



**Technical Information Series**  
**TS3**

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**SEAMS AND HEAD BURSTS**  
**AN UNFORTUNATE FACT OF LIFE IN FASTENER**  
**MANUFACTURING**

**by**  
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## Background

Split heads and head bursts are classified as 'surface discontinuities'. As such, they fall under the jurisdiction of consensus product quality standards such as ASTM F788/788M or SAE J1061. These and similar proprietary standards use the same criteria for classifying and for specifying the allowable limits of surface discontinuities that may occur during the manufacture and processing of metal threaded fasteners such as bolts, screws, studs and other types of externally threaded fasteners. Note that although these documents do not specifically refer to rivets, they are also applied to rivets.

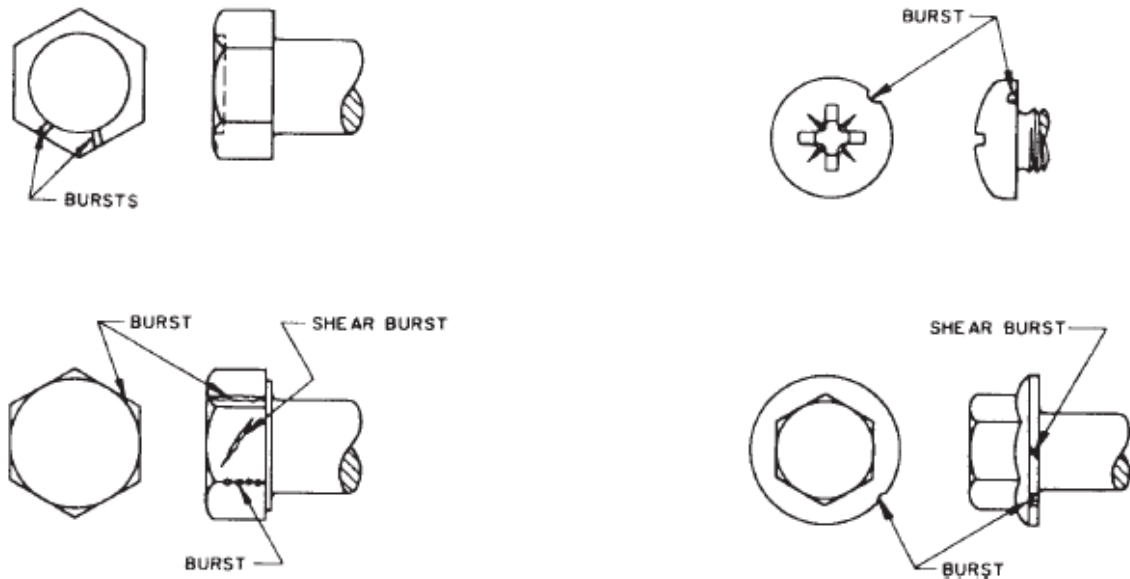
Discontinuities, and more specifically splits and bursts that are within the allowable limits do not have a negative impact on the fit, function and mechanical properties of the fastener. Consequently they are evaluated based on criteria that are limited to visual characteristics and aesthetic considerations. Very often the visual criteria are negotiated between the manufacturer and the customer, based on the limits established in the above mentioned standards. Only in very extreme cases that far exceed the allowable limits, will splits and bursts affect the fit and function, or deteriorate the mechanical properties of the fastener.

## Definitions and Root Causes

### *Bursts and Shear Bursts*

A burst is an open break in the metal during heading located on the flats or corners of the fastener head, or at the periphery of a flanged or round headed fastener. A shear burst is an open break in the fastener metal at approximately 45° to the product axis, usually located at the periphery of fasteners having flanged or circular heads or on the side of hex heads.

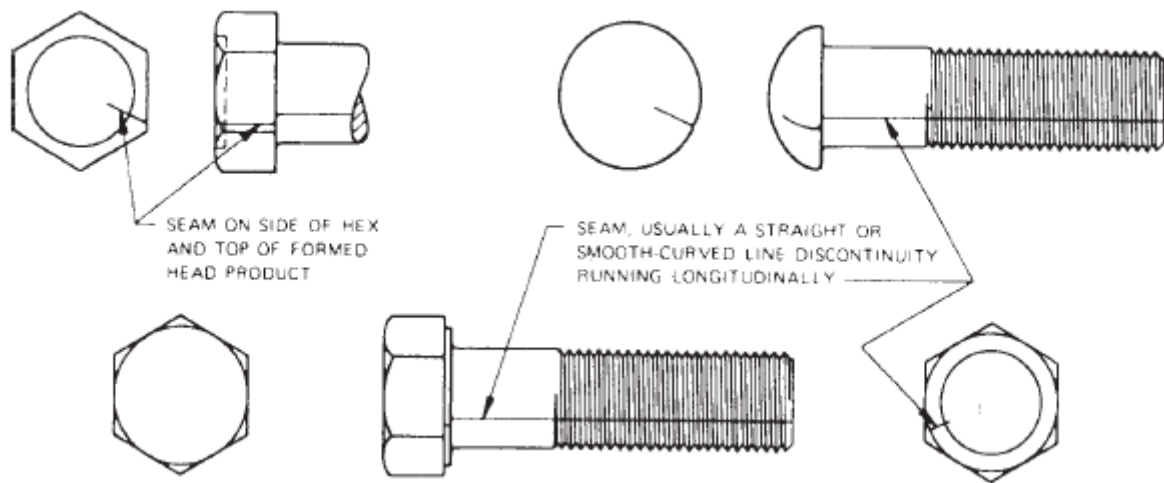
Bursts and shear bursts are typically caused by material that lacks the necessary ductility for a given upset ratio during heading. Bursts can also be caused by impurities in the material, such as inclusions.



**Figure 1: Typical Bursts and Shear Bursts – Source Ref. 1**

### Seams

A seam is a straight or smooth-curved line surface discontinuity running longitudinally on the fastener body and head. It is created during the rolling of a cast billet into rod, where the billet contains a sub surface inclusion or void that becomes elongated during rolling. Seams can split open in locations of greater material flow, such as at the head, or at the periphery of a flanged or round headed fastener.



**Figure 2: Seams – Source Ref. 1**

Impurities that cause seams can result from a number of different events during steelmaking. This makes prevention very complex for a large scale steel manufacturing process. Through years of trial and error, steel manufacturers have implemented solutions that have helped reduce inclusions and impurities. Some of these include selection of steel charge, better control of casting temperature, ladle stirring, modifications to tundish and nozzle design, and close control of cooling rate. However, antiquated melting/casting infrastructure and machinery used in North America make the complete elimination of this problem next to impossible. Clean steel practices are more commonly available in countries such as Japan and Germany thanks to the more recent steel foundry and casting facilities. However, even with these advances in clean steelmaking practice, seams and the resulting split heads have not been completely eliminated for fastener manufacturers.

## **Prevention & Detection**

### *During Steel Manufacturing*

There are a number of methods employed by steel manufacturers to minimize impurities and inclusions in steel and to help detect seams after rolling. Some of these techniques are as follows.

- Ladle and tundish stirring during billet casting
- Modification of tundish discharge nozzle design for billet casting
- Electromagnetic stirring (EMS) in continuous caster
- Billet scarfing and surface preparation prior to rolling
- Eddy current sensors located in rolling stands
- Upset testing of coil. This is merely a sampling of the front and back ends of a coil after it has been rolled.

### *During Fastener Cold Heading*

No fool proof prevention method is available to fastener manufacturers for eliminating splits and head bursts; however there are a number of measures that can mitigate the risk of occurrence or reduce the severity of the cracks. These are as follows.

- Work closely with steel supplier to control source and quality of billets for critical parts. Typically fastener manufacturers don't control the source of continuously cast steel billets used to supply them steel rod and wire. A rolling mill or outside processor may use steel billets from different sources to meet the same client specifications.
- Upset testing. Again this is merely a sampling of the front and back ends of a coil after it has been rolled. It offers no guarantee but can be useful.
- Limit the pre heading draw of the rod to 10% reduction in diameter.
- Lower the upset ratio during head forming blows. This might require an increase in the number of blows by moving complexes parts to multiple station machines.

- Use SAFS (spheroidize anneal at finish size) steel rod.
- Use lower carbon steel as permitted by the product specifications.

### *After Fastener Manufacturing*

The methods available for detection of head bursts, seams and splits vary in effectiveness and cost. Manual sorting is the least reliable method, but is most often used as a quick fix for either internal or external containment. Manual sorting is highly dependant on the training and diligence of the sorter, and the quality of boundary samples provided. Under the best circumstances, manual sorting has been shown to be only 70% effective. In other words 30% of defective parts typically escape detection.

The use of 100 percent automated inspection is by far the most effective and reliable route. However no single inspection technique fits all circumstances. Inspection methods that are most appropriate for detecting seams and bursts are, eddy current, vision, and ultrasonic resonant methods. Often a combination of these is required. Additionally, the manner in which parts are transported and located at checking stations will determine the effectiveness of detection. In many cases the parts must be rotated for verification of its entire periphery.

Since the Inspection technology already exists and is widely available, the feasibility of automated inspection depends strictly upon the economic justification. The feasibility equation must include the capital cost of the appropriate piece of inspection equipment, the selling price and volume of the parts being inspected, and a clear understanding of the customers' expectations. The decision to include 100 percent automated inspection must always be made in close cooperation between the manufacturer and the customer.

## **Conclusion**

Seams resulting in split heads and head bursts are unavoidable defects that occur during the cold heading of fasteners. There are a number of known root causes that can lead to split heads and head bursts. Many of these causes can be mitigated or prevented during the manufacturing processes. However preventive measures are by no means fool proof. In the vast majority of cases, seams and bursts have no deleterious impact on the fit, function or mechanical properties of the fastener; yet they do pose a challenge with respect to visual and aesthetic characteristics. For this reason there are industry standards such as ASTM F788/F788M that define the acceptable limits for various types of surface discontinuities, including split heads and head bursts. Manufacturers and customers must often examine and negotiate the acceptability of these defects based on the limits defined in industry standards. In cases where for one reason or another, the customer does not tolerate any degree of splits and bursts, detection methods namely manual sorting and automatic inspection are called for. In such cases the customer and manufacturer must reach a commercial agreement to cover the additional cost of 100 percent inspection.

## References

1. *ASTM F788/F788M*, Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
2. *ASTM F1789*, F16 Mechanical Fasteners
3. *SAE J1061*, Surface Discontinuities on General Application Bolts, Screws, and Studs

## About the Author



Salim Brahim is president of IBECA Technologies Corp., an engineering consulting firm rendering services in fastener metallurgy, fastener technology, failure analysis, and business process improvement.

A licensed member of the Quebec Order of Professional Engineers, Brahim has accumulated over 17 years of experience as a fastener professional. He began his career at Infasco in Marieville, Quebec where he notably served for seven years as Process Engineer and Quality Manager with Galvano, a coatings division of Infasco. From 1999 until 2002 he served as director of Quality and Applications Engineering at Kamax in Troy, Michigan. In 2002 he founded IBECA Technologies.

Brahimi has a bachelor's of engineering in metallurgy and a graduate diploma in management from McGill University in Montreal, where he is currently working towards a doctorate as part of an industry sponsored research program he initiated on the topic of fastener hydrogen embrittlement.

Brahimi is an active voting member of ASTM Committees F16 (Fasteners), the SAE Fastener Committee, the IFI Technical Committee, as well as the recently formed delegation representing Canada at ISO TC2 committee on fasteners. In May 2004 he was the recipient of the **Fred F. Weingruber** award by ASTM Committee F16 for his outstanding contributions to the development of fastener standards.

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