U.S. Department of Transportation
National Highway Traffic Safety Administration

ODI RESUME

Investigation: EA04-027
Prompted By: PE04-018, Consumer Complaints
Date Opened: 09/09/2004 Date Closed: 01/19/2005
Principal Investigator: Scott Yon
Subject: Underhood Fires

Manufacturer: American Honda Motor Co.
Products: MY 2003 - 2005 Honda CR-V
Population: 298,898 – Through 9/30/2004 production

Problem Description: Allegations of engine oil leaks resulting in underhood fires.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints: (26 duplicates exist)	62	95	131
Crashes/Fires: (21 duplicates exist)	42	67	88
Injury Incidents:	0	1	1
# Injuries:	0	1	1
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	264	264

*Description of Other: Warranty claims for oil filter leaks.

Action: Close this Engineering Analysis.

Engineer: *D. Scott Yon* 1/19/05 Date: *01/19/2005*
Div. Chief: *Jeffrey L. Quandt* Date: *01/19/2005*
Office Dir.: *Kathleen C. DeMeter* Date: *01/19/2005*

Summary: In documents provided during EA04-027, Honda identified a mechanism which causes the rubber seal (gasket) of the original equipment (OE) oil filter to adhere to the engine block of the subject vehicles. If an adhered seal remains when the OE filter is removed and a new filter is installed, a "double gasket" condition results. A subsequent rupture of the extraneous seal can result in oil contacting nearby exhaust system surfaces and a fire may occur. Throughout its discussions with ODI, Honda has maintained that it is the servicing technician's responsibility to inspect for and remove the seal prior to installing a new filter.

ODI's analysis found that seal adhesion, in conjunction with technician error and exhaust component location, resulted in a high rate of subject vehicle oil filter fires compared to earlier models and peers. Vehicles that have not had the OE filter disturbed are not at risk. Service replacement filter seals, which are manufactured by a different supplier, do not exhibit the seal adhesion condition. Therefore, if the initial oil change is done properly, the elevated fire risk is eliminated for the remainder of the vehicle's life. Based on average mileage accumulation and oil service interval, ODI estimates that more than two thirds of the subject vehicles have received their initial oil change and are no longer at an elevated risk.

Honda changed the design of the filter seal to prevent the adhesion condition and introduced the new seal at both CR-V assembly plants in December 2004. In a December 8, 2004 letter to ODI, Honda committed to send a notification to subject vehicle owners advising of the fire risk if an oil change is improperly performed. The letter discusses measures consumers can take to ensure the first oil change is done properly. Letter mailings commenced on December 10, 2004. Owners who have recently had their first oil change performed and are unsure if it was done correctly can have it inspected by a Honda dealer at no charge; if an improper filter installation is detected, a free remedy will be provided by the dealer. Unsold subject vehicles in dealer stock (~20,000 units) will have the OE filter replaced with a service component prior to retail.

The injury noted above occurred when a consumer slipped on oil that leaked from their vehicle. Recent report trends indicate that Honda's efforts to improve oil filter service proficiency at their dealerships have been effective. See the EA04-027 Summary Report for further details on this investigation.

VLJ 1/25/05

SUMMARY REPORT - ENGINEERING ANALYSIS 04-027

DATE OPENED: September 9, 2004 **DATE CLOSED:** January 19, 2005

SUBJECT: Underhood fires.

BASIS AND BACKGROUND: The Office of Defects Investigation (ODI) opened Preliminary Evaluation (PE) 04-018 on February 19, 2004 after receiving 5 vehicle owner questionnaire (VOQ) reports alleging an underhood fire occurred in model year (MY) 2003 CR-V vehicles. During the same time period, ODI had not received any VOQ reports of underhood fires in the MY 2002 CR-V, which uses the same engine design and configuration as the 2003 model.[1] In its response to ODI's PE information request (IR) letter, Honda identified 32 reports of MY 2003 CR-Vs developing a significant oil leak from the oil filter subsequent to the first engine oil service; 22 of the incidents resulted in an engine fire.

At that time, Honda did not identify any design, manufacturing or engineering changes between the MY 2002 and 2003 vehicles which could explain the fire reports, nor could it identify any product changes to prevent further occurrences. Honda maintained that the incidents were the result of service technician errors and began implementing field actions to improve oil filter service processes at Honda retailers. ODI closed its investigation on July 1, 2004, noting that 22 fires had occurred.

After closing PE04-018, ODI monitored new VOQs. In addition to receiving continued reports involving MY 2003 vehicles, ODI also received reports of MY 2004 CR-V underhood fires. Investigating further, ODI determined that some of the fire reports occurred subsequent to the field activities Honda undertook, leading to concern about the effectiveness of Honda's field actions and lack of product countermeasure. Consequently, on September 9, 2004 ODI opened Engineering Analysis (EA) 04-027. Chart 1 shows the count by receipt month for the 45 VOQs ODI recognized when EA04-027 was opened.

ALLEGED DEFECT: Engine oil leakage from, around, or in the vicinity of the engine oil filter, leading to a subsequent vehicle fire.

SUBJECT COMPONENT: For the purposes of conducting this investigation, ODI considered the engine oil filter and its rubber sealing gasket, the engine block surface to which the oil filter seal mates, and all other components used in the mounting and sealing of the oil filter as the subject components

POPULATION: The subject vehicles for this investigation were MY 2003 through MY 2005 Honda CR-V vehicles produced prior to mid-December 2004 and intended for sale

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1 MY 2002 and later second generation (GEN2) CR-Vs have significant engine design differences compared to MY 1997 – 2001 first generation (GEN1) CR-Vs. For the GEN2 CR-V, the oil filter is located in close proximity to the hottest portions of the exhaust system; in the GEN1 design the engine block separates these components. Additionally, and due primarily to more stringent tailpipe emission standards, the GEN2 exhaust system's surfaces reach significantly higher temperatures than the GEN1 design for the same operating conditions.

or lease in the United States. Honda manufactures these products at two factories, one located in the United Kingdom (UK) and one in Japan (JP). Table 1 shows vehicle production (through 9/30/2004) by factory and model year. ODI notes that the JP facility produced the majority of MY 2002 CR-V vehicles [88%].

Chart 1: Receipt Month for EA Open Resume VOQs (45)

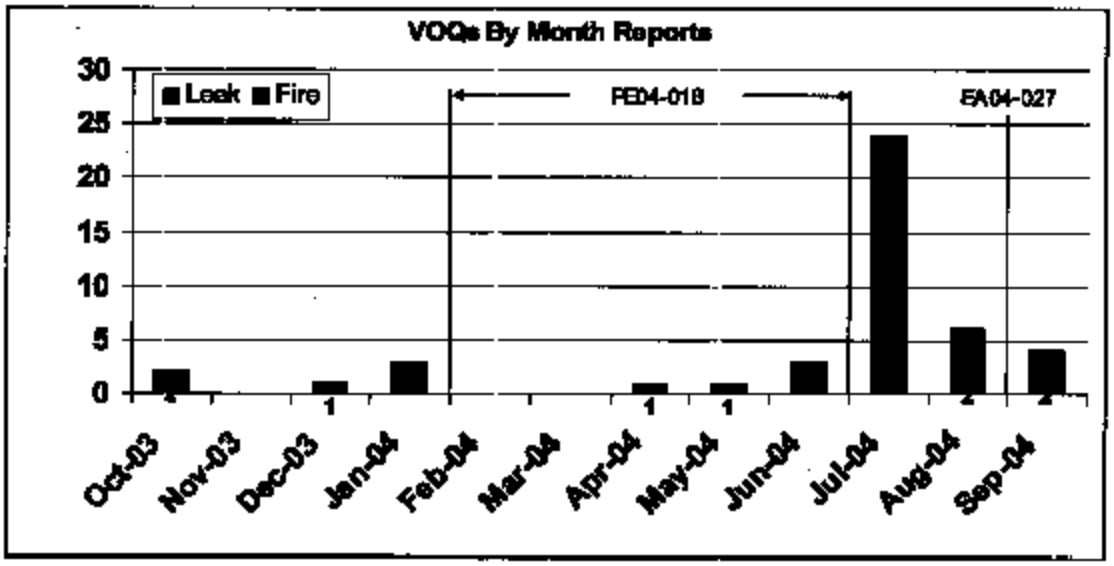

Table 1: Subject Vehicle Production

	Factory		
MY	**JP**	**UK**	***Total***
2003	69648	70545	***140193***
2004	84860	68346	***153206***
2005*	5428	71	***5499***
Total	***159936***	***138962***	***298898***

* - Through 9/30/2004

FAILURE MECHANISM/CAUSE OF FIRES: For the subject vehicles, a condition affecting the rubber seal of the original equipment (OE) oil filter increases the likelihood that the seal will adhere to the engine block when the OE filter is removed. If the servicing technician fails to detect the presence of the adhered seal before installing a new filter, a "double gasket" condition results. A subsequent rupture of the extraneous seal causes a high volume engine oil leak. If the leaking oil contacts nearby exhaust

system surfaces, either through direct flow/spray or from turbulence created by air movement or rotating vehicle components, an engine fire can occur.

CORRESPONDENCE: ODI submitted an IR letter to Honda on September 17, 2004. The letter specified a response date of October 11, 2004 for questions 1 - 9 and 18, and a response date of October 26, 2004 for the remaining questions 10 to 17.

Honda provided an initial response dated October 11, 2004, portions of which were marked preliminary or were incomplete (responses 1, 3, 4, 5, 6, and 7). A second response, dated October 26, 2004, contained the final and or updated responses for all except question 5. Honda requested confidentiality for all or portions of responses 10, 11, 14 and 15 via a separate letter addressed to the Office of the Chief Counsel and dated October 27, 2004. Honda provided its final and complete response to question 5 in a submission dated November 18, 2004.

Honda met with ODI on November 19, 2004 to discuss its findings regarding production materials and processes for the oil filter seal as well as field and service issues. The meeting is discussed in a December 3, 2004 memo to the investigatory file with a copy of Honda's presentation attached for reference.

PROBLEM EXPERIENCE: Analysis of ODI and Honda complaint and field data identified the report counts shown in table 2. The Honda counts included 26 complaints (and 21 fire reports) that were duplicates of ODI reports. ODI could not make a precise determination as to the extent and cause of oil leakage for most of the warranty claims due to the limited information contained in Honda's warranty data.

Table 2: Failure Report Summary

	ODI	Honda	Total
Complaints:	62	95	131
Fires:	42	67	88
Injury Incidents:	0	1	1
Injuries:	0	1	1
Other*:	0	264	264
*Description of Other: Warranty claims for oil filter leaks.			

DESIGN, MATERIAL AND/OR PRODUCTION MODIFICATIONS: Honda's IR response, including confidential portions on which the following is based, discusses the sourcing and manufacturing of OE and service oil filters used on the subject vehicles.

The Toyo Roki Manufacturing Company, Ltd (TRM) served as the sole tier one supplier of OE oil filters for MY 2002 CR-Vs produced at the JP facility, which handled the bulk of MY 2002 production. TRM has production facilities in Japan and uses a second tier Japanese supplier to produce the filter seal. During this period, Honda's analysis determined the normal stock and shipping time (the "pipeline") between seal production and filter installation was about one month.

TRM continued to supply oil filters for later MY JP production. However, during the last quarter of calendar year 2002 (i.e. early MY 2003 production), the second tier seal supplier transferred production to a new plant located in Shanghai, China. Honda's investigation did not identify any production concerns from this change other than an increase in the delivery pipeline from one month to about three months for JP production vehicles using TRM filters.

Mahle Tennex Corporation (MTC), another Japanese company, also supplied OE oil filters for the subject vehicles. Like TRM, MTC uses sub-suppliers to source the filter seal, all of which are Japanese-based. MTC is the sole supplier for UK production. MTC also supplied the JP facility (alongside of TRM) for MY 2003 and subsequent production.[2]

Honda determined that the delivery pipeline for MTC filters was about 2 months for JP production and 4.5 months for UK production. Honda's investigation also showed that due to the curing process controls used during MY 2003 production, the MTC sub-supplier allowed a key material parameter of the seal (rubber hardness) to drift towards the upper limit of specification tolerance.[3]

The significance of pipeline extension and material parameter drift are discussed in greater detail in the ODI Discussion section.

IR documents also identified two additional suppliers of Honda-sourced oil filters suitable for use on the subject vehicles; Honeywell and Filtech. Both are North American companies with domestic production facilities and supply filters used for service replacement in the U.S. market. Additionally, Honeywell and Filtech supply OE filters for domestic production of non-subject vehicle models that use the same engine configuration and filter (Accord and Element).

HONDA'S POSITION: Throughout its communications with ODI, both at the PE and EA levels, Honda has maintained that servicing technicians must identify and remove an adhered filter seal from the engine block when replacing the oil filter and asserted that the filter seal was not defective. Honda stated that some level of seal adhesion is both normal and expected. To emphasize the importance of checking for and removing an adhered seal prior to the installation of a new oil filter, Honda presented examples of service documentation from various industry sources during its November 19th meeting with the agency that highlighted the need to check for and remove the old oil filter seal. Honda also provided an update on field activities completed with Honda retailers and other oil service providers (quick lube industry sector), which Honda represented as being the most effective way of addressing "at risk" vehicles currently in consumer hands.

In its September 26, 2004 IR response, Honda acknowledges that the OE filter seal used on the subject vehicle has "a somewhat greater tendency to adhere to the aluminum engine block surface" compared to earlier and service replacement filters, attributing the tendency to differences in curing additives and an increased time delay between seal

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2 Honda was unable to identify at VIN level which supplier provided the filter installed at the JP facility so ODI cannot precisely determine volume split or incident rate detail for the JP facility.
3 ODI notes that the shift was within the specification limits identified by Honda for the seal design.

manufacture and installation, as discussed below. Honda notes that the second and any subsequently installed filter seal has a "significantly less likelihood of a double-gasketing error" because the service replacement filter seals do not have the same tendency to adhere.

In a letter dated December 8, 2004, Honda advised ODI of its intent to send a letter to registered operators of subject vehicles advising them of the "double gasket" concern and the risk of fire. The letter outlines steps operators can take to reduce the risk of fire if the initial oil service has not yet been conducted, as well as steps that can be taken if the initial oil change was recently completed. The letter also advised ODI that Honda dealers will replace the OE oil filters on unsold vehicles in dealer stock that were built prior to the production countermeasure,[4] and provided the implementation date of production countermeasures to eliminate the risk of seal adhesion.

ODI DISCUSSION: Honda conducted multiple engineering studies after PE04-018 was closed, the results of which were submitted in the EA IR response (with a request for confidentiality). In addition to these documents, ODI relied on its analysis of field and consumer complaint information; the information presented by Honda during the November 19, 2004 meeting; and informal discussions with established rubber industry experts.

As used on earlier Honda products (dating back more than 10 years), Honda specifies the use of acrylic rubber (ACM) for the fabrication of the oil filter seal. It also specifies the various ACM material properties (hardness, heat resistance, oil resistance, compression set, etc.) to ensure the seal is suitable for use in the oil filter application. Like other rubber materials, ACM requires curing (vulcanization) as part of the production process. A variety of ACM compounds, brands, and vulcanization systems exist. Honda does not specify the ACM brand, compound or cure system; the seal supplier selects these factors.

The ACM compound chosen by TRM and MTC for OE seal production uses a chlorine compound as the crosslinking site monomer, causing the post-cured rubber material to contain chlorine. The curing system used by TRM and MTC utilizes an accelerant material that contains zinc,[5] which creates zinc chloride ($ZnCl_2$) as a byproduct. Honda's analysis determined that the $ZnCl_2$ migrates to the surface of the seal through a process known as blooming, with longer periods of time (e.g., longer pipelines) resulting in more $ZnCl_2$ migrating to the seal surface. Additionally, Honda determined that the concentration of $ZnCl_2$ in the end product material is proportional to material hardness, with materials cured to a higher hardness having higher $ZnCl_2$ concentrations.

According to Honda and available industry information, $ZnCl_2$ is known to be hygroscopic (i.e. absorbs moisture) and has a strong deliquescent effect (i.e. dissolves and becomes liquid by absorbing moisture from the air) that results in the formation of an (Lewis) acid. In the presence of moisture (humidity) and aluminum oxide (present on the engine block surface), a chemical reaction causes acid corrosion and attacks the aluminum engine block. As a result of this attack, the engine's sealing surface can be

4 Honda estimates that approximately 20,000 vehicles will be addressed in this manner.
5 The accelerant chosen has a beneficial impact on end material compression set. The compound containing zinc, known as zinc dimethyl dithiocarbamate, is, according to Honda, commonly used in the Japanese auto industry.

etched. Honda theorized that the etched surface causes a mechanical bond to form between the seal and engine block, increasing the likelihood that the seal will adhere to the engine block when the OE filter is removed.

ODI notes that the subject vehicles are deep sea transported to the U.S. market after final assembly. Assuming the accuracy of Honda's theory, the shipping environment (in the hold of a deep sea vessel) and transportation period (about one month) would permit the surface etching process to occur and create a mechanical bond to the seal.

Using lab-based accelerated testing, Honda confirmed that acid corrosion could cause seal adhesion. ODI also confirmed the plausibility of Honda's theory by informally conferring with rubber industry experts, who confirmed that zinc curing components were known to be a source of $ZnCl_2$ in cured ACM. These experts also confirmed that with sufficient time in the presence of aluminum and moisture, the $ZnCl_2$ could form an acid material through blooming, causing corrosion and potential surface etching.

ODI reviewed the field and complaint data to see if they supported Honda's analysis, noting that vehicles with the highest levels of $ZnCl_2$ concentration and the longest seal pipelines would be more likely to exhibit adhesion, and have higher representation in leakage and fire complaints (assuming other factors constant). Accordingly, filters manufactured by MTC (higher $ZnCl_2$ levels) and supplied to the UK facility (longest delivery pipeline) would be more likely to exhibit seal adhesion than other OE filters.

Noting that UK production accounts for slightly less than half of subject vehicle population (~46%), ODI found that 73% of complaints and 72% of fires occurred in UK-manufactured vehicles, as shown in Table 3. A similar over-representation pattern of UK-produced vehicles was found in Honda's warranty data.

Table 3: Fire and Leakage Complaints by Production Facility

	Factory		
	JP	UK	
Fire	25	63	88
Leak	11	32	43
	36	95	131

According to Honda, domestic suppliers of Honda service oil filters utilize different base ACM rubber materials and curing systems that do not result in elevated concentrations of $ZnCl_2$ in the seal.[6] Therefore, vehicles serviced with domestically manufactured oil

6 Honeywell and Filtech use non-zinc based curing systems that result in sodium chloride (NaCl) in the final material. Honda's testing showed that NaCl does not have a detrimental effect on the engine block.

filters are not expected to exhibit seal adhesion after OE filter removal (throughout the duration of the vehicle's life).

Honda identified and subsequently implemented in December 2004 a short-term countermeasure to eliminate surface etching.[7] The countermeasure involves coating the seal mating surface with a thin layer of a PTFE (Teflon) material. The coating forms an inert barrier that prevents migrated $ZnCl_2$ from interacting with the engine block. Additionally, PTFE is known for its non-stick characteristics which may enhance seal release. Rubber industry experts confirmed that the use of PTFE was a viable countermeasure for the etching concern.

REASON FOR CLOSING: Honda appears to have accurately identified the cause of filter seal adhesion in the subject vehicle population and has implemented a production countermeasure to eliminate the condition. Honda's field actions, in conjunction with its consumer notification letter, have raised awareness and knowledge levels at both the consumer and service technician levels. ODI estimates that between 65% and 85% of the subject vehicle population has either had the initial oil change performed due to scheduled maintenance (based on field data analysis) or has had the OE filter removed by Honda prior to vehicle sale as a result of Honda's December field effort; ODI finds no evidence to suggest that these vehicles are at an elevated risk of experiencing an underhood fire.

In light of the actions that have already been taken and the limited opportunity remaining to impact vehicle safety, ODI will close the investigation. The closing of the investigation does not constitute a finding by NHTSA that a safety-related defect does not exist, and the agency will take further action if warranted by future circumstances.

Safety Defects Engineer — Date: 1/19/2005

I Concur:

Chief, Vehicle Control Division — Date: 1/19/05

Richard Boyd for K. DeNicola
Director, Office of Defects Investigation — Date: 1/19/05

7 Honda is researching other long term countermeasure to eliminate the need to apply the PTFE coating to the seal mating surface, such as the use of a chlorine free ACM.