

RECOMMENDATIONS REPORT FROM THE THAILAND AUTOMOTIVE TECHNOLOGY CONFERENCE/WORKSHOP

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PREFACE

This report presents conclusions and recommendations that were developed from a Conference/Workshop held in Bangkok from March 30-April 3, 1998. The purpose of the Thailand Automotive Technology Conference/Workshop was to examine in great detail the country's automotive industry/transportation system and generate ideas that could lead to a resurgence of the automotive industry as well as improvements in air quality, traffic congestion, safety, national economic performance, and overall quality of life.

At the three-day Conference portion of the event, more than 50 individuals holding key positions in government, industry, and academia from Thailand and the United States gave presentations covering all aspects of Thailand's automotive industry/transportation system. The two-day Workshop that followed was comprised of approximately 70 Thai and U.S. Experts (most of whom participated in the Conference), who reviewed information and data from the Conference and provided the technical expertise for the recommendations in this document. The Experts broke out into five working groups for in-depth analysis of:

- 1. Vehicle Emissions, Ambient Air Quality, and Transportation Infrastructure*
- 2. Fuels and Energy*
- 3. Harmonization of Standards and Regulations*
- 4. Development of the Automotive Industry*
- 5. National Automotive Strategies and Policies*

This report presents 62 policy and technical recommendations that government and industry in Thailand are encouraged to review and adopt as appropriate.

I. INTRODUCTION

Despite the continuing economic crisis that has severely curtailed automotive sales and production in Thailand, the long-term outlook remains bright. Immediate action to improve air quality and the transportation system is essential to enable sustainable economic recovery and growth in the next decades.

Several studies have demonstrated that traffic congestion in urban areas can have a significant negative effect on air quality and economic productivity. It has been determined that Bangkok could increase its gross domestic product significantly by eliminating traffic gridlock. It has been demonstrated in major metropolitan cities around the world that traffic congestion can be improved with mass transit and improved parking in the central business districts.

The Asian Institute of Technology reported in a recent study that the average yearly vehicle speed in Bangkok is 24 km/h for cars and 15 km/h for buses. In spite of this relatively lower vehicle speed, the traffic fatality rate in Thailand is higher than that of other countries and is attributable, in part, to the high proportion of motorcycles in the vehicle fleet. An economic study by the Thai Farmers Bank Research Center concluded that the loss of time and opportunities caused by the inefficient transport of people and goods exceeded 100 billion baht in 1995.

Transportation experts in Bangkok cite a litany of causes for traffic congestion, ranging from inadequate road space and ineffective land-use controls to uncoordinated transit modes and inefficient law enforcement.

The effect of the presence of global automotive companies on the economic development of Thailand, and

the country's potential for becoming the primary automotive center for Southeast Asia, are examined in this report. An improved infrastructure in Thailand is essential to support overall economic growth, particularly in the automotive industry.

Thailand is an emerging automotive market and has potentially significant advantages over nations with mature markets in that it can learn and benefit from their successes and mistakes. In addition, established technologies and standards are available for Thailand to modify and adopt as necessary to suit its specific needs.

Thailand can trim years off its technological growth cycles by making the proper selection of policies and technologies, and commit to follow through with those chosen policies. The great challenge for the country is reconciling a desire for growth of its automotive industry with the need to reduce air pollution, alleviate traffic congestion, and ensure safety. It is the belief of the Workshop Experts that adoption of recommendations in this document, in full or in part, will enable Thailand's automotive industry to emerge as a major global automotive industry player. The consensus from the Workshop is that the recommendations are viable options for the growth of Thailand's automotive industry and will reduce the negative effects that growth might otherwise have on air quality, traffic, and safety.

II. EXECUTIVE SUMMARY

Environmental and transportation agencies in Thailand have demonstrated leadership and expertise beyond those of other emerging nations with which the U.S. Experts have had experience. Considerable progress has been made in understanding vehicle emissions, air quality problems, and the limitations of the transportation infrastructure in Bangkok. The depth of knowledge and the valuable input provided by the Thai policy makers and technical experts are acknowledged.

Some of the recommendations provided in this report have been previously considered and/or recommended for implementation by various Thai government agencies. Future focus should be on continuity in planning and consistent execution of plans.

Development of an overall strategy in Thailand should involve all stakeholders, including the appropriate governmental ministries, oil companies, automotive manufacturers, suppliers, academia, and environmentalists. Specific implementation plans should be developed by government ministries and agencies. Initial funding and support to develop the strategy and infrastructure should be provided by the Thai government; subsequent contributions may come from key stakeholders including investors.

In the midst of the current economic crisis in Asia, technology and business alliances between Thailand and U.S. global companies are encouraged. This is a prudent strategy in the development of Thailand's overall economy, not just the automotive and automotive parts industry.

1. Vehicle Emissions, Ambient Air Quality, and Transportation Infrastructure: The formulation of solutions to the problems of air pollution and traffic congestion in cities such as Bangkok requires a systems approach.

A high-priority recommendation is the rapid development and implementation of strategies to reduce emissions from conventional 2-stroke motorcycles, diesel buses, heavy-duty trucks, and malfunctioning in-use cars, since more than 80% of vehicle emissions in Bangkok are generated from these sources. A general consensus from this working group is that an expansion of the current vehicle inspection and maintenance program, including improved enforcement, would provide the greatest benefit in the near-term.

2. Fuels and Energy: Demand for energy will increase, and utilization of fuels and energy for a national

transportation system should be part of a long-term strategic plan. Fuels will play a significant role in the transportation system, and their development and distribution have to be harmonized with the social and economic needs of an emerging market such as Thailand.

Clean and high-quality fuels from the supply side, when matched with the appropriate vehicle technologies, can lead to reduced emissions and improved air quality. The key recommendations include greater use of cleaner fuels such as reformulated diesel (RFD) and gasoline (RFG) for the current vehicle fleet, and a planned transition from the high-polluting, conventional 2-stroke engine to alternative propulsion systems with low-emission engines in passenger cars.

3. Harmonization of Standards and Regulations: Unique national standards almost always impose unnecessary burdens on any global industry — higher development and manufacturing costs, primarily, which ultimately must be borne by vehicle buyers. Numerous regional efforts have been progressing with the goal of achieving harmonization of environmental standards.

A key recommendation of this working group is that Thailand participate in United Nations Economic Commission of Europe Working Party 29, which is the global forum for vehicle regulations.

4. Development of the Automotive Industry: The public and private sectors play critical and complementary roles in countries with a thriving automotive industry. The hope of this working group is that government and industry work together to promote expansion of the domestic auto industry while simultaneously adopting solutions (as recommended in this report) to air quality, traffic congestion, and other problems.

On the government's part, rationalization of tariffs and taxes should be a priority, as should gradual reduction of trade barriers and simplification of export procedures. For their part, vehicle assemblers should strengthen their supplier support activities by, among other things, creating centers of expertise with local talent.

5. National Automotive Strategies and Policies: The motor vehicle is recognized as the preferred mode of personal mobility, and improvements in both personal and public transportation are a priority for Thailand. Successful strategies will reconcile this priority with environmental needs and the enhancement of traffic safety.

A comprehensive review of the country's transportation infrastructure, as well as its land-use policies, is recommended to provide a solid foundation on which to base decisions about improvements.

III. VEHICLE EMISSIONS, AMBIENT AIR QUALITY, AND TRANSPORTATION INFRASTRUCTURE

This working group considered the impact of vehicle emissions and transportation infrastructure on ambient air quality. One of the group's conclusions is that the formulation of solutions to the problems of air pollution and traffic congestion in cities such as Bangkok requires a systems approach.

It will be impractical to continue the uncontrolled expansion of personal transportation in Bangkok because gridlock and air pollution are already serious problems. A long-term plan should be developed and implemented to improve Bangkok's transportation infrastructure and ambient air quality. Transportation infrastructure development will be a critical factor in the rate of economic growth. Economic incentives to promote such infrastructure development must be part of this long-term plan.

Environmental Technology

This section of the report offers recommendations on emissions inventories, air quality, health effects, and cost-benefit analysis. Improved emissions inventories are needed to determine the relative importance of various emissions sources on ambient air quality in Bangkok.

There are many international efforts to help define the relationships between air quality and human health. The current debate on the potential adverse health effects associated with exposure to inhalable and respirable particles such as PM₁₀ and PM_{2.5} is quite intense in the U.S. Preliminary studies should be conducted in Bangkok to validate the conclusions.

The speciation of hydrocarbons and other criteria pollutants in ambient air samples in Thailand will further quantify the relative importance of exhaust and evaporative emissions from vehicles and solvent emissions from stationary sources.

Recommendations:

1. *Increase efforts to develop accurate inventories of emissions from mobile and non-mobile sources. High-priority efforts should include the development of improved emissions inventories for malfunctioning in-use vehicles, 2-stroke motorcycles, diesel buses, and heavy-duty trucks. Since current mobile-source emissions inventory models are not applicable to cities such as Bangkok, either new models should be developed or existing models should be modified.*
2. *Install more air pollution monitoring stations in Bangkok and other regional industrial areas. This will help define the nature of photochemical smog formation. Ozone monitors should be installed downwind (up to 200 km) of industrial areas as well. A long-term plan should include ambient air monitoring of fine particle mass (below 2.5 μm in diameter) and determination of the chemical composition of selected hydrocarbons.*

Regulations

Bangkok and Chiang Mai have significant air pollution problems, attributable primarily to emissions from vehicles, especially motorcycles. Two million motorcycles are built in Thailand each year, and motor vehicles generate approximately 40% of particle emissions in Bangkok. Vehicle emissions also account for more than half of the total CO emissions.

Recommendations:

3. *Give priority to the control of particulate pollutants, hydrocarbons, and CO from mobile and non-mobile sources.*
4. *Adopt a motorcycle emissions standard matching those of the best-in-class standards of other countries (e.g., Taiwan). Emissions standards should be promulgated for motorcycles that approach equivalency within the next five years. The excise tax on low-emissions motorcycles should be reduced to help encourage replacement of in-use, high-emissions vehicles.*

Inspection/Maintenance

A strong inspection/maintenance (I/M) program is the cornerstone of an effective vehicle safety and emissions control program. I/M programs in Thailand currently are carried out by hundreds of small garages.

Recommendation:

5. *Expand and improve I/M programs by assessing the lessons learned from the U.S. experience and increasing training for I/M technicians through the establishment of training centers. Organizations*

responsible for emissions inspection need to be disassociated from maintenance and repair garages.

Vehicle Technologies

A systematic approach is necessary for the introduction of well-established technologies for controlling vehicle emissions. The timetable for introduction of these technologies depends on many factors, including the availability of local suppliers; the expense of control systems hardware; the availability of high-quality unleaded fuel; the benefit of these technologies relative to their cost; and the relative costs of other emissions control strategies.

Recommendations:

6. *Require motorcycle manufacturers to develop low-emissions products. The Thai government should establish a cooperative program with one or more motorcycle manufacturers to encourage the development of such vehicles by all manufacturers. Manufacturers also should be required to submit detailed information on the amount of HC, CO, NOx, and particulate matter that their products generate.*
7. *Consider retrofit programs (engine replacement for old buses and trucks, catalytic converters, alternative fuel systems, etc.) for reducing emissions from in-use vehicles. These retrofit efforts should be closely coupled with inspection/maintenance programs to ensure that lower emissions are actually achieved.*

Transportation Infrastructure

As outlined earlier, the infrastructure for private and public transportation has a significant effect on ambient air quality, especially in Bangkok, Chiang Mai, and other major cities.

Recommendation:

8. *Establish more efficient public transportation routes, which could include dedicated lanes. Integrate public transportation into the overall traffic management system.*

Intelligent Transportation Systems..

The implementation of intelligent transportation systems (ITS), including intelligent vehicle systems (IVS) and the promulgation of workable urban transportation policies, will significantly increase travel efficiency, enhance personal productivity, reduce emissions, and conserve energy. ITS systems include relatively simple concepts — from timed traffic signals to satellite communication and global positioning systems for traffic control.

Recommendation:

9. *Implement ITS systems, primarily for the improvement of transportation efficiency and safety since it is not cost-effective solely for the purpose of emissions control. Engage the traffic police in design of a coordinated traffic management system such that they will have ownership of the operating system.*

Environmental and Health Education

The implementation of educational programs will help encourage personal responsibility for environmental protection. Some excellent programs already are in place. It would be cost-effective to expand existing

programs in the school system and encourage public service efforts by the local media.

Recommendations:

10. *Establish an award system for individuals and groups who make significant national and local contributions to the protection of Thailand's environment. Hold public meetings to encourage input from the public.*
11. *Increase public awareness and provide an impetus to policy makers to effect changes. Develop a public service advertising campaign focused on "green" technologies, highlighting the benefit of replacing conventional two-stroke engines in motorcycles and boats with low-emission engines.*

Policy/Organizational Structure

The Workshop Experts have carefully reviewed Bangkok's air pollution and transportation infrastructure problems. The major challenges for government organizations will be to implement effectively some of the key recommendations and manage the whole system.

Recommendations:

12. *Expand responsibilities of the Office of the Commission for Management of Road Traffic (OCMRT) to develop a master plan, especially for Bangkok. The OCMRT should solicit input from all transportation-related sectors. The OCMRT is the recommended organization for this responsibility because it already is developing a capability in this direction. The master plan should address ITS, fuels, energy, safety, etc. Solve short-term traffic problems first by starting with small projects from which there will be a quick benefit.*
13. *Establish a multidisciplinary group of world-class experts to review transportation policies as they are developed. This transportation authority should not be affected by politics and/or changes in elected officials. Use multidiscipline methodologies that include economic, environmental, energy, and other inputs to help the government better develop transportation policies. Develop a means for involving the private sector, especially the primary users of transportation in Bangkok.*
14. *Establish a Bureau of the Environment (or equivalent) that gives responsibility to one organization for environmental planning and for adoption, implementation, and enforcement of regulations.*
15. *Use economic incentives to discourage the use of personal transportation systems in central urban areas. Discourage and ultimately prohibit the operation of vehicles with high emissions in these areas.*

IV. FUELS AND ENERGY

Clean fuels, when matched with the appropriate vehicle technologies, can lead to reduced emissions and improved air quality. Implementation of appropriate strategies and technologies relating to both stationary and mobile combustion sources has led to compliance with stringent air quality standards in many countries. Since the mid-1970s, the use of unleaded gasoline and emissions control systems have been driving forces in minimizing vehicular emissions. More recently, expanded use of reformulated gasoline (RFG) in the United States has contributed to a further reduction of urban air pollution.

Thailand has a distinct advantage over some nations in that it has a modern oil refining industry. Two of the world's newest and most advanced oil refineries (Star Petroleum Refining Company Ltd. and Rayong Refinery Company Ltd.) are located in Rayong. Thus, capabilities already are in place to produce improved fuels for domestic consumption in Thailand as well as for export to ASEAN countries.

Fuel improvement is critical as part of a systems solution to reducing vehicle emissions to improve air quality and fuel economy. Taking into account the existing fuel and lubricant specifications and pre-Euro I engine technology in Asia, a primary goal of the Workshop was to develop strategies to improve, as quickly as possible, air quality in Bangkok, and preserve good air quality throughout the rest of Thailand. The recommendations that follow are aimed at an integrated vehicle/fuel system to reduce the ambient concentrations of particulate matter, carbon monoxide, ozone, nitrogen oxides, and hydrocarbon. A secondary goal was to examine long-term (>5 years) options to further improve air quality, to identify energy supplies, and to develop conservation measures.

Two-stroke engines, fuel quality, traffic management, vehicle inspection/maintenance, and government trade policy emerged from the workshop as the subjects of greatest interest. They are elements of Thailand's automotive industry/transportation system that, depending on the action taken, offer the greatest potential for benefit. Although the total number of motorcycles is only three times the number of passenger cars, they contribute more than ten times the pollutants in the air. A planned transition of the motorcycle fleet to low-emissions vehicles would be a top priority for Thailand to improve air quality.

Broad recommendations with the goal of reducing urban air pollution in Thailand are provided instead of suggestions for incremental improvements for each fuel type currently used. Long-term options include development of alternative fuels and advanced vehicle propulsion systems such as low-emission vehicles (LEV) and zero-emission vehicles (ZEV) powered by internal combustion engines, as well as future fuel-cell-powered vehicles.

The working group considered Thailand's unique intermodal transportation system, the prevalence of two-stroke motorcycles, and the country's tropical climate in developing its recommendations. Among specific topics addressed were the overbuying (unnecessary use) of high-octane fuel for use in vehicles and motorcycles, the potential benefits of cleaner fuels such as reformulated diesel (RFD) and reformulated gasoline (RFG), and the prospects for alternative fuels.

The special points from this working group are:

- Develop I/M programs and encourage the use of proper fuels and lubricants to reduce vehicle emissions.
- Encourage the use of advanced technologies such as direct injection (DI) gasoline and DI diesel engines and fuels with potential for significant reduction in emissions, fuel consumption, and CO₂ emissions.

- Develop a public service advertising campaign with a focus on “green” technologies such as 4-stroke engines to replace 2-stroke engines in motorcycles and boats.
- Promote and utilize clean fuels, such as reformulated gasoline (RFG) and diesel (RFD) as appropriate, to reduce emissions.
- Consider the vehicle and the fuel as a system along with the actual usage patterns in Thailand. All proposed changes should be implemented after a successful demonstration of the cost-effectiveness through testing programs and economic analyses.

Diesel Fuel

Approximately 40% of the transportation fleet in Thailand uses diesel fuel. Since much of the airborne particulate and NO_x are associated with diesel exhaust emissions, an effective strategy would be to match the fuel to engine performance, emissions, and spark timing.

The adoption of heavy-duty engine emissions limits, diesel fuel sulfur concentrations below 0.05%, and reformulated diesel fuel (RFD) are consistent with advanced engine technology. As Euro-2 heavy-duty limits and low-sulfur (0.05%) fuel will be effective in January 1999, the specification of maximum HFRR (high frequency reciprocating rig) lubricity limits should also be considered.

Recommendations:

16. *Continue the fuel-quality inspection program to ensure the quality of diesel fuel.*
17. *Promote the use of reformulated diesel fuels to reduce emissions and limit fuel sulfur to below 500 ppm. High boiling point fractions of diesel fuel should be limited, by lowering T90, to help reduce hydrocarbon and particle emissions.*
18. *Formulate a strategy to limit the life cycle of diesel engines by enforcing emissions standards to meet health and environmental needs.*
19. *Investigate the potential of producing liquid fuel from natural gas. This fuel may be used as a blending agent to improve diesel fuel quality or as a stand-alone fuel.*
20. *Implement programs to remove old-technology diesel engines from the vehicle fleet. Such programs may include:*
 - *Tax incentives or rebates to buy new engines and vehicles.*
 - *The implementation of a heavy-duty diesel vehicle inspection and maintenance program that encourages the replacement of high-emissions heavy diesel engines with those incorporating newer technologies.*
21. *Monitor progress in the development of advanced technology fuels such as dimethyl ether (DME), which may enhance and enable the diesel engine to achieve negligible emissions.*

Gasoline

Thailand has made considerable progress in improving the quality of gasoline for better vehicle performance and reduced emissions. The current gasoline quality monitoring program should be continued and expanded. The recent implementation of unleaded gasoline and catalytic converters in new vehicles has been significant in reducing emissions.

With more than 10 million motorcycles in Thailand, the 2-stroke engine is problematic in that as much as

25% of the fuel to power it can be emitted unburned in the exhaust. Since the role of 2-stroke engines has been important in the transportation culture and personal mobility infrastructure, a strategy is required to reduce their emissions. Retrofitting motorcycles with catalytic converters is an option, but recent studies presented at the Thailand Automotive Technology Conference/Workshop demonstrated that the catalytic converters on this type of engine may not be effective after 10,000 km of use. More technological improvements are needed: the ongoing research efforts in Taiwan and Japan to control emissions from two-stroke engines should be monitored.

Motorcycle owners typically buy premium-grade gasoline as a result of the misconception that the higher-octane fuel reduces emissions and improves engine performance. In reality, higher grades of gasoline offer no advantage over regular gasoline, and actually emit more pollutants. The Ministry of Commerce has estimated that a switch from the high-octane premium to lower-octane gasoline could result in savings of as much as one billion baht/year. Thus, this added economic incentive may convince the government to educate the public on the proper choice of regular-grade fuel for motorcycles and other vehicles.

Another strategy to reduce air toxics and vehicle emissions is the use of fuel blending agents such as oxygenates. It could have significant impact on air quality in Bangkok since the ambient CO concentration usually exceeds the U.S. air quality standards. Studies of current and projected CO concentrations in major cities in Thailand are needed to determine if a fuel-related strategy for CO reduction is warranted. The current policy of adding methyl tertiary butyl ether (MTBE) to gasoline should be evaluated in light of the use of 3-way catalysts in future vehicles with electronic control of the air/fuel ratio. Should the use of engine management controls with exhaust oxygen sensors negate the need to have MTBE as an oxygenate, the reduced use of MTBE will diminish it as an environmental contaminant in air and water.

Benzene is another compound of concern to public health, and a clear understanding of the actual risk of benzene exposure in realistic scenarios should be ascertained. This will require a rigorous risk assessment study to examine the impact of benzene and other aromatic hydrocarbons in gasoline. Reduction in benzene is usually a feature of RFG.

Recommendations:

- 22. Develop an action plan to encourage the use of regular-grade (87 octane) gasoline instead of premium grade for motorcycles and other vehicles. This will reduce the need for aromatics and other high-octane components that are reactive in the atmosphere as precursors to ozone formation. There is an associated economic savings as well.*
- 23. Determine to what extent adding oxygenates such as MTBE to gasoline would reduce emissions of carbon monoxide and air toxics, much of which can be attributed to the misconception among motorists about the benefits of using high-octane gasoline in 2-stroke engines. Examine the potential deleterious effects that MTBE might have as a contaminant in the water supply and in the air. Monitor the ongoing research efforts in Taiwan and Japan to control emissions from 2-stroke engines.*
- 24. Consider a cleaner gasoline reformulation to reduce emissions from current and future vehicles equipped with catalytic converters. The reformulated gasoline should have less than 50 ppm of sulfur.*
- 25. Require gasoline stations to install vapor recovery controls that will reduce evaporative emissions during vehicle re-fueling and fuel transfer from tanker trucks to storage tanks.*
- 26. Offer incentives to change the personal mobility culture in Thailand away from 2-stroke toward 4-stroke motorcycles or automobiles. This will improve the quality of life in terms of the environment, public health, and traffic safety.*

Alternative Fuels

The development of alternative fuels and new powertrains will be a technological challenge in the 21st century. Factors that will determine the future of alternative fuels and the next generation of vehicles designed for the new fuels include:

- Their cost relative to conventional fuels and vehicles
- The increased cost of owning and operating the vehicle
- The availability and convenience of fueling stations

In general, alternative fuels, compared to conventional diesel fuel and gasoline, result in less emissions. Particulate (PM) and non-methane hydrocarbon (NMHC) emissions are generally much lower, as has been demonstrated in vehicles using alternative fuels. However, the difference in emissions has been decreasing as emissions control technology and the quality of both gasoline and diesel fuel have improved. It is not clear that a reduction in emissions would justify the cost of using alternative fuels. In addition, the durability of alternative-fueled vehicles has not been established and must be addressed.

Compressed Natural Gas (CNG): CNG, burned in engines optimized for this alternative fuel, results in substantially lower HC, CO, NO_x and particulate emissions. The conversion to a CNG vehicle may limit the driving range, and the cost of retrofitting high-pressure fuel tanks and establishing centralized refueling stations may not be justified. One advantage of CNG is that it can be used in retrofitted fleets, and refueling safety issues can be explored before widespread use. Demonstration programs using city buses, taxi fleets, and ferries are encouraged. Such programs will provide the learning platform to examine durability and quality issues under field conditions.

Liquefied Petroleum Gas (LPG): LPG has been used mainly in 3-wheeled tuk-tuks and as a domestic fuel for cooking. Although there will be less trunk space for LPG passenger cars due to the larger fuel container, LPG may be a viable alternative for Thai taxis for several reasons: a) ease of metering, b) availability, c) low-emissions potential with appropriate retrofit, d) simple vehicle convertibility, and e) compatibility with existing engine components.

Electricity: Electric vehicles have been available for more than 100 years, but they have not become commercially acceptable because of their high cost and limited travel range, as well as the absence of vehicle re-charging infrastructure. Although electric vehicles themselves emit no pollutants, the power plants that produce the energy to charge their batteries do, and this should be taken into consideration. As it applies to 2- and 3-wheeled vehicles, electricity could be considered as an affordable, low-emissions option.

Ethanol: Ethanol is a renewable energy resource that can be derived from biomass. This option has not been economically attractive since the cost of ethanol has been higher than that of gasoline. However, efficient processes are being developed to produce ethanol from agricultural, forestry, and domestic wastes. Ethanol produced from these sources has been projected to cost about \$0.70/gallon by 2005. Countries such as Thailand, with very long growing seasons and ample rainfall, could produce a large amount of ethanol from agricultural and forest wastes. It can be added to gasoline at 5-15 volume % levels, reducing dependence on oil importation.

Methanol: This fuel is not a good candidate to replace conventional gasoline in internal-combustion, spark-ignition engines. It may, however, support the introduction of future fuel-cell-powered vehicles. This would require an infrastructure for production, storage, and distribution. It would also require a long-term commitment from the government, as well as infrastructure changes. Currently, its use is limited to the motorsports industry.

Hydrogen: Hydrogen is the ultimate clean fuel, but it does not exist naturally. It must be produced from another fuel, such as natural gas, coal, gasoline, alcohol, biomass, or water. Its combustion products are water and NO_x only, but it introduces an array of infrastructure problems. This is another clean alternative fuel which does not enjoy market success at present due to low fuel prices. It is best used in fuel cells, from

which water is the only emission. Ultimately, its use could be driven by tough global warming standards.

The success of alternative fuels will depend on the incentives provided to develop the market for new vehicles with fuels to meet stringent emissions standards. The problems associated with onboard storage and energy density for motor vehicles must also be resolved.

Recommendations:

27. Consider CNG for centrally fueled heavy-duty vehicles and vehicle fleets and ensure that CNG fuel quality meets SAEJ1616 specifications.

28. Monitor the development of fuels such as DME (dimethyl ether) and DMM (dimethoxy methane) for use in diesel engines, and ethanol for use in spark-ignition engines. These fuels may be appropriate for Thailand.

Lubricants

Engine manufacturers recommend specific engine oils for good engine performance, low emissions, and long-term durability. Most vehicle manufacturers use either European ACEA or API (American Petroleum Institute) specifications. For spark-ignition engines, American and Japanese auto manufacturers favor ILSAC (International Lubricant Standardization and Approval Committee) specifications, which represent a more highly defined version of engine oils specified by the API.

It should be noted that all automotive lubricants sold in Thailand are required to be registered with the Ministry of Commerce and must comply with or exceed API lubricant standards. Two criteria need to be met to ensure that oil of good quality is available in Thailand:

- Engine oils sold to the consumer must be identified as meeting the limits of the selected classification.
- Oil in the container must actually meet the specified limits on performance and physical properties.

The Thai government has an important role in ensuring that these criteria are met. The government should set up certification and sampling programs to evaluate the quality of commercial oils on a regular basis. U.S. certification programs could be used as an example, although specific programs should be identified and tailored to meet the needs of Thailand.

Recommendation:

29. Require that engine oils meet the requirements of recognized oil classification systems used in other parts of the world, and develop certification programs to ensure that oils sold in the marketplace meet the specifications indicated on their containers.

V. HARMONIZATION OF STANDARDS AND REGULATIONS

It is widely accepted that harmonization of standards will be beneficial to almost everyone. Unique national standards almost always impose unnecessary burdens on any global industry — higher development and manufacturing costs, primarily, which ultimately must be borne by vehicle buyers. Recently, there has been a dramatic acceleration in activities aimed at the global harmonization of vehicle standards in both the regulatory and non-regulatory areas.

Overall objectives of this working group were to discuss how the harmonization of regulations and standards can improve personal transportation in Thailand and strengthen the country's automotive industry. Harmonization of standards and regulations will stimulate trade and commerce regionally and globally while improving safety and air quality.

Global Harmonization of Standards

Numerous regional efforts have been progressing with the goal of achieving harmonization of environmental standards. To achieve true worldwide harmonization, activities are coalescing around the United Nations Economic Commission of Europe Working Party 29 as the global forum for vehicle regulations. Representatives from most of the vehicle-producing countries in the world regularly attend this forum. Currently, the European Union, Japan, and the United States are attempting to finalize a global agreement that should allow many non-European countries to become full participants in the process, thereby further accelerating harmonization of vehicle regulations worldwide.

The only way to ensure proper global trade and commerce in products and services is through international standards. Both the supplier and customer have an interest in establishment of international standards. They are key to ensuring that the customer can evaluate a product or service, particularly when the supplier and customer are separated by great distances. When international standards are used by the private and government sectors, maximum realization of the global market will be achieved. Suppliers, customers, citizens, and governments must all join in the process.

Most harmonization efforts thus far have been regional. Because of the desire by the business sector to pursue global harmonization, major government-industry initiatives are in process to create international mechanisms to further harmonization, both through technical/trade associations and through political/administrative bodies. The direction of most promise is the United Nations 1958 Agreement under which Working Party 29 (WP29) for the Construction of Vehicles functions.

A multinational proposal drafted by the U.S. Government, and supported by industry, was presented at the United Nations in June and November of 1997 to further this effort. A key element will be the establishment of a compendium of regulations whereby a country or region will be able to select from a group of regulations for application to its specific needs.

Recommendation:

- 30. Recognize UN/ECE WP29 as the primary focus for harmonization of global regulations and participate in that forum as soon as possible.*

Voluntary Standards

National standards bodies are an integral part of the process, having the expertise to develop unique domestic standards in the absence of appropriate international standards. Voluntary standards organizations such as the Society of Automotive Engineers (SAE) and the International Standards Organization (ISO) can provide the necessary infrastructure to help national standards bodies develop technical regulations. This would permit Thailand to adopt standards while avoiding unnecessary expenditures of resources and time.

Recommendation:

31. *Adopt SAE, ISO, and other international voluntary standards in addition to current national standards.*

Harmonization within ASEAN and APEC

There are a number of initiatives in process within ASEAN nations to pursue harmonization. Intergovernmental activities have been established to examine the potential for harmonization of technical, safety, and environmental standards.

The long-term objectives of APEC are to achieve free and open trade and investment in the Asia-Pacific area by 2010 for industrial economies and by 2020 for developing economies, with the key policy objective of standardization of rules and regulations and harmonization of technical, safety, and environmental standards. These actions are consistent with the desire for convergence of regulations worldwide. Approximately 270 automotive design features have been identified as being subject to regulation and standards within APEC countries.

APEC members recently narrowed the candidates for the Early Voluntary Automotive Sector Liberalization initiative, selecting among them the automotive industry because of its importance and linkage to other sectors. The work plan for the automotive sector consists of four major elements that would be pursued concurrently and serve as a balanced package to benefit all APEC member economies.

Thailand has played a prominent role in the APEC harmonization process. With the advent of a global process, Thailand would maintain its leadership role.

Recommendation:

32. *Continue leadership in coordinating harmonization efforts, first within the ASEAN region, and ultimately under the UN/ECE WP29 process. Support APEC transportation initiatives and continue participating in the APEC Transportation Working Group Road Transport Harmonization Project.*

Safety and Emissions Standards

The value of harmonized standards and regulations in the areas of safety and emissions should not be underestimated, since it bears directly on quality of life. Improvements in the areas of energy efficiency and anti-theft protection of vehicles and components are also achievable, at an affordable cost, through harmonization.

Recommendation:

33. *Adopt harmonized regulations/standards for vehicles, parts, and systems to promote safety and*

environmental protection.

Information Exchange

Relative to the above recommendations, an information exchange is necessary between the Thai and U.S. Experts to facilitate future efforts. Workshop Experts from the U.S. will provide their Thai counterparts with the following documents/materials:

- Copies of the UN/ECE/WP29 1958 Agreement on Global Technical Regulations
- A flowchart that outlines Thailand's participation in the global harmonization network (both regulatory and non-regulatory)
- Details on the International Harmonized Research Agenda (IHRA)
- Copies of the U.S. Code of Federal Regulations (CFR)

A flowchart would be beneficial to visualize the global process. This preferably would include both regulatory and non-regulatory processes from a worldwide perspective.

Thai representatives will provide the U.S. Experts with information on the APEC Early Voluntary Automotive Sector Liberalization (EVSL) initiative.

A mutual exchange of information will be essential to Thailand in determining how participation in ISO (International Standards Organization) can be of benefit. Similarly, an exchange is also needed to understand the operation and potential benefits of participation in SAE activities.

VI. DEVELOPMENT OF THE AUTOMOTIVE INDUSTRY

The growth of Thailand's automotive industry during the 1980s and 1990s was based almost exclusively on domestic demand. The recommendations in this section, if implemented, will help Thailand develop into a strategic automotive production center capable of meeting domestic demand while significantly increasing exports. Elements of an industry with such capabilities include:

- Multiple-model, world-class assembly plants with the flexibility to supply both domestic and export markets
- R&D and design capabilities that would enable domestic companies to develop and manufacture products that meet regional requirements
- A world-class tier-1 parts manufacturing base
- A supplier sector so strong that it could evolve into a regional parts sourcing center

Government Role

For Thailand to become a strategic automotive center, tax and tariff policy should be used as a stimulus. Rationalization of import duties and taxes, simplification of export procedures, and the provision of supporting infrastructure will revive what once was a high-volume domestic automobile and parts market. The elimination of protectionism will increase the competitiveness of the domestic industry, stimulating the auto market and the overall Thai economy. A stimulated, high-volume local market is necessary to develop world-class, competitive domestic auto producers, which in turn are necessary for expansion of the export market.

The government should recognize that the automobile is a necessity, not a luxury, and set policies accordingly.

Recommendations:

- 34. Levy taxes at the point of consumption, and accelerate the rationalization of tariffs and taxes. This should be done with a view to reducing import protection and assisting the domestic industry. Foster bilateral and multilateral agreements between Thailand and other countries in the Asia-Pacific region to gradually reduce trade barriers. Eliminate local content regulations and simplify export procedures.*
- 35. Maintain BOI (Board of Investment) privileges for the automotive sector, including related activities, and monitor and provide information to potential investors.*
- 36. Provide facilities for vehicle and parts testing, calibration, and certification.*
- 37. Increase emphasis on education and training of technical personnel. While the number of auto mechanics is high, there is a great need for more high-quality production technicians as well as tool and die designers and makers. The technical and engineering education system should be reformed to serve the manufacturing industry better. Engineers should have greater opportunity to design and perform applied R&D.*

Private Sector Role

Government alone cannot be expected to revive the automotive industry. Industry must do its part by, among other things, creating centers of expertise within Thailand to utilize local talents for creation of unique and innovative designs.

Recommendations:

38. *Strengthen assemblers' supplier support activities through development of centers of expertise.*
39. *Encourage more engineering design activities in Thailand to promote indigenous R&D and design capabilities.*
40. *Start transferring quality responsibility to suppliers by encouraging them to obtain international (ISO 9000, QS 9000, or ISO 14000) certification.*
41. *Use organizations such as SAE (Society of Automotive Engineers) as a resource to strengthen vocational training and industrial standards.*

VII. NATIONAL AUTOMOTIVE STRATEGIES AND POLICIES

Efficient mobility is an intrinsic human need that is essential for an improved quality of life and accelerated economic growth. The motor vehicle is recognized as the preferred mode of achieving mobility, and improving personal and public transportation is a priority for Thailand. At the same time, protection of the environment and enhancement of safety are important priorities. Successful strategies will recognize and reconcile the tradeoffs among these priorities.

Environmental Quality, Emissions, and Energy

Customers do not buy vehicles on the basis of their environmental friendliness; therefore, governments have a role in assuring that vehicle emissions do not become a hazard to public health. Opportunities for government-industry cooperation in reducing emissions should be pursued. Well-conceived emissions control programs are based on a determination of the source, nature, quantity, and health effects of all emissions, including those from stationary as well as mobile sources. All transportation-based emissions will be reduced by improved infrastructure and traffic management, which reduce congestion.

Recommendations:

42. *Develop research proficiencies utilizing domestic and global resources to devise national emissions control strategies.*
43. *Consider alternative fuels such as natural gas, which is readily available in Thailand.*
44. *Balance the possible benefits of greenhouse gas reduction measures against the need for sustainable economic development. The Intergovernmental Panel on Climate Change has outlined priority topics for research on this matter, and limitations on mobility should be considered only after the study is completed and reviewed.*

Institutional Mechanisms

The establishment of a mechanism for coordinating the activities of all government agencies that have responsibilities and resources for addressing transportation issues could improve the development and execution of comprehensive, effective transportation programs. This mechanism need not be a formal body with separate powers; it can take the form of a council made up of representatives from each transportation agency.

Recommendations:

45. *Use tools such as cost/benefit analysis for transportation planning. While such tools do not provide conclusive policy guidance, they are useful in providing a unified approach for analyzing the effects of policies on consumers, business, the environment, and the government.*
46. *Encourage high-potential university students to consider a future in the transportation field. Universities and institutions of higher learning should be encouraged to offer more programs in this field.*

Infrastructure

As population in urban and rural areas grows, so does the need for additional highways and streets. While government will continue to provide most of the infrastructure, private-sector funding for the construction and operation of roadways can be encouraged by removing barriers to such investment.

Citizen participation in transportation infrastructure planning assures public support for construction and funding policies.

Recommendations:

- 47. Adopt land-use policies that address traffic flow and infrastructure needs in congested areas. Policies promoting ring satellite towns and encouraging new industries and other employment centers (including government agencies) to locate outside of Bangkok would be helpful in meeting this objective. Land developers should be required to build access roads and parking lots for their construction projects, and abide by building setback rules.*
- 48. Give priority attention to public transportation. Bus systems provide the most flexible service, with their capability of changing routes and schedules to meet shifts in population and travel patterns. Rail systems can play an important role when properly planned. Thailand's vast river and canal system also presents a unique opportunity for transportation enhancements. Intermodal transportation coordination is essential to assure that highway usage, rail transit, river transport, and air travel are integrated to optimize their usefulness.*
- 49. Conduct a comprehensive study of Bangkok's existing road right-of-way to determine how to alleviate arterial congestion and fully utilize local streets. Enhance local street usage by widening to the full right-of-way width and consider road construction projects that can expedite traffic flow. A full review of the Hopewell transit project is important in identifying the most effective utilization of the existing construction. Modification to a rail-only project may prove cost-effective.*

Revenue for Infrastructure

The availability of a reasonably stable revenue stream for funding transportation projects is critical to ensure a sound, long-term program. Consideration should be given to a motor vehicle fuel tax, specifically for carrying out transportation plans. Fuel taxes are a way for the road user to pay for the facility. Public acceptance would depend on an understanding and trust that the money from the tax would be used strictly for road construction and repair. The regressive impact of the tax could be minimized by improvements in public transportation.

Recommendation:

- 50. Consider implementing a pilot congestion pricing program in which tolls on roads are increased during periods of heavy use and lowered when usage is low. Use existing electronic technology to eliminate the need for motorists to stop at tollgates.*

Operations and Enforcement

Exploration and adaptation of various traffic management measures, such as synchronized traffic signals, must be undertaken to alleviate congestion. Consistent enforcement of traffic laws also would be of great benefit.

Recommendations:

51. *Deploy technologies such as synchronized traffic signals and the electronic collection, organization, and communication of traffic information for use by drivers and dispatchers.*
52. *Enforce traffic laws, especially during rush hour, in a consistent way to condition motorists. Enforcement can be assisted by technology-based aids such as monitoring cameras that can identify violators for subsequent summons by authorities. Traffic laws should be drafted and enforced in ways that avoid the opportunity for abuse. Increase fines for offenses that can have a significant negative effect on traffic, such as double parking, running stoplights, etc.*
53. *Review and eliminate, where possible, reasons for vehicle trips taken in congested areas. For example, requirements that citizens appear personally at governmental or commercial offices for certain transactions can be reduced by permitting the transaction to be accomplished by mail or by decentralizing the office location.*
54. *Develop action plans to assure quick response to traffic accidents, which cause congestion. Motorists should be encouraged by educational programs and by insurance companies to move their vehicles out of traffic in less serious accidents.*

Highway and Traffic Safety

Reduction in traffic fatalities and injuries requires cooperation among the government, the automobile industry, and the public.

Recommendations:

55. *Open a dialogue involving government, motorists, and the automotive industry to permit discussion of new safety technologies. Such dialogue would be useful in identifying appropriate areas for voluntary measures by industry and/or government, and could encourage safety innovations.*
56. *Require the installation and use of safety belts in the rear seats of passenger cars.*
57. *Strengthen laws governing driving under the influence of alcohol and drugs. Additional enforcement training for police officers should be considered, and wide publication of enforcement actions would make drivers more aware of the risks of driving while under the influence.*
58. *Set stringent rules for driver licensing, including the demonstration of behind-the-wheel proficiency in traffic and frequent inspection of safety features (brakes and headlights) for all motor vehicles, particularly commercial trucks and buses. In developing and administering such rules, economic and productivity impacts should be considered.*
59. *Enforce cargo safety standards, with special attention on tie-down safety for heavy cargo; tank and pressure vessel safety for liquid and compressed gaseous fuels; and cask integrity for transportation of hazardous fuels and spent radioactive fuel products. Special routing criteria for different cargo should be reviewed.*
60. *Provide special training for ambulance personnel, police, and firefighters in emergency medicine. Consider similar training for bystander medical care for commercial and truck drivers, especially if they operate in rural areas.*
61. *Create a public awareness program that emphasizes the economic and emotional costs of traffic deaths and injuries. Concentrating on the effects of fatalities on surviving family members and friends may be more effective than featuring the harm to individual drivers.*

Two-Wheeled Motorized Vehicles

Since two-wheeled vehicles are used for roughly 40% of commuting trips in Thailand, care should be taken to avoid unnecessary interference with this important transportation mode. However, these vehicles are involved in an estimated 50% of traffic fatalities and produce a significant amount of air pollution and ambient noise. Mitigating their environmental and safety impacts, and studying ways to integrate them more efficiently into traffic patterns, should be priorities.

Recommendation:

- 62. Give priority to the reduction of emissions from conventional two-stroke engines. Develop incentives or policies to move owners of two-wheelers into safer and cleaner automobile, bus, or rail transportation. Success in doing so will depend greatly on whether infrastructure improvements will permit these modes to provide trips of similar rapidity.*