Request 15
Separately, describe in detail each type of quality control check, inspection, test, or analysis performed during the manufacturing of the intake valves for the subject vehicles. For each check, test, inspection, etc., describe the control specifications, the types of information or data collected and the frequency they are collected at. Explain the pass-fail criteria for each check, test, inspection, etc., and provide the reject rate over time by production date.

In addition, produce copies of all documents related to this request.

Answer

Ford is able to provide copies of the Special Characteristics Communication and Agreement Forms (SCCAFs) which detail the required characteristics for complete intake valves as agreed to by Ford and the intake valve supplier. The SCCAFs can be seen in files "EA23-002 Request 15 – SCCAF AA Suffix" and file "EA23-002 Request 15 – SCCAF BA Suffix." Please note that the SCCAF did not change between parts JT4E-6507-AA and JT4E-6507-AB. The SCCAFs detail the specification for each characteristic as well as the frequency in which that characteristic must be confirmed on a sample intake valve.

Ford notes that intake valve part number JT4E-6507-AB corresponds to the change in intake valve material to Silchrome Lite, which superseded prior part number JT4E-6507-AA. Intake valve part number JT4E-6507-BA corresponds to the change in intake valve material from Silchrome Lite to Silchrome 1. Additional details about part change history can be found in Ford's response to Request 11.

Table 15.1 below describes the inspection method and frequency for the product characteristics of interest from the SCCAF for JT4E-6507-AA approved on November 22, 2016.

Description	Specification	Process Control Method	Process Control Freq.	Process Control Description
Material	SAE J775– UNS S65007(-AA) SAE J775– UNS K14072 (-AB)	Eddy Current	100%	Raw material properties vs. the specification are certified by supplier as an incoming inspection per their internal control plan; this is not captured in the SCCAF. This SCCAF line-item addresses certification that the correct material was selected and utilized through the process. Eddy current testing is a non-destructive test that applies an electromagnetic field to every valve individually and compares the inductive signature to that of a master sample according to drawing specification. If the inductive signature of the piece being tested differs from the master sample, the part is automatically rejected.
Tip Hardness	50min HRC	Rockwell Hardness Tester	1pc per machine at start of shift and 1pc at tool change or changeover	Tip hardness inspection is a destructive test performed by a Rockwell C Indentation tester. One indentation is performed per valve on the flat portion of the valve tip. A hardness check is made on a valve tip after induction hardening (Coil 1) and after induction tempering (Coil 2). The Coil 1 measurement is to show that the valve has achieved the martensite transformation after quenching. The Coil 2 measurement verifies the final hardness of the valve after tempering vs. the drawing specification. The single valve tip surface measurement is a representation of the hardness through the entire induction hardened valve tip.

Table 15.1: Process Control Description from select line items from JT4E-6507-AA SCCAF

Table 15.2 below describes the inspection method and frequency for the product characteristics of interest from the SCCAF for JT4E-6507-BA approved on September 7, 2021.

Description	Specification	Process Control Method	Process Control Freq.	Process Control Description
Material	SAE J775– UNS S65007(-AA)	Eddy Current	100%	Raw material properties vs. the specification are certified by supplier as an incoming inspection per their internal control plan; this is not captured in the SCCAF. This SCCAF line-item addresses certification that the correct material was selected and utilized through the process. Eddy current testing is a non-destructive test that applies an electromagnetic field to every valve individually and compares the inductive signature to that of a master sample according to drawing specification. If the inductive signature of the piece being tested differs from the master sample, the part is automatically rejected.
Tip Hardness (1 of 2)	50-57 HRC (17.3-21.3 mm from valve tip)	Rockwell Hardness Tester	1pc per machine at start of shift and 1pc at tool change or changeover	Tip hardness inspection is a destructive test performed by a Rockwell C Indentation tester. One indentation is performed per valve on the flat portion of the valve tip. A hardness check is made on a valve tip after induction hardening (Coil 1) and after induction tempering (Coil 2). The Coil 1 measurement is to show that the valve has achieved the martensite transformation after quenching. The Coil 2 measurement verifies the final hardness of the valve after tempering vs. the drawing specification. The single valve tip surface measurement is a representation of the hardness through the entire induction hardened valve tip.

Tip Hardness (2 of 2)	50-57 HRC (17.3-21.3 mm from valve tip)	Vickers Micro-hardness Tester	3pc per machine per shift	Tip micro-hardness inspection is a destructive test performed by a Vickers microhardness tester. Prior to micro-hardness testing, the valve tip must be sectioned and mounted in a metallographic preparation. One microhardness test is performed per valve after induction hardening and tempering. For each valve, a series of microhardness measurements are made in ~3mm increments along the valve stem. The Vickers microhardness values are converted to HRC via ASTM E140 and reported vs. the drawing specification of 50-57HRC. In contrast to the single HRC measurement on the tip of the valve, the microhardness traverse provides evidence that the hardness specification is met from the valve tip through below the 3rd keeper groove. The lower specification limit of 50HRC ensures that the valve tip has undergone the martensite transformation to achieve the required strength. The upper specification limit of 57HRC ensures that the valve tip has received sufficient tempering to ensure the requisite tempered martensite microstructure.
Microstructure	Visual Check for Grain Structure and Grinding Burn per Supplier Internal Specification	Microscope	1pc at beginning of shift 1 pc at end of shift Every 8 hours	Tip metallographic inspection is a destructive test performed on a microscope in the plant metallurgy lab by a metallurgical technician. Prior to microscope inspection, the valve tip must be sectioned and mounted in a metallographic preparation, then etched to reveal the microstructure. This is performed according to industry standard metallurgical methods, outlined in supplier internal

				procedures. One metallurgy test is performed per valve after the keeper groove grinding operation. Microstructure is evaluated and compared to visual standards for presence of grinding burn. No evidence of thermally affected microstructure is to be present on the root of the keeper grooves. The visual standard is mutually agreed between Ford and the supplier, but is owned by the supplier.

Table 15.2: Process Control Description from select line items from JT4E-6507-BA SCCAF

All intake valves manufactured for use in the subject vehicles until and on September 6, 2021, were tested for valve tip hardness every shift change. Starting on September 7, 2021, the intake valves manufactured for use in the subject vehicles were tested for valve tip hardness every hour. Additionally, the SCCAF did not detail an upper tolerance limit for valve tip hardness until September 7, 2021. The SCCAF also did not include a microstructure inspection for grain structure and/or grinder burn at start of shift, end of shift, and every eight hours until September 7, 2021.