

REPORT NUMBER 104-GTL-06-001

# SAFETY COMPLIANCE TESTING FOR FMVSS NO. 104 WINDSHIELD WIPING AND WASHING SYSTEMS

HYUNDAI MOTOR COMPANY  
2006 HYUNDAI SONATA, PASSENGER CAR  
NHTSA NO. C60502

GENERAL TESTING LABORATORIES, INC.  
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COLONIAL BEACH, VIRGINIA 22443



JUNE 16, 2006

FINAL REPORT

PREPARED FOR

U. S. DEPARTMENT OF TRANSPORTATION  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
ENFORCEMENT  
OFFICE OF VEHICLE SAFETY COMPLIANCE  
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## SECTION 1

### PURPOSE OF COMPLIANCE TEST

#### 1.0 PURPOSE OF COMPLIANCE TEST

A 2006 Hyundai Sonata Passenger Car was subjected to Federal Motor Vehicle Safety Standard (FMVSS) No. 104 testing to determine if the vehicle was in compliance with the requirements of the standard. All tests were conducted in accordance with NHTSA, Office of Vehicle Safety Compliance (OVSC) Laboratory Procedure, TP-104-08 dated 26 June 1996 and General Testing Laboratories, Inc. (GTL) Test Procedure, TP-104-08A dated 4 April 1997.

1.1 The test vehicle was a 2006 Hyundai Sonata Passenger Car. Nomenclature applicable to the test vehicle are:

A. Vehicle Identification Number: KMHET46C96A162388

B. NHTSA No.: C60502

C. Manufacturer: HYUNDAI MOTOR COMPANY

D. Manufacture Date: OCT/31/05

#### 1.2 TEST DATE

The test vehicle was subjected to FMVSS No. 104 testing on April 26-27, 2006.

## SECTION 2

### COMPLIANCE TEST PROCEDURE AND SUMMARY OF RESULTS

#### 2.0 GENERAL

The 2006 Hyundai Sonata 4-door passenger car, NHTSA No. C60502 was subjected to FMVSS No. 104 tests on April 26-27, 2006. The selected portions of FMVSS No. 104 tests used were as amplified in the following subparagraphs. The test vehicle was positioned in the test system with three water spray nozzles suspended in line with the center of the longitudinal axis of the windshield and horizontal left/right center of the windshield to provide an even distribution of spray to the entire windshield. The height of the nozzles was approximately 22 inches above the glazing surface.

#### 2.1 WIPER FREQUENCY TEST

The wiper frequency test was performed with the engine operating and with a minimum of 50 cubic inches per minute of water from the spray nozzles. The wiper frequency was measured at the low and high wiper speed settings with the engine operating at idle RPM and 2,000 RPM.

#### 2.2 WIPED AREA TEST

The test was conducted with the windshield wiper system operating at the high speed setting, engine at idle RPM and the spray nozzles spraying water at a minimum of 50 cubic inches per minute. The wiper blade wipe pattern was outlined on the glazing surface and then transferred to a windshield pattern. The wiped area was determined for areas A, B and C from the windshield pattern.

#### 2.3 CAPABILITY TEST

The windshield glazing surface was coated with a mixture of water and fine grade test dust. Within 15 seconds following application of the water-dust mixture, the windshield wiper and washing system was activated in the high speed mode for ten complete cycles. The vehicle's engine was operating at idle RPM. The cleared areas of the windshield were marked on the inside windshield surface. After ten complete cycles the system was deactivated and the wiped area transferred to a windshield pattern.

The glazing surface was cleaned and dried. The water dust mixture was re-applied and the test repeated.

The windshield patterns were used subsequently to determine the cleared area percentages.

#### 2.4 SUMMARY OF RESULTS

Based on the test performed, the test vehicle's windshield wiping and washing system appears to meet the requirements of FMVSS 104.

## SECTION 3

## COMPLIANCE TEST DATA

3.0 TEST RESULTS

The following data sheets document the results of testing on the 2006 Hyundai Sonata.

SUMMARY OF DATA  
FMVSS 104, WINDSHIELD WIPING AND WASHING SYSTEMS

VEH. MOD YR/MAKE/MODEL/BODY: 2006 HYUNDAI SONATA PASSENGER CAR  
 VEH. NHTSA NO: C60502; VIN: KMHET46C96A162388  
 VEH. BUILD DATE: OCT/31/05 TEST DATE: APRIL 26-27, 2006  
 TEST LABORATORY: GENERAL TESTING LABORATORIES  
 OBSERVERS: GRANT FARRAND, JIMMY LATANE

WIPER TYPE: 2 SPEED ELECTRIC WITH DELAY & MIST

WASHER TYPE: HIGH PRESSURE ELECTRIC WITH 6 SPRAY NOZZLES

WINDSHIELD AREAS: A = 1141.7 in<sup>2</sup> B = 790.3 in<sup>2</sup> C = 263.1 in<sup>2</sup>

MANUFACTURER'S WINDSHIELD PATTERN USED: Yes X No     

ACCESSIBILITY:

- (1) Washer Control Accessible: Yes X No       
 (2) Wiper Control Accessible: Yes X No       
 (3) Washer Reservoir Filler Accessible: Yes X No

DESCRIBE UNUSUAL FEATURES OF WIPING AND WASHING SYSTEMS:

PERFORMANCE:

TEST	PASS	FAIL
WIPER FREQUENCY	X	
WIPED AREA	X	
WASHER CAPABILITY	X	

RECORDED BY: \_\_\_\_\_

DATE: 05/01/06

APPROVED BY: \_\_\_\_\_



FREQUENCY TEST DATA  
FMVSS 104 – WINDSHIELD WIPER SYSTEM

VEH. MOD YR/MAKE/MODEL/BODY: 2006 HYUNDAI SONATA PASSENGER CAR

VEH. NHTSA NO: C60502; VIN: KMHET46C96A162388

VEH. BUILD DATE: OCT/31/05 TEST DATE: APRIL 26, 2006

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE

Water Hardness: 7.0 grains/gallon (12 max.); Date Certified: 04/26/06

Water Spray Flow Rate: 65.0 in<sup>3</sup>/min. (specified range = 50 to 100 in<sup>3</sup>/min.)

Ambient Air Temp.: 69 °F (50-100°F); Water Temp.: 63 °F (100°F max.)

Manufacturer's Recommended Engine Idle Speed: 650 rpm

RUN 1, MAXIMUM WIPER FREQUENCY TEST:

TIME	ENGINE SPEED	TOTAL CYCLES	AVG. CYCLES/MIN. (45 MINIMUM)
1 <sup>ST</sup> 3 minutes	<u>650</u> (idle ± 50 rpm)	217	72.3
2 <sup>ND</sup> 3 minutes	<u>2000</u> (2000 rpm ± 50 rpm)	218	72.7

Frequency at least 45 cycles/minute regardless of engine speed: Yes X No    

RUN 2, LOWER WIPER FREQUENCY TEST:

TIME	ENGINE SPEED	TOTAL CYCLES	AVG. CYCLES/MIN. (20 MINIMUM)
1 <sup>ST</sup> 3 minutes	<u>650</u> (idle ± 50 rpm)	138	46
2 <sup>ND</sup> 3 minutes	<u>2000</u> (2000 rpm ± 50 rpm)	138	46

Highest and lower frequency differ by at least 15 cycles/minute, and lower frequency is at least 20 cycles/minute regardless of engine speed: Yes X No    

REMARKS:

RECORDED BY: \_\_\_\_\_

DATE: 04/26/06

APPROVED BY: \_\_\_\_\_

WIPE AREA TEST DATA  
FMVSS 104 – WINDSHIELD WIPER SYSTEM

VEH. MOD YR/MAKE/MODEL/BODY: 2006 HYUNDAI SONATA PASSENGER CAR

VEH. NHTSA NO: C60502; VIN: KMHET46C96A162388

VEH. BUILD DATE: OCT/31/05; TEST DATE: APRIL 26, 2006

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE

Air Temperature in test area = 69 °F (specified range of 50 to 100°F)

Air Velocity at windshield = .5 mph (specified range of 0 to 1 mph)

Engine speed = 650 rpm (manufacturer's recommended idle ± 50 rpm)

Temperature of water spray = 63 °F (100° F maximum)

Water spray flow rate = 65 in<sup>3</sup>/min. (specified range of 50 to 100 in<sup>3</sup>/min.)

Windshield wiper frequency = 72 cycles/min. (45 cpm minimum)

TEST RESULTS:

PERCENT WIPED				
WINDSHIELD AREA	ACTUAL	REQUIRED	PASS	FAIL
A	93.4%	80%	X	
B	95.0%	94%	X	
C	100%	99%	X	

REMARKS:

RECORDED BY: \_\_\_\_\_

DATE: 05/01/06

APPROVED BY: \_\_\_\_\_

CAPABILITY TEST DATA  
FMVSS 104 – WINDSHIELD WASHER SYSTEM

VEH. MOD YR/MAKE/MODEL/BODY: 2006 HYUNDAI SONATA PASSENGER CAR

VEH. NHTSA NO: C60502; VIN: KMHET46C96A162388

VEH. BUILD DATE: OCT/31/05; TEST DATE: APRIL 26, 2006

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE

Air Temperature in test area = 69 °F (specified range of 70 to 80°F)

Washer reservoir fluid temperature = 75 °F (specified range of 70 to 80°F)

Air Velocity at windshield = .5 mph (specified range of 0 to 1 mph)

Engine speed = 650 rpm (manufacturer's recommended idle ± 50 rpm)

Number of windshield washer nozzles on the vehicle = 6

Windshield washer system activation coordinated with components of the wiper system:

Yes X No     

TEST RESULTS:

CLEARED AREA PERCENTAGES						
WINDSHIELD AREA	TEST 1	TEST 2	AVG	REQ'D*	PASS	FAIL
A	93.9	93.9	93.9	75%	X	
B	95.3	95.3	95.3	75%	X	
C	100	100	100	75%	X	

\*NOTE FOR REFERENCE ONLY: SAE 942b, revised Jul72, recommends capability to clear 80% of the total wash area and 90% of the wash area included in AREA C.

REMARKS:

RECORDED BY: \_\_\_\_\_

DATE: 04/26/06

APPROVED BY: \_\_\_\_\_

SECTION 4  
INSTRUMENTATION AND EQUIPMENT LIST

TABLE 1 - INSTRUMENTATION & EQUIPMENT LIST

EQUIPMENT	DESCRIPTION	MODEL/ SERIAL NO.	CAL. DATE	NEXT CAL. DATE
TIMER	ACCU-SPLIT	ACT2	04/06	04/07
TEMPERATURE READOUT	OMEGA	43P	04/06	04/07
TEMPERATURE RECORDER	OMEGA	CT91	04/06	04/07
SPRAY SYSTEM	GTL	N/A	BEFORE USE	BEFORE USE
AIR VELOCITY METER	OMEGA	HHF-616	04/06	04/07
CYCLE COUNTER	GTL	GTL	BEFORE USE	BEFORE USE
SOFT WATER	N/A	N/A	04/06	04/07
TACHOMETER	MONARCH	ACT-3	04/06	04/07
TEST DUST	AC	GM FINE	CALIBRATED DUST	CALIBRATED BY VENDOR*
EVENT RECORDER	COMPUTER	GEO1	BEFORE USE	BEFORE USE

\*AC Inspection #503, Batch #1943, Measured with particle size roller analyzer.

SECTION 5  
PHOTOGRAPHS



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.1  
LEFT SIDE VIEW OF VEHICLE



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.2  
RIGHT SIDE VIEW OF VEHICLE



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

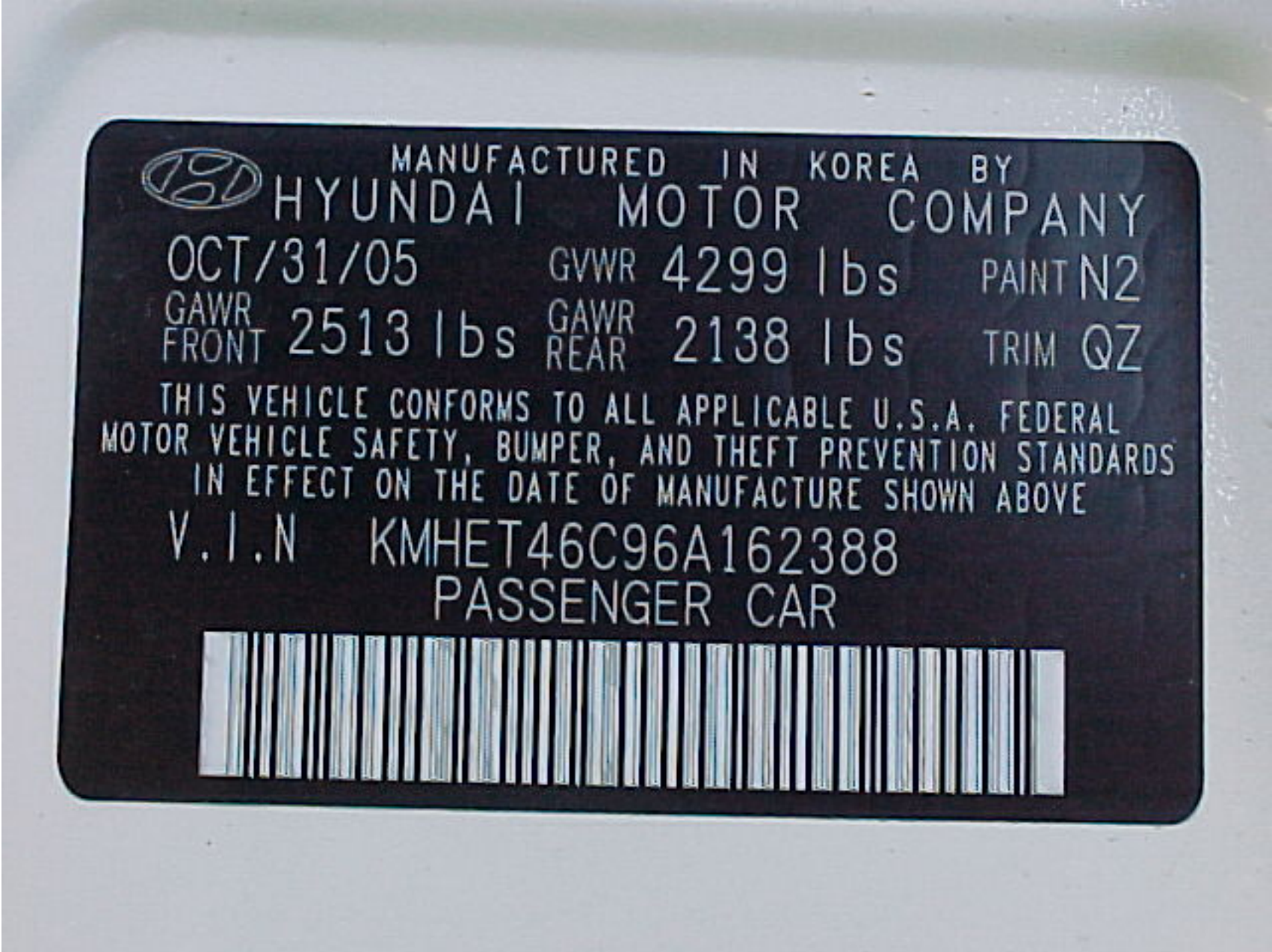
FIGURE 5.3  
¾ FRONTAL VIEW FROM LEFT SIDE OF VEHICLE





2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.4  
¾ REAR VIEW FROM RIGHT SIDE OF VEHICLE



MANUFACTURED IN KOREA BY  
HYUNDAI MOTOR COMPANY

OCT/31/05 GVWR 4299 lbs PAINT N2  
GAWR FRONT 2513 lbs GAWR REAR 2138 lbs TRIM QZ

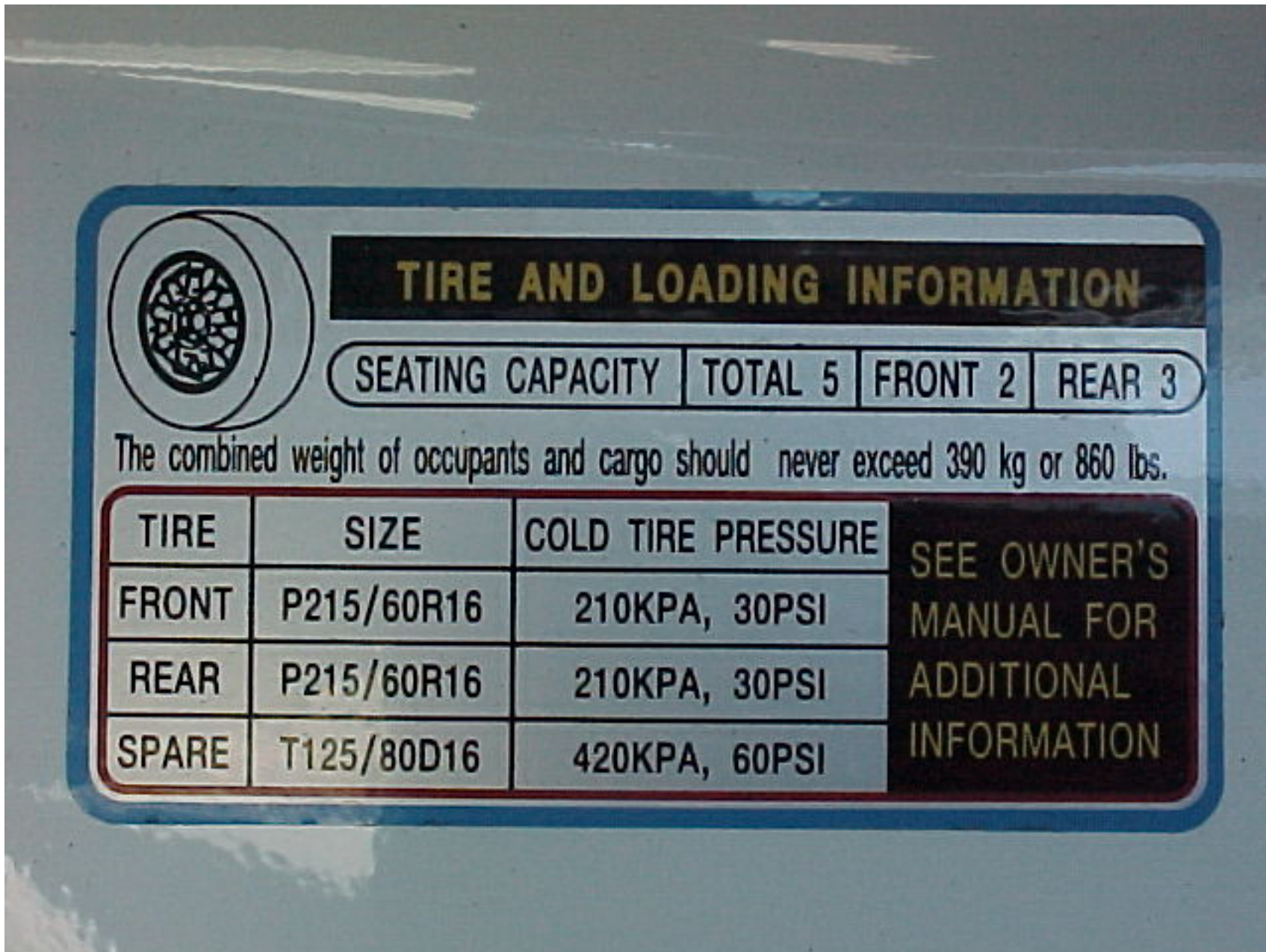
THIS VEHICLE CONFORMS TO ALL APPLICABLE U.S.A. FEDERAL  
MOTOR VEHICLE SAFETY, BUMPER, AND THEFT PREVENTION STANDARDS  
IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

V.I.N KMHET46C96A162388  
PASSENGER CAR



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.5  
VEHICLE CERTIFICATION LABEL



2006 HYUNDAI SONATA  
 NHTSA NO. C60502  
 FMVSS NO. 104

FIGURE 5.6  
 VEHICLE TIRE INFORMATION LABEL



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.7  
INSTRUMENTATION SET-UP



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.8  
EQUIPMENT SET-UP



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.9  
WIPED AREA TEST



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.10  
WIPED AREA TEST PATTERN



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.11  
CAPABILITY TEST #1 PRE-COATED WINDSHIELD





2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.12  
CAPABILITY TEST #1 IN PROGRESS



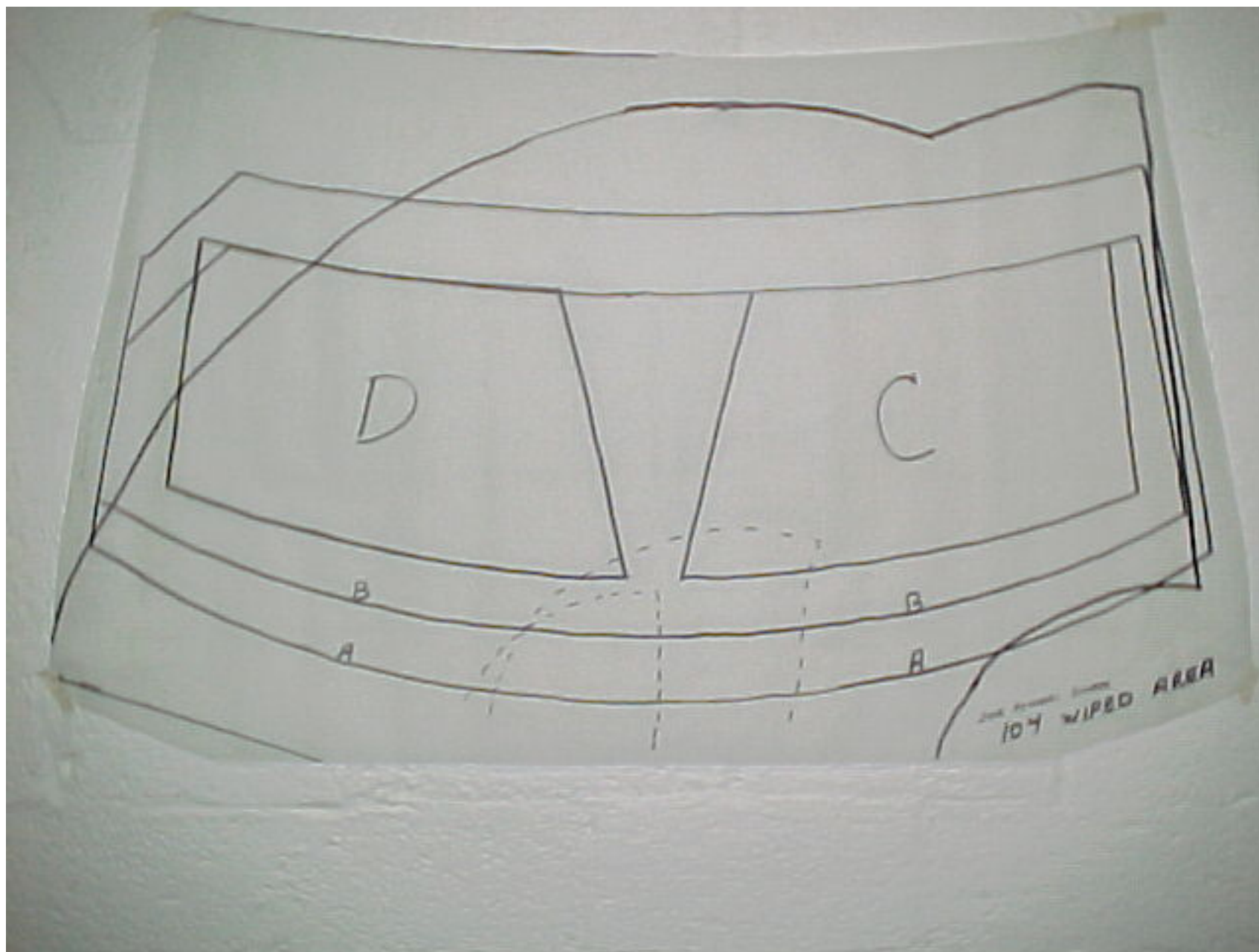
2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.13  
CAPABILITY TEST #2 PRE-COATED WINDSHIELD



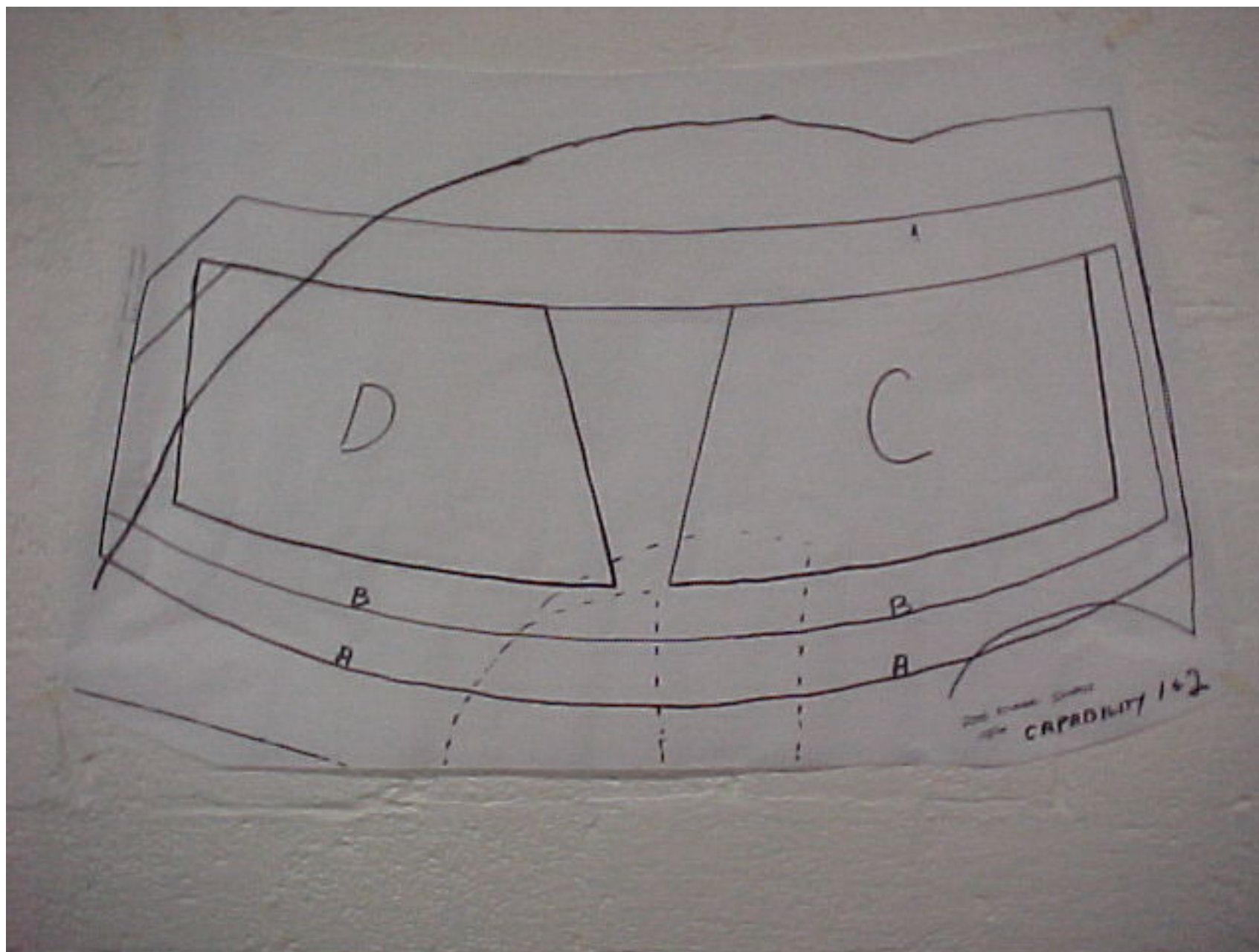
2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.14  
CAPABILITY TEST #2 IN PROGRESS



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.15  
WIPED AREA VELLUM PATTERN



2006 HYUNDAI SONATA  
NHTSA NO. C60502  
FMVSS NO. 104

FIGURE 5.16  
CAPABILITY TEST #1 & #2 VELLUM PATTERN

SECTION 6

OWNER'S MANUAL INFORMATION

FRONT FOG LIGHT SWITCH

B360B01L-AAT



B360B02NF

To turn on the front fog lights, place the switch in the "ON" position. They will light when the headlight switch is in the second position.

NOTE:

If you turn on the headlight high beams, the front fog lights will be turned off.

WINDSHIELD WIPER AND WASHER SWITCH

B350A01A-AAT



HNF2101-A

The windshield wiper switch has three positions:

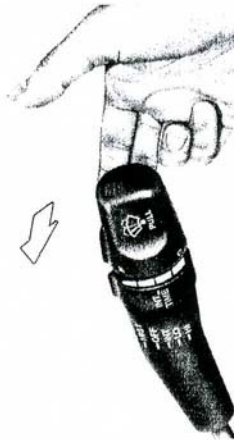
- 1. Intermittent wiper operation
- 2. Low-speed operation
- 3. High-speed operation

NOTE:

To prevent damage to the wiper system, do not attempt to wipe away heavy accumulations of snow or ice. Accumulated snow and ice should be removed manually. If there is only a light layer of snow or ice, operate the heater in the defrost mode to melt the snow or ice before using the wiper.

B350B01O-GAT

Windshield Washer Operation



HNF2105FA

To use the windshield washer, pull the wiper/washer lever toward the steering wheel. When the washer lever is operated, the wipers automatically make two passes across the windshield. The washer continues to operate until the lever is released.

NOTE:

- o Do not operate the washer more than 15 seconds at a time or when the fluid reservoir is empty.
- o In icy or freezing weather, be sure the wiper blades are not frozen to the glass prior to operating the wipers.
- o In areas where water freezes in winter, use windshield washer antifreeze.

HAZARD WARNING SYSTEM

65

B370A01A-AAT



B370A01NF-A

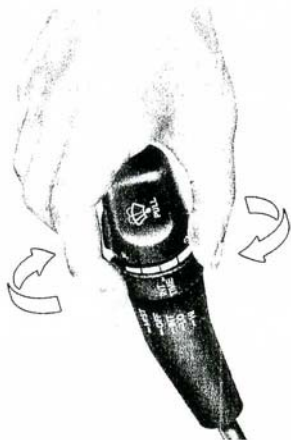
The hazard warning system should be used whenever you find it necessary to stop the car in a hazardous location. When you must make such an emergency stop, always pull off the road as far as possible.

The hazard warning lights are turned on by pushing in the hazard switch. This causes all turn signal lights to blink. The hazard warning lights will operate even though the key is not in the ignition.

To turn the hazard warning lights off, push the switch a second time.

B550C01NF-AAT

Adjustable Intermittent Wiper Operation



HNF2102-A

To use the intermittent wiper feature, place the wiper switch in the "INT" position. With the switch in this position, the interval between wipes can be varied from approximately 1 to 18 seconds by turning the interval adjuster barrel.

Mist Wiper Operation



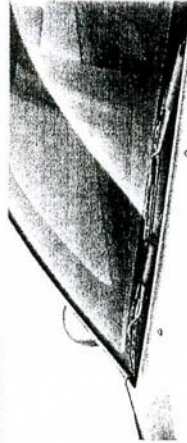
HNF2104-A

If a single wipe is desired to clear mist, push the windshield wiper and washer control lever upwards.



## WINDSHIELD WIPER BLADES

G080A02A-AAT



G080A01NF-A

The wiper blades should be carefully inspected from time to time and cleaned to remove accumulations of road film or other debris. To clean the wiper blades and arms, use a clean sponge or cloth with a mild soap or detergent and water. If the wipers continue to streak or smear the glass, replace them with genuine Hyundai replacement parts or their equivalent.



### CAUTION:

- Do not operate the wipers on dry glass. This can result in more rapid wear of the wiper blades and may scratch the glass.
- Keep the blade rubber out of contact with petroleum products such as engine oil, gasoline, etc.

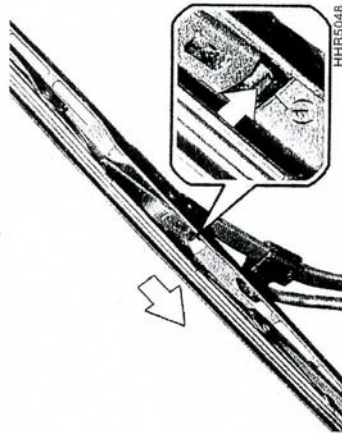
15

G080B01HR-GAT

### Replacing the Wiper Blades

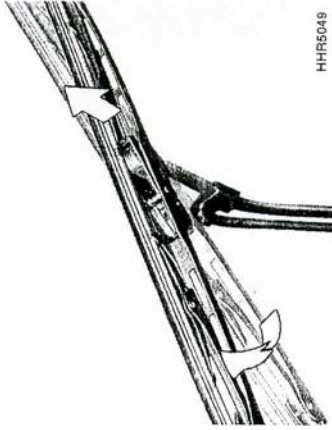
To replace the wiper blades, raise the wiper to the vertical position.

### To remove the wiper blade



HHR5048

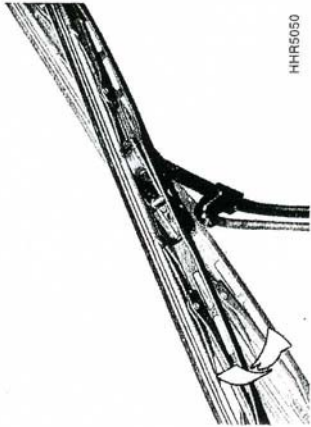
1. Push down the wiper blade with the locking clip (1) pressed to detach it from the wiper arm.



HHR5049

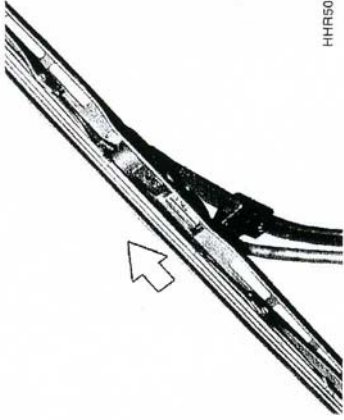
2. Raise the wiper blade lightly and pull it up.

To install the wiper blade



HHR5050

1. Put a new wiper blade onto the wiper arm and lower the wiper blade at the level of the wiper arm as shown in the drawing.



HHR5051

2. Pull up the wiper blade until you hear an audible "click" to engage in the end of the wiper arm.

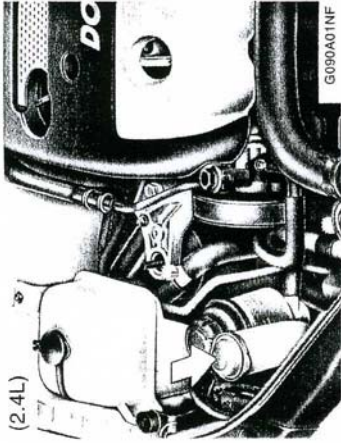
**NOTE:**

Do not allow the wiper arm to fall against the windshield.

**FILLING THE WASHER RESERVOIR**

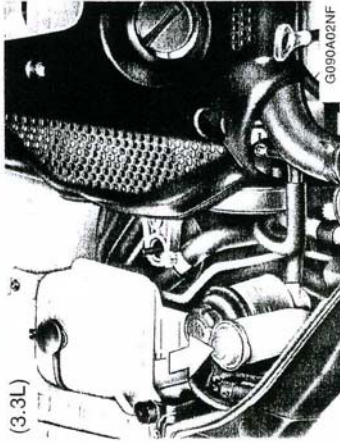
G090A02NF-AAT

(2.4L)



G090A01NF

(3.3L)



G090A02NF

The washer fluid reservoir supplies fluid to the windshield washer system.