

**EA04-020**  
**HYUNDAI**  
**10/8/2004**  
**ATTACHMENT**  
**1, 2, 3, & 4**

**EA04-020**  
**HYUNDAI**  
**10/8/2004**  
**ATTACHMENT**  
**1**

**Kia Motors America  
Consumer Affairs Department**

Page 1 of 1

Last name	First name	VIN of 2001 RIO	Case Number	Mileage
[REDACTED]	[REDACTED]	KNADC123516 [REDACTED]	K318940	77,651
[REDACTED]		Prod. Date: 10/10/00	Dealer:	

**Case History**

Inquiry Warranty Info

\*\*\* PHONE LOG 05/25/2004 09:42 AM TDannelly

CUSTOMER STATES:

1. MY HUSBAND TOOK WHEEL OFF CAR
2. FOUND THAT THE RIM, IS **CRACKED**
3. IS THIS SOMETHING THAT IS COVERED UNDER WARRANTY
4. VEHICLE WAS MAKING A KNOCKING NOISE AND WHEN MY HUSBAND TOOK TIRE OFF, FOUND **RIM CRACKED.**
5. THANKS FOR INFO.

WRITER STATES:

1. APOLOGY FOR SITUATION
2. ADVISED OF IN SERVICE DATE
3. ADVISED VEHICLE BLW CURRENTLY EXPIRED
4. CUSTOMER HAS BALANCE OF POWER TRAIN WARRANTY REMAINING, WHICH COVERS ENGINE, TRANSMISSION AND AXLES.
5. RIM WOULD FALL UNDER BLW SO WOULD BE OUT OF WARRANTY.

\*\*\* CASE CLOSE 05/25/2004 09:42 AM TDannelly

9/15/04

10:11:32

vwd079

VIN No : KNADCL23516

Warranty Service Department

WARRANTY HISTORY INQUIRY

NAKAMURAB

KIAPROD

1/27/01

In Service Date:

Model . . 31202

Series . RIO

Repair Date	W Dlr T No.	Repair Order#	Ver	Repair Labor Code	Causal Part	Mileage
6/23/04	R AL008	87320	A 01		DIST ASSY-FUEL	72055
2/18/04	R AL008	83475	A 01		UNIT-CONTROL,EGI	70983
7/07/03	W AL008	76046	A 01	Engine Sub Assy, (Lo	SEAL-OIL	57122
7/07/03	W AL008	76046	B 01		STOPPER-RUBBER	57122
7/07/03	W AL008	76046	C 01	Engine Mounting Rub	RUBBER-ENG.MTG,NO.3	57122
7/07/03	W AL008	76046	D 01	A/T Lever Cable Assy	CABLE ASSY-CONTROL	57122
7/07/03	W AL008	76046	A 02	Engine Sub Assy, (Lo	SEAL-OIL	57122
7/07/03	W AL008	76046	E 01		STOPPER-RUBBER	57122
7/07/03	W AL008	76046	F 01		CABLE ASSY-CONTROL	57122
6/02/03	W AL008	74901	A 01	Generator/Alternator	ALTERNATOR	54699
10/15/02	W AL012	22494	A 04	Main Fuse Block, R&R	METER-AIR FLOW	41024
8/11/01	F AL012	16431	A 01	Engine Oil Filter A		16178

More...

F3=Exit

F11=Summary/Detail

9/15/04  
10:11:32  
wsd079

Warranty Service Department  
WARRANTY HISTORY INQUIRY

NAKAMURAB  
KIAPROD

In Service Date: 1/27/01

VIN No : KNADC123518 [REDACTED]

Model . . 31202  
Series . RIO

<u>Repair Date</u>	<u>W Dlr T No.</u>	<u>Repair Order#</u>	<u>Ver</u>	<u>Repair Labor Code</u>	<u>Causal Part</u>	<u>Mileage</u>
11/27/00	W 8104W	86126	J 01	INTERIOR CLEAN OF NP		1

Bottom

F3=Exit

F11=Summary/Detail

**Kia Motors America  
Consumer Affairs Department**

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<b>Last name</b> [REDACTED]	<b>First name</b> [REDACTED]	<b>VIN of 2001 RIO</b> KNADC123616 [REDACTED]	<b>Case Number</b> K337784	<b>Mileage</b> 59,000
<b>City, CA</b> [REDACTED]	<b>PH:</b> [REDACTED]	<b>Prod. Date:</b> 7/29/00	<b>Dealer:</b>	

**Case History**

Inquiry    Warranty Info

\*\*\* PHONE LOG 07/14/2004 09:36 AM MEstrella

CALLER STATES:

1. I HAVE A **CRACKED WHEEL**, IS THAT COVERED UNDER WARRANTY, NOTICED WHEN WAS ROTATING TIRES
2. HAVE AN APPT FOR THE SC026 FUEL DIST RECALL ON FRIDAY
3. SHOULD BE OK TO DRIVE

WRTR STATES:

1. HIS BLW IS 5/60 AND HIS PTW IS 10/100 FPOR MFR DEFECTS AND 5 YRS R/A
2. ADVISED SC034 ECM RECALL ALSO OPEN, HAVE DLR COMPLETE AS WELL
3. WRTR SUGGESTS TO TOW TO DEALER IF **WHEEL IS CRACKED**, PROBABLY NOT A GOOD IDEA TO CONTINUE DRIVING LIKE THAT, JUST IN CASE
4. OFFERED TRANS TO R/A, ADVISED TO CALL THE DLR TOO, TELL THEM WILL TOW IN NOW DUE TO **CRACKED WHEEL**

CALLER AGREED  
WRTR TRANS TO R/A

\*\*\* CASE CLOSE 07/14/2004 09:36 AM MEstrella  
TRANS TO R/A

9/15/04

10:11:48

wd079

Warranty Service Department

WARRANTY HISTORY INQUIRY

NAKAMURAS

KIAPROD

In Service Date:

12/18/00

VIN No : KNADQ123616

Model . . 31201

Series . RIO

Repair Date	W Dlr T No.	Repair Order#	Var	Repair Labor Code	Causal Part	Mileage
7/14/04	R CA173	31816	1 01		DIST ASSY-FUEL	59034
7/14/04	W CA173	31816	2 01		CONNECTOR-HOSE	59034
7/14/04	W CA173	31816	3 01		WHL-DISC 13X5J	59034
7/14/04	R CA173	31816	4 01		UNIT-CONTROL, EGI	59034
7/14/04	W CA173	31816	2 02		CONNECTOR-HOSE	59034
11/11/03	W CA173	26839	1 01	Door Belt Outside We	WTHSTP ASSY-DOOR, LH	46548
6/28/02	W CA133	15503	1 01	Headlamp Assy, R&R,	LAMP-HEAD, RH	25559
6/14/02	W CA133	15065	1 01	Fuse, R&R, One or Al	FUSE-10A	25052
1/07/02	W CA133	11191	1 01		VALVE ASSY-SOL.	17801
8/27/01	W CA133	8084	1 01	Auto Transmission Ga	GASKET-OIL PAN	12186
3/14/01	W CA133	61982	1 01	Rocker Cover Assy an	GASKET-HEAD COVER	4110
3/14/01	W CA133	61982	2 01	Camshaft Oil Seal, R	SEAL-OIL	4110

More...

F3-Exit

F11-Summary/Detail

9/15/04  
10:11:48  
wd079

Warranty Service Department  
WARRANTY HISTORY INQUIRY

NAKAMURAB  
KIAPROD

In Service Date: 12/18/00

VIN No : KMADC123610 [REDACTED]

Model . . 31201  
Series . RIO

<u>Repair</u> <u>DATE</u>	<u>W Dlr</u> <u>T No.</u>	<u>Repair</u> <u>Order#</u>	<u>Var</u>	<u>Repair Labor Code</u>	<u>Causal Part</u>	<u>Mileage</u>
2728701	F CA133	61699	1 01	Engine Oil	FILTER A	3482

Bottom

F3-Exit

F11-Summary/Detail







9/15/04

Warranty Service Department

NAKAMURAH

10:12:02

WARRANTY HISTORY INQUIRY

KIAPROD

wd079

In Service Date:

2/14/01

VIN No : KNADC123E16

Model . . 31201

Series . RIO

Repair Date	W Dlr T No.	Repair Order#	Ver	Repair Labor Code	Causal Part	Mileage
7/15/04	G CA144	54770	1 01		WHL-DISC 13X5J	86163
6/30/04	R CA144	54407	1 01		DIST ASSY-FUEL	84579
3/15/04	S CA144	51899	1 01	Audio Assy, R&R	AM/FM CD RADIO	75013
3/01/04	R CA144	51502	1 01		UNIT-CONTROL, EGI	73787
5/19/03	W CA144	23101	1 01	Roof Moulding Assy,	MLDG-ROOF, LH	50799
5/19/03	W CA144	23101	2 01	Door Opening Weather	WTHSTP ASSY-DOOR, RH	50799
4/14/03	W CA144	22456	1 01	Door Opening Weather	WTHSTP-FRT DOOR, LH	40354
4/14/03	W CA144	22456	2 01	Sunvisor Assy, R&R,	SUNVISOR, LH	40354
4/08/03	W CA144	22371	1 01	Audio Assy, R&R	STR MECH.DECK	48075

Bottom

F3=Exit

F11=Summary/Detail

**Kia Motors America  
Consumer Affairs Department**

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Last Name	First Name	VIN of 2001 RIO	Case Number	Mileage
[REDACTED]	[REDACTED]	KNADC123816 [REDACTED]	K328749	0
[REDACTED] Valley, CA	PH: [REDACTED]	Prod. Date: 9/24/00	Dealer: CA139 First Kia	

**Case History**

Complaint Repair Assistance

\*\*\* PHONE LOG 06/22/2004 12:19 PM JHirshfield

caller: (owner [REDACTED])

1. car is in my name - my daughter drives it
2. currently at First Kia needs new **WHEEL** well and **WHEEL**
3. this was some kind of defect
4. parts are being replaced under warranty
5. she needs to get two new tires and has to pay for them herself
6. she just put them on a few months ago
7. she is also without transport and the car won't be ready until Fri
8. what is Kia going to do for her?

wtr stated:

1. I apologize for the situation
2. need to speak with svc dept

wtr spoke with Vince @ CA139 who stated:

1. this **WHEEL** had been **cracked** for quite some time until it eventually broke off the hub
2. where ever she was getting her maint done had not been checking the **WHEELS** apparently
3. when she bought new tires, they should have seen it also
4. DPSM, Joe hegmann has looked at the car and the **WHEEL**
5. agreed to replace all 4 rims, the hub, the **WHEEL** well damage, etc
6. he will not replace the tires (non-Kia brand) and will not provide for rental
7. mother makes it very difficult to want to help out at all

wtr thanked svc mgr for the assistance -

wtr reiterated to cust what svc mgr had stated

cust not very happy - will continue to seek assistance

9/15/04

Warranty Service Department

NAKAMORAB

10:12:15

WARRANTY HISTORY INQUIRY

KIAPROD

wd079

In Service Date:

6/23/01

VIN No : KNADC123816

Model . . 31202

Series . RIO

Repair Date	W	DLR T No.	Repair Order#	Ver	Repair Labor Code	Causal Part	Mileage
6/16/04	W	CA139	25435	A 01	Tire Assy of Wheel A	WHL-DISC 13X5J	55368
6/16/04	R	CA139	25435	B 01		UNIT-CONTROL, EGI	55368
6/16/04	R	CA139	25435	C 01		DIST ASSY-FUEL	55368
9/07/01	F	CA139	11925	A 01	Engine Oil Filter A		3413
9/07/01	W	CA139	11925	C 01	Multifunction Switch	SWITCH-COMBINATION	3413

Bottom

F3-Exit

F11-Summary/Detail

**Kia Motors America  
Consumer Affairs Department**

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Last name	First name	VIN of 2001 RIO	Case Number	Mileage
[REDACTED]	[REDACTED]	KNADC123216 [REDACTED]	K337748	63,000
[REDACTED] blin, VA	[REDACTED] H:	Prod. Date: 9/27/00	Dealer: VA007 Hart Kia	

**Case History**

Complaint Warranty

\*\*\* PHONE LOG 07/14/2004 08:42 AM Pacific Daylight Time OSprague

Received Letter - Customer states

1. I am very dissatisfied with the way your warranty works.
2. I have been in several times to get things fixed.
3. My WHEEL was broken and your warranty did not cover it
4. I went in for a problem and they told me a mouse ate through my wires. That cost almost \$250
5. My CEL was on so I asked them to check and see what was wrong
6. They did a tune up and then told me the clutch was out and I was looking at \$1,000 worth of labor and parts.
7. I believe the clutch should be under warranty. I have 63,000 miles on my vehicle.

Case Dispatched - Letter forwarded to the Eastern Region for handling

\*\*\* NOTES 07/14/2004 01:42 PM Eastern Daylight Time SHubbs Action Type:Manager review

Writer called customer

1. Writer left a voicemail
2. Writer left contact information
3. Writer will attempt to contact writer w/in 24 hours.

\*\*\* NOTES 07/14/2004 04:21 PM Eastern Daylight Time SHubbs Action Type:Manager review

Writer called customer

Per Writer

1. I spoke w/ my DPSM
2. Unfortunately, w/ 63,000 miles on your veh., your clutch repairs will be customer pay
3. General maintenance items hold a 12 month/12,000 mile warranty status
4. I cannot do anything for you regarding warranty assistance on this matter
5. Please keep my name and number handy in case anything else arises

Per Customer

1. Ok, thank you

\*\*\* NOTES 07/14/2004 04:21 PM Eastern Daylight Time SHubbs Action Type:Manager review

Writer closing case pending further contact from customer.

\*\*\* CASE CLOSE 07/14/2004 04:22 PM Eastern Daylight Time SHubbs

9/15/04

Warranty Service Department

NAKANURAS

10:12:27

WARRANTY HISTORY INQUIRY

KIAPROD

wd079

In Service Date:

2/26/01

VIN No : KNADC123216

Model . . 31201

Series . RIO

Repair Date	W Dlr	Repair Order#	Ver	Repair Labor Code	Causal Part	Mileage
7/08/04	R VA007	43508	1 01		DIET ASSY-FUEL	62999
5/23/03	W VA007	24418	1 01	Tire Assy or Wheel A	WHL-DISC 13X5J	40622
5/14/03	W VA007	23934	1 01	Tire Assy or Wheel A	WHL-DISC 13X5J	39991
2/26/01	P 8108W	G3056	1 01	Spot Repair		1
11/02/00	W 8108W	E1851	1 01	INTERIOR CLEAN of NP		1
11/02/00	W 8108W	E1851	2 01	Parking Brake Lever	LEVER ASSY-PARK.BRAK	1

Bottom

F3-Exit

FileSummary/Detail

**Kia Motors America**  
**Consumer Affairs Department**

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Last name	First name	VIN of 2001 RIO	Case Number	Mileage
[REDACTED]	[REDACTED]	KNADC123X16 [REDACTED]	K333108	63,950
[REDACTED] CATUR, GA [REDACTED] H [REDACTED]		Prod. Date: 11/7/00	Dealer: GA048 Kia AutoSport	

**Case History**

Complaint Dealer

\*\*\* PHONE LOG 07/01/2004 04:28 PM US Mountain Standard Time CRountree  
CUSTOMER STATES

1. HAD A BAD SERVICE FOR ON 6/11/4.
2. THEY DID TUNE UP AND FIXED AXLE.
3. ON 6/12 HEARD NOISE AGAIN.
4. TOOK BACKON 6/16 THEY SAID IT WAS THE WHEEL BEARING.
5. TOOK BACK THAT WEDNSDAY MORNING.
6. THAT AFTER NOON THEY PUT ME IN A RENTAL.
7. THE FINALLY FOUND A **BROKEN** RIM.
8. THEY SAID THE DIDNT THINK THE HAD TO CHECK OUT THE RIMS.
9. ON THE 24TH THEY CHANGED THE RIMS.
10. TOOK TO ANOTHER DEALER THEY SAID THE TUNE UP WAS NOT DONE RIGHT.
11. BOUGHT VEHICLE IN JUN OF 2001.
12. WILL FAX THE BILL OF SALE IN FOR CORRECTION.
13. THIS IS THE 4TH TIME I TOOK IT IN FOR THE PROBLEM.
14. COMPLETELY

WRITER STATES:

1. SORRY FOR THE PROBLEM
2. WARRANTY START DATE 4/16/2001.

\*\*\* CASE CLOSE 07/01/2004 04:28 PM US Mountain Standard Time CRountree  
CLOSED PENDING FAX OF BILL OF SALE.

\*\*\* NOTES 07/09/2004 05:17 PM US Mountain Standard Time CRountree Action Type:Manager review

WRITER STATES:

1. BILL OF SALE FAXED INTO FILE.
2. CUSTOMER BOUGHT VEHICLE IN JUN 2001 AS NEW.
3. VEHICLE SHOWS SOLD TO CUSTOMER IN APR OF 2001; 2 MONTHS EARLIER.

\*\*\* NOTES 07/12/2004 07:45 AM Pacific Daylight Time ARomo Action Type:Manager review

Writer to forward all documents for RDR correction.  
Writer to dispatch case to the region for further handling.

\*\*\* NOTES 07/16/2004 01:45 PM Pacific Daylight Time ARomo Action Type:Manager review

All documents are being forwarded to the Region via interoffice mail.



9/15/04

Warranty Service Department

NAKAMURAB

10:12:38

WARRANTY HISTORY INQUIRY

KIAPROD

wed079

In Service Date:

4/16/01

VIN No : KNADC123X16

Model . . 31202

Series . RIO

Repair Date	W Dlr T No.	Repair Order#	Ver	Repair Labor Code	Causal Part	Mileage
6/24/04	G GA048	16015	1 02		WHL-DISC 13X5J	63652
6/22/04	D GA048	16012	1 01	Wheel Bearing Assy(R	BRG.-WHL.IN.	63652
6/22/04	G GA048	16105	1 01		WHL-DISC 13X5J	63652
6/11/04	W GA048	15843	1 01	Driveshaft(Front), R	SHAFT ASSY-DRIVE, RH	63074
2/18/04	R GA048	14258	1 01		UNIT-CONTROL,BGI	55490
8/31/02	W GA023	23558	1 01	Pulse Generator Assy	GENE ASSY-PULSE	22787
10/01/01	W GA023	19735	1 01	Multifunction Light	SRC ASSY	4931
6/11/01	W GA023	17537	1 01	Instrument Cluster A	METER SET	9
12/27/00	W 8104W	89371	J 01	INTERIOR CLEAN of NP		1
12/27/00	W 8104W	89371	1 01		HEAD LAMP,RH	1

Bottom

F3=Exit

F11=Summary/Detail

**EA04-020**  
**HYUNDAI**  
**10/8/2004**  
**ATTACHMENT**  
**2**

## ALLEGED WHEEL SEPARATION INCIDENTS

1. [REDACTED]  
VIN: KNADC12321 [REDACTED]  
Summary: Impact Damage  
Kia has made several attempts to contact this customer but has been unsuccessful.
2. [REDACTED]  
VIN: KNADC12321 [REDACTED]  
Summary: Mechanic error (one wheel fixed then other wheel broke)  
Kia has made several attempts to contact this customer but has been unsuccessful.
3. [REDACTED]  
VIN: KNADC123816 [REDACTED]  
Summary: over torquing—crack around lug nuts.  
Kia has made several attempts to contact this customer but has been unsuccessful.
4. [REDACTED]-See Attached  
VIN: KNADC123416 [REDACTED]

**TEMPLATE FOR CALLING OF CUSTOMERS IDENTIFIED  
ON CONSUMER AFFAIR FILES**

Is this [insert customer name]? [redacted] - No - [redacted]  
If not, is [customer name] available?  
If not, ask to speak to a family member available who may have driven the car.

*mother - daughter  
on  
vacation*

**Preliminary Statement**

This is JD. I am working with Kia Motors America and our records indicate that you purchased a 2001 model year Rio. Is that correct? yes. I am calling you as part of a safety survey in response to a call you once made regarding a problem with one or more of your vehicle's wheels.

Kia is following up with persons who complained about wheel cracking to get a better understanding of the circumstances surrounding the cracking in order to better understand the needs of its customers. I would appreciate it if you would be willing to provide that assistance to other customers by answering just a few questions. It should take about 5 minutes.

**Ownership and Use**

Do you still own your Kia Rio? YES/NO

If NO: who owns, when sold, if knows person

*No recall to whom, sold a couple months ago*

Do you recall ever placing a call to the Consumer Affairs Department to complain about wheel cracking?

*Daughter called because her wheel broke off while she was driving 5-10 miles an hour while she was going up to a light to turn.*

Were you the principal driver of vehicle at that time? YES/NO

o If No, who was? *Daughter*

o Did others regularly drive the vehicle at that time? ~~Yes~~

*She did on occasion*

*Daughter told mom that the whole wheel came off*

**Wheel Cracking Questions**

Please let me know how you first knew that there was a problem with your wheel(s)?

In particular did you hear or feel anything? *Have to tell, car just didn't drive right*

Did a technician ever tell you there was a problem with your wheels?

*No. The vehicle had been taken to dealer a couple of times because daughter heard a "rattling noise," but they didn't find anything*

Prior to that time, when driving the vehicle, did you hear or feel anything related to the vehicle that indicated that something might be wrong with the vehicle?

*Vehicle just didn't drive right*

Would the noise and/vibration become more or less apparent when driving in a certain way? *Didn't like the way car drove.*

Did the \_\_\_\_\_ change over time?

How long had you heard the noise/felt the vibration before taking the vehicle to someone to inspect the wheel? *Daughter took vehicle to get looked at on several occasions.*

Did you ever look at the wheels when you heard [or felt] the \_\_\_\_\_? *NO*  
What did you see?

Did anything you felt, saw or heard lead you to believe that you should take the car to a repair shop? *NO response - said to talk to daughter*

Did you believe that you had a safety problem? *believed the car was a safety problem the minute the car was bought*

**Questions for Customers that Reported Property Damage**

Kia's file on your vehicle notes body damage.

Was the body damage as a result of the wheel cracking? *yes, wheel bounced up*

What was damaged? *the car*

Can you let me know how the wheel cracks led to the damage?

Do you remember approximately what it cost to repair the body damage?

**Vehicle Maintenance** *- said to talk to daughter*

Did you regularly check tire pressure on the vehicle at that time?  
How about after?

Did you regularly rotate the tires on the vehicle at that time?

How about after?

Do you take the vehicle to a Kia dealer for replacement and rotation of your tires or did you go to an independent tire repair shop?

Talk to daughter

Is there anything Kia could have done to have handled this situation better?

Talk to daughter

Thank you for taking the time to answer these questions.

Note: Tried to contact daughter on several occasions but unable to get a hold of her.

**EA04-020**  
**HYUNDAI**  
**10/8/2004**  
**ATTACHMENT**  
**3**

REPORT NO.	<b>QUICK REPORT</b>	Approval	Staff	W/G Manager	Team Manager
BCFASU-2002010013			approved 1/15	approved 1/15	approved 1/15

1. **TITLE:** RIO ROAD WHEEL (Steel) Crack Analysis Report

2. **PREPARED BY & DATE:** [REDACTED] of Metal Element Research Team / 2002. 1. 15.

3. **PURPOSE:** To analyze the cause of crack on Rio Steel Road Wheel Disc

4. **INCIDENTS REPORTED:** 2 Incidents in Oman

5. **SUMMARY OF CRACK:** Crack started in R-area between Disc's vent hole and disc's rib and then progressed toward Vent Hole and Hub Hole

#### 6. ANALYSIS RESULTS

1) Chemical Element Analysis (unit: wt%)

Element	C	Si	Mn	P	S	Cr	Ni	Ti	Fe
Normal Wheel 1	0.072	0.034	1.38	0.006	0.009	0.01	0.003	0.045	Rem.
Normal Wheel 2	0.071	0.043	1.36	0.006	0.008	0.012	0.004	0.045	Rem.
Wty Return (Oman)	0.073	0.006	1.21	0.006	0.001	0.013	0.006	0.042	Rem.

\* As shown in the results, chemical elements in all 4 are identical, and it is perceived that there is no problem with materials. According to chemical composition, it is perceived to be 60k level high-tension steel. (attached Spec's)

2) Hardness (unit: HV)

Hardness of	Flat Area	R-Area
Wty Return (Oman)	195	231 - 245
Normal Wheel 1	199	236 - 240
Normal Wheel 2	207	235 - 243

\* Measurement of hardness shows no difference between Wty-return part and normal part. There is about 30 ~ 40 units of difference in hardness between Flat area and R-area because treatment process increases the hardness.

3) Cross section inspection on Cracked wheel & Normal wheel: Refer to attachment

4) Notch Surface Analysis by Electron Microscope: Refer to attachment

#### 7. CONCLUSION

1) According to the results from chemical element analysis and hardness analysis, the materials are perceived to be identical on Warranty-return part and normal part and to be free of any defect.

2) According to the results from Cross-section analysis on Warranty-return part and normal part, it is perceived that the crack started from R-area, which is around the borderline between Vent Hole & Disc Rib area, and that it developed/progressed toward Vent Hole and Hub Hole.

3) According to the results from Notch surface analysis by electron microscope, it was confirmed that the starting point of crack was same as identified in above Conclusion 2)

4) Since the shapes of normal part & warranty return part are not the same, it is perceived that they were not produced by the same mold. Notch radius of warranty return part was 0.6r while that of normal part was 2.95r.

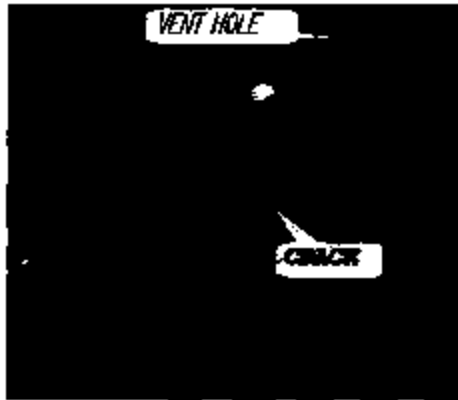
It is perceived that R-area of warranty return part was the direct cause of crack.

5) When notch radius of R-area is small, this area works like a notch, and the fatigue strength is reduced.

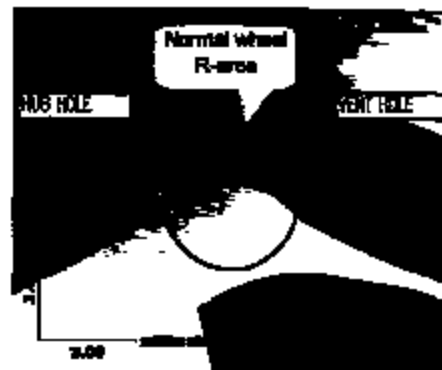
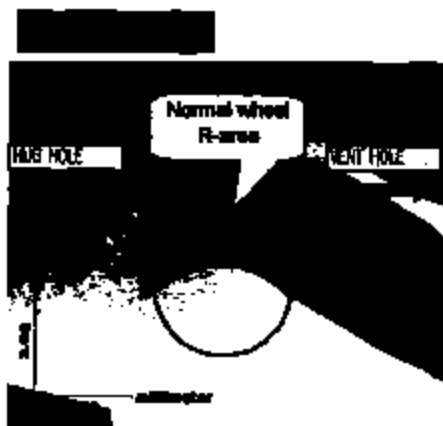
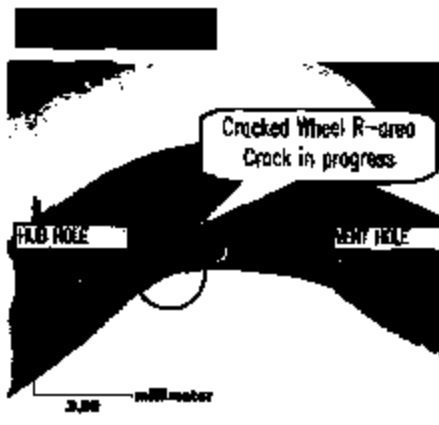
If the relationship between Notch Radius, r, and Notch-sensitivity is considered, the maximum endurance is reduced by reduced by 22% on warranty-return part, compared to normal part. (Refer to attachment) - END -



### Condition of Cracked Wheel

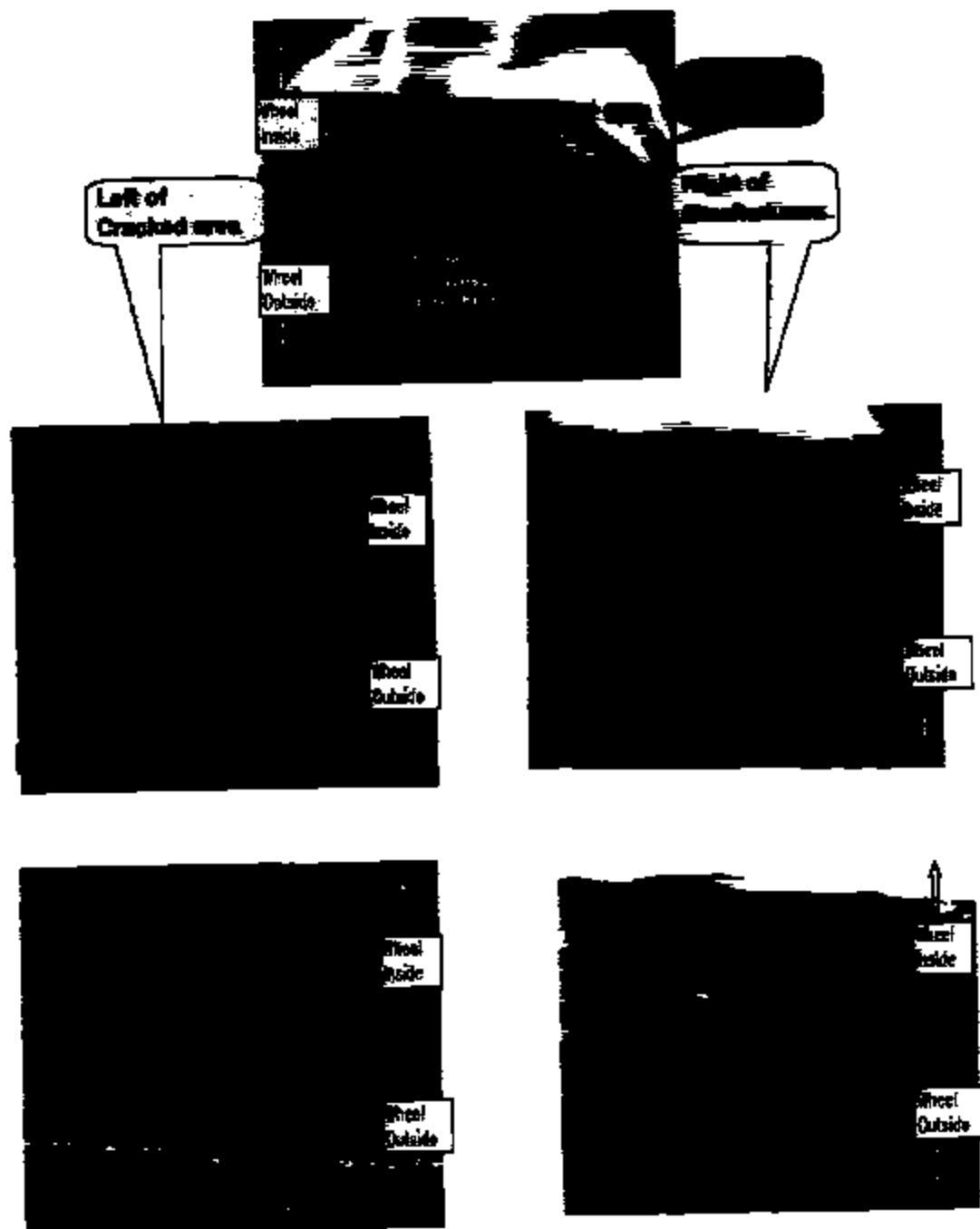


### Picture of Cracked Wheel vs. Normal Wheel (area where VENT HOLE & DISC RIB meet)



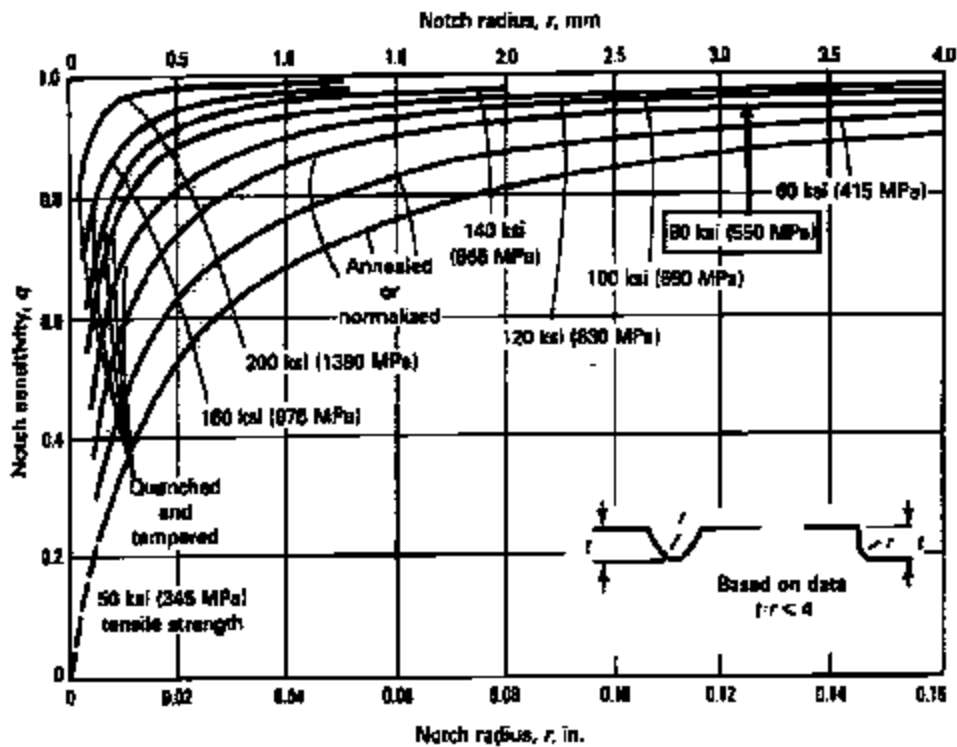
\* When cracked wheel and normal wheel were compared under the same magnification, notch radius of R-area on NORMAL wheel is much larger than that on CRACKED wheel.

## Result of Notch Surface Analysis by Electron Microscope



- According to notch surface observation by electron microscope, the crack started from R-area, which is around the borderline between Vent Hole and Disc Rib Area, and the crack started outside surface of Disc and progressed to inside. The crack starting point is formed by high level of stress at the low cycle condition, then BEACH MARK of high-cycle & low-stress condition is formed by continuously repeated loads. The crack progressed further.

**Variation of notch-sensitivity index with notch radius for steel tested in axial fatigue loading. (Metal handbook)**



\* Above graph shows the relationship between Notch radius and Notch sensitivity

\* The relationship between Notch sensitivity and maximum endurance is

$$S_f = K_f \cdot \sigma_0$$

$$K_f = 1 + (K_s - 1) \cdot q_f$$

$S_f$  = fatigue strength, Pa

$K_f$  = stress concentration factor for cyclic loads

$K_s$  = static stress concentration factor

$q_f$  = notch sensitivity factor

$\sigma_0$  = alternating stress, Pa

\* Measurement: Notch radius of Warranty return part: 0.6R

Notch radius of Normal part: 2.95R

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# KOREAN VERSION

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REPORT NO. 3CFASU- 2002010013	<b>QUICK REPORT</b>	결 재	담당	W/G 장	팀장
결재란 1/15			결재란 1/15	결재란 1/15	

1. 제 목 : 리오 ROAD WHEEL(STEEL材) 파손분석 보고
2. 작성자 및 작성일 : 금속재료연구원 문경일 / 2002. 1. 15.
3. 목 적 : 리오 차종의 STEEL ROAD WHEEL DISC 파손문제가 발생되어 이에 대한 파손 원인 분석
4. 발생현황 : 오만 2건
5. 파단개요 : DISC의 VENT HOLE과 DISC RIB부 사이의 R부 에서 파단 발생되어 VENT HOLE과 HUB HOLE 방향으로 진행되어 파단됨
6. 분석 결과

1) 화학성분 분석(단위:wt%)

성분	C	Si	Mn	P	S	Cr	Ni	Ti	Fe
양품1	0.072	0.034	1.19	0.018	0.009	0.01	0.013	0.045	Rem.
양품2	0.071	0.041	1.18	0.018	0.008	0.012	0.014	0.045	Rem.
고품(오만)	0.073	0.016	1.21	0.018	0.001	0.013	0.018	0.042	Rem.

\* 결과에서 보듯이 4종류 모두 화학성분 동일하여, 재질상 결함은 없는것으로 판단됨  
성분구성으로 볼때 80K급 고장력강으로 판단됨(SPEC 만족)

2) 경도(단위:HV)

	평면부 경도	R부 경도
고품(오만)	195	231~245
양품1	199	236~240
양품2	207	235~243

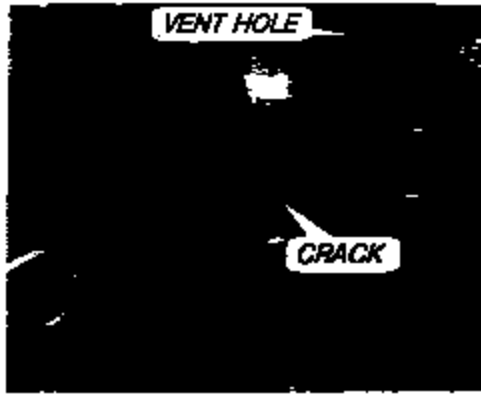
\* 경도 측정결과 고품과 양품의 차이는 없었으며, 평면부와 R부와는 가공경화에 의한 경도값 상승 때문에 30~40정도의 경도차 발생함.

- 3) 파손품 및 양품의 단면검사 : 유침 참조
- 4) 파단면 전자현미경 검사 : 유침참조

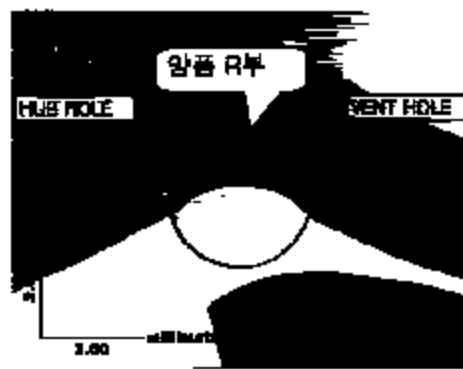
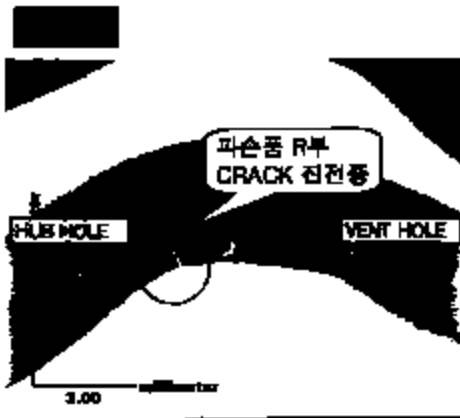
7. 결 론

- 1) 화학 성분 및 경도 분석결과 고품 및 양품 모두 동일하며 재질상의 결함은 없는것으로 판단됨.
- 2) 고품 및 양품의 단면 분석결과 고품의 경우 VENT HOLE 과 DISC RIB부의 경계면인 R부위에서 CRACK이 발생되어 VENT HOLE과 HUB HOLE 방향으로 진행됨것으로 판단됨.
- 3) 파단면의 전자현미경 분석결과 파단의 기점은 상기 결론의 2)항목과 동일함을 확인할수 있음.
- 4) 양품과 고품의 단면형상이 일치하지 않는것은 상이한 금형으로 제작됨것으로 판단되며 R부 곡률반경은 고품 0.8r, 양품 2.85r 이여 고품의 R부가 파단의 직접적인 원인으로 판단됨.
- 5) R부의 곡률반경이 작으면 이곳이 NOTCH로 작용되어 피로강도가 감소하게 되는데 곡률반경 r 과 Notch-sensitivity와의 관계를 고려해 볼때 부품의 내구한도는 고품이 양품에 비하여 약 22% 감소됨을 알 수 있다.(유침참조) -끝-

파손품 CRACK 발생현황

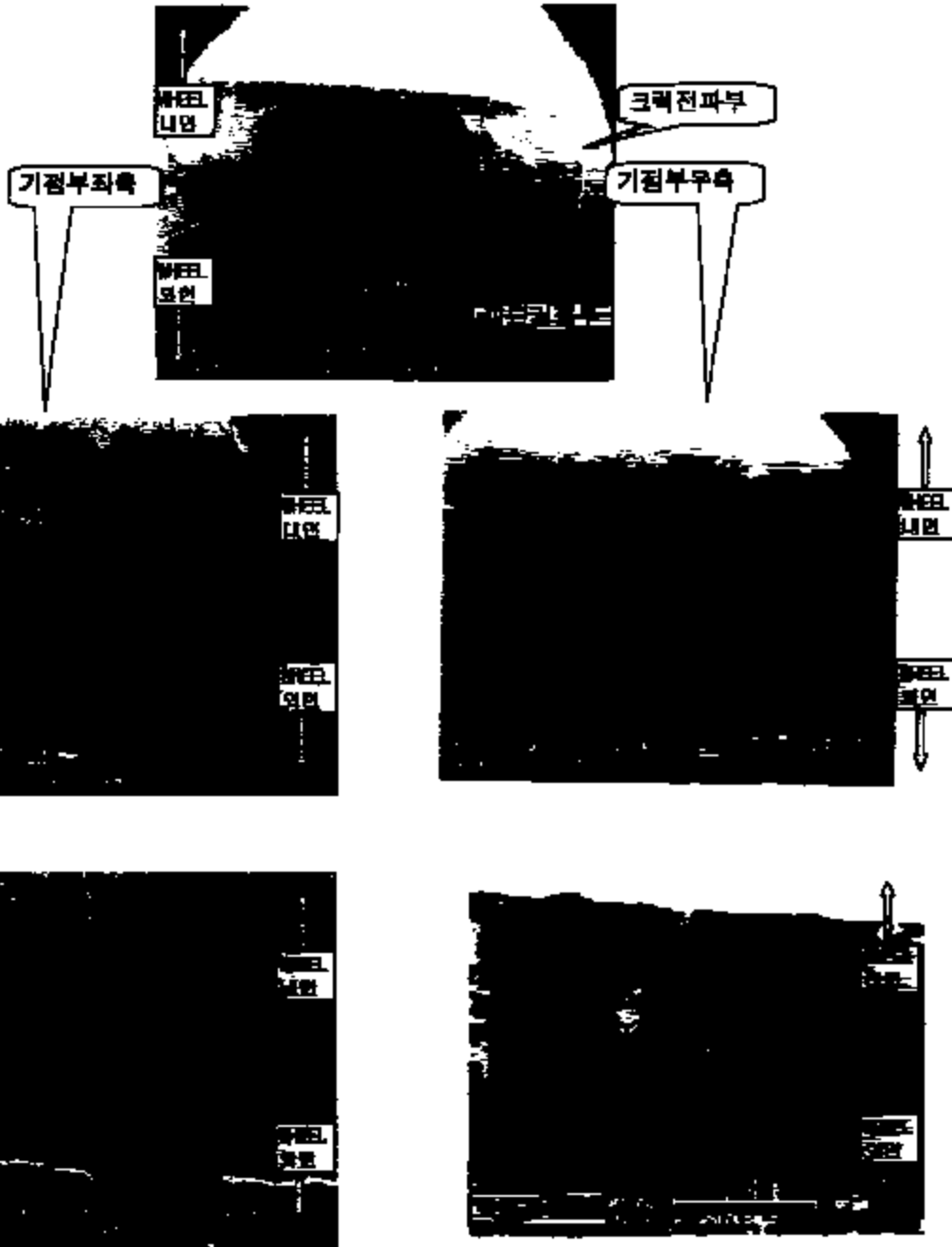


파손품/양품의 단면사진(VENT HOLE과 DISC RIB부 경계면)



\* 동일한 재료로 파손품 및 양품의 단면을 측정 한 결과 파손품의 경계면 일부에 비하여 양품의 R부 곡률반경이 훨씬크다.

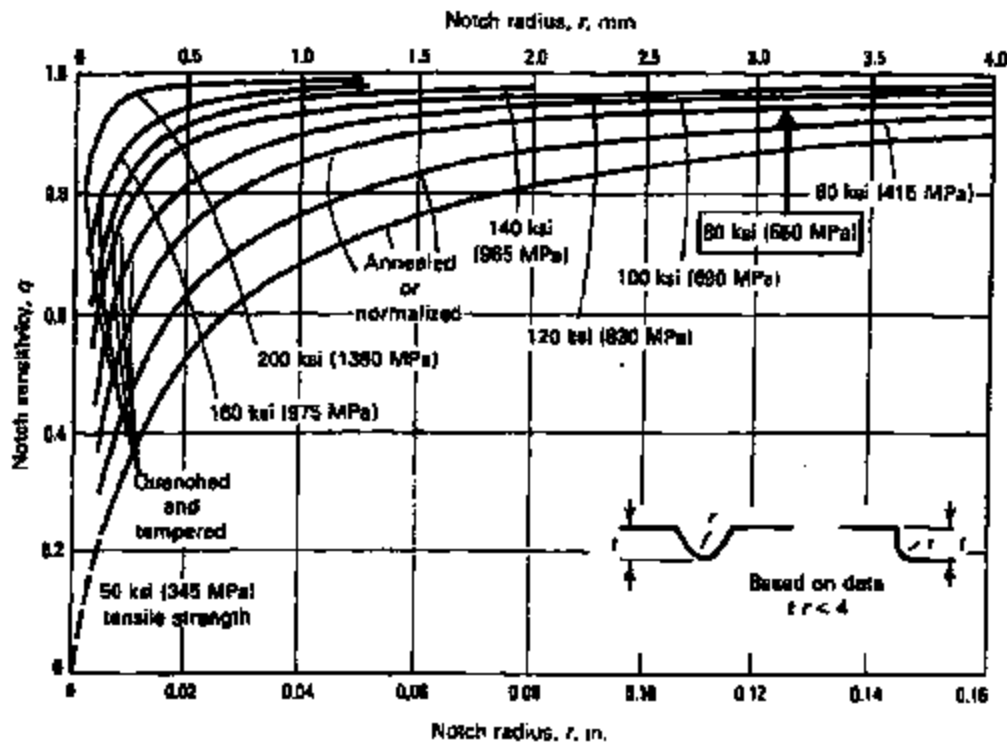
## 파단면 전자현미경 분석결과



- 파단면의 전자현미경 관측 결과, 파단의 기점은 VENT HOLE과 DISC RIB 부의 경계면인 R부에서 발생하였으며, CRACK 발생 및 진전방향은 DISC의 외면에서 내면으로 진전됨을 알수있다

파단의 형태는 저주기 상태에서 고응력에 의해 기점부가 형성된 후에 계속되는 반복하중에 의하여 고주기 저응력상태의 피트마크(BEACH MARK)를 형성하면서 계속진전되어 파손.

Variation of notch-sensitivity index with notch radius for steel tested in axial fatigue loading. (Metal handbook)



- 곡률반경에 따른 notch-sensitivity를 나타낸 도표임.
- Notch-sensitivity 와 내구 한계와의 관계는

$$S_f = K_f \cdot \sigma_a$$

$$K_f = 1 + (K_s - 1) \cdot q_n$$

$S_f$  = fatigue strength, Pa  
 $K_f$  = stress concentration factor for cyclic loads  
 $K_s$  = static stress concentration factor  
 $q_n$  = notch sensitivity factor  
 $\sigma_a$  = alternating stress, Pa

- 측정결과 고준 곡률반경: 0.6R  
 양준 곡률반경: 2.85R



**EA04-020**  
**HYUNDAI**  
**10/8/2004**  
**ATTACHMENT**  
**4**

**Rio Steel Wheel  
Warranty-Return Part Analysis  
Summary**

2002. 3.25

**Kia Motors  
Quality Assurance Team 1**

# 1. Summary of Warranty-Return parts from N. American markets

NO	Country	Date Reported	VIN	Production Date	Dealer (R/L)	Warranty Production Date	Problem Reported	Resolution	Analysis of Warranty Return Part
1	U.S.A.	'01.8/22	KNADC125316	'00.10/13	29,704	'00.10/4	brought the vehicle to dealership due to unusual noise while driving, (steel wheel cracked)	none	Material Analysis (SHHP60) : Spec's satisfied
2			KNADC123316	'00.10/13	36,931	'00.10/4		none	
3		'01.12/19	KNADC123416	'00.10/4	93,709	'00.9/26		none	Depth of notch surface in HAT-area measured: 6.82mm (Normal part: 5.85mm)
4		'01.12/22	KNADC123016	'00.10/10	25,684	'00.10/4	brought the vehicle to dealership due to unusual noise while driving, (steel wheel cracked)	none	
5		'02.01/04	KNADC123116	'00.10/13	47,232	'00.10/4		none	
6		'02.1/16	KNADC123316	'00.5/28	38,942	'00.5/28	brought the vehicle to dealership due to unusual noise while driving, (steel wheel cracked)	none	
7			KNADC123316	'00.8/15	88,084	-		none	
8		'02.01/17	KNADC123816	'00.10/13	-	'00.10/04		none	
9		'02.3/21	KNADC123216	'00.9/1	53,333	'00.8/30		none	
10	Canada	'02.2/19	KNADC123916	'00.10/11	45,815	'00.10/04	brought the vehicle to dealership due to unusual noise while driving, (R/LH/RH steel wheel cracked)	none	

• KNADC123316 [REDACTED] (U.S.A.)



• KNADC125316 [REDACTED] (U.S.A.)



• KNADC123416 [REDACTED] (U.S.A.)



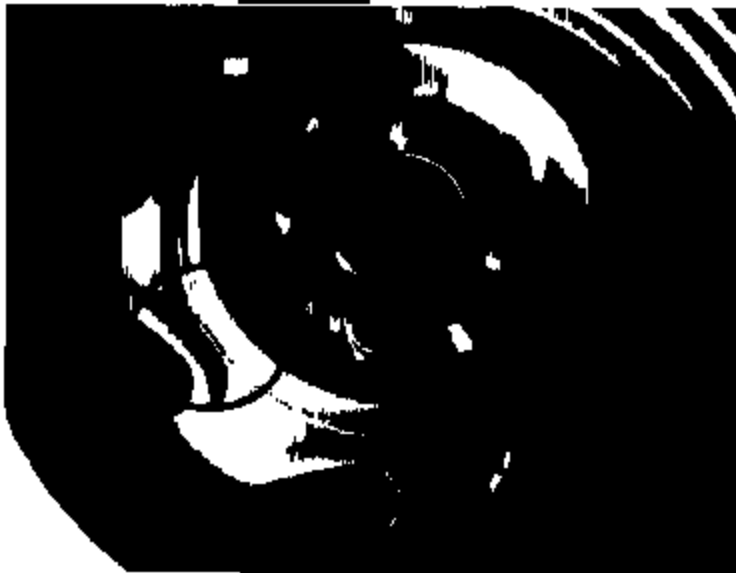
• KNADC123916 [REDACTED] (Canada)



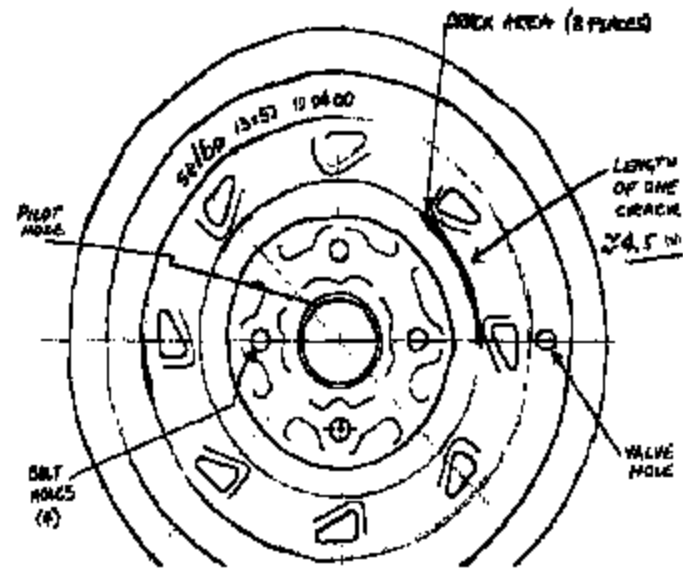
## 2. Summary of Warranty-Return parts from other countries

NO	Country	# of (vehicles)	Date Reported	VIN	Production Date	Mileometer (KM)	Warranty Expiration Date	Customer Report	Resolution	Customer Satisfaction	Remarks
1	Oman	2	'01.5/2	KNADC223416	'00.10/11	42,280	'00.10/4	brought the vehicle to dealership due to unusual noise while driving, (steel wheel cracked)	none	Material Analysis (SHHP60) : Spec's satisfied	for Taxi
2				KNADC1X1603	'00.10/12	57,000	'00.10/4		none		
3	Venezuela	4	'01.5/12	KNADC223216	'00.10/10	45,576	'00.10/4	brought the vehicle to dealership due to unusual noise while driving, (steel wheel cracked)	none	-	
4				KNADC223216	'00.10/11	-	-		none	-	
5			'02.1/12	KNADC221216	'00.7/27	78,456	'00.7/22		none	-	
6				KNADC223316	'00.10/10	92,000	-		none	-	
7	Trinidad	1	'02.01/12	KNADC223316	'00.10/08	34,642	'00.10/4	brought the vehicle to dealership due to unusual noise while driving, (steel wheel cracked)	none	-	
8	Australia	5	'02.2/10	KNADC243316	'00.8/15	33,653	'00.8/8		none	-	
9			'02.03.22	KNADC223316	'00.8/10	46,798	'00.7/27		none	-	
10				KNADC243216	'00.9/6	39,624	'00.9/8		none	-	
11				KNADC243216	'00.7/11	123,228	'00.7/8		none	-	

• KNADC1X1603 [REDACTED] (Oman)



• KNADC223216 [REDACTED] (Venezuela)



• KNADC223316 [REDACTED] (Trinidad)



• KNADC243216 [REDACTED] (Australia)



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# KOREAN VERSION

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# 1. 북미 고품내용 요약

NO	국가	접수일	VIN	생산일	주행거리 (Km)	월 LOT	정보내용	사고유무	고품분석결과	
1	미국	'01.8/22	KNADC12531	'00.10/13	29,704	'00.10/4	주행중 이음 발생으로 덜러 입고 (스틸릴 크랙 발생)	無	▶ 재질(SHHP60) 분석 : 규격만족	
2			KNADC12331	'00.10/13	36,931	'00.10/4		無		
3		'01.12/19	KNADC12341	'00.10/4	93,709	'00.9/28		無	▶ HAT부 단면깊이조사 : 6.82mm (양품 5.85mm)	
4		'01.12/22	KNADC12301	'00.10/10	25,884	'00.10/4	주행중 이음 발생으로 덜러 입고 (스틸릴 크랙 발생)	無		
5		'02.01/04	KNADC12311	'00.10/13	47,232	'00.10/4		無		
6		'02.1/18	KNADC12331	'00.5/29	38,942	'00.5/28	주행중 이음 발생으로 덜러 입고 (스틸릴 크랙 발생)	無		
7			KNADC12331	'00.8/15	88,084	-		無		
8			'02.01/17	KNADC12381	'00.10/13	-		'00.10/04	無	
9			'02.3/21	KNADC12321	'00.9/1	53,333		'00.8/30	無	
10	캐나다	'02.2/19	KNADC12391	'00.10/11	45,815	'00.10/04	주행중 이음 발생으로 덜러 입고 (Rr LH/AH 스틸릴 크랙 발생)	無		



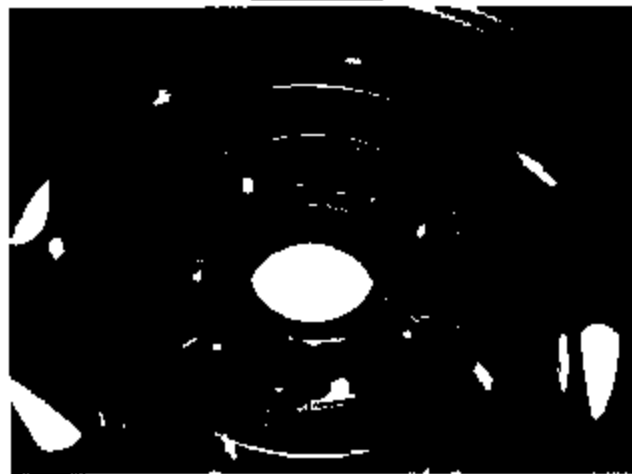
● KNADC123316 [REDACTED] (미국)



● KNADC125316 [REDACTED] (미국)



● KNADC123416 [REDACTED] (미국)



● KNADC123916 [REDACTED] (캐나다)



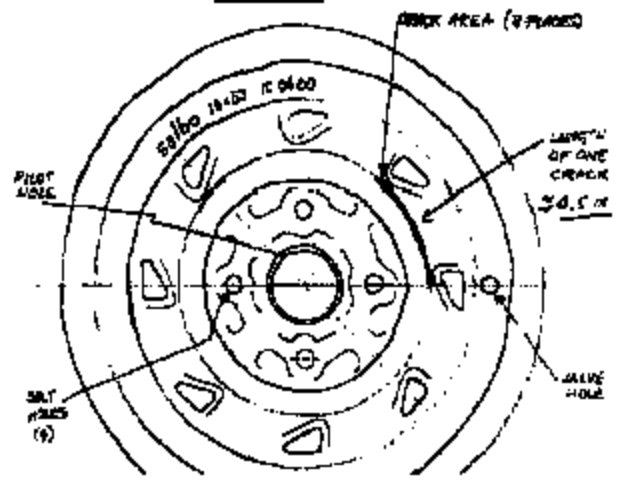
## 2. 기타지역 고품내용 요약

NO	국가	건수	결수일	VIN	생산일	주행거리 (Km)	출 LOT	정보내용	사고유무	고품분석결과	차량용도
1	오만	2	'01.5/2	KNADC223410	'00.10/11	42,260	'00.10/4	주행중 이음 발생으로 덜러 입고 (스틸링 크랙 발생)	無	▶과질 (SHHP80) 분석 : 규격안착	택시용
2				KNADC1X1602	'00.10/12	57,000	'00.10/4		無		
3	비네주엘라	4	'01.5/12	KNADC223210	'00.10/10	45,578	'00.10/4	주행중 이음 발생으로 덜러 입고 (스틸링 크랙 발생)	無	-	
4				KNADC223210	'00.10/11	-	-		無	-	
5			'02.1/12	KNADC221210	'00.7/27	78,458	'00.7/22		無	-	
6				KNADC223310	'00.10/10	82,000	-		無	-	
7	트리니다드	1	'02.01/12	KNADC223310	'00.10/08	34,842	'00.10/4	주행중 이음 발생으로 덜러 입고 (스틸링 크랙 발생)	無	-	
8	호주	5	'02.2/18	KNADC243310	'00.8/15	33,853	'00.8/8		無	-	
9			'02.03.22	KNADC223310	'00.8/10	46,788	'00.7/27		無	-	
10				KNADC243210	'00.9/8	39,524	'00.9/5		無	-	
11				KNADC243210	'00.7/11	123,228	'00.7/8		無	-	

● KNADC1X1609 (오만)



● KNADC223216 (베네수엘라)



● KNADC228316 (트리니다드)



● KNADC243216 (호주)

