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April 7, 2004
Ref. No.: GA04-019

Ms. Kathleen C. DeMeter, Director
Office of Defects Investigation NVS-214
National Highway Traffic Safety Administration
400 Seventh Street, SW
Washington, DC 20590

RE: NVS-214LLO - EA03-024 Subaru WRX

Dear Ms. DeMeter,

This letter and enclosures are in response to your letter concerning the Agency's Engineering Analysis request (EA03-024) for additional information regarding allegations of extended stopping distance in 2002 and 2003 Subaru Impreza WRX vehicles.

As requested in your letter, our response is provided after repeating verbatim the applicable request which is in bold text.

1. Update your response to Request No. 2 of Preliminary Evaluation Information Request (PE03-029) dated July 9, 2003, by providing all information and producing copies of all documents received by Subaru or of which Subaru has otherwise become aware, that have not previously been submitted to ODI relating to any of the:
 - a. Consumer complaints
 - b. Field reports, including dealer field reports;
 - c. Reports involving a crash, injury, or fatality, based on claims against the manufacturer involving a death or injury, notices received by the manufacturer alleging or proving that a death or injury was caused by a possible defect in a subject vehicle, property damage claims, consumer complaints, or field reports;
 - d. Property damage claims;
 - e. Third-party arbitration proceedings where Subaru is or was a party to the arbitration;
 - f. Lawsuits, both pending and closed, in which Subaru is or was a defendant or codefendant.

For subparts "a" through "d" state the total number of each item (e.g., consumer complaints, field reports, etc.) separately. Multiple reports involving the same vehicles are to be counted separately. Multiple reports of the same incident are also to be counted separately (i.e., a

consumer complaint and a field report involving the same incident in which a crash occurred are to be counted as a crash report, a field report and a consumer complaint). In addition, for items "c" and "d", provide a summary description of the alleged problem and causal and contributing factors and Subaru's assessment of the problem, with a summary of the significant underlying facts and evidence. For items "e" and "f", identify the parties to the action, as well as the caption, court, docket number, and date on which the complaint or other document initiating the action was filed.

Response 1:

This additional information was gathered from current internal files and databases by several departments within Subaru during the week of March 3, 2004. The original counts of information already supplied in our first response (PE03-029) have not been included in these counts:

a. New consumer complaints:	11
b. New field reports:	23
c. New reports including a crash:	1
Injury:	0
death:	0
d. New property damage claims:	0
e. New third party arbitration proceedings:	0
f. New lawsuits:	0

*Customer complaint number 589395 reported accident upon start-up from a red light. The vehicle in front of him suddenly stopped. Customer claimed that brake pedal went to floor and the customer rear ended the vehicle in front of him.

2. Separately, for each item (complaint, report, claim, notice, or matter) within the scope of your response to Request No. 2, state the following information:

- a. Subaru's file number or other identifier used;
- b. The category of the item, as identified in Request No. 2 (i.e., consumer complaint, field report, etc.);
- c. Vehicle owner, address, and telephone number;
- d. Vehicle's VIN;
- e. Vehicle's make, model and model year;
- f. Vehicle's mileage at time of incident;
- g. Incident date;
- h. Report or claim date;
- i. Whether a crash is alleged;
- j. Whether property damage is alleged;
- k. Number of alleged injuries, if any; and
- l. Number of alleged fatalities, if any; and
- m. Summary description.

Provide this information in Microsoft Access 2000, or a compatible format, entitled "REQUEST NUMBER TWO DATA." See Enclosure 1, Data Collection Disc, for a pre-formatted table that provides further details regarding this submission.

Response 2:

The information for Request 2 a. - f. is provided in the enclosed Access file ("combined_report2.mdb").

3. Produce copies of all documents related to each item within the scope of Request No. 2. Organize the documents separately by category (i.e., consumer complaints, field reports, etc.) and describe the method Subaru used for organizing the documents.

Response 3:

Enclosed are the requested documents. They are in sequence, by the Subaru identification number found in column 2 of the Access file provided in the response to Request 2.

4. State, by model and model year, a total count for all the following categories of claims, collectively, that have been paid by Subaru to date that relate to, or may relate to, the alleged defect in the subject vehicles: warranty claims; extended warranty claims; claims for good will services that were provided; field, zone, or similar adjustments and reimbursements; and warranty claims or repairs made in accordance with a procedure specified in a technical service bulletin or customer satisfaction campaign.

Separately, for each such claim, state the following information:

- a. Subaru's claim number;
- b. Vehicle owner or fleet name (and fleet contact person) and telephone number;
- c. VIN;
- d. Repair date;
- e. Vehicle mileage at time of repair;
- f. Repairing dealer's or facility's name, telephone number, city and state or ZIP code;
- g. Labor operation number;
- h. Problem code;
- i. Replacement part number(s) and description(s);
- j. Concern stated by customer; and
- k. Comment, if any, by dealer/technician relating to claim and/or repair.

Provide this information in Microsoft Access 2000, or a compatible format, entitled "WARRANTY DATA." See Enclosure 1, Data Collection Disc, for a pre-formatted table that provides further details regarding this submission.

Response 4:

These additional data are provided by Subaru's Customer Dealer Services Dept. and included warranty claim data finalized through March 31, 2004. Please see the enclosed Access file ("warranty_data.mdb").

Claim Category	Subaru WRX Model Year 2002	Subaru WRX Model Year 2003
Warranty claims	48	22
Extended warranty claims ("SAS")	2	0
Goodwill claims	1	0
Field adjustments	0	0
TSB/satisfaction campaign claims	0	0
	51	22

5. Describe in detail the search criteria used by Subaru to identify the claims identified in response to Request No. 4, including the labor operations, problem codes, part numbers and

any other pertinent parameters used. Provide a list of all labor operations, labor operation descriptions, problem codes, and problem code descriptions applicable to the alleged defect in the subject vehicles. State, by make and model year, the terms of the new vehicle warranty coverage offered by Subaru on the subject vehicles (i.e., the number of months and mileage for which coverage is provided and the vehicle systems that are covered). Describe any extended warranty coverage option(s) related to the alleged defect that Subaru offered for the subject vehicles and state by option, model, and model year, the number of vehicles that are covered under each such extended warranty.

Response 5:

Data was compiled using "Brake" Component Group from our Holos Database. The following is a description of the specific Problem Codes (Fail Codes and corresponding Trouble Codes) selected as related to ABS.

Problem Code	Fail Code Description	Trouble Code Description
QAA-42	Caliper	Output incorrect
QAA-43	Caliper	Erratic operation
QYF-00	Brakes/Performance	Could not Duplicate
QYF-85	Brakes/Performance	Concern Duplicated/normal
QYG-00	Brakes/Dash Light	Could not Duplicate
QYG-85	Brakes/Dash Light	Concern duplicated/normal
QYH-00	Brakes/System Operation	Could not Duplicate
QZF-00	Brakes/Performance	Could not Duplicate
QZF-85	Brakes/Performance	Concern Duplicated/normal
QZG-00	Brakes/Dash Light	Could not Duplicate
UCD-39	ABS Electronic Control Unit	Open
UCD-41	ABS Electronic Control Unit	Poor contact/connection
UCD-42	ABS Electronic Control Unit	Output incorrect
UCD-43	ABS Electronic Control Unit	Erratic operation
UJW-38	ABS Wheel Speed Sensor	Short
UJW-39	ABS Wheel Speed Sensor	Open
UJW-41	ABS Wheel Speed Sensor	Poor contact/connection
UJW-42	ABS Wheel Speed Sensor	Output incorrect
UJW-43	ABS Wheel Speed Sensor	Erratic operation

After retrieving claims based on the above coding, a final review of the dealer/technician comments (if there was any) resulted in deleting some of the claims as clearly unrelated to the alleged defect.

The 2002 and 2003 Subaru WRX models have the following warranty coverage:

Warranty	Years Limitation	Mileage Limitation
New Car Warranty	3	36,000
Seat Belt Warranty*	Useful Life of Vehicle	Unlimited.
Powertrain Warranty*	5	60,000
Rust Perforation Warranty*	5	Unlimited.
Parts and Accessories*	1	Unlimited.

*not applicable to the alleged defect

The only optional coverage offered by Subaru are extended service contract plans under the Subaru Added Security (SAS) Program. There are two general plan categories: "Classic" and "Gold Plus". Within each category, there are 3 possible deductibles (\$100, \$50, \$0) and eight (8) possible plan year/mileage terms (3/45,000; 4/60,000; 5/60,000; 6/60,000; 6/80,000; 5/100,000; 6/100,000; 7/100,000). This yields 24 possible plans.

"Classic plans cover nearly 1000 parts in all major component areas, including engine, transmission, drive trains, front suspension, steering, brakes, electrical, cooling and fuel systems and air conditioning. Also provides towing and rental car reimbursement for covered repairs."

"Gold Plus plans include all Classic plan coverage plus hundreds more parts. In fact they provide essentially the same "bumper-to-bumper" coverage as the basic factory warranty. Only a few maintenance items and body parts are not covered. The Gold Plus plan also reimburses for lodging and meals when a breakdown interrupts your out-of-town travel, plus: 24-hour emergency roadside assistance, \$100 allowance for "Sign & Drive" dispatched towing, jump start, tire change, gasoline delivery, locksmith service, road hazard tire protection, computerized trip routing, dealer locator service and travel assistance."

As of August 10, 2003, Subaru had the following number of WRX vehicles with the indicated plans:

Plan	Model Year 2002	Model Year 2003
24 Mo. /24,000 Miles	1	0
36 Mo. /36,000 Miles	4	1
36 Mo. /45,000 Miles	642	226
48 Mo. /48,000 Miles	9	0
48 Mo. /60,000 Miles	532	156
48 Mo. /80,000 Miles	14	0
60 Mo. /60,000 Miles	1,157	551
60 Mo. /80,000 Miles	35	0
60 Mo. /100,000 Miles	966	428
72 Mo. /60,000 Miles	1,442	626
72 Mo. /80,000 Miles	2,342	958
72 Mo. /100,000 Miles	928	353
84 Mo. /100,000 Miles	765	374
	8,667	3,673

6. Produce copies of all service, warranty, and other documents that relate to, or may relate to, the alleged defect in the subject vehicles, that Subaru has issued to any dealers, regional or zone offices, field offices, fleet purchasers, or other entities. This includes, but is not limited to bulletins, advisories, informational documents, training documents, or other documents or communications, with the exception of standard shop manuals. Also include the latest draft copy of any communication that Subaru is planning to issue within the next 120 days.

Response 6:

No new service or warranty documents relating to this issue have been released since our response to PE03-029.

7. Describe all assessments, analyses, tests, test results, studies, surveys, simulations, investigations, inquiries and/or evaluations (collectively, "actions") that relate to, or may relate to, the alleged defect in the subject vehicles that have been conducted, are being conducted, are planned, or are being planned by, or for, Subaru.

For each such action, provide the following information:

- a. Action title or identifier;
- b. The actual or planned start date;
- c. The actual or expected end date;
- d. Brief summary of the subject and objective of the action;
- e. Engineering group(s)/supplier(s) responsible for designing and for conducting the action; and
- f. A brief summary of the findings and/or conclusions resulting from the action.

For each action identified, provide copies of all documents related to the action, regardless of whether the documents are in interim, draft, or final form. Organize the documents chronologically by action.

Response 7:

In addition to Subaru's responses in "RE: NVS-214Lio/Pe03-029 Subaru WRX" made on September 29, 2003, and "RE: NVS-214Lio/Pe03-029/EA03-024 Subaru WRX" made on December 19, 2003, FHI and SOA made an investigation plan based on suggestions from NHTSA during our technical meeting on January 15, 2004. NHTSA's suggestion and the updated status of our investigation is described below.

- 1) NHTSA's suggestion
 - Investigations of two WRX vehicles which were conducted by Subaru were insufficient to conclude there is no safety defect.
 - NHTSA recommends that Subaru obtain and test two additional customer vehicles which represent typical complaints.
- 2) Updated investigation status
 - Subaru has not yet found applicable customer vehicles at this point.

Actions

- a) ABS rough road (Investigations of customer complained vehicles) issue.
- b) January 16, 2004.
- c) Not decided yet and it is under investigation.
- d) In order to duplicate customers' complaints of ABS activation and brake performance status when braking on rough roads, FHI will search for and investigate customer complaint vehicles. If necessary, this will be followed by testing at FHI proving ground.
- e) - Search of customer complaint vehicles: SOA
 - Investigations in local places and testing at FHI (FHI Vehicle Research & Experiment Dept.).
- f) Subaru has not found applicable customer vehicles at this point.

8: Describe all modifications or changes made by, or on behalf of, Subaru in the design, material composition, manufacture, quality control, supply, or installation of the Anti Lock (ABS) system, from the start of production to date, which relate to, or may relate to the alleged defect in the subject vehicles. For each such modification or change, provide the following information:

- a. The date or approximate date on which the modification or change was incorporated into vehicle production;
- b. A detailed description of the modification or change;
- c. The reason(s) for the modification or change;
- d. The part numbers (service and engineering) of the original component(s) of the ABS system;
- e. The part numbers (service and engineering) of the modified component(s) of the ABS system;
- f. Whether the original unmodified component(s) was withdrawn from production and/or sale, and if so, when;
- g. When the modified component(s) was made available as a service component(s); and
- h. Whether the modified component(s) can be interchanged with earlier production components.

Response 8:

There is no further progress from our response in "RE: NVS-214LJo/Pe03-029 Subaru WRX" made on September 29, 2003.

In addition, we are requesting concise answers to the following questions regarding the ABS system of the subject vehicle:

9. In connection with the ABS system installed in the subject vehicles, provide in detail, a response to each of the following:
 - a. State how reference speed is calculated. Does the algorithm use information from all four wheels to calculate an "overall vehicle reference speed"? If "yes", state how the "overall reference speed is calculated. If the answer is "no", state how reference speed is calculated for each wheel. Does the algorithm calculate separate reference speed for each wheel using only the information from that wheel? State how the "overall vehicle reference speed" is calculated.
 - b. State how the raw wheel speed signal is processed. Is there an analog filter prior to signal processing by the algorithm? If "yes", state how the analog filter calculates the sinusoidal wave period. If "no", is there a digital filter in the software? If there is a digital filter, please identify how it filters, smoothes, or averages the wheel speed information in the software.
 - c. State the internal update rate or clock speed of the Electric Control Unit (ECU). State how often the wheel-speed is examined, and how often the commanded input/output valve control information is updated.
 - d. When a tire is in the air (between bumps) during braking, state the rate of wheel deceleration that triggers the algorithm to choose a more severe action? State the depth and duration of wheel slip necessary to trigger the algorithm to create and maintain a sustained brake line pressure dump? What wheel speed recovery (to reference speed) rates cause the algorithm to continue pressure rebuild rates?
 - e. State how many accumulator (reservoirs) are present in the Hydraulic Unit (HU). Is there one accumulator for each circuit of the diagonally split hydraulic system?
 - f. When all outlet valves are open, state in detail whether the displaceable fluid volume in the master cylinder exceeds the capacity of the ABS HU accumulators.
 - g. Provide detailed internal ABS-ECU electrical diagrams and ABS-HU hydraulic diagrams.

Response 9a:

Reference speed is calculated using wheel speed sensor value of all four wheels and values of front/rear G sensors. The reference speed is calculated based on the value of either third or fourth fastest wheel when ABS is not activated, and it is done based on the value of second fastest wheel when ABS is activated. Under these circumstances, the acceleration/deceleration grade will be compensated according to the value of front/rear G sensors.

Response 9b:

The raw wheel signal is converted from sine wave to rectangular wave by comparator after passing through analog filter. In the next step, the period is calculated by monitoring rectangular wave edge in software within a specific time, and it is multiplied by coefficient of tire radius or coefficient of tone wheel teeth number to calculate wheel speed. During the procedure, grade restriction and balance processing of wheel speed variation is performed. All these works are performed at each of four wheels independently.

Response 9c:

The internal ECU is updated every 10 msec. The wheel speed data check and the commanded input/output valve control information are also updated every 10 msec.

Response 9d:

Response to the first half of the question:

Wheel deceleration, slip ratio, etc., which make hydraulic pressure reduction choice will be decided according to the following conditions:

- $\text{Wheel status} = K1 \times \text{"wheel slip ratio"} + K2 \times \text{"wheel deceleration"} + K3 \times \text{"vehicle body deceleration"} + K4 \times \text{"threshold value"}$
- Pressure reduction is chosen under the conditions indicated below:
Both "wheel status" is less than zero (0) and "wheel slip ratio" is greater than $K5 \times \text{"slip filter"}$.

Note: K1 through K5 indicate parameters and they contain factors which may vary according to vehicle travelling (cruising) status. Refer to Appendix 9d, part 1.

There is a learning function to decide whether pressure reduction control is necessary. The system monitors acceleration and deceleration in each of four (4) wheels while ABS is not controlled, and in case a condition of acceleration and deceleration over designated values were detected over designated times, wheel slip ratio that triggers ABS control would be changed to higher values. The lines of front and rear wheel will be shifted upward in the chart, Appendix 9d, part 1.

Response to the latter half of the question:

Increase or maintenance of the hydraulic pressure will be chosen according to wheel slip ratio and wheel acceleration. Start timing of pressure increase will be changed according to wheel acceleration value, i.e. hydraulic pressure would start increasing in earlier timing when wheel acceleration value was large. The start timing of pressure increase will be delayed most when the wheel speed becomes consistent with the reference speed. (See the circled portion in the attached Appendix 9d, part 2.)

Response 9e:

There are two accumulators in the HU, i.e. a low-pressure accumulator in each of the diagonally split brake circuits. The Hydraulic circuit drawing is shown in Appendix 9e.

Response 9f:

The fluid volume in the master cylinder exceeds the capacity of the ABS HU accumulators. The amount in detail is as follows:

- 1) Capacity of accumulator: 3000 mm³ for each brake line.

2) Capacity of master cylinder: "effective section area" x "maximum cylinder stroke".

- Diameter of cylinder: 26.99 mm
- Primary cylinder stroke: 15 mm
- Secondary cylinder stroke: 16 mm
- Capacity of primary cylinder = $(26.99/2)^2 \times \pi \times 15 = 8582 \text{ mm}^3$
- Capacity of secondary cylinder = $(26.99/2)^2 \times \pi \times 16 = 9154 \text{ mm}^3$

Capacity of each of primary and secondary cylinder is greater than the capacity of accumulator.

Response 9g:

Drawing of internal ABS-ECU electrical diagrams and ABS-HU hydraulic diagrams is provided as "Appendix 9g."

All of the Appendices have been sent to the NHTSA Office of Chief Counsel since they are considered "Confidential".

Should you have any questions regarding this response, please contact me at (856) 488-8844 or Gerald Plante at (856) 488-3226.

Sincerely,

SUBARU OF AMERICA, INC.



Don Bearden, Director
Governmental Affairs

Enclosures - Documents & CD

cc: Office of Chief Counsel