DEVELOPMENT OF SIDE IMPACT AIR BAG SYSTEM FOR HEAD CHEST PROTECTION

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Paper Number 98-S8-O-05

ABSTRACT

Most of the Side Impact Air Bag systems in the current market are designed to protect the thorax area only. The new Head and Thorax SRS Side Impact Air Bag system, which Nissan recently introduced into the market, was designed to help provide additional protection for the head in certain side impacts. The system may help protect occupant head contacts when the vehicle collides into a tree, or the high hood of a large striking vehicle. This paper introduces the additional features and function of the new Head and Thorax SRS Side Impact Air Bag system, and some evaluation results in laboratory testing.

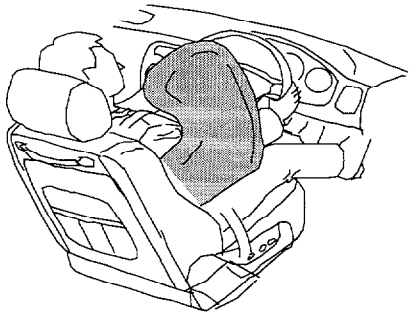

Figure 1. Head & Thorax Side Impact Air Bag

SIDE IMPACT ACCIDENT RESEARCH

Accident statistics in Japan are shown in Figure2. The fatality rate in side impact collisions is rated second (24%) of the total, following frontal impacts, which is 71%.

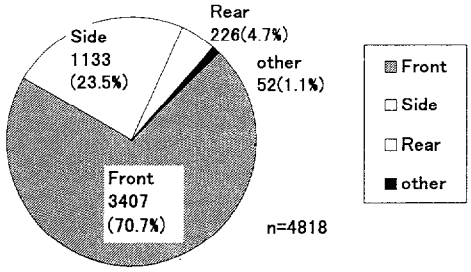

Figure 2. The fatality rate in impact collisions. Accident statistics in Japan(1993).

In side impacts with AIS>3, the occupant in the struck side suffers injury mostly in the head area, second in thorax, third in pelvis, and fourth in the abdomen.
If Head and thorax injuries are combined , they occupy more than 50% of the AIS>3 injuries. (See Figure 3.)

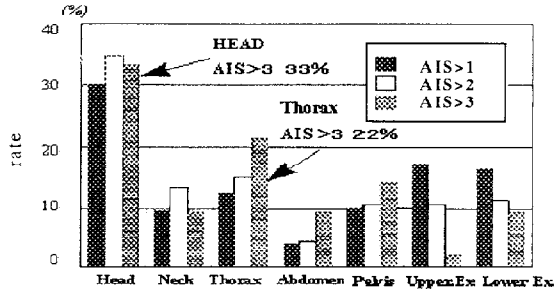

Figure 3. Injury area distribution of the occupant on the struck side in side impacts.
Data source ; National Police Agency, Management and Coordination Agency.

BACKGROUND OF HEAD AND THORAX SRS SIDE IMPAPCT AIR BAG SYSTEM DEVELOPMENT

The result of side impact collision research initiated the development of the Head and Thorax SRS Side Impact Air Bag System to help provide additional protection to the head area in certain side impacts.

CONFIGURATION OF HEAD AND THORAX SRS SIDE IMPACT AIR BAG SYSTEM

The total Hear & Thorax SRS Side Impact Air Bag system diagram is shown in Figure.4

1. A satellite sensor which detects the impact force is located on the bottom of the each center pillar.
2. A control unit, which provides signals for deployment and diagnosis of the whole system is located on the center of the tunnel (control unit is common for frontal impact SRS system).
3. An air bag module which is located in the side of the seat back .
4. A warning light which is installed in the instrument panel to indicate system malfunction.

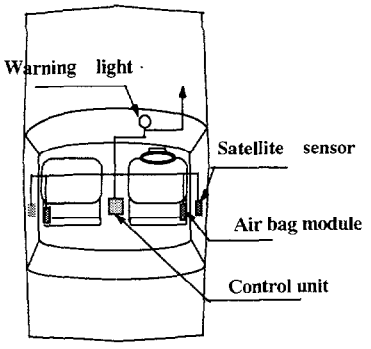

Figure 4. Configuration of Head & Thorax SRS Side Impact Air bag system.

Sequential Event of Air Bag Deployment is described as Follows

1. A satellite sensor in the struck side and a safing sensor in the control unit detect the impact force.
2. If a satellite sensor judges that the impact force is severe enough to deploy the air bag, the control unit provides a signal to the air bag module.
3. The gas produced by the inflator deploys the air bag.

CONFIGURATION OF HEAD AND THORAX SRS SIDE AIR BAG MODULE

Air bag module consists of;

1. Bag to protect Head and Thorax
2. Inflator
3. Housing to secure Bag and Inflator
4. Module tube to protect bag and to control the air bag deployment trajectory.

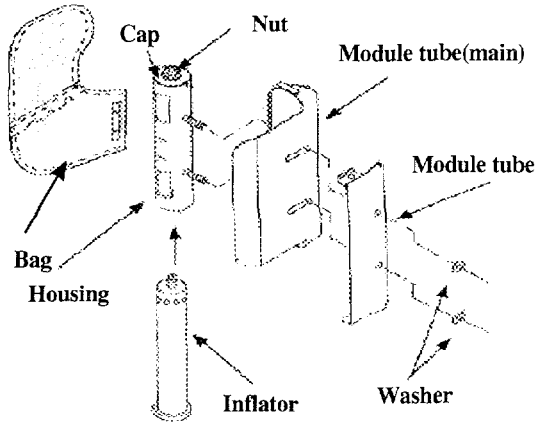

Figure 5. Configuration of Air Bag module

The air bag module is attached to the seat back frame and covered by cushion and the trim of the seat back.
When the air bag deploys, air bag deployment force tears the seam and the bag comes out in a forward direction.

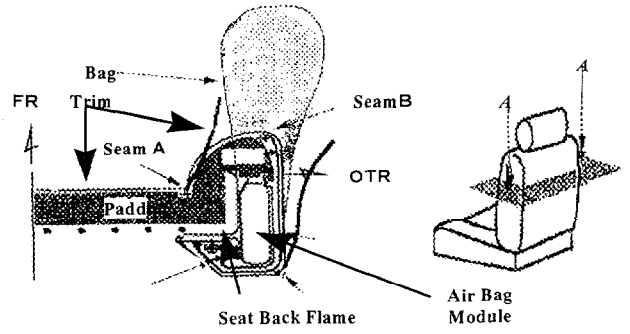

Figure 6. Seat back section (A-A)

ADDITIONAL FEATURES OF HEAD AND THORAX SRS SIDE AIR BAG SYSTEM

This newly designed and developed Head and Thorax SRS Side Air Bag has been enlarged to provide additional protection for the head area while still configured for the thorax.
This new Head and thorax SRS Side Impact Air Bag system, is mounted in the seat back to provide consistent performance for the occupant in various fore/aft seat positions which is the same as the current Thorax SRS Side Impact Air Bag system.

BAG DESIGN

Bag shape

Combines thorax protection area and head protection area to make a single air bag shape, providing a larger occupant protection area by using a simple configuration. The deployment shape of a bag was decided from the range of occupant sizes.

Bag folding

The bag folding technique shortened the time for full deployment.
The deployment shape is shown in Figure. 7.

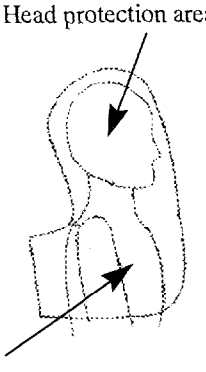

Figure 7. Side view of the deployed bag

BAG DEPLOYMENT STEPS

Bag deployment Step.1

Start of the deployment (Signal is sent from control unit to inflator).

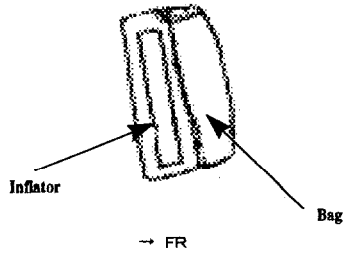

Figure 8.Bag deployment Step.1(time 0msec)

Bag deployment Step.2

Bag deployment pressure tears seat seam and deploys thorax protection area in the forward direction.

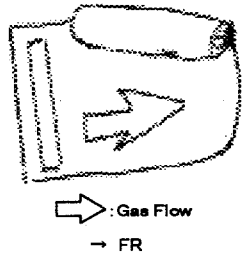

Figure .9 Bag deployment Step.2

Bag deployment Step.3

Gas deploys in the thorax area first, and then partial gas transfers to the head area.

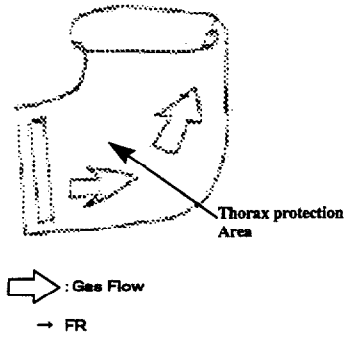

Figure 10. Bag deployment Step.3(after about 8msec)

Bag deployment Step.4

Gas deploys in the head area.(full deployment)

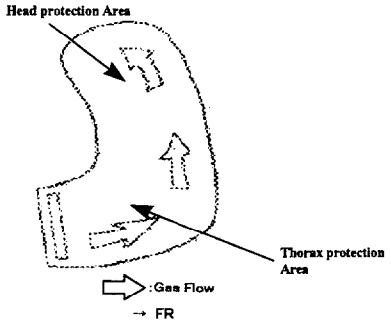

Figure 11.Bag deployment Step.4(after about 20msec)

OCCUPANT PROTECTION PERFORMANCE EVALUATION

Head Protection Performance

There are various kind of head protection performance evaluation tests. We selected a pole impact test as one of the evaluation tests. This test condition simulates that a vehicle crashes into an utility pole or a tree from the side of the vehicle and the occupant head hits into the utility pole or the tree directly. This procedure is under discussion at ISO meetings.

Test results are shown in Figure 12. Deceleration applied for the head was reduced to less than 1/10 of the deceleration applied without Head and Thorax SRS Side Impact Air Bag system.

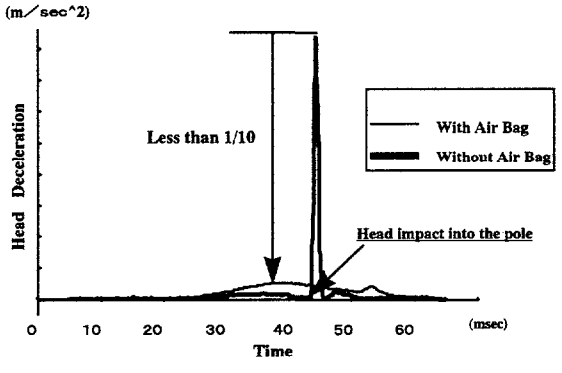

Figure 12. Dummy head deceleration in side pole impact test.

Thorax Protection Performance

The Head and Thorax SRS Side Impact Air Bag System reduces impact force by a maximum of 10~15% in our laboratory testing.

OCCUPANT AIR BAG INTERACTION EVALUATION

Out of Position e Evaluation

To simulate possible O.O.P riding posture, some O.O.P testing was conducted. Among various possible O.O.P postures, three test conditions are evaluated as possible high frequent postures and/or close to the air bag module.

Child Seat Evaluation

In addition to O.O.P test conditions, a child in a child seat was evaluated.

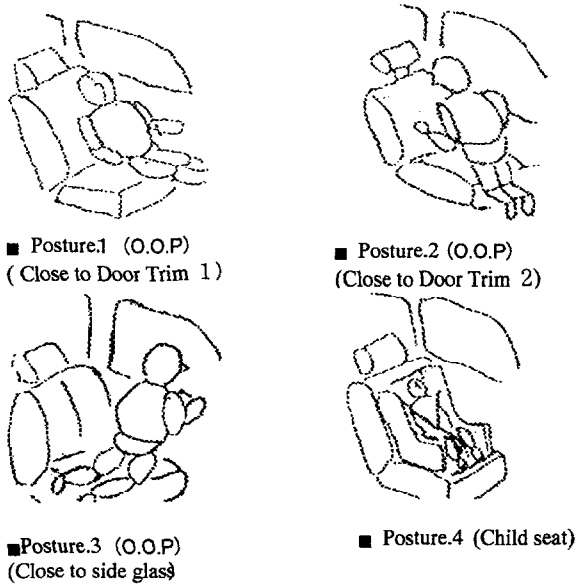

Figure.13 O.O.P and child seat test posture(Dummy AC03)

Test Result

O.O.P and child seat test results are shown in Figure.14~17.
As results show, dummy injury numbers are less than IARV(Injury Assessment Reference Values).
The MVSS 208 criteria is used for the IARV.

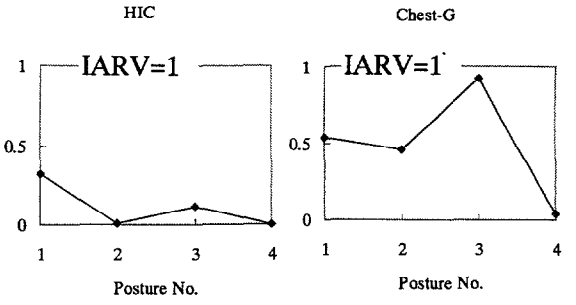

Figure 14. Dummy injury index in o.o.p and child seat test (HIC, Chest G)

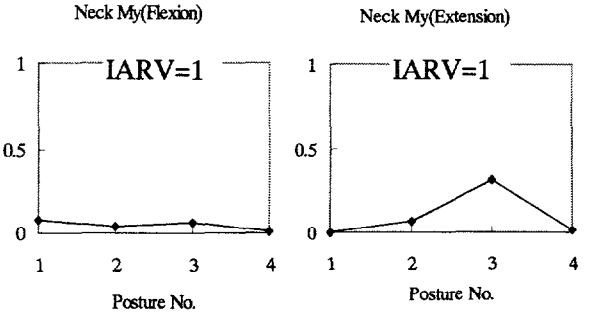

Figure.15 Dummy injury index in o.o.p and child seat test (Neck ;My)

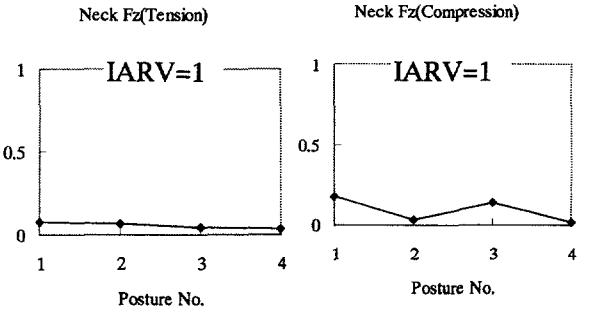

Figure.16 Dummy injury index in o.o.p and child seat test (Neck ;Fz)

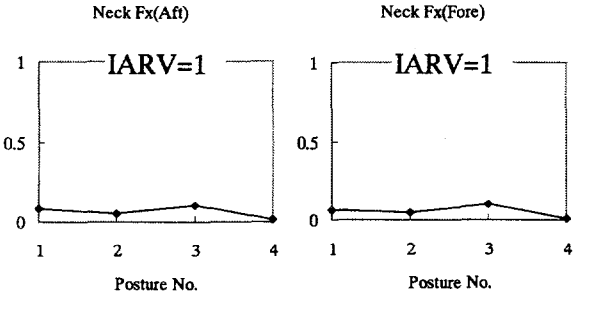

Figure.17 Dummy injury index in o.o.p and child seat test (Neck ;Fx)

ARM/AIR BAG INTERACTION EVALUATION

The test procedure for Arm interaction with side impact airbag is being discussed in the ISO Working Group. For one of the evaluation conditions, there is the elbow on the window sill deployment test condition.

As a part of Airbag interaction evaluation test, the elbow on the window sill condition test was conducted. It was figured that current dummies are not adequate to use for the arm evaluation at the arm and side impact air bag interaction evaluation tests. Since the shoulder joints of existing dummies are not well simulated like the actual human being. This finding was reported to the ISO Working Group meeting. To evaluate the Arm/Airbag interaction, it was agreed to modify the shoulder joint to get better simulation of actual human kinematics.

Human volunteer tests were conducted to evaluate Arm/Airbag Interaction during our development.
Based on the reports from human volunteers, the feeling of impact from Arm/Airbag Interaction is like a slight slap from the side of upper arm and no effect for shoulder and bones. It was concluded that there is a very low risk of arm injuries from Arm/Airbag Interaction.

CONCLUSION

Based on our development and evaluation of the Head and Thorax SRS Side Impact Air Bag System, It was introduced into the Japanese market in September '97, and will be introduced into the US market in Fall of '98.

FUTURE OBJECTIVES

It is very important to evaluate the side effects of the new restraint device before it is introduced into the market, since there are not always adequate evaluation equipment and measuring devices.

In this report the shoulder articulation was discussed, it is desirable to find new necessary improvements and share them among the experts to resolve. The shoulder joint issue is well known among the experts and will be moving towards the favorable solution.

REFERENCE

ISO Technical Report "Road Vehicles-Test Procedures for Evaluating Various Occupant-Interactions with Deploying Side Impact Airbags", ISO TC 22/SC 10/WG3 N130. August 19, 1996.

ISO Technical Report "Road Vehicles - Dynamic Crash Test Procedures for Evaluating Various Occupant - Interactions with Side Impact Airbags when the Impact Object is a Pole, Moving Deformable Barrier, or high - Hooded Vehicle Simulation", ISO TC 22/SC 10/WG3 N131. August 20,1996.

ISO Technical Report "Side Arm/Air Bag Interaction in Static Tests with Combination Autoliv Side Air Bag", ISO TC 22/SC 10/WG3 N166. April 3 1998.