TT00013
Tuliped Intake Valves Shortly After Rebuild On Gasoline Engines

S. B. International, Inc., offers the following information regarding tuliped intake valves shortly after rebuild. This condition has been noticed after rebuild of engine or reconditioning of the cylinder head. A tuliped valve has an increased total valve length and the top of the valve has the appearance of a "cup".

Combustion chamber temperatures that have exceeded the engine's original design parameters usually may cause a tuliped intake valve. Each valve used in an engine has a specific requirement, which results in different materials for intake and exhaust valve locations. Design engineers will specify which materials will economically work best for the intake and for the exhaust locations.

A typical automotive intake valve may be composed of a steel alloy such as Silchrome 1 (Sil 1). It is used because of its strength at the intake valve operating temperatures, relative low cost and the ability to be hardened at the valve tip. Intake valves run at a much cooler temperature than exhaust valves. The air and gasoline mixture temperature is generally in the range of 150- 250° F. This "cool" air passes over the intake valve while it's open in route to the engine's combustion chamber area. That process also has a cooling effect on the valve.

Some exhaust valves are made from 21-2N or 21-4N stainless steel, which offers greater temperature strength to lead oxide corrosion. The 21-2N and 21-4N material is used at the exhaust locations because it withstands higher heat temperatures. Exhaust valves usually have to endure temperatures that are generally in the range of 1000-1500° F as shown in Figure 1 while they are open and exhausting the cylinder. That process does not have much of a cooling effect. Exhaust valves rely on the head casting to transfer the majority of the valve temperature.

The two intake valves shown in Figure 2 are both out of the same engine. The one tuliped valve is .220" longer than its original length. This was the result of an abnormally high combustion chamber operating temperature. This temperature is in the cylinder of the engine, NOT THE ENGINE COOLANT TEMPERATURE. The temperature surrounding the valve got much higher than the valve was ever designed to withstand. That excessive temperature resulted in the valve material softening, allowing the valve head to stretch to create what is called a "tulip" shape.

A normal combustion process operating temperature in the combustion chamber could be considered 2500° F with cylinder pressures between 900-1200 psi. Engine valves will only survive the normal temperatures because they are seated during the combustion process and transfer heat as designed to the head casting.

An abnormal combustion process may increase the operating temperature in the combustion chamber as high as 5000° F with pressures between 3,500 - 5,000 psi. If this "tulip" condition re-occurs after rebuilding of the engine or reconditioning of the cylinder head, the original problem has not been fixed. This condition may affect one or more valves at a time.

Items to check: properly working EGR system, correct ignition timing, ECU operation, vacuum leaks (intake manifold, hoses, etc.), correct air to fuel mixture, correct angles between the valve and the valve seat, excessive valve spring pressure and any other source that affects the combustion process.

Figure 1: Valve Head Temperatures - FAILURE ANALYSIS

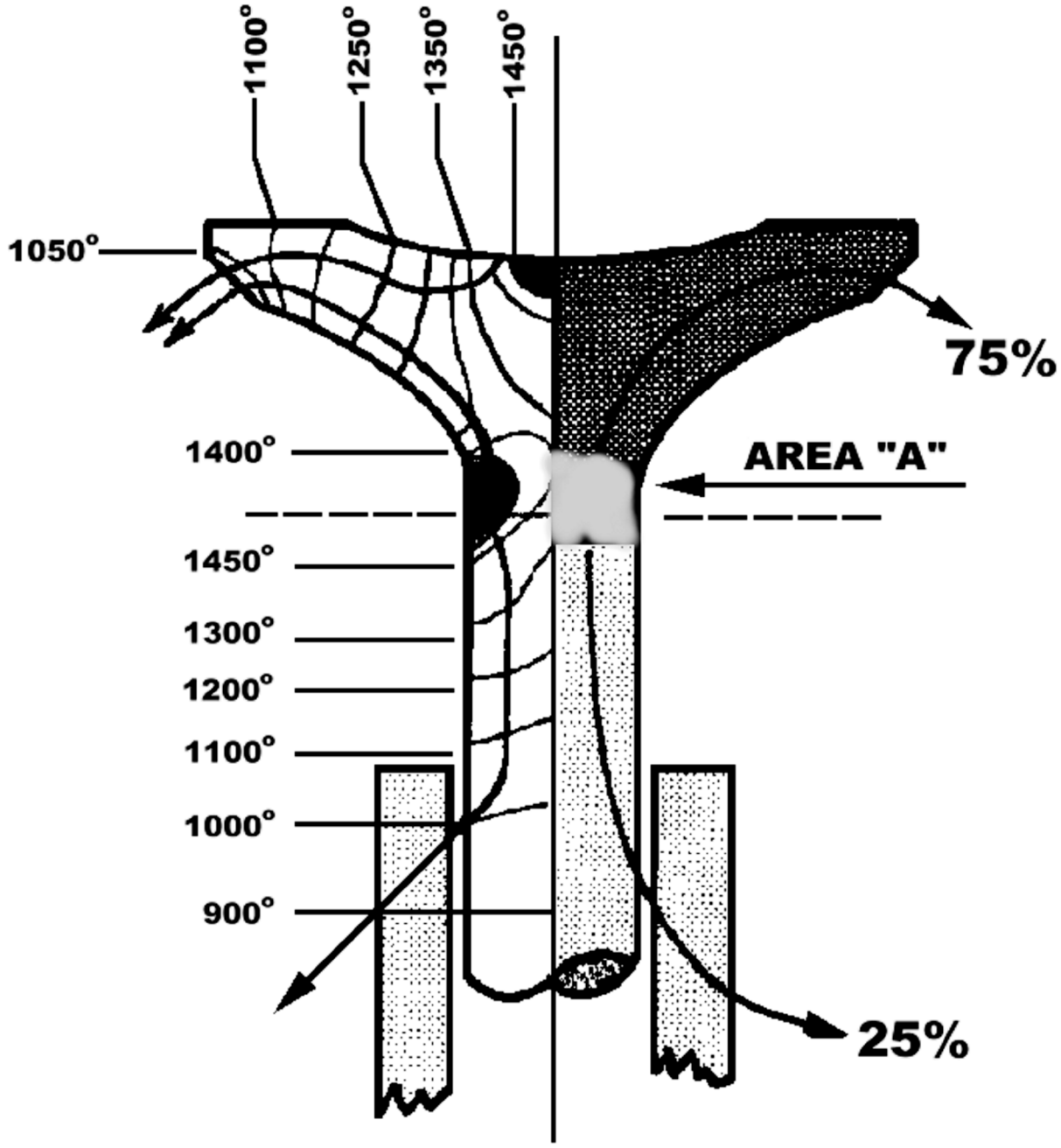

Figure 2: Valve Length Comparison - FAILURE ANALYSIS