# PE06-042
# HYUNDAI
# 12/22/06
# ATTACHMENT 1 & 2

# Supplemental Response
# Preliminary Evaluation
# (PE06-042)

2002MY Sportage Engine Cooling Fan

December 22, 2006

# PE06-042
# HYUNDAI
# 12/22/06
# LETTER TO ODI
# TAB 1

# 02MY Sportage Cooling Fan Crack, Separation Reconstruction Testing Report

2006. 12. 06

KMC Quality
Assurance Team 2

# 1. Test Introduction

- Purpose : Investigation on 02MY Sportage Cooling Fan Separation
- Date and Location : '06. 11/6 ~ 11/30, Hwasung R&D testing facility/GMB testing facility
- Test Method : Install artificially cracked fans in test vehicle to duplicate actual crack conditions (partial separation).
- Test Vehicle : Sportage in KMC's custody
- Testing Items :

▷ Evaluate driver's recognition of fan failure

- assess extent of noise and vibration during each cracked fan blade separation.

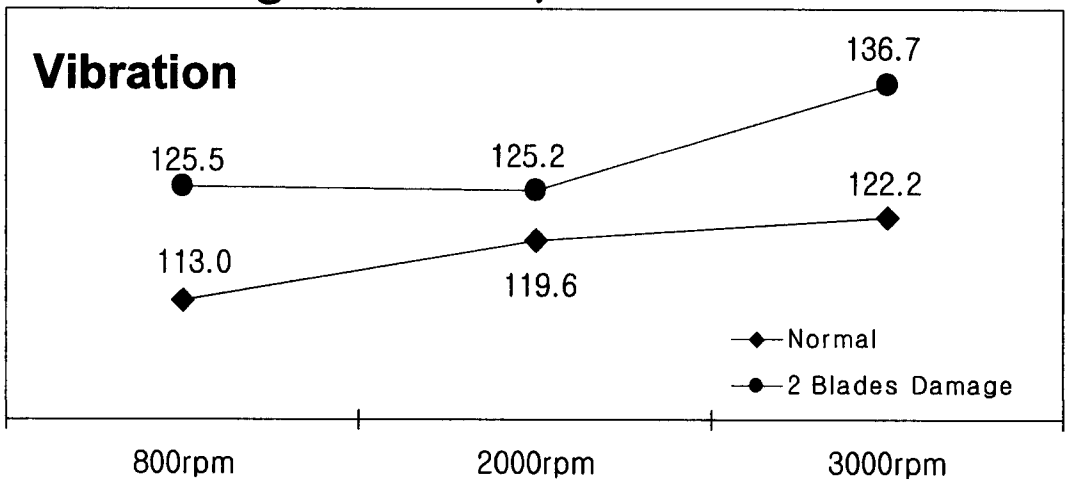
▷ Evaluate directional angle of separating fan blades and resulting damage to other engine parts.

- testing done at various rpm levels (by engine rpm)

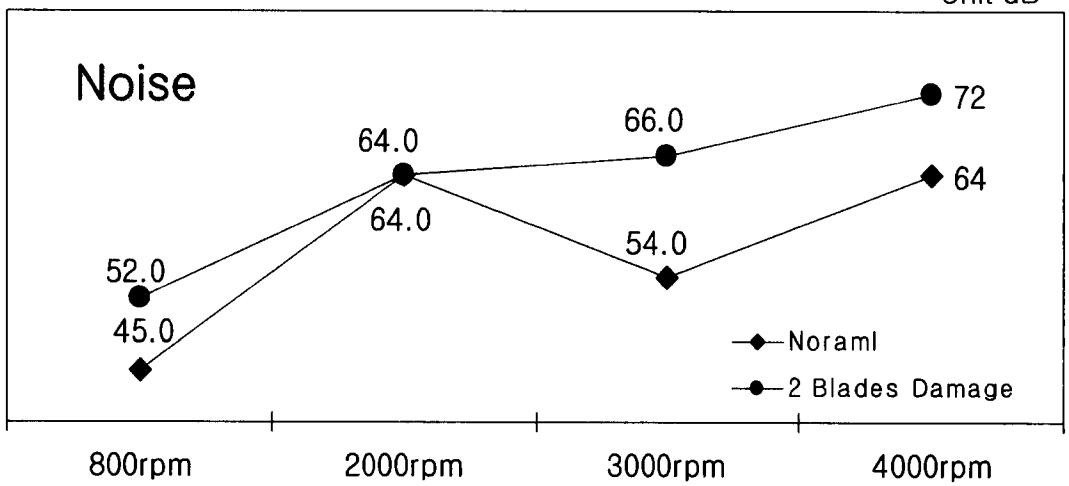
# 2. Test Reports

## 1) Damaged Cooling Fan's effect on steering wheel's vibration and noise (Non-Driving Condition)

Unit dB




Unit dB




Damaged cooling fan blades
(Two Blades)
increases steering wheel
vibration and noise.
Driver can recognize
the condition.

▶ At 3,000 rpm condition
Vibration : 14.5 dB ↑
Noise : 12 dB ↑ b

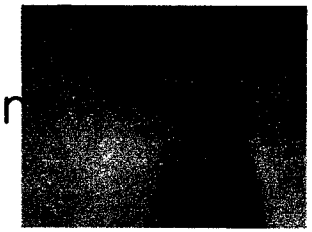
Video Attached

# 2. Test Result

2) Directional angle of separating fan blades and resulting damage to other engine components. (Driving Condition and Non-Driving Condition)

**Test Condition**

▶ Install used cooling fan add addition cracks



▶ Driving condition: engine rpm range (1,000~4,000 rpm)
cooling fan ON

▶ Non-Driving condition: engine rpm range (800~2,500 rpm)
cooling fan ON

**Test Result**

▶ Cooling Fan Damage Condition

| | Engine rpm | Happen |
|---|---|---|
| Driving | 3,000 | Damage 1 Fan |
| Non-Driving | 2,500 | 8 Fans Individual fans damaged one at a time |

▶ Damaged fan blade causes a, "doo doo dook" noise and vibration on steering wheel (driving condition)

▶ Damaged fan blade hits Shroud Panel and falls to the ground
- No radiator damage (No coolant leaking)

## 2. Test Result

3) Directional angle of separating fan blades and resulting damage to other engine parts. (Fan Assembly Condition)

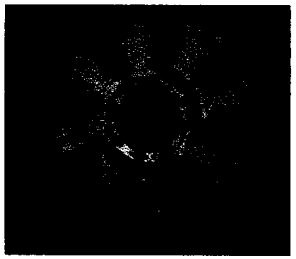
**Test Condition**

▶ Install cooling fan to test machine with induced cracks similar to those reflected on used parts

▶ Tested at 2,500 rpm condition. (normal cooling fan assembly condition is 1600 rpm)

**Test Result**

▶ Of the 8 fan blades, 4 separated



▶ The 4 separated blades hit Shroud Panel: 2 on top, 1 on side, 1 on bottom; then fell to the ground

▶ No evidence of damage to the front area (radiator direction )

## 3. Test Opinion

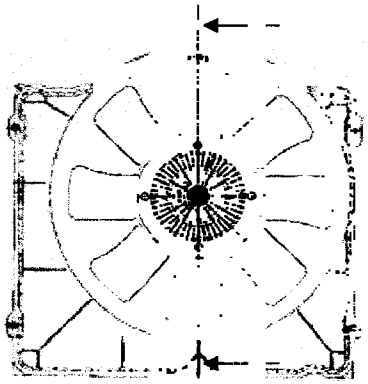
▣ Driver can recognize fan separation condition by noise and vibration. Even if ignored, driver may notice a rise in the temperature gauge.

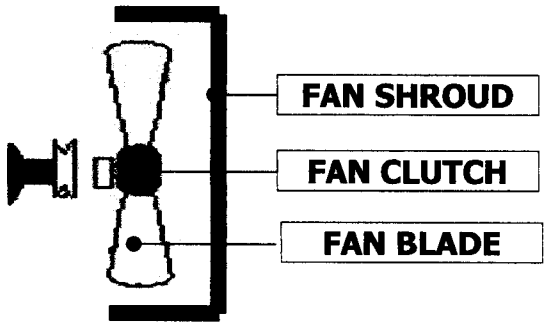
▣ If driver fails to recognize these conditions, engine overheating will occur.

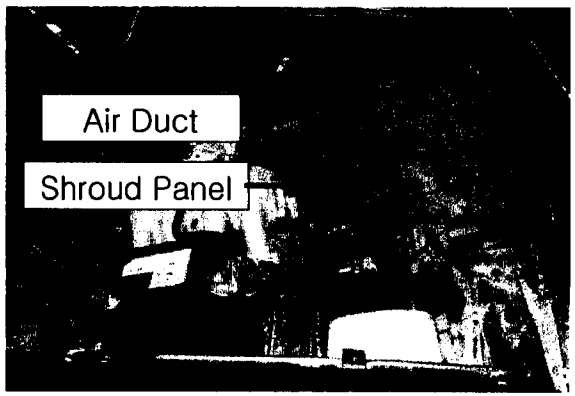
# 3. Test Opinion

▣ If fan blade separation occurs during repair (Engine ON), the fan blade will hit the Shroud Panel or other engine components before falling to the ground.

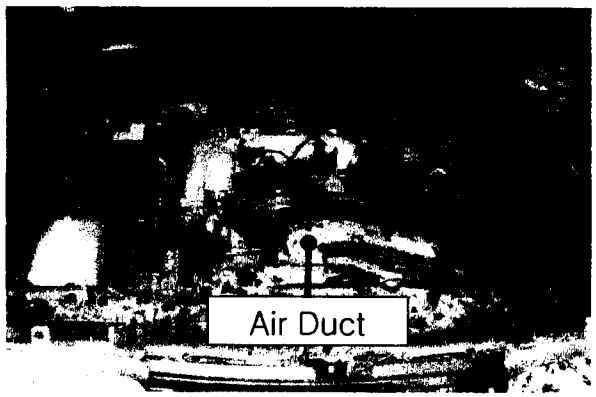
- Test results show that the blade hits Shroud Panel and falls to the ground



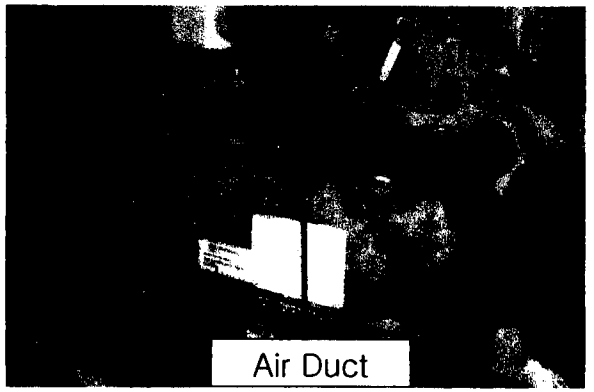



Right Side




Front

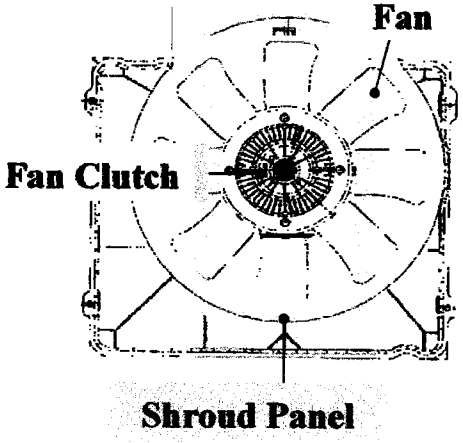


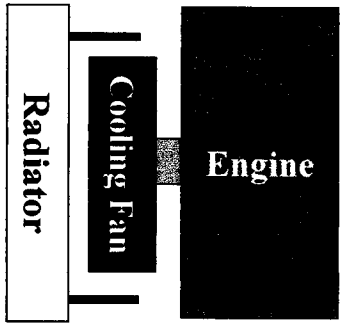

Left Side

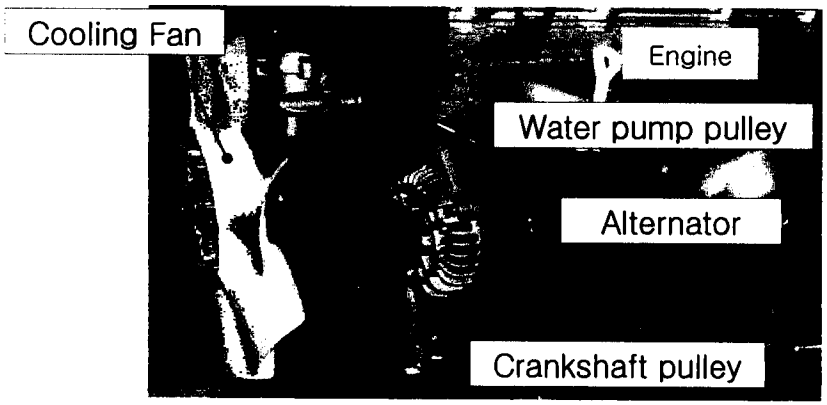
Supplement

# ▣ Cooling Fan Structure and Its Operation

## Location



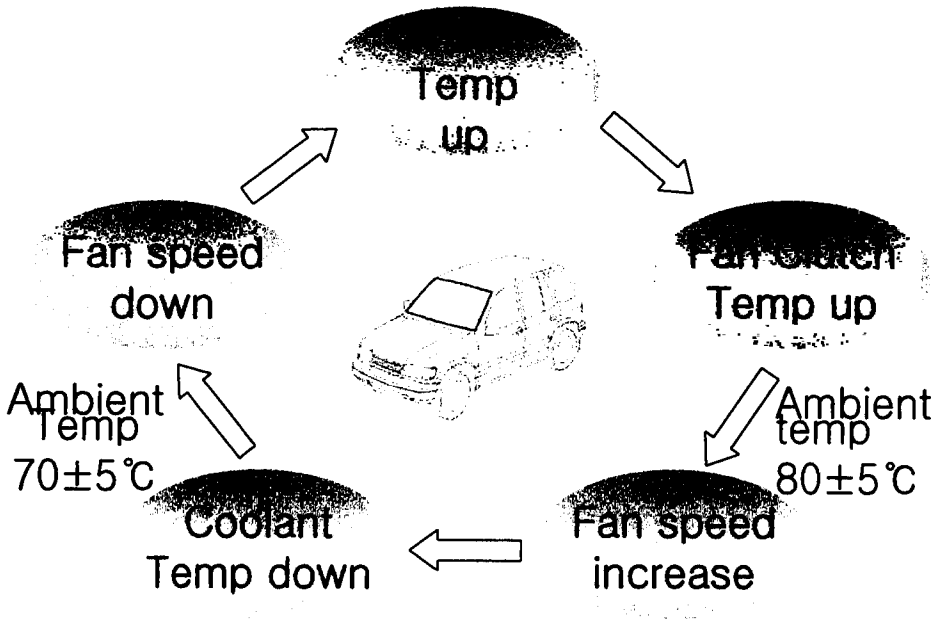




## Operation

▷ Powered by Water Pump pulley, Fan Clutch controls Fan Speed based on ambient temperature from radiator

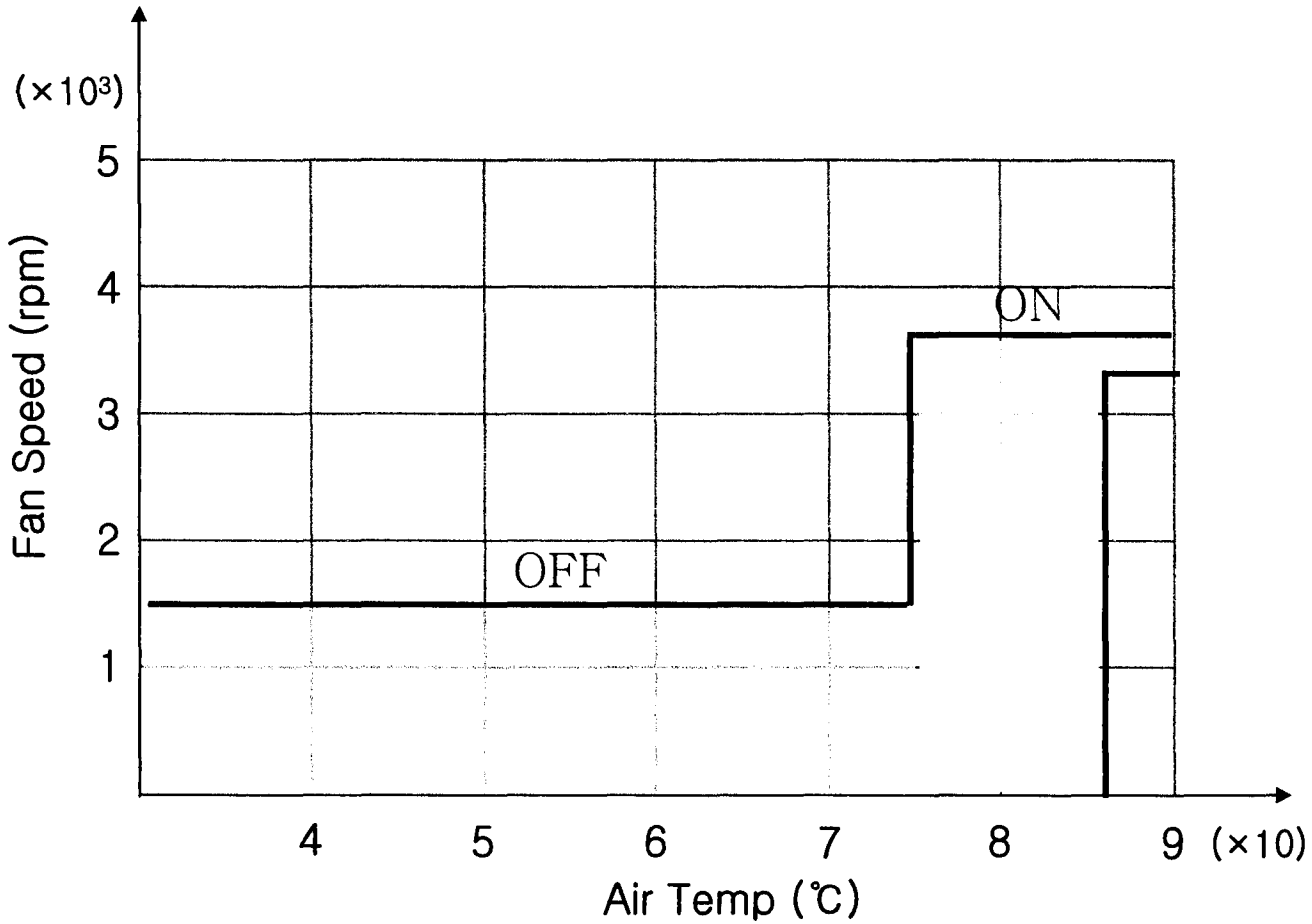
▷ When engine is OFF, fan motor is always OFF (mechanical type)



Supplement

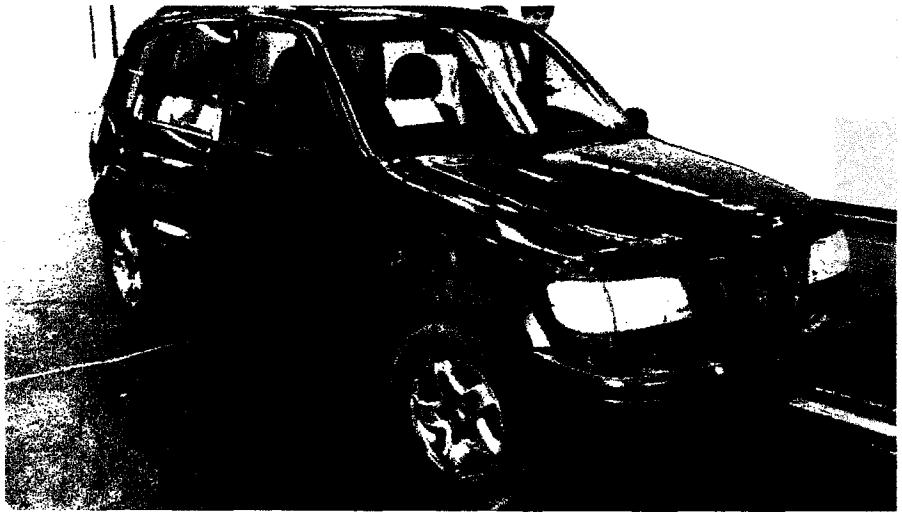
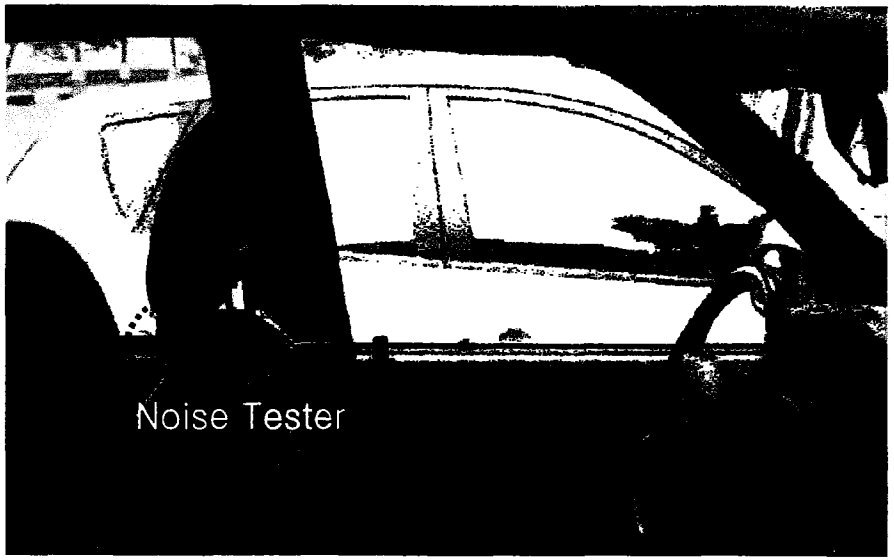
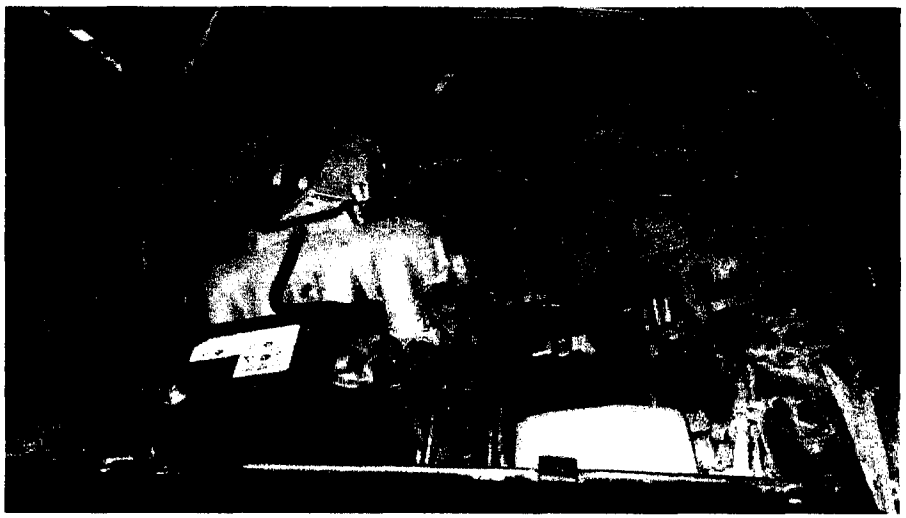
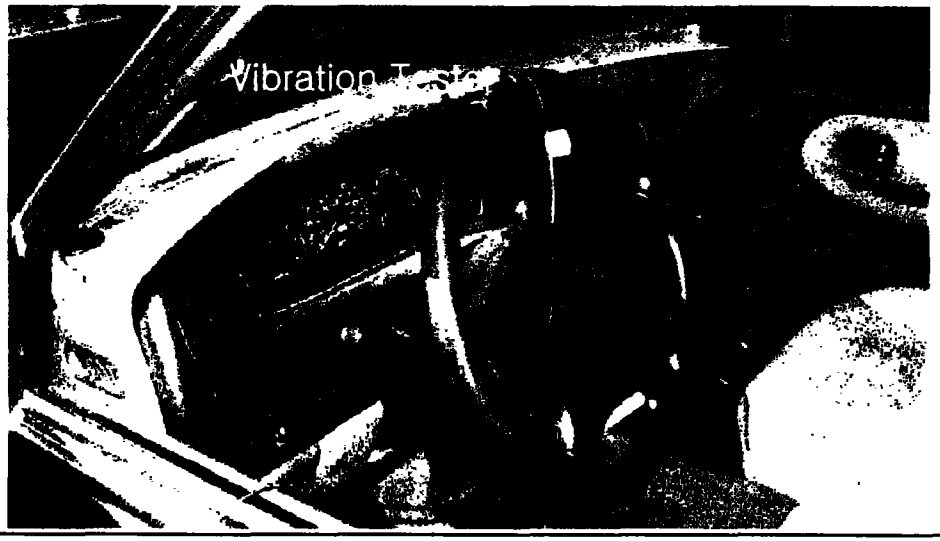
## ▣ Operating Condition of Cooling Fan Assembly

| Shaft Speed | Ambient Temp | | Fan Speed | Hysteresis |
|---|---|---|---|---|
| 4,200 rpm | ON | 80 ± 5 ℃ | 3,500 ± 100 rpm | ≤ 10 ℃ |
| | OFF | - | 1,400 rpm (Max) | |

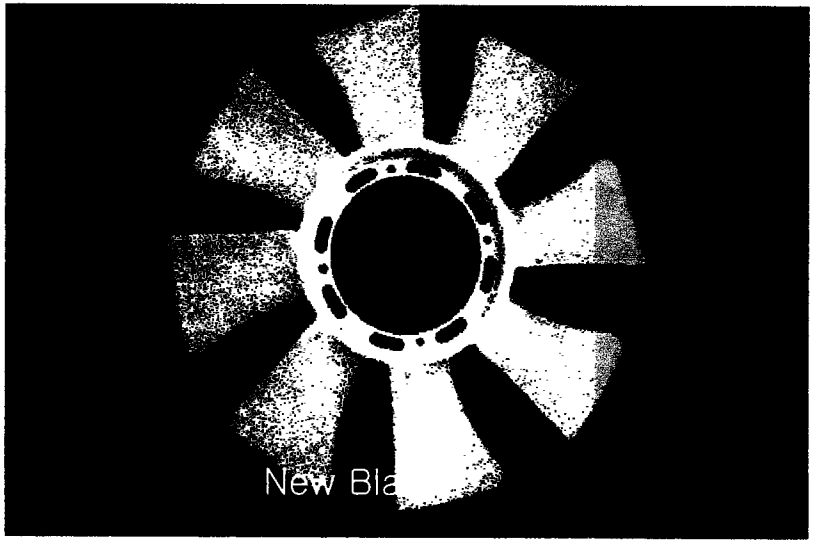


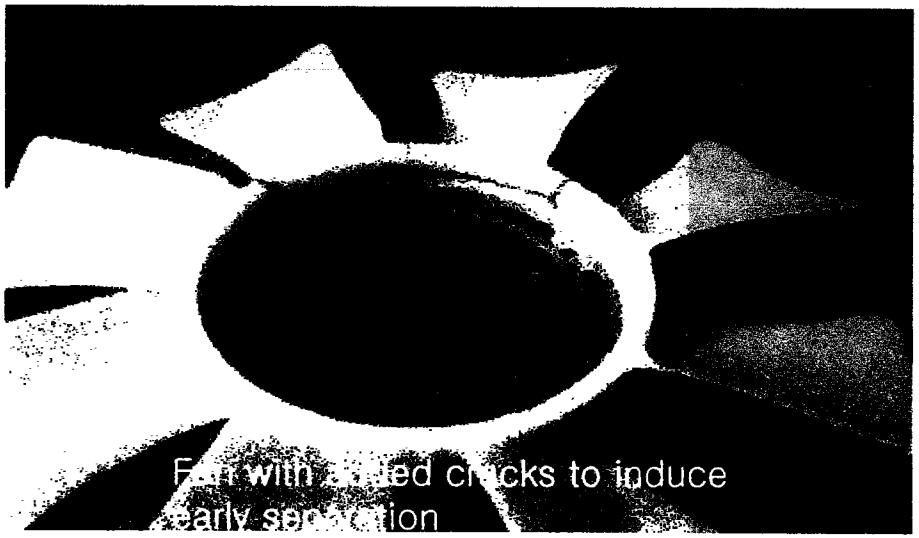
## ▣ Test Photos

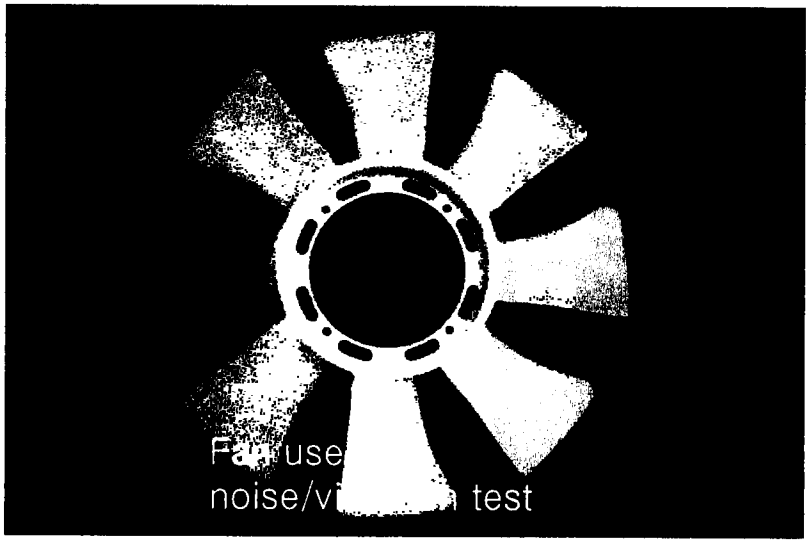
Supplement

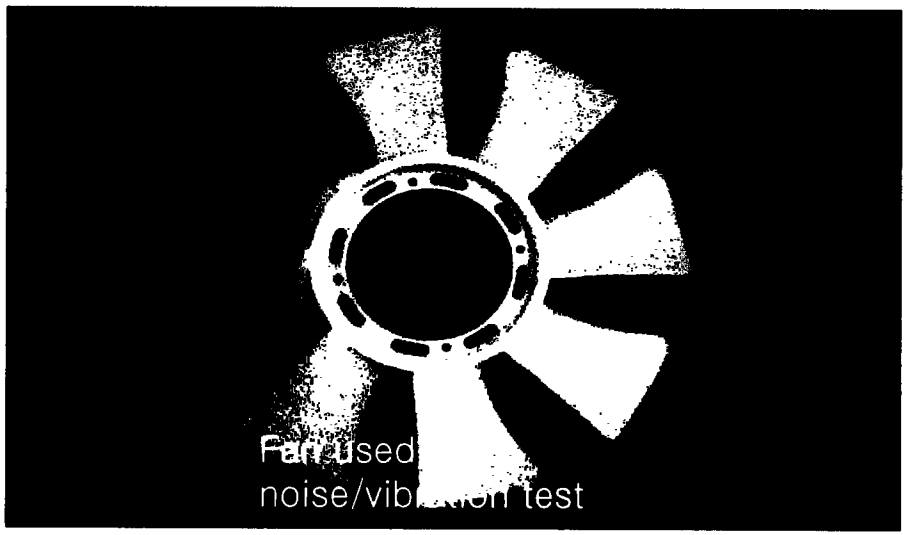
| Test Vehicle | Measuring Equipments |
| --- | --- |
|  |   |
|  |   |

## Testing Sample (Blades)

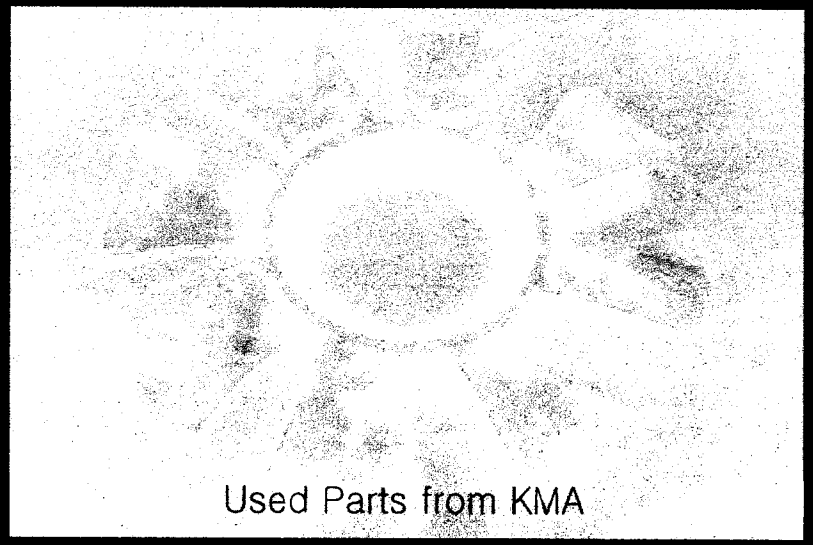


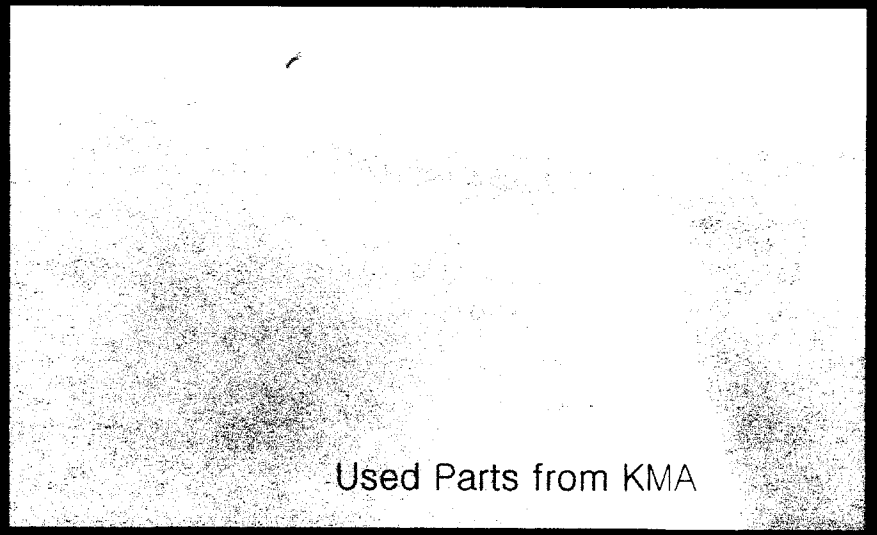



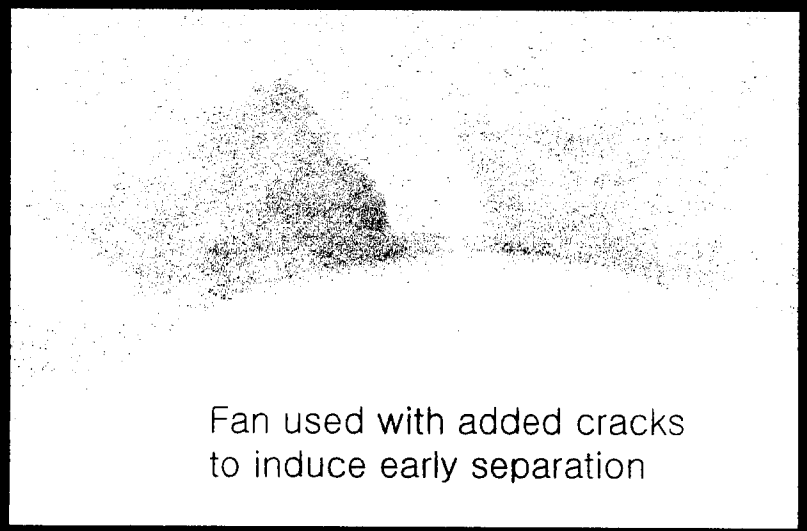
## Testing Sample (Blade)



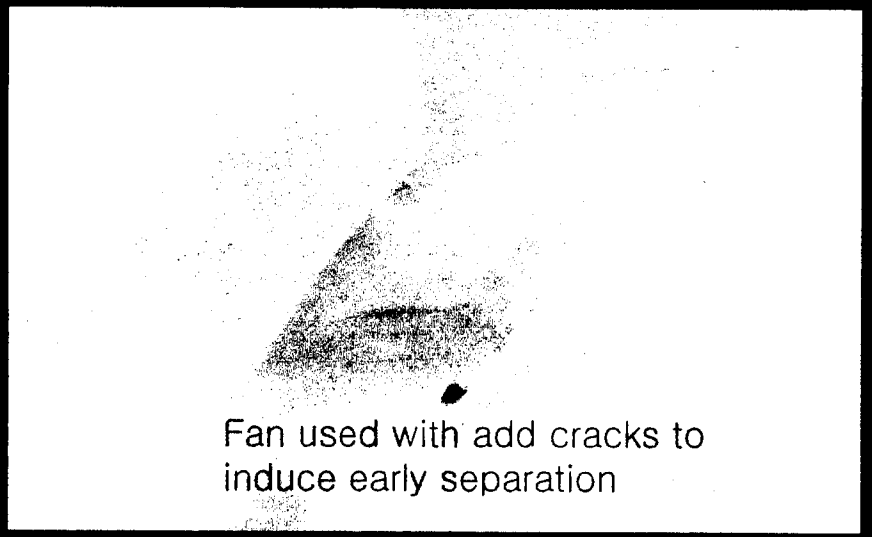
Used Parts from KMA



Used Parts from KMA



Fan used with added cracks
to induce early separation



Fan used with add cracks to
induce early separation

# ◈ Test Report ◈

| Team | Function T 3, Noise Vib Gr. | | M No. | - | ※ Rep | - |
|---|---|---|---|---|---|---|
| Reporter | J.H Han ☎ 7032 | | Date | 2006. 11. 1 | ※ M/Fno | -※Original No.- |
| Title | 2002MY Sportage Cooling Fan Damage NVH evaluation | | | | | |
| Drawing # | - | | | | Parts | - |
| Project. No. | Development | E/G | T/M | BODY | Material | Method | TDP-Function-01-01-02 idle Vibration testing |
| - | MP | Gasoline 2000cc | - | - | - | | |
| Test Date | 2006. 10. 20 | | | | | Vendor | - |
| Distribution | QA2, Design Improvement 2,Testing3, Quality Strategy ,Oversea Service 1/2 | | | | | Attachement | None |

## 1. Purpose and Methods

- Evaluate the effect of North America 2002MY Sportage cooling fan blades separation on NVH
- Comparative evaluation after fan blade separation (Intact fan/ 1 blade separation / 2 blade separation)

## 2. Conclusion

☑ Vibration increase significantly

→ Lay person can recognize it

## 3. Test Result

- Steering Wheel Vibration (unit: dB)

| | Idle | 2000 rpm | 3000 rpm |
|---|---|---|---|
| Intact | 113.0 | 119.6 | 122.2 |
| 1 Blade Separation | 115.0 | 124.9 | 124.2 |
| 2 Blade Separation | 125.5 | 125.2 | 136.7 |

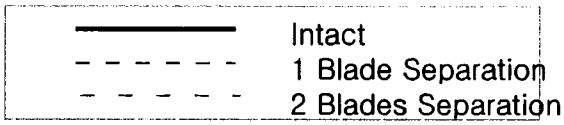
## 4. Testing Condition

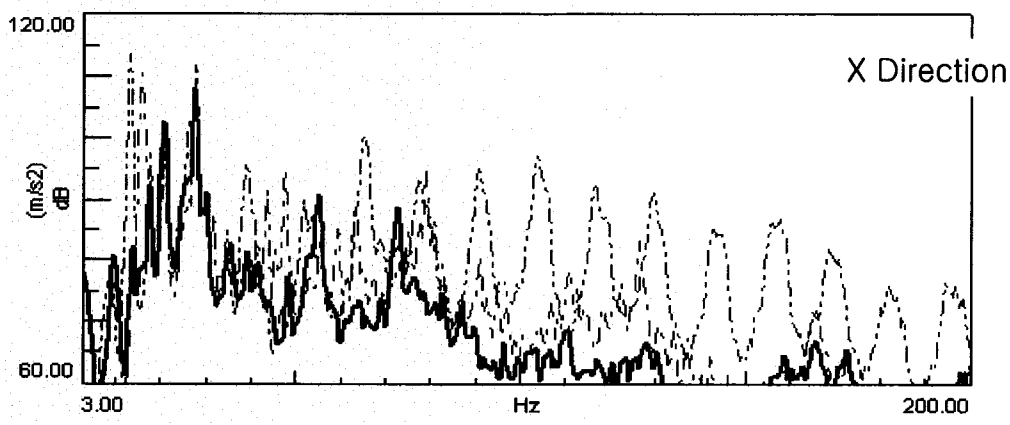
1) Vehicle : Sportage KNDJB7233W5 556328 (2WD M/T)
2) Location : Hwasung Plant
3) Tester : JH Han

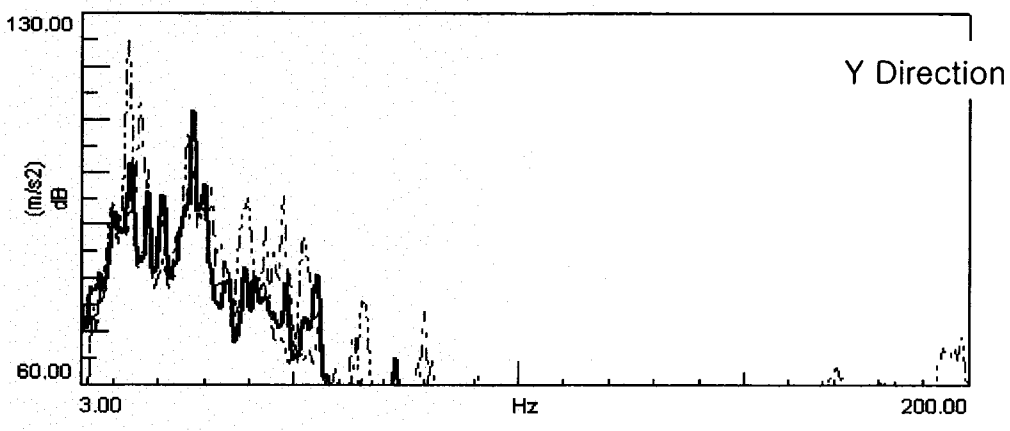
<Note> 1.※ Must be filled by tech management team
2. Must put control number
3. Color photos and video are managed separately

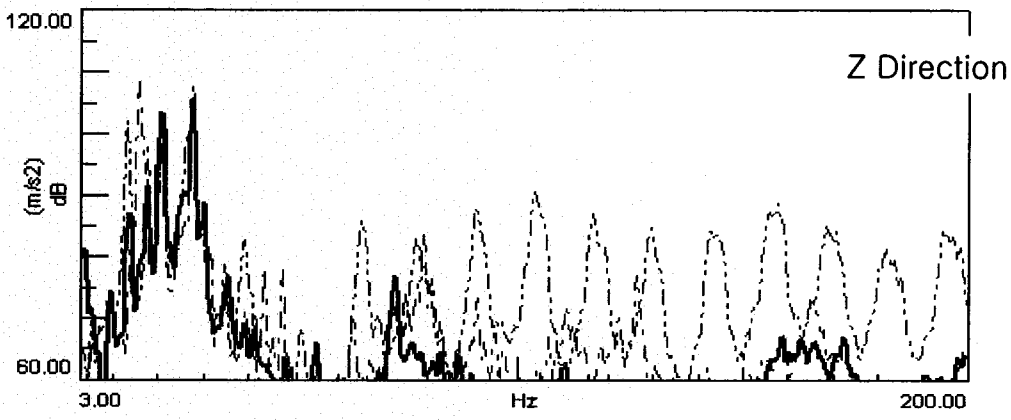
| Draft | Evaluation | Approval |
|---|---|---|
| | | |
| / | / | / |

## ▣ IDLE

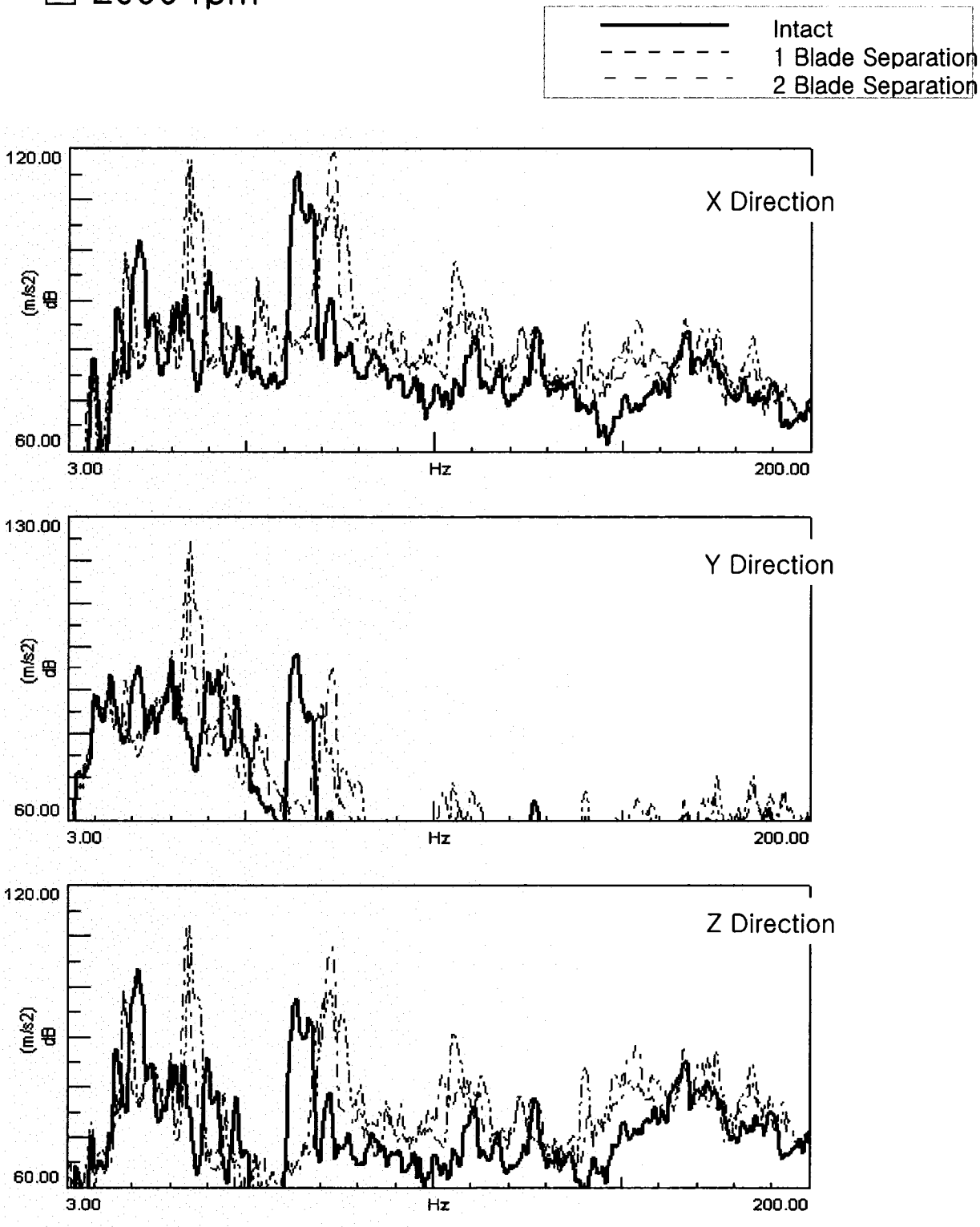

Intact
1 Blade Separation
2 Blades Separation


120.00
(m/s2)
dB
60.00
X Direction
3.00
Hz
200.00

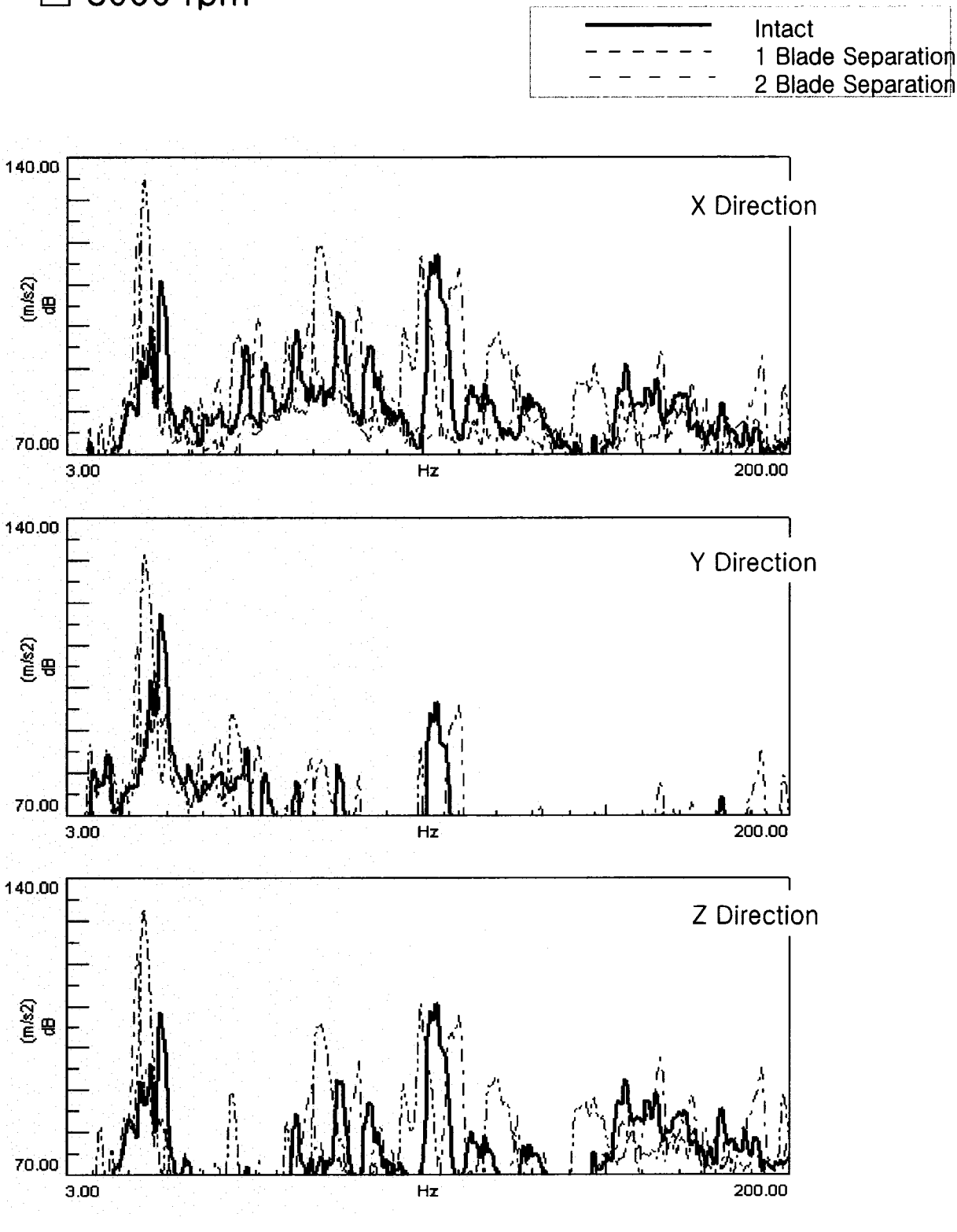

130.00
(m/s2)
dB
60.00
Y Direction
3.00
Hz
200.00


120.00
(m/s2)
dB
60.00
Z Direction
3.00
Hz
200.00

## ▣ 2000 rpm

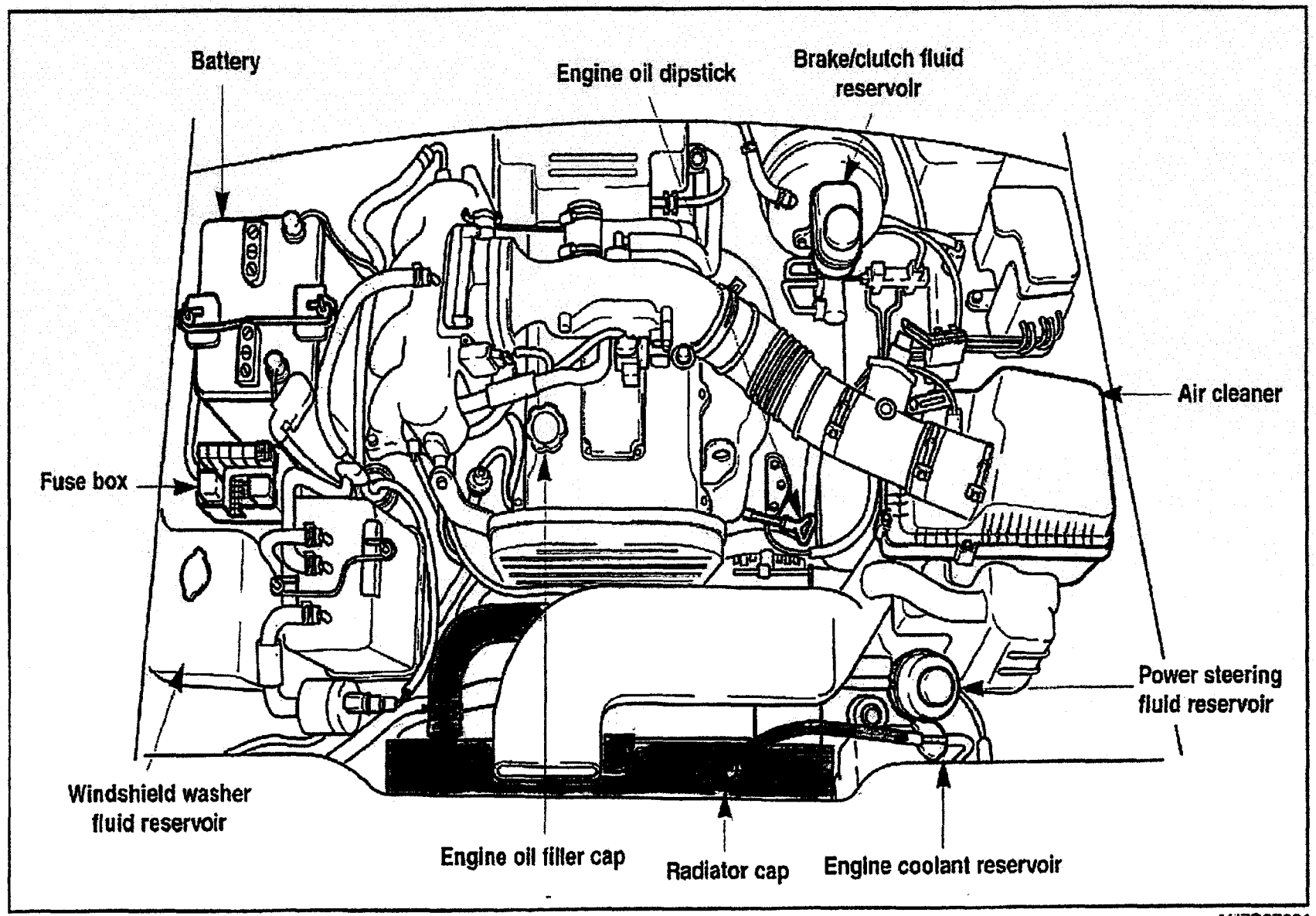

Intact
1 Blade Separation
2 Blade Separation
120.00
(m/s2)
dB
60.00
3.00
Hz
200.00
X Direction
130.00
(m/s2)
dB
60.00
3.00
Hz
200.00
Y Direction
120.00
(m/s2)
dB
60.00
3.00
Hz
200.00
Z Direction

## ▣ 3000 rpm


Intact
1 Blade Separation
2 Blade Separation
140.00
70.00
(m/s2)
dB
X Direction
3.00
Hz
200.00
140.00
70.00
(m/s2)
dB
Y Direction
3.00
Hz
200.00
140.00
70.00
(m/s2)
dB
Z Direction
3.00
Hz
200.00

# PE06-042
# HYUNDAI
# 12/22/06
# LETTER TO ODI
# TAB 2

# Engine Compartment

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