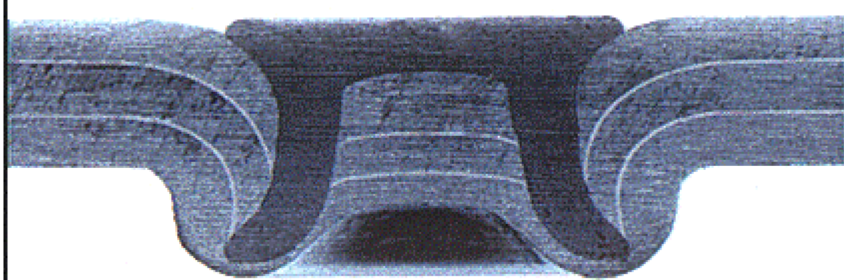
Self Pierce Riveting Joint Quality

Manual Part Number: 30-00046

Henrob™ Self-Pierce Riveting Technology



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Intentionally Blank

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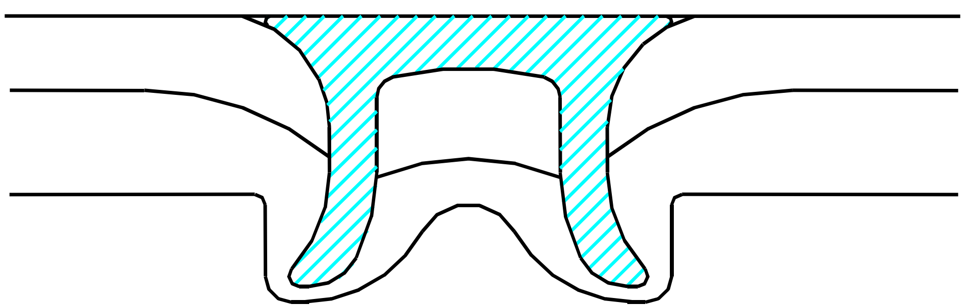
1.0 Quality Control of Self Pierce Riveted Joints

1.1 Parameters for Joint Quality

High quality SPR joints are achieved by the correct combination of five variables. These are:

- Rivet type - this includes geometry, hardness, and coating.
- Riveting insertion force - defined as velocity for servo tools (mm/sec).
- Clamping force - factory pre-set load system for servo tools.
- Upsetting die geometry.
- Well defined specification of materials that are to be joined.



Typical Example of a Henrob SPR Joint

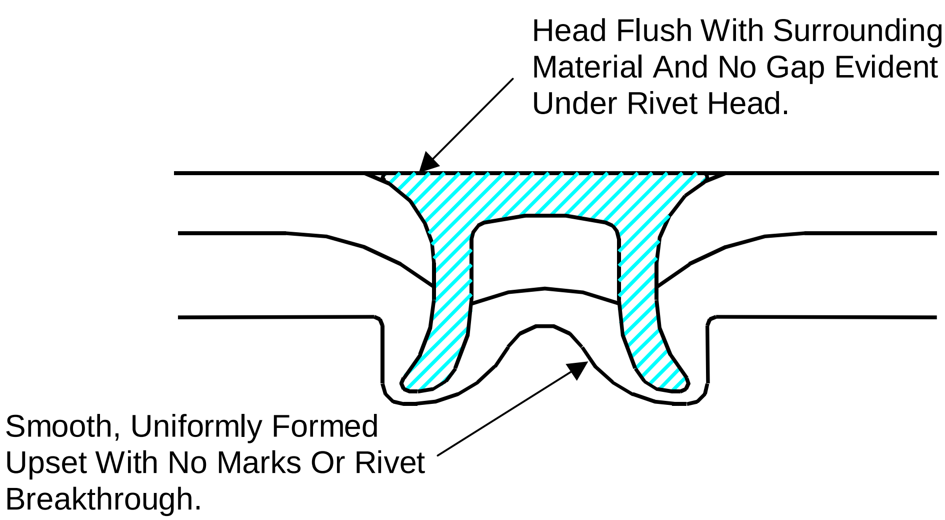
The values for the above variables are determined following extensive engineering evaluation and development testing. Once established, none of these variables should be changed or adjusted without a new evaluation exercise. The Henrob self-pierce riveting (SPR) process, once set up for a given application, should require no further adjustment. The process is inherently reliable but can fail if the control parameters are not maintained or the equipment becomes damaged or degraded.

This section provides descriptions of potential process failures, how to identify them, and what corrective actions will eliminate them.

1.2 Visual Quality Inspection

A great deal can be learned about the quality of a riveted joint by a simple visual inspection. A good joint is characterized by:

- The underside of the rivet head is in close contact with the surface of the top sheet of parent material leaving no gap evident.
- A well-formed rivet tail (upset) on the reverse side of the material sandwich. In most cases, this protrusion should have a mushroom-like shape where the parent material has been formed against the upsetting die. There should be no cracking of the material forming the rivet tail.
- The material around the rivet should be smooth and flat with all sheets in the joint clamped tightly together.
- Sectioning sample joints by cutting the rivet through its longitudinal axis and polishing smooth will reveal further detail. A cross section of a satisfactory rivet is shown.



1.3 Tensile Testing

The most reliable measure of joint integrity is made using tensile testing. This method is metric based and not susceptible to any operator variation. Samples of production materials are riveted together using the production equipment and then pulled on a tensile test machine. The resulting ultimate force value is then compared to the established acceptance parameters.

Tensile test coupons are preferably cut from batches of production product. Alternatively, material of the same specification as that used for product manufacture may be used, however attention must be given to any changes in material gauge or hardness, etc. that may have occurred during production stamping or forming operations. Henrob typically suggests the test coupons measure 1" by 4" and are riveted together using coupon assembly fixtures providing a 1" overlap.

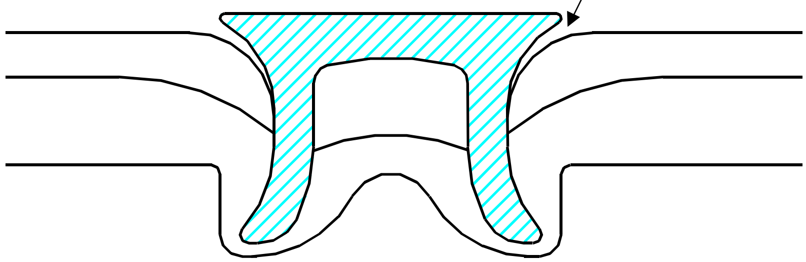
1.4 Sectioning Samples

Most of the diagrams in this document show examples of cross-sectioned riveted joints. This is the best way to visually evaluate a joint. Joints are sectioned by cutting the sample with a fine high-speed abrasive wheel. The cut should be made just off the centerline of the rivet to ensure a full half remains. The sample is then polished allowing the detail to be easily viewed.

2.0 Detailed Definition of Potential Faults

2.1 Rivet Head High

(Standing proud)



The flushness of the rivet head with the parent materials being joined is a primary indicator of joint quality. Typically, a rivet should be inserted to such a depth that there is no discernable gap between the underside of the rivet head and the parent material. If the rivet head is not clamped down tightly on the parent material, it will result in a joint with reduced static and/or dynamic strength. Also the under head gap can provide a crevice for corrosive agents to collect, which can result in rapid degradation of the parent material.

The depth to which a rivet can be inserted is dependent on a number of factors. Any one or combination of which can result in the rivet head standing proud. These factors are:

- **The punch driving the rivet must push it fully in:** limited force determines punch travel up to its maximum stroke. The punch stops traveling once this pre-determined force is achieved or it reaches the end of its travel.

  Therefore, if the rivet insertion force is set too low or the placement of the rivet setter in the C-frame is such that the punch has inadequate travel, the rivet will not be driven fully in.

- **The correlation of rivet material volume to available die volume:** When a joint is made, a finite volume of material is added to the joint area in the form of the rivet. As the rivet is inserted, the material it displaces must be allowed to flow elsewhere. The cavity in the die provides the available space for this.

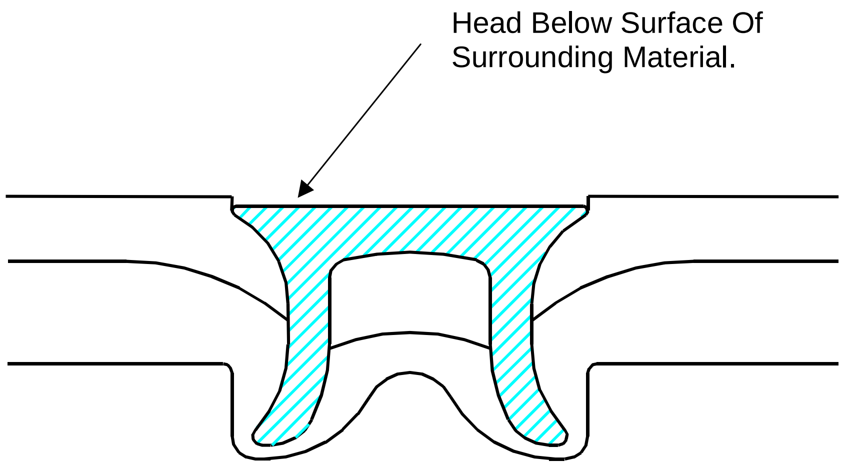
  The volume of the die is selected to be correct for the joint in which it is used. If a die with less volume is accidentally used, the rivet will require substantially more force to drive it flush. In addition, the volume of a correctly specified die can be reduced in the event that material breaks away from a joint and partially fills the die cavity. (See Section 2.7)

- **The correct matching of rivet length to joint thickness:** If the rivet is too long or the materials being joined are too thin, the rivet head will stand proud.

  The rivet length in combination with the die type is selected to be correct for the joint for which they are specified. Normal variations in rivet length due to manufacturing tolerances will typically not have a measurable effect on rivet head height. Significant changes in rivet length or material thickness however will.

- **The rivet geometry and hardness will also affect required insertion force:** The rivet geometry and hardness are selected to be correct for the joint in which the rivet is specified. These are carefully matched to the physical properties of the materials being joined. Significant changes in the material properties of either the rivet or the product will affect the required force to set the rivet.

2.2 *Rivet Head Low* (Under flush)



The flushness of the rivet head with the parent materials being joined is a primary indicator of joint quality. Typically, a rivet should be inserted to such a depth that there is no discernable gap between the underside of the rivet head and the parent material.

If the rivet is driven substantially beyond this point, the underside edge of the rivet head will begin to cut into the parent material and cause a reduction in joint strength. This 'burying' of the rivet head will typically result in a substantial loss in peel strength as the rivet head is predisposed to tearing through the top sheet of material.

The depth to which a rivet can be inserted is dependent on a number of factors. Any one or combination thereof can result in the rivet head being pushed too deep. These factors are:

- **The punch driving the rivet must push it only to the correct depth:** Punch travel is controlled by a limited force, up to its maximum stroke. The punch stops traveling once this pre-determined force is achieved or it reaches the end of its travel.

  Therefore, if the riveting force is set at too high a level, the rivet can be driven deeper than intended.

- **The correlation of rivet material volume to available die volume:** When a joint is made, a finite volume of material is added to the joint area in the form of the rivet. As the rivet is inserted, the material it displaces must be allowed to flow elsewhere. The cavity in the die provides the available space for this.

The volume of the die is selected to be correct for the joint in which it is used. If a die with more volume is accidentally used, the rivet will require less force to drive it flush. In addition, the volume of a correctly specified die can be compromised when it becomes excessively worn. A damaged die can have this same effect.

- **The correct matching of rivet length to joint thickness:** If the rivet is too short or the materials being joined too thick, the rivet head will go beyond flush.

  The rivet length in combination with the die type is selected to be correct for the joint for which they are specified. Normal variations in rivet length due to manufacturing tolerances will typically not have a measurable effect on rivet head height. Significant changes in rivet length or material thickness however will.

- **The rivet geometry and hardness will also affect required insertion force:** The rivet geometry and hardness are selected to be correct for the joint in which the rivet is specified. These are carefully matched to the physical properties of the materials being joined. Significant changes in the material properties of either the rivet or the product will have a significant effect on the required force to set the rivet.

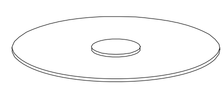
2.3 Damaged Rivet Head

After the rivet has been inserted into the joint, there should be no evidence of any mechanical damage to the rivet head. It should appear round, flat and true to the surface of the surrounding material.

Rivet head marking usually indicates excessive wear or failure in rivet gun components.

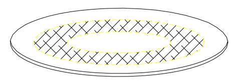
Typical damage marks are:

- Raised pip in center of rivet head.



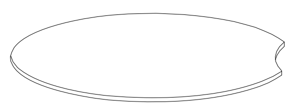
The presence of a pip in the head of the rivet after it has been set is usually an indication that a matching indent will be found in the face of the punch. This damage to the punch is a result of the rivet gun being cycled without either material or rivets in place. Under these circumstances, the punch will strike the pip in the die, both flattening the pip and making an indent in the punch. *Both punch and die need to be replaced to correct this fault*.

- Heavy circular gouge on top of rivet head concentric with head diameter.



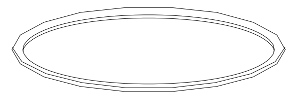
Such a mark typically indicates a new rivet being set on top of an existing rivet. The rivet that was already in place will receive the circular gouge as the new rivet presses down on it. The upper rivet will typically remain stuck in the nose of the rivet gun, its geometry destroyed. However if the rivet gun is then cycled again on fresh material, this damaged rivet will be pressed into the joint by the next advancing rivet which will subsequently also be damaged and so on. Therefore, the presence of a circular gouge will usually mean that at least a minimum of two rivets are defective and potentially a much larger quantity.

- Small, rounded chip missing from edge of rivet head after insertion.



If the edge of the rivet is chipped, it indicates that it was likely hit by the punch one cycle before it was actually set. This happens when the rivet carrier tape is under tension as the punch pushes the rivet out. If the tape is under tension, the rivet to be set will be pulled past center and the next rivet in line will be consequently pulled slightly into the path of the advancing punch. Thus, the punch chips this second rivet as it passes by. Tension in the tape is typically a result of the pneumatic lines to the sprocket feed actuator being reversed. Thus, the actuator 'parks' at the wrong end of its travel with the tape under tension.

- Full circular depressions in rivet head approximately ½ mm smaller than the head diameter.



Typically such marking is caused when the rivet is excessively soft. The insertion force applied by the punch causes the head to spread and the punch leaves an impression on it.

- Irregular cuts or marks on rivet head.

The face of the punch where it presses on the head of the rivet should be smooth and flat with a rounded edge. The presence of any irregular marking on the rivet head will normally indicate that the punch has been damaged and requires replacement.

2.4 Tumbled Rivets

(Rivets lying sideways or fully inverted)

A correctly functioning system will deliver rivets square to the surface of the parts and insert them true to this same surface. If rivets are found to have been inserted sideways or fully inverted then it is most likely that they were positioned that way prior to being pressed into the product by the punch. Rivets seldom, if ever, tip sideways once the insertion stage of the process has begun. Obviously, a rivet that is inserted out of true cannot provide any assurance of acceptability.

Rivet orientation is determined by its attitude as it is pressed out of the carrier tape and by the nose insert which aligns the rivet just prior to insertion. If a rivet tumbles, it typically occurs just beneath the punch during the indexing of a new rivet into place or in the initial stages of the punch advancing.

- **When the rivet is pressed out of the carrier tape, it must be reasonably centered in the nose insert. If the rivet is significantly over or under fed it can catch on the edge of the nose insert and roll as it enters the nose. It is also important that the entry slot in the nose insert that allows access for the shank of the rivet is not excessively deep. The slot should be of such a depth that the end of the rivet has passed**

