# JAPAN'S VEHICLE CRASH AVOIDANCE RESEARCH PROGRAM(S)

Observational Report
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**Report Outline**

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**Background and Overview**

Japan's vehicle crash avoidance research activities were initiated as parts of three separate research programs undertaken by the Ministry of International Trade and Industry (MITI): the Super Smart Vehicle System; the Ministry of Transport (MOT): the Advanced Safety Vehicle; and the Ministry of Construction (MOC): the Advanced Highway Safety System, now part of its Automated Highway System Program (AHS).

**MITI's Super Smart Vehicle System (SSVS)** program is built upon research conducted in the 1970% and research in the 1980's on vehicle-to-vehicle communications and laser radar system for obstacle warning. The SSVS program is focused on improving safety and efficiency through (1) reducing the driver's load, and monitoring driver and road conditions; (2) improving traffic information through road-to-vehicle and vehicle-to-vehicle communications; (3) developing inter-vehicle cooperation; and (4) developing interactive systems with intelligent intersection traffic management systems. MITI's overall ITS program is geared toward advanced concepts that strive to maintain the competitive edge in this area for Japanese industry, to Improve the* efficiency of transport logistics, and to prevent traffic accidents and congestion. No details on any MITI sponsored crash avoidance technologies were obtained, but such research would tend to be basic and elemental .

**MOT's Advanced Safety Vehicle (ASV)** program was a five year research effort initiated in 1991 to develop a passenger car that is safer and easier to use by the beginning of the 21 st century. The four ASV target technology areas were: preventative safety, accident avoidance, crash injury reduction, and post-collision injury reduction. The first phase ended in a successful ASV prototype demonstration. Phase two was started in April 1996 to study the feasibility of the

technologies developed in phase one.

MOT' s ASV activities are aimed at defining the vehicle technologies and developing relevant technical guidelines for the automobile manufacturers to follow. This is consistent with MOT's role as the regulator of vehicle safety. Seven of the twenty technologies (divided into the above noted four technology areas) identified in the first phase deal with "accident avoidance technology" - see Reference 1. A comprehensive ASV Research Results Report published in March 1996 (in Japanese) reported that technology #11, "automatic collision detection and prevention system" was estimated to prevent 3,192 accidents out of a total of more than 600,000 accidents a year in Japan. (Appendix H, page 81)

Nine Japanese automobile manufacturers undertook a total of 88 projects under the ASV framework- see Reference 2. Thirty three projects involved crash avoidance related technologies such as adaptive cruise control, vehicle following-distance sensing and warning systems, automatic collision detection and prevention systems, vehicle lane-change hazard avoidance systems, lane deviation warning systems, and nighttime object detection and warning systems. Of the 88 projects in ASV phase one, the MOT reported three to have led to commercialized products: Toyota's Low Tire Pressure Warning (1996)- page 2; Mitsubishi's Intelligent Cruise Control (1995) - page 10: and Honda's Drowsy Driver Warning System (1997) - page 14.

In phase two of ASV (1996-2000), trucks, buses and motorcycles have been added to the program. Thirteen vehicle manufacturers are participating - in addition to the nine car manufacturers listed in Reference 2, Nissan Diesel and Hino are truck & bus manufacturers participating; and Yamaha and Kawasaki are motorcycle manufacturers participating. The key focuses in phase two are: (1) man-machine interface, and (2) vehicle-infrastructure interaction. Additional areas of work include harmonizing their efforts with MOC' s AHS efforts, possibly re-arranging the four technical areas, and possibly adding "autonomous driving technologies." Most of the twenty ASV technologies in phase one have been carried over into phase two with some modifications/questions: e.g., #l, drowsy driver - warning-only or automatic braking?; #11 collision avoidance - warning-only or automatic action? A total of 32 technologies are now proposed for phase two (see Appendix I).

Because MOT regulates certain technologies more strictly (e.g., automatic braking) than others (e.g., warning systems), the ASV technical guidelines vary in detail. Phase two will define which systems will require MOT approval. MOT would like to complete work on ASV technologies by 2000, but if technical issues remain, MOT may consider a phase three for the ASV program.

On the liability issue of ITS, the MOT maintains a strict position that ASV technologies are only to "support" the driver. The clear principle being adhered to is that the driver is responsible for control of the vehicle and that the vehicle manufacturer is only responsible for the integrity and reliability of basic vehicle components.

**MOC's Advanced Highway Safety System (AHSS)** research was started in 1989 with a focus on traffic accident prevention in conjunction with the infrastructure - automated driving was not originally included. A private sector organization (Highway Industry Development Organization, aka HIDO) combined efforts with the MOC's Public Works Research Institute (PWRI) in 1991 to undertake joint research. The MOC defined the AHSS's three-phased evolution in 1992 as: (1) "warning system", (2) "prevention system", and (3) "automated driving system". In 1994, 24 private companies in the fields of automobile manufacturing, electronics, and telecommunications joined the research effort. This research was aimed at developing technologies in road-ahead danger warning, position indication of surrounding vehicles, and rear-end collision prevention. The results of this research were demonstrated in November 1995 at the PWRI test track during the ITS World Congress in Yokohama, and in September 1996 on a 5.4 kilometer section of the expressway between Tokyo and (to the northwest) Nagano.

In September 1996, the Advanced Cruise-Assist Highway System Research Association (AHSRA) was created to oversee research and development of AHS road infrastructure. AHSRA has twenty one private participating companies in the fields of automobile manufacturing, electronics, and telecommunications. The membership list is in Reference 3. The association will conduct a three-phased research and development program: (1) "danger warning" or AHS-i; (2) "assistance for driving" or AHS-c; and (3) "automated highway systems" or AHS-a. AHS-i and AHS-c are targeted for deployment in the year 2000 (coinciding with the end of phase two for **ASV),** while AHS-a deployment is anticipated in the "beginning of the next century." With respect to crash avoidance, AHS-i involves short range adaptive cruise control technology that looks ahead 100-l 50 yards. Whereas AHS-c and AHS-a primarily involves longer range sensing of 2-3 miles for vehicle detection, obstacle detection, and automatic collision detection.

**Coordination Within Japan**

It is evident that the three vehicle-related programs were initiated and advanced independently by the respective ministries. In August 1995, in order to unify Japan's ITS activities, the "Basic Guidelines for ITS" were adopted by the five Japanese ministries dealing with ITS: MITI, MOC, MOT, the Ministry of Post and Telecommunications (ITS radio frequency allocation), and the National Police Agency (traffic management). In July 1996, the five ministries compiled the 'Comprehensive Plan for ITS" that defined the above three phases of AHS: (1) "danger warning" or AHS-i; (2) "assistance for driving" or AHS-c; and (3) "automated highway systems" or AHS-a. The MOC and MOT have started regular meetings to coordinate development of ASV and AHS. There is recognition that interoperability is the key to successful marketing of ITS products.

**Funding and Resource Commitments**

MITI was not able to provide funding and resource figures.

In 1997 MOC provided three billion yen ($25 million) for AI-IS. AHSRA is primarily aimed at infrastructure developments and sensor development. The private sector provided subsidies or

contributions to AHSRA amounting to 600 million yen ($5 million) and engages about 750 associated researchers (not necessarily full time) for AHS - including vehicle-side technologies. The rough estimate of private company internal commitments to this effort was put at more than 20 billion yen (>$167 million).

The MOT's effort with ASV started as a vehicle-side safety effort, and also will be considering AHS infrastructure-side matters in phase two. ASV funding was only 23 million yen ($192,000) in 1997 which basically is to produce reports and draft guidelines. The automobile manufacturers are expected to follow such guidelines in developing any ASV technologies. The MOT informally estimated that each of the nine auto manufacturers on average has expended more than one billion yen ($8.3 million) for development of prototypes/products under ASV phase one.

See Reference 4, 'Crash or Collision Avoidance" - Related Budget in Japan, for additional information.

**Commercialization of Crash Avoidance Products**

Eight crash avoidance products are currently available commercially in Japan. Three are for passenger cars (by Mitsubishi and Toyota), and five are for trucks and buses (by Mitsubishi and Isuzu). See Reference 5, Crash Avoidance Products in Japan for details. The Mitsubishi ICC (Intelligent Cruise Control), available since January 1995, now re-named "Preview Distance Control" is the product with the most units sold: 150. References 6 and 7 are excerpts from sales brochures of the respective high-end vehicles (Mitsubishi's Diamante and Toyota's Celsior) which contain product information on the crash avoidance features. The full color brochures are included as Appendices M and N.

Market analyses reveal that the slow sale of crash avoidance products in Japan is due to the expensiveness of the products - 350,000 yen (about $3,000) for the Mitsubishi product. The Mitsubishi product has been available as an option since January 1995, and is now standard equipment for the Mitsubishi Diamante since August 1997. The Toyota product entered the Japanese market in August 1997.

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# KEY CONTACTS

## AUTOMATED HIGHWAY SYSTEM

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Hisao TAMADA, Commercial Specialist, Foreign Commercial Service
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# REFERENCES


1. **Advanced Safety Vehicle - Advancing Toward the Twenty First Century**
   Descriptive brochure of the ASV program with twenty technologies grouped into four technology areas. Japan Ministry of Transport

2. **Advanced Safety Vehicle - ASV Project Network**
   Booklet with thumbnail descriptions of the eighty-eight projects undertaken by nine Japanese automobile manufacturers under the ASV program. Japan Ministry of Transport

3. **Participating Companies of AHSRA**
   Twenty-one member companies of the Advanced Cruise-Assist Highway System Research Association (AHSRA)

4. **Crash or Collision Avoidance - Related Budget in Japan**
   FY 1997 budgets in Japan dedicated to crash-avoidance research and development, and other ITS technologies and deployment initiatives. Japan Ministry of Construction

5. **Crash Avoidance Products in Japan**
   Table of eight crash avoidance products commercially available in Japan as of September 1997. AHSRA 9/97

6. **Diamante - Preview Distance Control**
   Excerpt of intelligent cruise control feature from a Mitsubishi Diamante sales brochure. Mitsubishi Motors (In Japanese)

7. **Celsior - Adaptive Cruise Control**
   Excerpt of adaptive cruise control feature from a Toyota Celsior sales brochure. Toyota Motors (In Japanese)

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# APPENDICES

**A. Status and Plans of Vehicle Control in Japan**
Overview presentation text of SSVS, ASV, and particularly AHS crash/collision avoidance research in Japan - Japan Ministry of Construction

**B. Status and Plans of Vehicle Control in Japan**
Viewgraphs for presentation (Appendix A) of SSVS, ASV, and particularly AHS crash/collision avoidance research in Japan - Japan Ministry of Construction

**C. Considerations Regarding AHS**
Presentation text on the evolution of the Ministry of Construction's AHS research program into the three-phased ***AHS-i,c,a*** program. - Japan Ministry of Construction

**D. Considerations Regarding AHS**
Viewaraphs for presentation (Appendix C) on the evolution of the Ministry of Construction's AHS research program into the three-phased ***AHS-i, c,a*** program.
Japan Ministry of Construction

**E. Advanced Cruise-Assist Highway System Research Association**
Brochure describing the evolution of AHS and the components of the AHS-i,c,a program sponsored by the Ministry of Construction being undertaken by the Advanced Cruise-Assist Highway System Research Association (AHSRA)

**F. Crash Avoidance Research Program**
Viewgraphs on the AHS-i,c,a research program sponsored by the Ministry of Construction, and commercial products currently in the Japanese market. - AHSRA

**G. Plan for the Promotion of the Development of Advanced Safety Vehicles**
Viewgraphs on the Advanced Safety Vehicle (ASV) program sponsored by the Ministry of Transport - presented at the ITS World Congress in Orlando - October 1996.
Japan Ministry of Transport

**H. Results of the Research on Advanced Safety Vehicles**
Research report on the first phase of the Advanced Safety Vehicle (1991-l 996) with analyses of the estimated safety benefits of the 20 technologies.
Japan Ministry of Transport, March 1996 (In Japanese)

**I. Promotion Plan of the Development of Advanced Safety Vehicle (ASV)**
Presentation text on the ASV program for presentation at the ITS World Congress in Berlin - October 1997. It provides an update on the ASV program and reflects the addition of two technical areas to the previous four: Autonomous Driving Technologies, and Fundamental Automotive Engineering Technologies. Bringing the total technologies from 20 to 32. - Japan Ministry of Transport

**J. Development of an Intelligent Cruise Control System**

Published technical paper the development of the intelligent cruise control (ICC) system - describing the sensing system, the control algorithm, and an evaluation of the system effectiveness. - Mitsubishi Motors Corporation [obtained from AHSRA]

**K. (Preview Distance Control)**

Published paper on the features of the Mitsubishi Preview Distance Control, previously known as "intelligent cruise control." - [obtained from AHSRA] (In Japanese)

**L. A Study on Driver Support Systems**

Published paper that discusses the issues of driver support systems to reduce driver fatigue and improve vehicular safety, including the interface between the driver and machine, the risk of driver over-reliance on such systems, and system reliability - [obtained from AHSRA]. (In Japanese)

**M. GDI Diamante**

Sales brochure for the Mitsubishi Diamante with in-vehicle navigation system features (pages 10- 11, 24-25), and adaptive cruise control - "Preview Distance Control" (page 21) - Mitsubishi Motors Corporation (In Japanese)

**N. Celsior**

Sales brochure for the Toyota Celsior with in-vehicle navigation system features (pages 12-13, 36-37), and Adaptive Cruise Control (pages 38-39) - Toyota Motors Corporation (In Japanese)