

## **Chronology of Defect / Noncompliance Determination**

**Provide the chronology of events leading up to the defect decision or test data for the noncompliance:**

April 2012-Aug 2015: SUBARU CORPORATION (Subaru) received a technical report from the Japan market which indicated a rough idling and an abnormal noise. From the investigation of the collected engine, it was estimated that the valve spring broke, fell off and the valve made contact with the piston, causing a rough idling and an abnormal noise. Investigation of the broken valve spring including observation of fractured surface and a component analysis was conducted, however, there was no spring material flaw and the cause of the fracture could not be determined.

As a precaution, In May 2013, the lower limit of the tolerance of the spring wire diameter was raised. During this period, eleven technical reports related to stalling were reported from the U.S. Because of the limited number of reporting, Subaru continued to monitor the field for any changes and continued parts (engine) collection for additional analysis.

Aug 2015-Oct 2016: Based on an additional investigation of parts (engines) collected from the field, Subaru determined that a very small amount of impurity within the composition of the spring material, a factor not avoidable in the manufacturing process may affect spring fracture.

Subaru determined that the spring wire diameter tolerance improvement implemented in May 2013 sufficiently compensated for the presence of impurity within the composition of the spring material. Three technical reports related to stalling was issued from the U.S. Due to the continued low number of reports, Subaru continued to monitor field data.

Nov 2016-Sep 2018: From the continuous monitoring of the worldwide technical reports, it was determined that a higher occurrence rate than estimated with general manufacturing dispersion from the vehicle manufactured prior to May, 2013, which is the timing of change of the tolerance of the wire diameter. Subaru and the valve spring supplier cooperatively conducted an investigation to find a cause other than manufacturing dispersion. The development history, drawings, and specifications were reviewed as a part of this investigation. As a result, it was found that due to the improper design of the valve train, stress generated exceeded the design condition. The excessive stress combined with the dispersion of impurity within the composition of the spring material under normal course of production may cause the valve spring concern to fracture from fatigue.

Oct 25 2018: Based on the assessment of multi-national field data and the conclusions of the technical root cause evaluation, Subaru determined that a safety recall will be performed for vehicles that may be equipped with a similar valve train design but with manufacturing dates prior to the tolerance adjustment made in May 2013.