

INTERNATIONAL VALVE SPRING WIRE MANUFACTURERS ASSOCIATION

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IVSWMA POSITION STATEMENT ON “ZERO SURFACE DEFECTS FOR VALVE SPRING WIRE”

ISO 8402 defines a defect as: "Non-fulfillment of intended usage requirements." This assumes that the "intended usage requirements" can be fulfilled, and it is the responsibility of whoever defines them to do it in a way that they can be met.

This statement is directed to valve spring users and all associated manufacturing and design functions to achieve a finished product that fulfills its intended usage requirements. A valve spring that fails during service due to a defect is usually the result of either a surface defect (button/scab) or inner defect (inclusion).

Using surface defects as an example, this statement intends to describe the limits of surface testing systems and to show that defect management is the responsibility of the entire supply chain including the design of a component. Every link in the supply chain has to be aware of the capabilities of its predecessors and successors in terms of avoiding, detecting and removing surface imperfections; because a surface imperfection can become a defect simply by changing the "intended usage requirements." If that is done without involving the supply chain, the ultimate goal of zero defects cannot be achieved. **The end user who designs the valve spring has a vital responsibility not to decrease safety margins by increasing loads beyond the entire supply chain's ability to prevent, detect or remove surface defects.**

During the process route from steel production to finished valve springs, many actions are taken to deal with surface imperfections. The emphasis must be on avoiding defects, but in a well coordinated and closely cooperating supply chain the best way to move closer to the goal of zero defects is to share responsibility for zero defects across production steps.

The technology to detect surface defects during hot rolling of wire rod is very limited. Knowing this, the next link in the supply chain, the valve spring wire producer, has to apply a special surface shaving process to remove surface imperfections and defects. Only in combination with this process, hot rolled wire rod can be safely used as raw material for valve springs.

During valve spring wire production every precaution is taken to avoid damaging the wire surface, but there is no guarantee that no harmful defect will be present. To get one step closer to the goal of zero defects, 100 percent of the finished valve spring wire is electronically eddy current tested (ECT). By using ECT, surface imperfections deeper than 40—50 µm can be detected, marked and subsequently removed in the spring coiling operation. It is the responsibility of the next link in the supply chain, in this case the spring coiler, to identify and scrap the marked sections of wire. ECT is applicable for wire sizes over approx 2.5 mm. However, the detection accuracy can be skewed depending on the types and shapes of surface defects. For example, closed surface defects may not be 100 percent detected by ECT even if they are greater than 40—50 µm. Suppliers of eddy current equipment will not guarantee a minimum defect depth for safe detection.⁽¹⁾

It needs to be pointed out that the above limit of 40 — 50 µm only applies to open artificial defects on round wire and the actual defect type and defect orientation have a major impact on detection capability.

Smaller engines and higher fuel efficiency trends in the auto industry require high-strength valve spring wire. "High-strength valve spring wire" is more susceptible to a spring failure due to surface defects. Thus, even 40—50 µm deep surface defects could cause spring breaks or failures

This statement should be looked upon as a guidance to move closer to "Zero Defects." All purchase order details have to be agreed upon between supplier and customer.

IVSWMA is a group of worldwide companies that produce the steel wire rod and finished wire for the production of valve springs for automotive applications. The current membership of the IVSWMA group is as follows:

MEMBERS OF THE INTERNATIONAL VALVE SPRING WIRE MANUFACTURERS ASSOCIATION

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| 1. AMERICAN SPRING WIRE CORPORATION | 8. POSCO |
| 2. ARCELORMITTAL DUISBERG GMBH | 9. SHINKO WIRE COMPANY, LTD. |
| 3. JOH. PENGG AG | 10. SUMITOMO (SEI) STEEL WIRE CORPORATION |
| 4. KISWIRE, LTD. | 11. SUNCALL CORPORATION |
| 5. KOBE STEEL, LTD. | 12. SUZUKI GARPHYTTAN AB |
| 6. NIPPON STEEL & SUMIKIN SG WIRE CO., LTD. | |
| 7. NIPPON STEEL & SUMITOMO METAL CORPORATION | |

References:

⁽¹⁾ “Statement regarding Eddy Current Testing of Valve Spring Wire,” *Foerster* (February 2011).



Statement regarding Eddy Current Testing of Valve Spring Wire

Since many years CIRCOGRAPH systems from FOERSTER are used for testing valve spring wire.

CIRCOGRAPH + Rotating head detects predominately longitudinal surface open defects.

This rotating probe system is normally supplemented by a DEFECTOMAT channel and encircling coil to detect short punctual and transverse defects.

- The sensitivity of the **CIRCOGRAPH** system is very high for the test of **round** valve spring wire in the area of crack depth $\geq 40 \mu\text{m}$, sometimes even better depending on test conditions.

The sensitivity for **ovate** valve spring wire is in the area of crack depth $\geq 70 \mu\text{m}$ for wire dimensions where maximum diameter is only up to 1.2 mm bigger than minimum diameter. Proper guiding conditions are necessary.

In case of larger difference between max and min. diameter the sensitivity is less.

- The sensitivity of the **DEFECTOMAT** system is different for round and ovate shaped wire when using round encircling coils. Sensitivity for ovate wire varies at the circumference of the wire because the distance surface/coil is different in respect to the non round shape. Calibration has to be done with artificial defects at the minimum diameter. To overcome this disadvantage of round coil for ovate wire we offer since some years ovate coils which must be individually adapted to the different shapes of wire. And it makes it necessary to use shaped nozzles as well to guide the wire in an exact position through the coil. At present these kind of coils are not state of the art everywhere. We introduce just now these kind of coils.

CIRCOGRAPH systems as all technical products are subjected to technical development.

The basic principle of the instrument and the testing method remains same.

The technical performance of the instrument changes according to technical standards.

FOERSTER sold

since 1975 CIRCOGRAPH 6.231 systems

since 1989 CIRCOGRAPH S/CS 6.410 systems and

since 2000 CIRCOGRAPH DS systems

It is for sure that extensive in house tests at FOERSTER guarantee that the capability and sensitivity is maintained or even improved for the testing method. Of course some technical features in respect to frequency range, number of testing channels, digitalisation of signal processing, and result presentation and storage are improved by using modern PC techniques.

February 2011