EA94-018

ENGINEERING ANALYSIS CLOSING REPORT

SUBJECT: Fuel Injector Assembly Leakage.

BASIS: This Engineering Analysis was opened June 23, 1994, when ODI upgraded its Preliminary Evaluation, PE94-018, of engine compartment fires in 1986 through 1988 Nissan 300ZX and Maxima vehicles. The Preliminary Evaluation was opened February 22, 1994, prompted by 19 reports of engine compartment fire and 6 reports of fuel injector assembly leakage. In opening PE94-018, ODI noted an increase in reports of fuel injector assembly leakage and engine compartment fire. Ten of the fire incident reports and 3 involving injector assembly leakage had been received within the two month period preceding the investigation. In responding to PE94-018, Nissan identified the subject vehicles as the 1984-89 Z31 300ZX and 1985-88 U11 Maxima vehicles. The scope of the investigation was broadened in the Engineering Analysis to include the full range of subject vehicles. Figure 1 shows the trends of ODI engine compartment fire and fuel injector assembly leakage inputs for subject vehicles from January 1993 through September 1995.

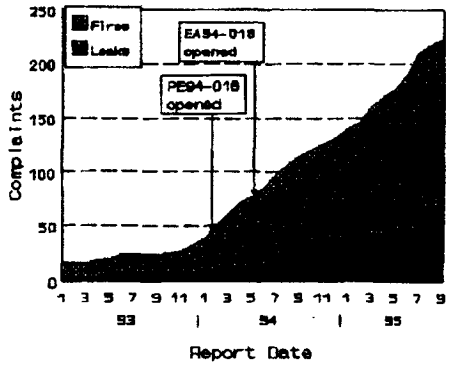

Figure 1 - ODI Complaint Trend, Cumulative Reports.

ALLEGED DEFECT: The fuel injector assembly may leak from either the fuel rail interconnecting hoses, the injector hoses, or the injectors. In the presence of an ignition source, fuel injector assembly leakage may result in a fire in the vehicle engine compartment.

DESCRIPTION OF COMPONENT/VEHICLE SYSTEM: The subject vehicles are equipped with Nissan's VG30E 3.0 liter V-6 engine. The engine is longitudinally mounted in the rear-wheel drive 300ZX and transverse mounted in the front-wheel drive Maxima. The VG30E is a multi-point fuel injected engine.

The fuel injector assembly is located in the valley of the V-6 engine. It consists of a pressure regulator assembly, fuel tube assembly, and six injectors. The injectors are mounted on the branch portions of the intake manifold. The intake manifold receives incoming air from the intake collector. The collector is mounted on top of the intake manifold, extending out over most of the injector assembly. The pressure regulator is the most visible component of the injector assembly, located at the front of the intake manifold and collector (right side of the engine compartment in the Maxima vehicles).

Pressurized fuel is delivered to the injector assembly by an electric pump mounted in the fuel storage tank. The pressure regulator maintains the required differential between the fuel pressure and the intake manifold. Nissan initially used top feed injectors in the subject vehicles before switching to bottom feed injectors in the 1986 300ZX vehicles equipped with turbochargers. Top feed injectors have only a fuel supply connection to the fuel rail, while the bottom feed injectors have both a supply and a return connection to provide for greater fuel circulation. In the 1987 and later model years, all of the subject vehicles were equipped with bottom feed injectors.

Inside the injectors is a plastic bobbin which functions both as a form for the injector coil and as a portion of the passageway for the fuel through the injector body. The spool-shaped bobbin has a flange at either end to contain the coil and a hollow axis to accommodate the passage of fuel through the injector. The bobbin is constructed of fiber reinforced nylon 6/6. The coil is in a dry region of the injector, sealed from the fuel channel by o-rings at either end of the bobbin. The injectors are supplied by Unisia JECS.

The injectors are not directly coupled to the fuel rail with a retaining device and an o-ring seal, as is the standard industry practice. Instead, they are connected by short lengths of hose (injector hoses). Thus, vehicles equipped with top feed injectors are equipped with six injector hoses and vehicles equipped with bottom feed injectors are equipped with 12 injector hoses. The inlet hoses on bottom feed injectors are secured to the rail tubing by screw type hose clamps. Otherwise, all injector hoses are secured by barbed "Christmas tree" type fittings.

The fuel rail tube assemblies also include short lengths of hose (fuel rail interconnecting hoses). While there are slight variations in assembly configurations, depending on model and injector feed type, each tube assembly consists of two pipe assemblies that are joined at the front and rear by clamped hose sections. The fuel rail crossover hose connects the two sides of the fuel rail assembly at the rear. At the front, the two sides of the assembly are joined at the pressure regulator by additional hose sections.

CORRESPONDENCE:

NHTSA to Mfr.	Mfr. to NHTSA	Mfr. to NHTSA Supplement	Confidentiality		
			Date Requested	Date OCC Response	Confidential Attachments
03-Mar-94	23-May-94	-	23-May-94	06-Jun-94	H, I, J, N-3, O-2, O-3, P, R-1, and R-2
23-Sep-94	18-Nov-94	11-Aug-95	23-Nov-94		VI, VIII, IX, X, and XIV
			11-Aug-95	06-Sep-95	A and D

Table 1. Correspondence.

VEHICLE POPULATION: Nissan sold 688,343 subject vehicles in the United States. A breakdown of the population by model, model year, and injector type is furnished in Table 1.

	MODEL YEAR						
Model	1984	1985	1986	1987	1988	1989	Total
300ZX non-turbo	59,218	62,645	53,280	28,920	16,609	4,013	224,685
300ZX turbo	16,376	12,038	8,382	4,737	6,838	201	49,072
Maxima		90,164	71,310	187,809	65,303		414,586
Total	75,594	164,847	133,472	221,466	88,750	4,214	688,343

Table 1. Subject Vehicle Population.

PROBLEM EXPERIENCE:

	EA Opened		EA Closed	
	ODI	MFR	ODI	MFR
Reports	84	449	274	590
Fire Incidents	73	250	223	357
Injury Accidents/ Injuries	0	0	0	0
Fatal Accidents/ Fatalities	0	0	0	0

Table 2. Problem Experience.

NISSAN'S POSITION: Nissan maintains that, while the subject vehicles may exhibit a high level of fire experience as they become older, the failures can be attributed to a combination of factors which are not the responsibility of Nissan. Specifically, Nissan has identified owner maintenance and unforeseen changes in fuel composition as the primary factors responsible for the current level of fuel leakage incidents and fires occurring in the subject vehicle population.

OBSERVATIONS:

- The subject vehicle fire incidence rate ranks high among previous ODI engineering analyses of issues involving the potential for engine compartment fire.

- The subject vehicles are older than other vehicles ODI has investigated for issues related to non-collision engine compartment fire. The average failure mileage for the reported fire incidents is slightly over 100,000 miles.

- Analysis of insurance fire claim data shows that the subject vehicles' fire experience is slightly below that of their peers for the first five years, but increases sharply relative to peers after about the sixth year of service (Figures 2 and 3).

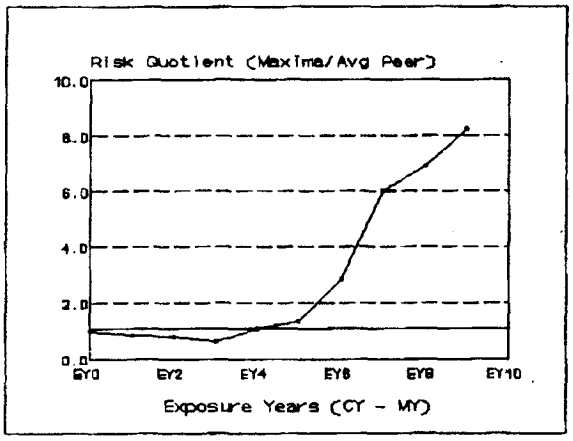

Figure 2 - Maxima Fire Rate Trend, Relative to Peer Average.

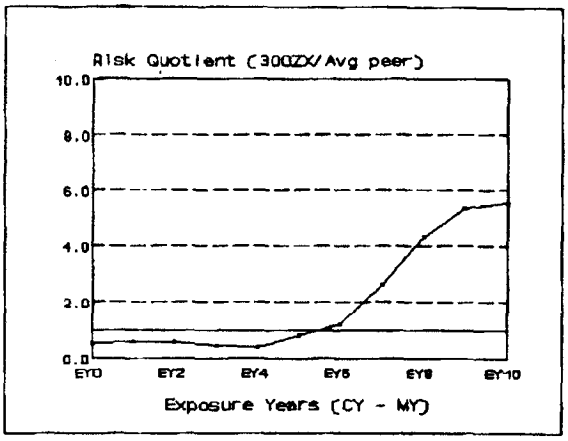

Figure 3 - 300ZX Fire Rate Trend, Relative to Peer Average.

- Nissan maintains that owner maintenance and changes in fuel composition are responsible for the volume and trend of fire experience in the subject vehicles.

- Nissan has submitted data showing that fuels containing an oxygenate blend, Methyl Tertiary Butyl Ether (MTBE), cause the injector coil bobbins to suffer greater loss of strength over time than when exposed to base gasoline. Nissan's tests were conducted with relatively high fuel temperature, 120°C (248°F).

- MTBE was permitted to be blended in fuel in concentrations of up to 11 vol% since 1981. In 1988, the EPA granted a waiver increasing the limit to 15 vol%. The use of MTBE in fuel experienced a dramatic increase in the winter of 1992-93, with the implementation of the Clean Air Act Amendments of 1990.

- ODI makes no findings regarding the fuel composition/material compatibility issues raised by Nissan. ODI does note that the trend of fire incidents in the subject vehicles appears

to be driven by age and not by changes in MTBE demand. Analysis of fire incidents by state also showed no apparent correlation to areas with mandatory seasonal oxygenated fuels programs. At present, there is no indication of similar fuel injector leakage patterns in other makes of vehicles.

- Nissan has changed the material composition and dimensions of the injector coil bobbin as a countermeasure to the potential for accelerated reduction in strength due to MTBE. Nissan estimates that the changes will increase the service life of the parts from 60,000 miles to over 360,000 miles.

REASON FOR CLOSING: In a letter dated October 27, 1995, Nissan confirmed its intention to conduct a campaign (95I-006) to replace the fuel injectors and related hoses in all subject vehicles which remain in service at no cost to owners. The campaign will notify owners of the potential for fuel leaks developing in the injector assembly which could result in a vehicle fire originating in the engine compartment and explicitly confirm that such a fire would pose a safety risk. ODI believes that the action proposed by Nissan will provide the appropriate remedies for both the fuel hose and fuel injector leakage conditions.

Safety Defects Engineer — Date: 11/8/95

I Concur:

Chief, Vehicle Integrity Branch — Date: 11/9/95

Director, Office of Defects Investigation — Date: 11-9-95