or nonferrous materials, most gasketing materials do not require clearance between the punch and the die in all steel tooling. The common practice is to construct all steel tooling with minimum clearance between the punch and die. In many instances, the punch may be hard with a soft die which allows the die to be "peened" against the punch to provide zero clearance conditions. Zero clearance provides clean cut parts. As the edges of the punch and die become rounded due to the abrasive action of the material being cut, the quality of the cut part may diminish.

Dimensional tolerancing for all steel tooling can be controlled to a few thousandths of an inch. The improved accuracy of all steel tooling over rule die tooling results in more accurate part dimensional capabilities. Although the all steel tooling used to produce a gasket may be built to very close tolerances, the tolerance of the part depends upon the gasketing material. The material may pull or stretch during the cutting action. The cut part may be subject to shrinkage or expansion depending on the atmospheric conditions after cutting. To maintain maximum dimensional stability on parts produced from all steel tooling, the die should be maintained in a sharp condition and the parts should be packaged in a stable environment.

Dimensional Capabilities for Steel Rule Dies

It is important to know that the dimensions of the die cut part are determined not only by the die, but also by the material type, hardness, density, thickness, and variations of these factors. The greater the variation of these factors, the greater the variance of the die cut dimensions.

Different types of tooling have different dimensional tolerances.

All steel tooling provides the most accurate tolerances. These can vary depending on type of tool construction methods, but generally +/-.002 to +/-.005 can be held.

Steel rule tooling also varies with the type of construction method. The most accurate is laser cut board with automated bent rule. Depending on length of rule, tolerances can range from +/-.005 to +/-.015. The longer the rule is, the more variation can be expected.

Steel rule dies that are laid out by hand and jigsaw cut can not be held this tight and will generally vary +/-.030.

Holes that are cut using punches will have the same tolerance regardless of die construction method. The industry accepted variation on punch dimensions are as follows:

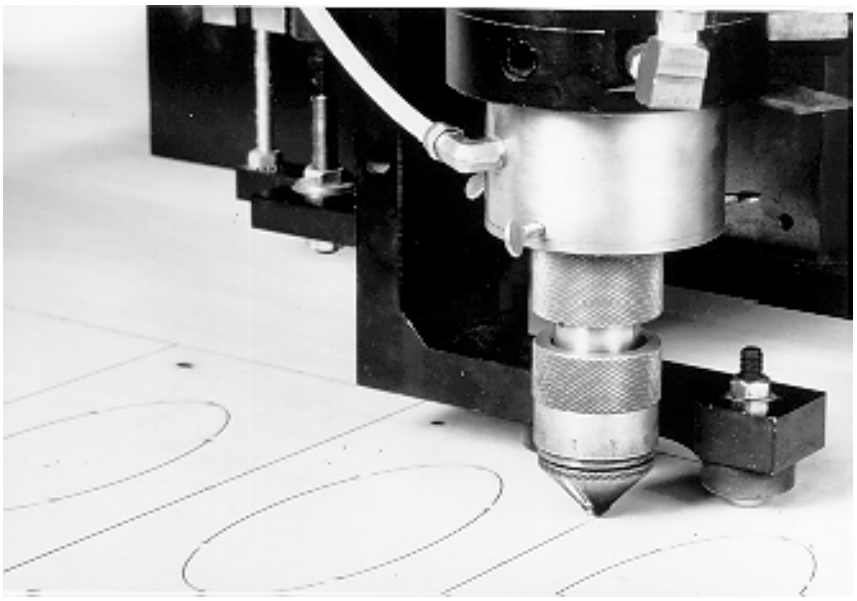
Hole diameter—less than 3/4" +/-.002
Hole diameter—from 3/4"-1 5/8 +/-.003
Hole diameter—greater than 1 5/8 +/-.005

Hole position tolerance is again best achieved using laser cutting and automated rule bending. Depending on distance between holes +/-.005 to +/-.015 can be expected. If the die is laid out by hand and jigsaw cut, the tolerances could be +/-.010 to +/-.030.

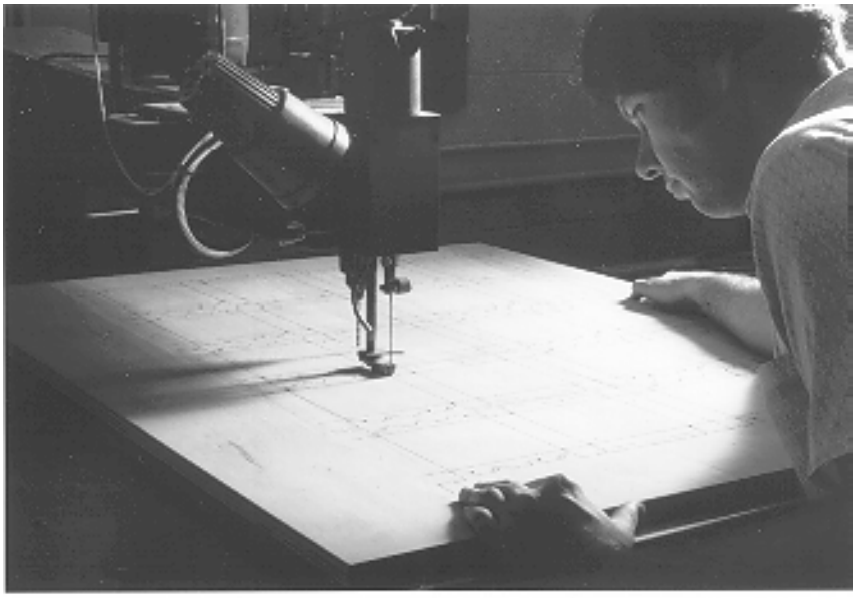
These tolerances are general guidelines and can vary based upon die building equipment and the skills of the die maker.

Steel Rule Die Making Methods

The die making process begins with the layout. The layout can be done either manually or by C.A.D.



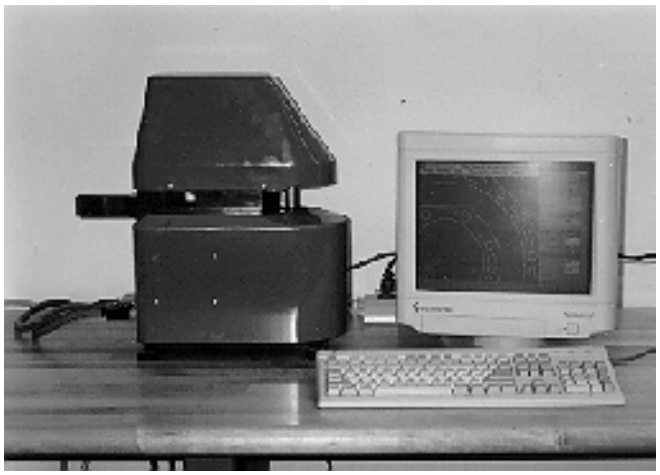
A computer controlled laser cuts the die board.

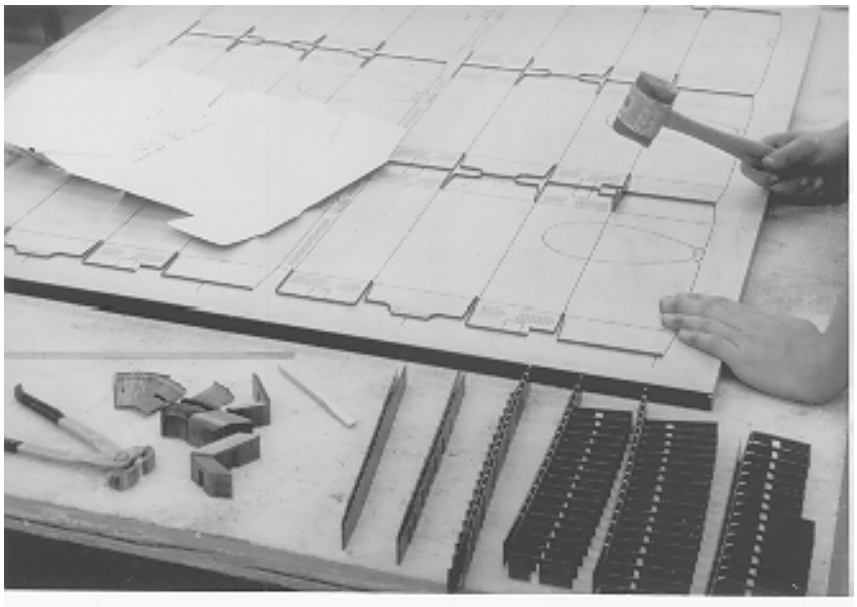


The pattern is cut with a precision jig saw.

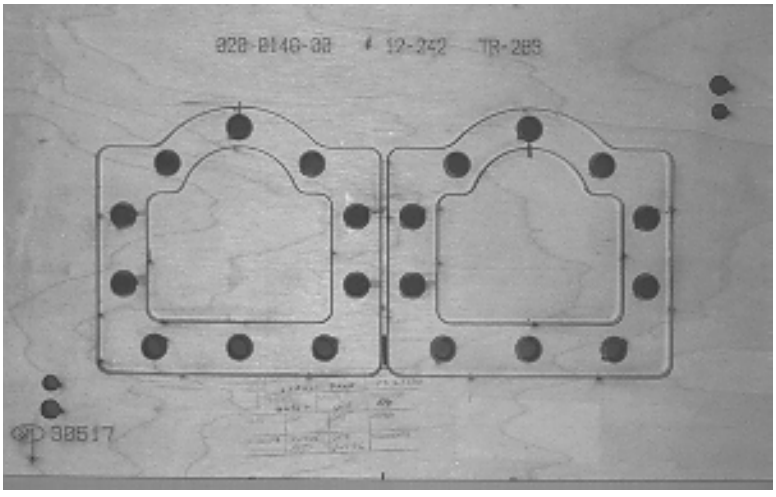
The steel rule is hand cut and bent to proper configuration.

(Right) A computer controlled machine cuts and bends the rule.





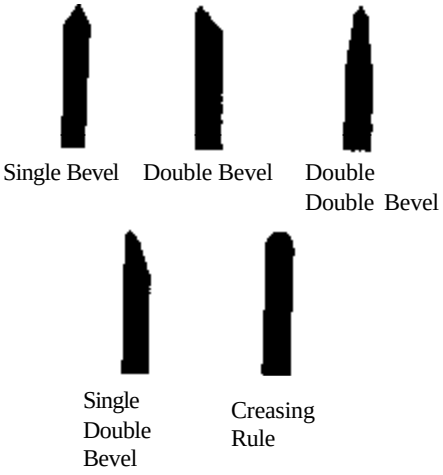
The steel rule is inserted into the die board.



The steel rule die is complete.

Dimensional Verification

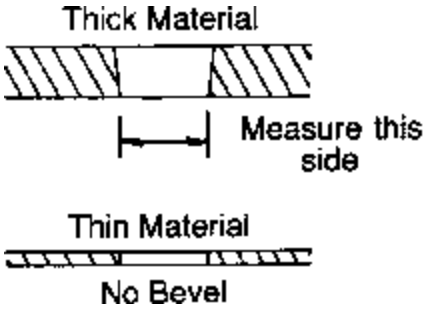
Various methods are used to check dimensions on production tooling or parts. In most cases, it is difficult to measure the dimensions on the steel rule die itself, because of the many types of bevels and position of the cutting edge.



It is not recommended to use the gasket as a measuring device since the part is usually flimsy and unstable. Some gasket materials are subject to change due to atmospheric conditions, such as humidity.

Die impressions are commonly used to check dimensions. The impression should be made on stable material. These materials are not subject to change due to temperature or moisture conditions. Mylar, plastics and tag paper are commonly used. An impression is created by either cutting partially into the plastic material, which gives a clear defined line to measure against, or a dark line impression can be obtained by placing carbon paper between the die and manila tag. If a coordinate measuring machine is used for checking, the plastic impression is best to use since a defined line is present in which to position the stylus. Caution should be used when making the impression. Distortion can result if the impression is too deep which can cause errors in measurement.

Manila tag impressions can be easily measured using standard drafting techniques or they can be used with coordinate measuring machines similar to plastic impressions.



Punched holes dimensions should be measured by means of plug gauges in the punched hole of the gasket. The hole should be measured opposite the initial pierced side. On relatively thin materials, there will be little, if any, size variation from one side or the other. On thick materials, the bevel of the punch tube may distort the hole to some degree.

Hole true position can best be determined by coordinate measuring machines. All positional tolerance requirements are to be based upon maximum material conditions (MMC) unless otherwise specified.

An example of hole location tolerance for floating fasteners and tolerances for radius with an unlocated center is illustrated at the top of the next page.

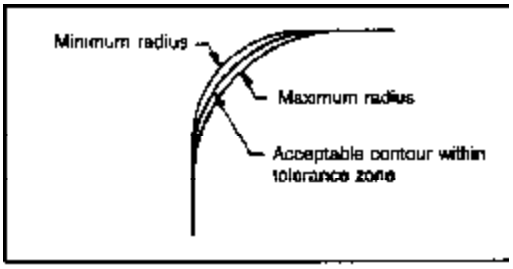
PART ACCEPTANCE TOL

PART HOLES AT LOW
LIMIT .265 [6.73] MMC
POSITIONAL TOL .015 [0.38] Ø

PART HOLES AT HIGH
LIMIT .277 [7.04]
POSITIONAL TOL .027 [0.69] Ø

Toleranced Radii.

A toleranced radius with an unlocated center creates a tolerance zone defined by arcs tangent to adjacent surfaces within which the part contour must have a faired curve without reversals. The part contour falls entirely within the zone between the minimum radius and the maximum radius, regardless of the actual shape of the part. The radius at all points of the part contour shall neither be smaller than the specified minimum limit nor larger than the maximum limit. See illustration.



ZONE FOR A TOLERANCED RADIUS WITH AN UNLOCATED CENTER

MATERIAL THICKNESS TOLERANCES

To perform their function, gaskets are expected to be compressible and resilient. Materials are often selected for specific applications because of their compressibility.

Since the material is intended to be compressed, original thickness and thickness tolerances are important only to the extent that sufficient material remains after compression to fill the gap between flange surfaces. Accordingly, in general, soft compressible materials (sponge, cork) have greater thickness tolerances than firm, less compressible materials (compressed sheet). In no case should these resilient materials be specified with the same thickness tolerances as non-resilient materials such as steel.

Typical thickness tolerances for resilient gasketing materials are listed below.

Typical Thickness Tolerances (Inches)*
Resilient Gasketing Material

Product/Process	.016"	.031"	.047"	063"	.094"	.125"
Beater Addition Fiber	+.002 −.003	±.003	±.004	+.004 −.006	+.010 −.006	+.011 −.009
Compressed Sheet	+.005 −.002	±.005	±.005	±.008	±.008	±.010
Cork Composition	±.010	±.010	±.010	±.010	±.010	±.013
Cork–Rubber						
Rolls	–	±.005	±.005	±.005	±.010	±.010
Sheets	–	±.010	±.010	±.015	±.015	±.015
Flexible Graphite	±.002	±.002	±.002	±.002	±.009	±.013
Rubber	±.010	±.012	±.012	±.016	±.016	±.020
Rubber Coated Fabric	±.003	±.003	±.005	±.006	±.009	±.013
Sponge	–	–	–	+.032 −.016	+.032 −.016	+.032

*Derived from published literature, ASTM F–104 Standard Classification System, and RMA Sheet Rubber Handbook. Actual tolerances may vary, by manufacturer. Some manufacturers offer tighter tolerances at premium prices.

MEASUREMENT

In the previous section "Dimensional Characteristics," it was suggested that dimensional verification of tooling be made on die impressions rather than on cut gaskets due to the dimensional instability of some materials. This procedure may be acceptable in the fabricator's workplace but it may not satisfy the needs of the gasket user. Accordingly, attention must be given to the gasket dimensions at the place of application. If the gasket material shows significant dimensional change in changes of atmospheric conditions, the gasket must be protected from these influences. In recognition of this characteristic, gaskets fabricated from cork containing materials are generally packaged in polyethylene bags. Although cellulosic materials are subject to dimensional change in varying environmental conditions, some cellulose based materials have been reinforced with inorganic fibers to reduce atmospheric dimensional change.

Notwithstanding the above information, there are times when fabricated gaskets must be checked for their dimensional conformance to blueprint or application requirements. In order to achieve verifiable and accurate dimensions, consideration must be given to atmospheric conditioning of the gasket. ASTM Standard F104-83, Paragraph 8, details the currently accepted conditioning practices.

Measuring devices available and commonly used by gasket fabricators are:

- Calipers
- Coordinate Measuring Machines
- Durometer Gage - instrument to check hardness of rubber and rubber-like material
- Gage Pins - straight, unflanged pins with specific diameters and extremely close tolerances
- Light Section Microscope
- Metal Hardness Tester-device to determine hardness of steel being fabricated
- Micrometers
- Optical Comparators
- Radius Gages - precision ground metal strips with accurate radius machined on each end
- Scales - 6" 12" 18"
- Shadow Graph Machines
- Templates - Soft (thin plastic or mylar) Hard (1/8" to 1/2" thick plastic or mylar with steel pins)
- Tolerance Gauge - Tool for visual pass/fail dimensional inspection.

PART IDENTIFICATION

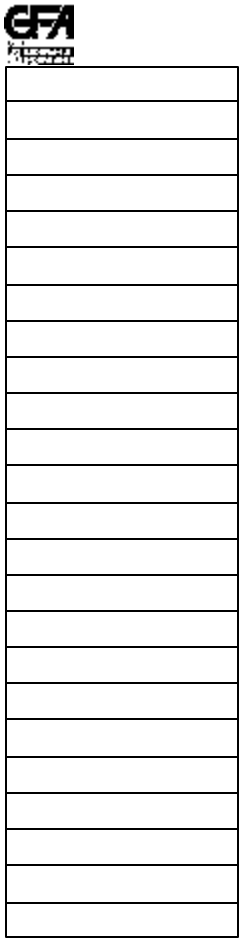
Some manufacturing operations utilize a multitude of similar gaskets. Accordingly, it is frequently desirable to individually identify different parts by number and/or supplier. This identification provides for:

1) Traceability
2) Inventory Verification
3) Efficient Application

There are a number of identification alternatives which can be arranged. Among them:

1) Rubber Stamp with ink - Part Number and/or Supplier Logo
2) Metal Stamp - No ink - Indent Material with Part Number and/or Supplier Logo
3) Screen Print - Part Number and/or Supplier Logo
4) Tie In Bundles and Tag
5) Package Specific Quantities in Printed Envelopes
6) Shrink Pack Specific Quantities - Label
7) Color Code with Rubber Stamp or Screen Printing
8) Notch Edge of Gasket According to Prearranged Code

NOTE: Special operations may add to cost of gasket.



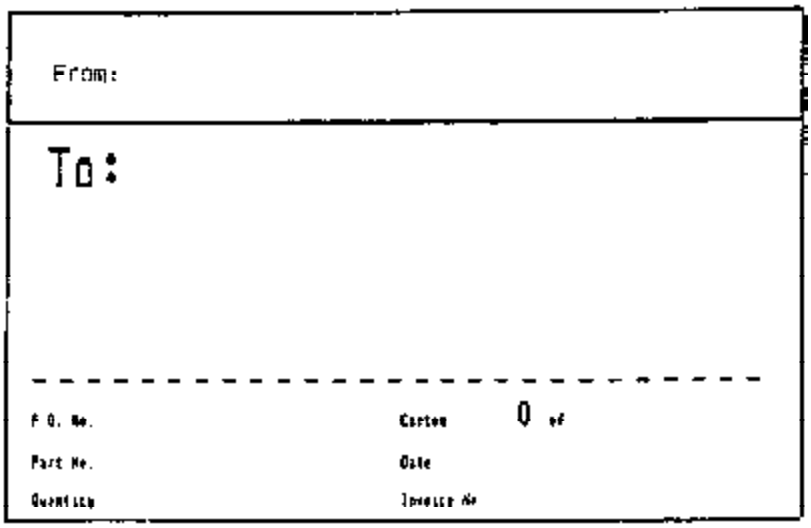
LABELING

Effective labeling is an important component of good customer/supplier relationships. It is important that labels be placed for easy viewing from any vantage point, they must be visually clean, and they must include all of the information pertinent to the transaction.

In many cases, all of the required information cannot be provided and should not be provided on the same label. Many companies prefer shipping information be separated from product information. In other cases, format is the prime consideration. In any case, these details can always be negotiated between customer and supplier. Typical labels are as follows:

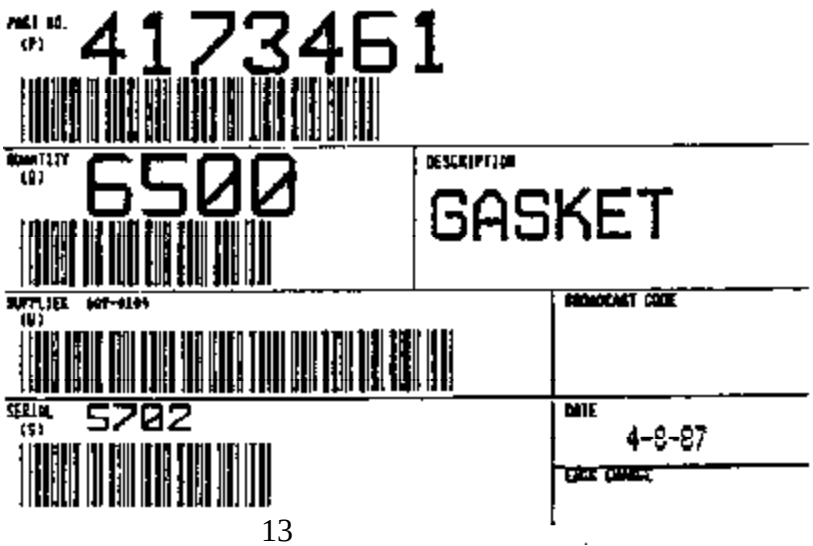
All Inclusive Label

This label includes all of the basic required information.



Bar Code Label

For those organizations using bar code readers, this label provides product identification and quantity information in an AIAG standard format.



LOT TRACEABILITY

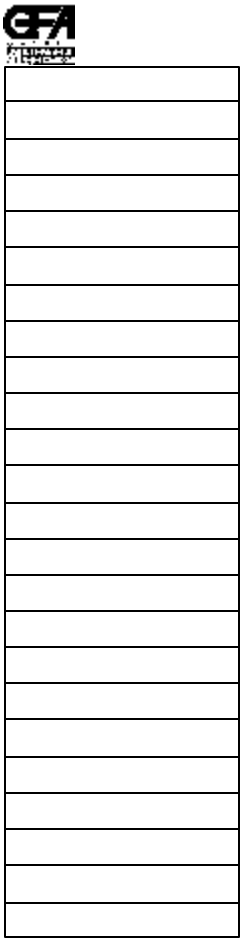
➢ Lot Traceability System

Gasket manufacturers should establish a system for positive identification and record keeping for use when required by customers. The lot identification number for finished gaskets should provide traceability to major manufacturing operations, inspection, testing, and significant raw materials. The method of lot control and identification should be developed by the gasket manufacturer, consistent with their manufacturing facilities and operations, and should include the elements discussed below.

➢ Lot Identification

The lot identification and lot size should be determined by one of the major manufacturing, testing or inspection operations. Significant raw materials may also be considered for lot size and identification. In continuous operations, it may be necessary to select a specific length of time, such as a shift, one day, one week, etc. to determine lot size. In all cases, the lot number assigned to finished gaskets must provide traceability to major manufacturing operations, inspection and test records and significant raw materials.

The gasket supplier should assign only one lot code to a lot, regardless of the number of shipping designations. When successive subdivisions of the lot are necessary, the principal code must be supplemented by additional subordinate codes to identify each of the sublots. Each shipping container must be identified with the principal and subordinate codes.



The supplier may ship more than one lot on a pallet, but each container on the pallet must contain parts from only one lot. The packing slip must state the number of containers comprising each lot.

➢ Lot Traceability Control

The gasket supplier must establish a system for identifying lots so that:

- Records indicating inspection or tests results contain the principal and subordinate lot code.
- The final inspection reports are cross-referenced to supporting inspection and test documents and the supplier's code.

QUALITY ASSURANCE

Policy

Fabricators will employ appropriate operating procedures and controls to assure that parts supplied conform to customer specification requirements.

Procedures

A. Fabricators will establish and maintain written procedures covering all phases of the control system. These procedures will be dated and signed by an authorized individual and will be available for review by customer representatives.

B. Records of conformance will be retained for 12 months, or as required by the customer after shipment of parts. Retained records will include:

- Supplier evidence of conformance to specification
- Fabricator evidence of manufacturing process capability
- X and R Charts of critical characteristics

References

- Harvey C. Charbonneau and Gordon L. Webster. Industrial Quality Control, Prentice-Hall, Inc. 1978
- Eugene L. Grant and Richard S. Leavenworth . Statistical Quality Control, McGraw-Hill, Inc. Fifth Edition, 1980.
- J.M. Juran, Frank M. Gryna, Jr., and R.S. Bingham, Jr. Quality Control Handbook, McGraw-Hill, Inc., Third Edition, 1979.

H. STATISTICAL PROCESS CONTROL (S.P.C.)

S.P.C. provides a means for changing the emphasis of quality control from detection of defects to prevention of defects.

S.P.C. operates by:

- Returning control of quality to the place where it starts; the operator, tool setter, supervisor.
- Detecting changes in process at the earliest possible point.
- Providing sound knowledge of reasons for a process change.
- Determining the inherent variations in a process.

S.P.C. provides:

- Knowledge of the place and time to take corrective action and avoid continued production of bad parts.
- A road map which enables a manufacturer to better his process.

Results of a good S.P.C. program are:

- Improved customer satisfaction.
- More realistic processes and tolerances on any given product.
- A formal program for "best of quality" output.
- Lower costs.

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