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Report on the Spring 2004 Mission

VEHICLE DESIGN STANDARDS AND PROCUREMENT PRACTICES IN EUROPE

This TCRP digest summarizes the mission performed May 6–21, 2004, under TCRP Project J-3, "International Transit Studies Program." This digest includes transportation information on the cities and facilities visited. This digest was prepared by Margaret C. Mullins of the Eno Transportation Foundation and is based on reports filed by the mission participants.

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INTERNATIONAL TRANSIT STUDIES PROGRAM

The International Transit Studies Program (ITSP) is part of the Transit Cooperative Research Program (TCRP). ITSP is managed by the Eno Transportation Foundation under contract to the National Academies. TCRP was authorized by the Intermodal Surface Transportation Efficiency Act of 1991 and reauthorized in 1998 by the Transportation Equity Act for the 21st Century. It is governed by a memorandum of agreement signed by the National Academies, acting through its Transportation Research Board (TRB); by the Transit Development Corporation, which is the education and research arm of the American Public Transportation Association (APTA); and by the Federal Transit Administration (FTA). TCRP is managed by TRB and funded annually by a grant from FTA.

ITSP is designed to assist in the professional development of transit managers, public officials, planners, and others charged with public transportation responsibilities in the United States. The program accomplishes this objective by providing opportunities for participants to learn from foreign experience while expanding their network of domestic and international contacts for addressing public transport problems and issues.

The program arranges for teams of public transportation professionals to visit exemplary transit operations in other countries. Each study mission focuses on a theme that encompasses issues of concern in public transportation. Cities and transit systems to be visited are selected on the basis of their ability to demonstrate new ideas or unique approaches to handling public transportation challenges reflected in the study mission's theme. Each study team begins with a briefing before departing on an intensive, professionally stimulating 2-week mission, after which team members return home with ideas for possible application in their own communities. Team members are encouraged to share their international experience and findings with peers in the public transportation community throughout the United States.

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Study mission experience also helps to better evaluate current and proposed transit improvements and can serve to identify potential public transportation research topics.

Study missions are normally conducted in the spring and fall of each year. Study teams consist of up to 15 individuals, including a senior official designated as the group's spokesperson. Transit properties are contacted directly and requested to nominate candidates for participation. Nominees are screened by a committee of transit officials, and the TCRP Project J-3 Oversight Panel endorses the selection.

Study mission participants are transit management personnel with substantial knowledge and experience in transit activities. Participants must demonstrate potential for advancement to higher levels of public transportation responsibilities. Other selection criteria include current responsibilities, career objectives, and the probable professional development value of the mission for the participant and sponsoring employer. Travel expenses for participants are paid through TCRP Project J-3 funding.

For further information about the study missions, contact Gwen Chisholm-Smith at TCRP (202-334-3246; gsmith@nas.edu) or Kathryn Harrington-Hughes at the Eno Transportation Foundation (202-879-4718; khh@enotrans.com).

ABOUT THIS DIGEST

The following digest is an overview of the mission that investigated vehicle design standards and procurement practices in Europe. It is based on individual reports provided by the team members (for a roster of the team members, see Appendix A), and it reflects the views of the team members, who are responsible for the facts and accuracy of the data presented. The digest does not necessarily reflect the views of TCRP, TRB, the National Academies, APTA, FTA, or the Eno Transportation Foundation.

VEHICLE DESIGN STANDARDS AND PROCUREMENT PRACTICES IN EUROPE

The theme of this study mission was "Vehicle Design Standards and Procurement Practices in Europe." The mission concentrated on the development and use of standards in the design of buses and rail vehicles as well as the procurement processes used to purchase both types of transit vehicles. Meetings were held with transit agency management as well as officials of the European Commission and railcar and bus manufacturers (for a list of host agencies, see Appendix B). The 2-week mission included site visits to Brussels and Bruges, Belgium; Stuttgart, Germany; Gothenburg, Sweden; and Reykjavik, Iceland.

OVERVIEW

European Union

Because the procurement process, rail technical issues, and bus technical issues are influenced by EU history and structure, it is useful to consider here a brief overview of the EU.

The creation of the European Union (EU) began with the Treaty of Rome in 1957. This original treaty was later amended by the Single European Act (SEA) in 1986, the Treaty of Maastricht in 1992, the Treaty of Amsterdam in 1997, and finally the Treaty of Nice in 2001. As a result of these modifications to the original, the treaty is now known as the EU Treaty. Overall, these treaties determined the scope of the EU and its responsibilities relative to the member states; the EU can only exercise authority specified in the treaties.

The EU Treaty eliminates, in principle, the application of any trade barriers or tariffs with respect to third countries. Accordingly, this treaty

- Guarantees free movement of goods, services, and capital between member states and disallows barriers to free trade;
- Forbids quantitative restrictions of imports of any measure;
- Prohibits discrimination based on nationality;
- Grants free use of services to nationals of one member country in all the other member countries; and
- Explicitly calls for equal treatment, open communication, and mutual recognition among all member states.

The EU is an organization of representatives from 25 European countries. There are multiple levels of membership to the EU. Full membership occurs when the country has adopted all EU legislative initiatives. Other membership designations exist, such as the European Economic Council, to which Iceland belongs, and the European Free Trade Area, to which Switzerland belongs. These membership categories offer varying degrees of participation and guarantees within the EU. However, participation in the legislative process is only allowed to full members.

The EU is not a state or government, but a body comprising a European Parliament, Council of the European Union, European Commission, Court of Justice, and Court of Auditors. These five EU institutions each play a specific role in the complex decision-making process. The EU has no tax-raising authority.

The European Parliament is composed of 626 representatives elected by the people of the member states every 5 years. This body acts as the EU's public forum, debating issues of significance and questioning policy initiatives.

The EU's governing body is known as the European Commission (EC). It can only act when in the best interest of the European community. The EC proposes policy and recommends legislative action, known as directives. These directives form the basis of implementing the EU's treaty provisions. The current EC consists of 20 commissioners, including the president, who are appointed by the member states and approved as a body by the European Parliament. Commissioners have designated areas of responsibility and act in the interest of the union, independently of the member states. Large countries have two commissioners, and small countries have one commissioner. The EC issues the directives affecting policy related to public transit procurement and vehicle design.

The Council of the European Union represents the national governments of the member states and guides intergovernmental cooperation. The European Council has the authority to adopt, reject, or change a directive initiated by the EC. The Court of Justice ensures compliance with the laws, and the Court of Auditors controls the management of the EU budget.

Société des Transports Intercommunaux de Bruxelles (STIB), Brussels, Belgium

The Brussels public transport company, commonly referred to as STIB, has a service area of 241 km^2 and over 1.6 million inhabitants. The city of Brussels covers 161 km^2 and has over 965,000 inhabitants. STIB operated as a private company until December 31, 1945. Because of the shortage of investment capital after World War II, a law was passed in December 1953 that created STIB as a public-private venture with 50/50 ownership. In 1978, STIB was nationalized when the public sector purchased the private shares of the company. When Belgium was divided into three geographic regions—Flanders, Brussels, and Wallonia—STIB came under the jurisdiction of the Brussels region. STIB competes with the private sector for the right to operate in the Brussels region.

STIB operates an integrated network of metro lines, trams, and buses. The public transport network extends almost 700 km. The network is composed of three metro lines with 68 stations covering 43.1 km, 17 tramway lines covering 205 km, and 47 bus lines with over 2,200 stops covering 432 km. The fleet consists of 90 metro units (217 cars), 292 tramway units, and 571 buses. Figure 1 shows a stopped tram in Brussels.

The regional government in Brussels is responsible for and owns the right-of-way and tunnels that STIB operates for its metro trains, trams, and in some areas buses. Up until the last two procurements, STIB was the owner of the metro cars. All of the system's buses are owned by STIB and are purchased as part of the organization's ongoing capital program.

Buses and, to a small extent, vans for persons with disabilities are used by STIB as feeders to the tram and metro networks, which carry the bulk of the passenger loads. STIB has an ongoing fleet replacement program, with buses lasting 8 to 9 years. At the time of the mission, STIB was preparing a public tender for 160 new replacement buses. This represents approximately 28% of the STIB fleet. Along with its ongoing bus replacement program, STIB expects to acquire 30 new metro units and 50 new low-floor tramway units between 2006 and 2007.

Currently, STIB identified 75% of its ridership as local residents within the 19 municipalities and 25% residing outside of Brussels. STIB says that this demographic has affected the political agenda within

Figure 1 Stopped tram in Brussels, Belgium.

the region and provides greater awareness of mobility issues, stronger alliances between the region and STIB, more ambitious financial planning, open discussions on fare policies and public tendering, and debate on the desired regulated competition.

In 2003, STIB recorded 220 million trips on its transit system, with an average daily ridership of 650,000 trips. Over the last 3 years, there has been a 39% increase in trips. This increase is attributed to increased vehicle frequency, increased visitors, and decreased fare evasion due to the limited free access on the system.

Stuttgarter Straßenbahnen AG, Stuttgart, Germany

Stuttgarter Straßenbahnen AG (SSB AG) is the transit agency serving the greater Stuttgart, Germany, area. SSB AG is a private company controlled by the public and managed in a manner similar to a not-for-profit corporation in the United States. While SSB does not operate a heavy-rail subway system, the agency operates an extensive network of tramways, light rail, and buses.

SSB AG serves a population in the metropolitan area of about 2.5 million people, of which about 600,000 live in the city of Stuttgart. Similar to STIB, buses are used primarily for local transport in outlying areas and as feeders to the light-rail and tram networks.

In 2002, the SSB AG network was composed of 13 light-rail lines and 57 bus lines. There were 546 km of lines and 124 km of tracks. Rolling stock consisted of 175 rail vehicles and 252 buses, of which 155 were articulated, and serviced 810 stations or stops. The company operated 28.8 million vehicle-kilometers and transported 181 million passengers in that year. Future plans include the expansion of the light-rail system with 3 new lines and increasing the total service length by about 115 km (71 miles). SSB AG also plans to open a third vehicle maintenance facility.

SSB AG has an annual budget of 300 million euros, of which 110 million euros is dedicated to capital investment, materials, and rolling stock. Funding comes from various sources, such as revenue from investment properties, external maintenance contracts, advertising, and fares. Revenue from fares, compensations from the city, and funds from four surrounding counties cover 75% of operating expenses. SSP AG is the owner of the infrastructure and rolling stock. It receives capital subsidies for 85% of infrastructure, 50% of light rail, and 55% of buses.

In the last 10 years, the organization has reduced its deficits from 63.9 million euros to 31.5 million euros. Deficit reduction focused on four main areas:

- Efficiency—Restructuring of staff.
- Wages and social benefits—New labor agreements and concessions.
- Pension plan—Reorganization of plan.
- Social services for the city—Reduced service.

During this same time period, passenger travel increased 28% and the agency's employment was reduced by 10%.

In a survey of the Stuttgart population, many residents expressed their satisfaction with the public transport service. From this survey, 70% indicated that they were very satisfied with public transport and 42% supported more funding.

Presently, the transport modal split in the region of Stuttgart is as follows:

- Pedestrians 26%
- Bikes 6%
- Cars 46%
- Public Transport 22%

Public transport has seen a 6% increase since 1976, while cars and pedestrians have decreased.

Over the last 25 years, SSB AG has invested over 2 billion euros in its light-rail system. The light-rail vehicles travel at an average speed of 26 km/h and have a low life cycle cost with a 99.5% availability. The railway has 97% high-floor platforms with 22% of the system underground. The bus system consists of low-floor, low-emission diesel buses. Portions of the bus public routes are separate bus lanes, which SSB indicates has reduced travel time by 10%. Finally, the operation of both the light-rail and bus systems is coordinated by a computer-based automatic vehicle control system. Both the light-rail and bus systems have priority signaling or right-of-way at traffic lights, and both systems possess a dynamic passenger information system.

Vasttrafik, Gothenburg, Sweden

Public transport in Sweden is coordinated countywide by the Public Transportation Authority, which is politically and financially responsible for all local and regional public transportation. The deregulation of local and regional bus services on July 1, 1989, allowed transportation authorities, both public and

private, to provide services under competition. Before competition, the county authorities negotiated with only one bus company per route.

The city of Gothenburg is located on the west coast of Sweden. Gothenburg, with a population of around 460,000, is the home to Vasttrafik, the region's public transportation company. Vasttrafik coordinates an impressive array of transit services, including regional and commuter rail, tram, bus, and ferry service and on-demand paratransit in the county of Vasta Gotaland.

Vasttrafik was formed in 1999 when five different companies serving different provinces merged to serve one regional province with a population of 1.7 million. Vasttrafik has 135 regular employees and 4,000 private-sector contract employees. The Vasttrafik staff handles most of the administrative functions, such as finance, information technology, and support functions. Vasttrafik is owned jointly by the regional government and by the 49 municipalities within it. Vasttrafik is divided up into four companies with separate governing boards that serve the areas of Skaraborg, Vanersborg, Boras, and Gothenburg.

Vasttrafik owns the commuter-rail rolling stock and some of the rights-of-way. The city of Gothenburg owns the trams and other parts of the right-of-way. The bus-operating contractors are responsible for procuring, maintaining, and operating all buses within performance-based guidelines provided by Vasttrafik. Vasttrafik is also responsible for maintaining the infrastructure to support all operations, with the exception of the trams.

Vasttrafik provides over 20,000 services each day on a network that consists of 205 trams, 50 trains, 1,500 buses, and 34 boats that cover 900 routes with 22,000 stops. Over 60% of the daily 300,000 passengers travel on the tramway. Figure 2 shows a tram operating in Gothenburg, Sweden.

During the 1990s, ridership on the system increased by over 10%, and large investments were made to the infrastructure. Presently, the fare box revenue ratio for the system is approximately 60%. Nevertheless, the agency is concerned with the rising cost of operations. In November 2003, fares were increased by 12%, and the new bus-operating contract is much more costly than the previous one. Ferries operating in the harbor have been reduced by 33%, and further service cuts are anticipated, with a projected 1% decrease in passenger numbers expected.

Figure 2 Tram operating in Gothenburg, Sweden.

Greater Reykjavik Transport (Straeto), Reykjavik, Iceland

Reykjavik, Iceland, is one of the most northern cities in the world. The Greater Reykjavik Transport, commonly known as Straeto, operates the bus system. Straeto provides transport services to 110,000 inhabitants of the city of Reykjavik and about 180,000 inhabitants of the immediate service area. Straeto began operating on July 1, 2001, and is owned by the city and the municipal governments of the six neighboring communities.

The agency is presently involved in four major activities: reorganization of its networks, evaluation of automatic fare collection systems, coordination of a fuel cell bus project, and the feasibility of light rail/street cars study.

Straeto operates fixed-route bus and paratransit service, owning 75% of the fleet of about 100 revenue vehicles. The remaining vehicles are owned by contractors. About 385 people are involved in providing transportation, of which 285 are directly employed by the agency.

Future plans for the system include reducing walking distances between stops, increasing travel speed, and establishing a 10-minute time frame between bus stops during peak travel time and a 20-minute time frame during nonpeak travel time.

Volvo Bus Corporation, Gothenburg, Sweden

Volvo is a multinational corporation headquartered in Gothenburg, with locations in Europe, Asia,

Africa, Australia, and North and South America. The Volvo group includes eight business areas—Mack Trucks, Renault Trucks, Volvo Trucks, Volvo Buses, Volvo Construction Equipment, Volvo Penta, Volvo Aero, and Volvo Financial Services.

Volvo has a work force of over 3,000 in Europe and approximately 2,400 in the United States. Its largest bus market is Mexico City, which has 1,133 units. The company also owns Prevost and Nova bus, which have units operating in North America. Volvo maintains 18 manufacturing facilities worldwide.

Volvo is the second largest manufacturer of buses in the EU in terms of units sold. Volvo estimates that it had about a 14% share of the bus market for new vehicles in the EU in 2003.

The company is currently reviewing the development of a "Life Cycle Assessment" that would cover the entire life of the vehicle. The assessment would include materials and production, fuel and exhaust emissions, and maintenance.

Bombardier, Bruges, Brussels

The city of Bruges is about 89 km northwest of Brussels. Bruges, which is also known in Flemish as Brugge, was formerly one of the principal cities of the historic region of Flanders. It is a picturesque old city noted for its numerous canal bridges. Bruges is linked by canals to the North Sea port of Zeebrugge and other cities. The city is a trade and transportation center and the location of one of Bombardier's rail car assembly plants.

Bombardier, Inc., is a multinational corporation with 63,800 employees and is headquartered in Montreal, Quebec, Canada. The once family-owned business, founded by Joseph-Armand Bombardier, has diversified into Aerospace, Transportation and Recreational products, Financing, and Global Marketing. The corporation has locations in North and South America, Europe, and Asia. Over 90% of its revenues are generated outside of Canada.

Bombardier Transportation offers services in rail equipment manufacturing, a full range of passenger railcars, and complete transportation systems. It also manufactures locomotives, freight cars, airport people movers, and propulsion. It controls and provides rail control solutions. Bombardier Transportation is also a provider of maintenance services.

PROCUREMENT PROCESS

EU Directives

The EU has established a series of directives to ensure that public procurement is open to Europewide competition and that suppliers and service providers in any EU member state are given an equal opportunity to tender and receive public contracts. The EU has begun the process of standardizing all types of procurements to

- Reduce the time required for processing procurements,
- Reduce the cost of the procurement process,
- Obtain cost efficiency in the manufacturers' pricing that is then passed along to the procuring agencies, and
- Lower the cost of operations maintenance and the cost of vehicle overhauls due to commonality of parts and systems.

The history of the application of these directives on the part of the member states has presented challenges, particularly related to interpretation and incorporation of the national measures. Three facts are important to mention about this dilemma:

- Member states are under obligation to adopt binding rules in implementing the directives into national law. Countries may be held liable if they fail to pass European directives into national legislation.
- European law supercedes national legislation. In the event of a conflict between European and national legislation, the former prevails.
- National legislation related to procurement remains effective, provided it remains below the defined EU monetary thresholds.

In promoting standardized procurement processes with the member states, the EU first solicited opinions and comments from citizens and procurement experts. Then, in the early 1990s, the EU began issuing public-sector directives. These directives cover contracts awarded by central government, local authorities, and other bodies in the public sector. The substantive rules for these public bodies, known as contracting authorities, are outlined in the following directives:

- Council Directive 93/36/EEC of 14th June 1993 coordinated procedures for the award of public supply contracts (the supplies direc-

tive). In addition, this Directive requires the evaluation criteria to be listed, but does not require the relative weight applied to each criterion to be listed.
- Council Directive 93/37/EEC of 14th June 1993 concerns the coordination of procedures for the award of public works contracts (the works directive).
- Council Directive 93/38/EEC of 14th June 1993 coordinates the procurement procedures of entities operating in the water, energy, transport, and telecommunications sector (the utilities directive).
- Council Directive 92/50/EEC of 18th June 1992 relates to the coordination of procedures of the award of public service contracts (the services directive).

On March 31, 2004, Directive 2004/18/EC was issued to amend the public procurement procedures outlined in the works, services, and supply directives. In particular, Article 53 of Directive 2004/18/EC repeals Directive 93/36/EEC. As a result, contracting authorities will be required to identify the evaluation criteria and the relative weight for each criterion in the call for tender. The weights for each criterion may be expressed by providing a range with an appropriate maximum spread or with an exact figure. Member states have until January 31, 2006, to comply with this directive.

As part of these directives, the EU requires all procurements over 250,000 euros to be advertised in the *Supplement to the Official Journal of the European Communities.* Advertising in this publication also helps to ensure that procurement announcements are translated into other languages. However, contracting authorities can require the tender to be submitted in the authorities' native language. For procurements over 50,000 euros, three tenders are required. In addition, procurement rules apply for transport services when contract awards are over 160,000 euros for national authorities, over 249,000 euros for local and regional authorities and over 6,242,000 euros for work contracts.

In addition, the EU has defined potential breaches of the procurement rules. Some of these include when

- The awarding authority fails to advertise a relevant contract in the *Supplement to the Official Journal of the European Communities;*
- The authority uses non-objective criteria in choosing its supplier, whether at the qualification or award stage, which discriminates between suppliers;
- The authority fails to specify its qualification and award criteria at the outset of the procedure, or the authority does so but then changes the criteria, or the authority applies the criteria in an unfair way;
- The authority lays down technical specifications or standards that discriminate against certain suppliers; and
- The authority fails in some other way to respect the duty to treat all tenderers equally.

As a result of potential breaches, the procurement rules are supported by two directives that deal specifically with remedies. Council Directive 89/665/EEC (dated December 21, 1989) and Council Directive 92/13/EEC (dated February 25, 1992) require each member state to ensure effective remedies. Means of enforcement are made available to suppliers, contractors, and service providers who believe that they have been harmed by, or infringed upon by, the procurement rules. In addition, the remedies directives require member states to ensure that interim measures are available. In particular, complainants must have the possibility of obtaining an interim suspension order, which suspends the contested award procedure in question.

The remedies directives also stipulate that national courts or tribunals be given the authority to lay down set-aside orders and orders for the amendment of documents. As for the issue of damages, the directives require that the remedy of damages be available to a complainant, regardless of whether or not the contract in question has been entered into. In all member states, damages may only be granted in the ordinary civil courts, even though the complainant typically has to apply to an administrative court or tribunal in order to obtain interim or set-aside orders.

Another alternative is for the supplier to submit a complaint to the EC. The EC has audit authority over contracting agencies and final authority. When a decision is rendered by the EC, it is published in the *Supplement of the Official Journal of the European Communities* so that all interested parties may learn from the rendered decision.

Tender Evaluation Criteria and Award

The evaluation of tenders received by a contracting authority rests with the authority. Contracting authorities are allowed to consider two evaluation criteria: lowest price or the most economically advantageous bid. The EU does not direct which type of tender the contracting authority must use. Typically, standard items with clear specifications are procured under the lowest price bid. Items or services of a complex nature are usually procured under the most economically advantageous bid.

If the contracting authority chooses to award a contract based on the most economically advantageous bid, the authority must make certain that the economic and quality criteria upon which the tenders will be evaluated are clarified in the call for tenders. Such criteria may include, but are not limited to, quality, environmental characteristics, technical assistance, delivery date, energy consumption, compliance with the tender, company history, and technical merit. The evaluation criteria selected should enable submitted tenders to be compared and evaluated objectively. It is further stated in Directive 2004/18/EC that the criteria should not be set higher than what the contracting authority needs to make a reasonable and sound determination. All tenders are to be evaluated on the previously established criteria to determine which one offers the best value for the money by meeting all technical specifications and achieving the greatest number of evaluation points.

In some complex procurements, the weighting of the criteria might not be established in advance by the contracting authority. If this happens, justifiable reasons must be documented in order to be in compliance with Directive 2004/18/EC. If the weights are not listed in the call for tenders, then the evaluation criteria are listed in descending order of importance.

Transit Agencies

Each member state is required to adopt the EU directives into law within 21 months of legislation. Contracting agencies must comply with the directives, but, like the member states, they have the option of implementing changes immediately or waiting until the date specified in the directive.

STIB

STIB complies with all EU procurement directives. During the most recent heavy-rail procurement, however, Directive 2004/18/EC had not been adopted. Because of this, STIB staff determined the evaluation criteria in advance, but did not disclose the weighted importance of each criterion in the call for tenders. STIB uses a negotiated procurement process that is designed to comply with both Belgian and EU legislation regarding tendering.

The procurement process begins with a public call for tenders announced in the *Supplement to the Official Journal of the European Communities.* The public call for tenders lists the procuring agency, a brief description of the item, a provisional order of procurement dates, and the deadline for answering. After receiving responses to the public call for tenders, STIB confirms the expressions of interest by requiring certain financial and economic certifications, technical capability data, and prior experience references from each potential submitter. At the completion of this information-sharing phase, interested suppliers receive instructions for submitting a preselection package. In that package, suppliers are required to submit a confirmation of their interest in the procurement, as well as financial and economic data and any other required certifications. A description of the firm's experience in this type of procurement is submitted with references supporting the agency's claims. Vendors must also describe their ability to build the type of vehicle required by the procurement. Preselection packages must be submitted by the deadline set by STIB.

Preselection packages are analyzed on a pass/fail basis by STIB staff. Selections are made based on the information submitted with the general manager making the final decision. Preselected suppliers are notified that their applications have been approved. The suppliers are then told they will receive a call for tenders and specifications package. Only preselected vendors may participate in the tender process. The preselection process is carefully documented in the event of a complaint. In the event that a firm is excluded from the procurement, the company receives a letter explaining the reasons for the determination.

STIB uses an alternative preselection process for bus procurement contracts. STIB prequalifies bus manufacturers on a yearly basis for potential procurement opportunities. This prequalification task requires similar documentation to the railcar preselection process. Once qualified, a bus manufacturer only needs to contact STIB on an annual basis to reconfirm interest in future procurement opportunities. Then, when STIB issues a call for tenders, only

those vendors who have been prequalified receive an invitation to participate in the bus procurement.

During the preselection process and prior to issuing the call for tenders, STIB formulates the technical specifications and critical terms and conditions of the expected contract. The evaluation criteria are established and listed in the call for tenders in descending order of importance with no weights assigned. Price is listed as a factor, but not allocated any weight. It's important to note that weights for this procurement were established internally within STIB for evaluation purposes, but the weights are kept confidential during the entire procurement process.

The call for tenders goes out as a written invitation to the preselected or prequalified manufacturers. Before submitting the tender, manufacturers are asked to provide additional information that assists in the evaluation process. Also, during this stage, based on the information provided by the manufacturers, complements or addendums to the call for tenders are issued to all suppliers participating in the procurement.

Tenders submitted by potential suppliers are detailed. Comprehensive rewriting of administrative and technical clauses, which describe proposed exceptions to specifications and terms and conditions, form the body of the tender. Required technical and administrative forms are submitted. Equipment options are proposed by the supplier. Technical documentation and supporting calculations are submitted. A description of the supplier's infrastructure and means for support within 24 hours is required. Finally, the supplier makes a commitment on the stability of the project manager's position.

Technical and administrative forms are categorized by importance. Category 0 forms document essential requirements, such as maximum weight and minimum number of seats. Non-compliance with Category 0 requirements, results in exclusion from the tender. Category 1 requirements are very important and are a basic part of the tender. However, suppliers can propose options to the specified requirement. Category 2 and 3 requirements are of lesser importance.

After receiving the tenders in two parts (one technical and one price), a group of technical experts analyze and evaluate the technical proposal. This evaluation team attempts to get the various proposals on equal terms through discussions and informal negotiations with the vendors. Evaluation of the technical quality of the tender includes compliance with the technical specifications, the degree of compliance with category items (Categories 0, 1, 2, and 3), a commitment to energy conservation, and the ability for later product evolution, such as software upgrades.

An intermediate evaluation report is given to the general manager, who asks the manufacturers to make presentations (note: no scoring is done yet). Technical tests are also performed to confirm vehicle conformance with the performance-based specifications. Some of these tests are performed in Brussels, while others require technical observation at the manufacturer's plant or at other locations where a similar system is in service. At the completion of this testing period, the final technical evaluation is completed and scores are assigned by the technical evaluation team on the preestablished weighted criteria.

At this point in the process, the general manger and assistant general manager of procurement review the price tender. In the recent rail car procurement, price was assigned a 50% weight (100 points) based on a maximum score of 200 points. Other weighted factors included technical (73 points), commercial terms and conditions such as payment schedules and guarantees (11 points), organization (11 points), and clarity of tender (5 points). For bus procurements, the weighted factors are similar, although price is given a weight of only 45%. Overall, the final evaluation criteria are generally

- Financial quality,
- Commercial quality,
- Price,
- Payment schedules,
- Guarantees,
- Technical quality,
- Compliance with specifications,
- Energy consumption,
- Ability for later evolution,
- Relationships with subcontractors,
- Ergonomics, and
- Credibility/reliability/history of performance.

The teams write a 60-page report outlining the reasons for the selection and the process undertaken to reach it. Then, the evaluation teams recommend an award of contract to STIB's Management Committee, composed of both senior STIB managers and the agency's Board of Administration (Board of Directors). Once the final decision is made, it is conveyed to the successful supplier as an "intention to order." The suppliers not selected are notified and

informed that they can request a copy of an evaluation justification report.

STIB does not finalize the contract's terms and conditions until after the notification of the contract award. At this point, STIB enters into final negotiations with the supplier and drafts the final contract documents. The actual contract includes administrative, financial, and commercial clauses. Some examples of administrative and commercial clauses include construction, supply, and preparation of putting into service the set number of vehicles; driving simulators; technical documents and calculations; list of subcontractors; means for intervention within 24 hours; and commitment to stability of the project manager.

As part of the contract, payment schedules are tied to milestone completion. In the most recent rail car procurement, the first five milestones generated payments totaling 22.5% of the contract value. The milestones included approval of systems (6 months), approval of specifications and models, acceptance and approval of the first finished car body, and approval of prototype testing. In addition, STIB required 20% of the overall award to be held in escrow until acceptance of the first prototype car. There are no incentives for early delivery or meeting deadlines.

There are also monetary penalties (as a percentage of the contract value) for non-compliance with contract provisions, including frequency of meetings not met, availability for passenger service not met, changing the project manager for reasons other than force majeure, and non-compliance with the rules for subcontracting. Violations of the technical specifications can also result in penalties for exceeding the weight of the vehicle or its main components, not meeting performance requirements (acceleration, braking deceleration), excess noise or vibration, or incompatibility with the existing operating environment or signal system. Some deficiency is acceptable, great deficiency is penalized, and above great deficiency is not acceptable.

There is an overall vehicle warranty that is in place until final acceptance. Warranties for certain systems continue in place beyond final acceptance. There are also warranties for minimum availability levels of 92% until complete provisional acceptance and 97.5% until final acceptance.

The entire procurement process for a vehicle acquisition normally takes 1.5 to 2 years for rail cars and about 6 months or less for buses.

SSB AG

The procurement process at SSB AG begins with the technical (i.e., design and functional) specifications of the vehicle. The legal and commercial terms and conditions are also prepared. The agency issues an invitation for tenders and commissioning.

Similar to STIB, SSB AG uses negotiated procurement procedures for purchasing vehicles, and the call for tenders is published in the *Supplement to the Official Journal of the European Communities.* The notice published in the journal outlines the basic technical specifications as well as commercial terms and conditions of the procurement. It also outlines special requirements for a supplier to participate in the tender, such as special knowledge, ability, reliability, and financial and economic conditions.

Evaluation criteria are specified in the tender request. Tender offers are graded on the degree of fulfillment of the technical requirements of the tender. Other evaluation factors include the availability of the supplier to perform; the economic condition of the supplier; price; contract terms and conditions; parts delivery and warehousing; necessary workshop equipment and special tools: service department, warranty, and goodwill commitments; production quality; maintenance costs; appealing design; and commitment to repurchase used vehicles.

The contract specifies the final negotiated terms, conditions, and specifications. The delivery schedule is also specified, and the permanent quality control process is incorporated. Other conditions include a warranty for life cycle maintenance costs.

Vasttrafik

In June 2001, the city of Gothenburg decided to acquire 40 new light-rail vehicles with an option to acquire up to 80 additional units. The tender was based on functional specifications that were developed through independent working groups representing technology, design, customer and accessibility, and financial interests. Evaluation criteria were decided in advance, with quality and price the most important criteria.

A two-step procurement process was used with interested parties. The first step entailed suppliers passing the three functional areas: technology, design, and financial. When the manufacturers passed these three functional areas, they proceeded to the second step, submitting a tender.

A consultant was contracted to write the technical specification in the call for tenders and to coordinate the effort. During this procurement, it was decided that the light-rail vehicles would be 100% low floor and would use proven technology that is being used in other cities within Europe. Special considerations included the severe weather conditions in Sweden, internal and external noise, vibration, and electronic interference. The driver's cabin had to be designed for driver comfort and visibility. There was also a requirement that at least 95% of the vehicle had to be recyclable at the end of its life. Vehicle-testing procedures were also described.

The design, customer, and accessibility group consisted of marketing, accessibility, and design professionals. The design standards related not only to the passenger but also to the image of the vehicle on city streets. The design group included a woman, since the majority of public transit riders in Gothenburg are women. The tender required the delivery of a 10-m, full-scale model to evaluate construction methods and to be publicly displayed. The tender offer was also required to include several ways of visualizing the design, such as design sketches, three-dimensional computer-assisted design (3D-CAD), and a model.

The financial group included a consultant and the financial officer from the regional transit agency. The tender specifications included a proposed contract to preclude surprises at the signing stage. An optional maintenance contract was specified as well as delivery tests, documentation, and training requirements.

For this particular procurement, when the tender offers were received, they were divided among the three teams. The first team evaluated the technical aspects of the bid, the second team evaluated the design aspects of the bid, and the final team evaluated the price proposal. All three teams evaluated the tenders in accordance with the evaluation criteria published in the call for tenders, which consisted of 50% for cost and 50% for quality. Since Vasttrafik places great emphasis on quality, the quality category was further broken down into sub-categories: 30% for promised quality, 12% for perceived quality, and 8% for vehicle standards.

The points earned from the technical and design criteria were added to the points earned under the price category by the price team. During the process, the financial background of the bidders and other important qualifications were checked. Tenders with the highest total points from a qualified company were recommended for contract award.

The three contracts that were awarded had terms of 8 years with a 2-year extension, 7 years, and 3 years with five 1-year extensions. The 8-year contract was considered standard for this type of service and consistent with Swedish law. Incentives and penalties were included as provisions of the contract. Two prototype vehicles were delivered 1 year before delivery of the production vehicles. They were tested in all operating environments, including the severe Swedish winter conditions.

In addition, the daily operation of the different modes of transport is contracted to a private operator, who bids on a contract and is selected through a procurement process, to provide drivers for each service or required schedule. The contract is retained for 7 years and tendered after this period. Vasttrafik decides on route network, size of vehicles, operating hours, headways, fares, environmental factors, and quality measures for the contract.

Straeto

Icelandic Public Procurement Act No. 94/2001 ensures equal treatment of bidders on public procurement and encourages active competition and efficiency in public operations. This act also provides for the options of conducting procurements as an open procedure, a restricted procedure, or a negotiated procedure. If the contracting authority decides to participate in a restricted tender, according to the act, prequalification is required. Chapter 13 of the act also covers complaints, the use of expert advice and assistance, rights of referral, time limits and processing, temporary suspension of contract procedures, and remedies available to the Tender Complaints Committee. In addition, if the contracting authority intends to award a contract on the basis of the most advantageous tender received, the act stipulates that evaluation criteria must be specific and listed in order of importance in the call for tenders. The city follows the procedures outlined in the EU directives when tendering for goods or services in excess of 250,000 euros. Otherwise, all other procurements follow the Public Procurement Act No. 94/2001.

Straeto's tendering document consists of three sections: process, contractual elements, and technical specifications. The city of Reykjavik governs and coordinates procurements for Straeto. Straeto staff prepares the technical specifications, but the city procurement department issues and evaluates the tenders.

Evaluation for Straeto is similar to that of other public transit authorities in that the technical and other criteria identified in the call for tenders are evaluated and ranked first. The price proposal points are placed on a matrix from highest points earned (lowest price) to lowest points earned (highest price). The technical and other criteria points are added to the price points to determine the most competitive bid. The Greater Reykjavik Transport Board consists of representatives from seven municipalities. These board members are responsible for making the final award of contract decisions during their monthly meetings.

Manufacturers

The tendering process in the European market for transit products and systems is evolving from a traditional approach that involves exhaustive and precise specification covering the whole product or system to a broader approach, where specifications are limited to essential requirements that components and products must meet. This broader approach has the potential for greater harmonization and interchangeability of products and components from different manufacturers. A critical element of the broader approach is the establishment of standards that define conformity procedures and allow flexibility at the product interface level.

Bombardier Transportation

Officials at Bombardier support the 2004/18/EC directive requiring contracting authorities to list the relative importance of each evaluation criterion in the call for tenders. Prior knowledge of each evaluation criterion will allow Bombardier to develop a more competitive tender.

The firm is investigating standardization based on vehicle platforms where existing products can be used in different markets to meet functional specifications. The major focus in this approach is to verify that all designs meet the performance requirements of the purchaser through

- Design reviews,
- Approval of drawing with the client,
- A type test to meet requirements,
- Routine test programs,
- Reliability reviews,
- Supplier/manufacturer reviews,
- Analysis of failure reports,
- Manual and documentation reviews, and
- Resolution meeting for contract deliverables.

Bombardier's contracts typically have provisions for incentives and penalties. Incentives can include additional payment for early delivery or for a lower vehicle weight. Penalties are assessed for late delivery; high vehicle weight; or not meeting goals for reliability, availability, or life cycle costs. The company also provides a 2-year total vehicle warranty with on-site support. Maintenance and operator training is provided at Bombardier's plant and at the customer's facilities.

Payment schedules are typically tied to the cash flow of production. Thirty percent is usually due at preliminary design, final design, and delivery milestones, and the final 10% is due after acceptance and warranty. Bank guarantees, parent company guarantees, and performance bonds are the forms of surety that Bombardier provides.

Volvo Bus Corporation

Volvo supports the EU's efforts to standardize the vehicle procurement process. Volvo also supports the call for tenders practice that results in the awards going to the most advantageous proposal when both technical capabilities and price are evaluated equally. Similar to Bombardier, Volvo also supports publicizing and knowing the assigned weights of the evaluation criteria. In addition, representatives stated that having vendors work together to make large purchases would not only make the process easier but also help standardize the product.

From a procurement perspective, Volvo is developing a life cycle assessment that would cover the entire life of the vehicle. The assessment would include materials and production, fuel and exhaust emissions, and maintenance. Volvo representatives stated that a manufacturer should produce vehicles that meet the authority's technical and quality standards and then fully certify them.

RAIL TECHNICAL ISSUES

European Rail Research Advisory Council

The European Rail Research Advisory Council (ERRAC) is an advisory body to the EU that represents member states, the railway manufacturing and supply industry, rail operators, infrastructure managers, users, academia, environmentalists, and urban planning organizations within Europe. These indus-

try stakeholders work in close partnership and by consensus to strengthen and reorganize rail transport research and development efforts in Europe. The first ERRAC meeting was held in November 2001.

Presently, ERRAC's overall goal is to stimulate innovation in Europe by focusing its research activities on the enhancement of capacity and improvement of value within the rail industry. The council recommends policies that address the standardization of products, innovation in technological growth and development, and protection of the environment. All policies correspond to the EU's directives. More specifically, ERRAC focuses on

- The development of an efficient European system, including interoperability;
- The increase of competitiveness of the global railway system;
- The improvement of the efficiency of the infrastructure while improving rail safety; and
- The limitation of noise and emission of pollutants.

ERRAC's activities include

- Launching and approving the strategic research agenda;
- Evaluating the overall results and benefits of the strategic research agenda for member states, the commission, and stakeholders groups;
- Recommending measures for optimizing the use of existing research infrastructures and achieving cost-effective investments in such infrastructures;
- Recommending measures for improving educational policies to attract young people to work as scientists and engineers and to develop industry-needed skills; and
- Developing and implementing a communication strategy to promote awareness of the strategic research agenda and to disseminate information on stakeholders' research programs for facilitating consensus on priorities.

In addition, a member of ERRAC explained to the team that the council's basic purpose is to develop precompetitive research with the rail stakeholders in the following areas:

- **Interoperability**—to establish, guarantee, and continuously improve the conditions for the operational and technical integration of the different national railway systems in the EU and the accession countries.
- **Intelligent Mobility**—to harmonize systems related to seamless transport and to organize and harmonize transport information systems and databases relative to logistics, customers, and freight.
- **Safety and Security**—to identify and reduce hazards and to continuously improve railway safety. This area is not simply technical safety and security, but a more philosophical approach. A culture of safety and security must be established, with the results cumulating in a reduction in cost to railway stakeholders.
- **Environment**—to adapt noise-attenuating techniques to differing networks ahead of emerging standards using noise and vibration footprints in comparison with other modes; to reduce emissions, including electromagnetic emissions; to recycle material used in the construction and refurbishment of all rail vehicles and infrastructure, including design for prolong use; and to address energy efficiency and alternative energy sources.
- **Innovative Materials**—to achieve cost reduction for new build products and their maintenance. Innovation will improve rolling stock life cycle cost through engineering sciences that enhance the railway value chain, such as environmental compliance and safety.
- **Production Methods**—to develop innovative production technology and automation that will increase production quality, decrease cycle time, decrease scrap and rework, and decrease production space.

In addition, ERRAC has established the Strategic Rail Research Agenda (SRRA) to be the driving force in the vision to double passenger movement and triple freight traffic volume. Three factors have been identified by ERRAC as critical to making the vision a reality. First, research efforts in Europe will have to be better focused and effectively implemented. Second, a change in approach is needed to ensure that step changes in technology occur rather than the incremental changes that have characterized railway development in the past. Lastly, a considerable increase in coordinated investment is needed from the rail sector, the EU, and the member states.

As a result of the SRRA, in 2003 significant investments were allocated to research and development for rail programs:

- The rail supply industry invested 1 billion euros.

- The rail operators invested 250 million euros.
- The EU approved 200 million euros.

Libertine—Standardization of Light-Rail Vehicles

Libertine is a relatively new EU project that is focusing on the technical standardization of light-rail vehicles. It is funded by the European Commission Directorate General for Research. A consortium consisting of five consultants and the Union of the European Railway Industries (UNIFE) manages the project. The project began in September 2002 and will last 30 months.

The project expects to improve the competitiveness of the European rail industry, reduce manufacturing costs, and serve the needs of European transit customers more effectively. The project is also intended to build consensus among operators, the industry, national authorities, and industry experts. As the final outcome, Libertine will propose new technical standards and legislation/regulation for light rail and its components. These proposed standards are expected to be adopted by the EU and will influence future design, development, and operation of light-rail systems.

Working groups have been established and are addressing 10 priority topic areas: loading parameters; heating, ventilation, and air conditioning (HVAC); electromagnetic compatibility; noise; fire safety; structure gauging (rail gauge); access (accessibility); derailment prevention and ride quality; maintenance management; and the tendering process.

The loading parameters working group is proposing to establish a standardized maximum load allowed on a light-rail vehicle. Current maximum loads range from 5 to 10 passengers per square meter. The reach is 75 kg per seat, or 500 kg/m^2 for standees.

The main purpose of the HVAC working group is standardization of the mechanical, electrical, and logical interfaces between HVAC systems and light-rail vehicles. The goal is to increase modularity.

The group discussing electromagnetic compatibility has a serious challenge. There are a large number of vehicle systems and subsystems, components, infrastructure, and signaling and train detection systems throughout Europe. This makes it impossible to develop a single document that will address all of the applications. Therefore, the group plans to produce an unambiguous document that is sufficient to enable suppliers to substantially comply with the requirements and still remain competitive.

The noise group is looking at both curve squeal noise and the noise and vibration transmitted through the ground. A lot of work has been done in these areas in the past for heavy rail without coming to any substantial conclusions. The curve noise effort will focus on compiling a list of good and bad ways to eliminate squeal noise. Checklists will be developed for ground noise and vibrations. These checklists may lead to design parameters in the future.

The fire safety group is looking at modifying the existing fire safety rules for heavy rail and metros to include light-rail vehicles in surface operations by establishing a separate category for vehicles without an on-board fuel supply, with easy passenger evacuation, and with adequate communication equipment.

The structure-gauging working group is looking at a European standard for track gauging. Currently, for every country, calculations must be performed on a case-by-case basis for infrastructure dimensions, clearances, and so forth. The working group seeks to integrate light-rail vehicle requirements into an existing standard for heavy rail. Heavy-rail standards are speed dependent, whereas light-rail standards must be curve dependent.

Accessibility addresses the mobility disabled, the sensory disabled, those with cognitive and learning disabilities, and people with other forms of disability. The accessibility working group decided to divide the project into seven major accessibility topics with 81 sub-topics. The major topics include provision of information, layout and facilities at stations and stops, boarding and alighting, access to facilities and services on the vehicle, circulation within the vehicle, vehicle layout, and staff training. As an example, the boarding and alighting sub-topic of vehicle doorways will look at the minimum clear width and height of the vehicle door opening, the threshold, the number of accessible doors, the signage, the closing of doors, and the visibility of doors.

The goal of the derailment prevention and ride quality working group is to produce an optional vehicle-track interface specification that will initially focus on track geometry parameters and use standard vehicle designs as much as possible.

The maintenance management group is working on a handbook that summarizes maintenance best practices, especially in the area of life cycle costs. Input from transit operators, consultants, and the rail industry will be used. The objective is to en-

courage the rail industry to adopt strategies for implementing design concepts to improve maintenance and lower life cycle costs. The large number of possible topics will be reduced to those that are relevant to the largest number of transit operators and suppliers.

The tendering process working group is reviewing current practices in procuring light-rail systems and vehicles throughout Europe to identify best practices and recommend simplification of the tendering process. The group has found that a standardized form of tendering documentation could reduce the size and complexity of tender proposals and reduce the time and cost of the tendering process.

Bombardier Transportation

One of the world's leading rail vehicle manufacturers provided an overview to the team on some of the processes involved in the construction and delivery of a rail vehicle.

At one of Bombardier's plants, the activities at a vehicle-fitting area provided an overview of its six-sigma quality improvement program and its lean manufacturing processes. Bombardier explained that its six-sigma program is a very successful endeavor that continues to identify methods and make continuous improvements to the processes and procedures of its manufacturing plants. In the plant, the firm presently has one quality controller for every 10 assemblers. The plant is working on a program that will allow its assemblers to build quality into their work in order to improve quality and reduce inspection activity and cost.

One example of a lean manufacturing process that greatly reduces vehicle-fitting time is the creation of vehicle wire harnesses adjacent to the vehicle. Each vehicle requires 1 km of wire for each 1 m of a 30-m car. The organization's production staff determined that creating the harness adjacent to the vehicle reduced time and cost for packaging, logistics, and transportation. In order to address the complexities that constantly arise during the construction of a vehicle, the firm has a visibility center where daily reviews are conducted to discuss project status relating to the following: inventory, quality control/quality assurance, fitting methods, production, and planning. These reviews are essential because of the penalties that are embedded in contracts. These penalties result from reliability, availability, life cycle cost, and weight.

Officials expressed that one of their most challenging activities, in the vehicle manufacturing process, is a non-manufacturing activity. The delivery of manuals and documentation are often delayed because of the difficulty in obtaining ready data from sub-suppliers. Problems relating to language barriers, quality, and legibility are also encountered with drawings, prints, and schematics.

Bombardier, as previously stated, has a functional specification for review and use by clients. However, the company prefers, at a minimum, to have a vehicle designed and owned by Bombardier and acceptable to all members of the EU. Production time and cost would be lowered if the company did not have to customize every order. The singular design could be altered to a degree to satisfy the unique requirements of individual clients. Extensive reengineering would not be necessary, and items that differ from the primary design could be noted on as-built drawings. The different engineering standards from country to country and the different quality assurance and quality control programs from client to client are responsible for a great deal of increased production cost.

Technical Standards

STIB developed and employs the following technical standards for new rail vehicle procurements:

- Operational Conditions
  - Compatibility with the Existing Environment
    - Existing Infrastructure, Clearances
    - Noise
    - Vibrations
    - Electromagnetic Compatibility
- Maintenance Infrastructure
- Personnel and Clients: Ergonomic Aspects

The technical standards employed by SSB AG for new light-rail vehicles include the following:

- Technical Concept from the 80's
- Bi-Directional, Paired Light-Rail Vehicle with High-Level Boarding
- All Axles Are Powered
- Built-In Performance of 880 kW
- Top Speed of 50 mph
- Three Independent Braking Systems
- Convincing Design
- Positive Public Image—"Mercedes on Rail"

Additional technical standards for SSB are provided by the Verband Deutscher Verkehrunternehmem (VDV), the German association of transport operators (the US equivalent of the American Public Transportation Association), including the following:

- Low Floor
- Smog
- Air-Conditioning
- Noise
- Driver Place

Performance Standards of Vehicles

Although STIB officials noted the following items as functional specifications, for the purposes of this document they fall within the category of performance standards of vehicles:

- Vehicle Capacity
- Performance
  - Acceleration
  - Braking
  - Energy Consumption
- Operation Modes
- Passenger Comfort
- RAMS (Reliability, Availability, Maintainability, Safety)
- Industrial Design
  - Exterior
  - Interior

SSB AG performance standards for new light-rail vehicles included the following:

- Driven by All Axles with High-Level Boarding
- Length of 38.15 m
- Built-In Performance of Approximately 1,000 kW
- Top Speed of Approximately 80 km/h
- Passenger Capacity of 249, with 108 Seated
- Three-Phase Electrical Current Technology Instead of Direct Current
- Air-Cooled System
  - Better Dependability
  - Lower Maintenance
  - Less Environmental Impact
- Components/Systems Redundancy
  - Electrical Current Regulator
  - Power Transformer
  - Propulsion Unit
- Component Over Design
  - Use of the Propulsion Set at 80% of Its Design Capacity
- Reduction in the Amount of Cables
  - Modular Design
- Environmentally Friendly Materials
  - Recycled Materials
  - Polyvinyl Chloride (PVC)–Free Material
- Articulation Between Two Vehicle Halves
- Screwed-In Side Windows
- Expanded Passenger Information System
- Automatic Warm-Up/Self-Check Procedure
- Design of the Operator's Cab According to the Latest Ergonomic Concepts
- Air-Conditioning in the Operator's Cab
- Improvement of the Passive Protection of Other Vehicles and Their Occupants by Means of Better Visibility for the Operator
- Minimization of the Risk of Injury for Other Vehicles via Design of the Vehicle Front and a Retractable Rear Coupling

Technical Specifications

STIB has technical specifications for the following components:

- Car Body
  - Structural Requirements
  - Exterior Finish
- Passenger Compartment
  - Interior Finishing
  - Seats
  - Windows
  - Doors
  - HVAC
  - Special Provisions for Accessibility of People with Disabilities
- Passenger Information
- Communications System
- Driver Cabs
  - Overall Design
  - Driver's Comfort
  - Equipment
- Electric Traction and Braking Equipment
- Brake Systems
- Bogies
- Auxiliary Equipment
  - Batteries
  - Electrical Installation and Cabling
  - Compressed Air
  - Hydraulic Equipment

- Electronics
- Interaction with Signaling
- Fare Collection

- Driving Simulators
- Maintenance Simulators

In Gothenburg, Sweden, technical specifications for light-rail vehicles include the following:

- Track Standards
  - To Clarify the Conditions Under Which the Vehicle Has to Operate
- Electrical Interferences Among Electronic Equipment
- Sound Emissions
  - External
  - Internal
- Vibrations
- 95% of the Vehicle (by Weight) Must Be Recyclable
- Vehicle Surfaces
  - Minimize the Graffiti
- Driver's Cabin
  - Visibility
  - Air-Conditioning
- Vehicle Computers
  - Ticket Validators

BUS TECHNICAL ISSUES

EU Standards/Directives

Bus standards begin with Directive 70/156/EEC, which prescribes three main classifications for buses: M1, M2, and M3. M1 vehicles, which carry the least restrictive standards, are passenger vehicles that carry no more than eight passengers. Classifications M2 and M3, for which the bulk of the directives apply, are differentiated by vehicle weight. M2 vehicles are designed and manufactured for carrying more than eight passengers plus the driver and having a mass not exceeding 5 metric tons. These vehicles are primarily minibuses. M3 vehicles are designed and manufactured for carrying more than eight passengers plus the driver and having a mass exceeding 5 metric tons. An update to 70/156/EEC is currently under development for release in 2005.

Standards affecting the maximum dimensions and masses of vehicles were implemented in March 2004. Vehicle length is limited to 13.5 m for two-axle vehicles, 15 m for three-axle vehicles, and 18.75 m for articulated vehicles and vehicles with trailers. The maximum width for all vehicles is 2.55 m, and the maximum height for all vehicles is 4.00 m. Vehicle mass is limited to 18 tons for two-axle vehicles, 25 tons for three-axle vehicles, and 32 tons (plus additional restrictions) for four-axle vehicles.

The following list shows all of the current standards for buses:

- 70/157/EEC Permissible sound level and the exhaust system of motor vehicles
- 70/220/EEC Measures to be taken against air pollution by emissions from motor vehicles
- 70/221/EEC Liquid fuel tanks and rear protective devices for motor vehicles and their trailers
- 70/222/EEC Space for mounting and the fixing of rear registration plates on motor vehicles and their trailers
- 70/311/EEC Steering equipment for motor vehicles and their trailers
- 70/388/EEC Audible warning devices for motor vehicles
- 71/127/EEC Rear view mirrors of motor vehicles
- 71/320/EEC Braking devices of certain categories of motor vehicles and their trailers
- 72/245/EEC Radio interference (electromagnetic compatibility) of vehicles
- 72/306/EEC Measures to be taken against the emission of pollutants from diesel engines for use in vehicles
- 74/61/EEC Devices to prevent the unauthorized use of motor vehicles
- 74/408/EEC Seats, anchorages, and head restraints of motor vehicles
- 76/114/EEC Statutory plates and inscriptions for motor vehicles and their trailers, and their location and method of attachment
- 76/115/EEC Anchorages for motor vehicle safety belts
- 76/756/EEC Installation of lighting and light signaling devices on motor vehicles and their trailers
- 77/389/EEC Motor vehicle towing devices
- 77/541/EEC Safety belts and restraint systems of motor vehicles
- 78/316/EEC Identification of controls, telltales, and identifiers
- 78/317/EEC Defrosting and demisting systems of glazed surfaces of motor vehicles
- 78/318/EEC Wiper and washer systems of motor vehicles

- 78/548/EEC Heating systems for the passenger compartment of motor vehicles
- 80/1269/EEC Engine power of motor vehicles
- 88/77/EEC Measures to be taken against the emission of gaseous and particulate pollutants
- 92/22/EEC Safety glazing and glazing materials on motor vehicles and their trailers
- 92/23/EEC Tires for motor vehicles and their trailers and their fitting
- 92/24/EEC Speed limitation devices or similar speed limitations on-board systems of certain categories of motor vehicles
- 94/20/EC Mechanical coupling devices of motor vehicles and their trailers and their attachment to those vehicles
- 95/28/EC Burning behavior of materials used in the interior construction of certain categories of motor vehicles
- 97/27/EC Masses and dimensions of certain categories of motor vehicles and their trailers
- 2001/85/EC Special provisions for vehicles used for the carriage of passengers comprising more than eight seats in addition to the driver's seat
- 2002/7/EC Masses and dimensions

Additional technical requirements known as annexes have been established in more specific directives that apply to buses, mostly in the context of amendments to the original 70/156/EEC directive.

In 2001, the EU released its most comprehensive directive, referred to as 2001/85/EC. This directive established three classes for vehicles with more than 22 passengers in addition to the driver. Class I vehicles allow areas for standing for frequent passenger movement. Class I vehicles must be accessible for people with reduced mobility, including wheelchair users. Wheelchair users have access to the vehicle by means of a boarding aid, such as a lift or ramp. The height of the first step for at least one service door cannot exceed 0.25 m. If it does, then a kneeling system is required. Class II vehicles have seated passengers but allow standing passengers in the gangway and/or in areas that do not exceed the space provided for two double seats (about 10 passengers). Class III vehicles allow only seated passengers. For vehicles with 22 passengers or fewer, there are two subclasses. Class A vehicles have seated passengers with room for standing passengers. Class B vehicles allow only seated passengers. Finally, Directive 2001/85/EEC contains special provisions for passengers with disabilities for vehicles carrying more than eight seats in addition to the driver. Effective February 13, 2004, member nations may refuse the registration, sale, and entry of new vehicles that do not comply with the requirements of this directive.

Bus Standard Development Process

The detailed technical requirements to meet the EU directives are being developed by experts involved in the European Committee for Standardization (CEN) and/or European Committee for Electrotechnical Standardization (CENELEC). In addition, consumer groups, member states, and manufacturers are involved in the process. These groups receive the proposed standards and issue comments. Then, public hearings are held and the documents are finalized.

Each member state will generally implement the directives through its own legislation, which can exceed the EU standards. Overall, vehicles will have to undergo testing in order to verify conformity to the applicable standards. Once the conformity is determined, the vehicle is certified for use across the EU. Starting with the European Economic Commission (EEC), the EU has outlined standards for buses based on the individual states' standards that had in many instances been in place for a number of years.

Safety and Security

The 2001/85/EC is quite specific in regard to many elements of safety in buses. For instance, the directive focuses on requirements for handrails and handholds for standees, number and main dimensions for doors, access to doors for regular use and in emergencies, emergency windows, and fire protection.

The example below is taken from the directive and relates to the minimum specification for emergency window egress:

> Source: Directive 2001/85/EC
>
> 7.6.8.2 Every emergency window shall:
>
> 7.6.8.2.1 either be capable of being easily and instantaneously operated from inside and from outside the vehicle by means of a device recognized as satisfactory, or
>
> 7.6.8.2.2 be made of readily breakable safety glass. This latter provision precludes the possibility of using panes of laminated glass or of

plastic material. A device shall be provided adjacent to each emergency window, readily available to persons inside the vehicle, to ensure that each window can be broken.

The EU, along with the Working Party on General Safety Provisions of the UN Economic Commission for Europe (UNECE) Inland Transport Committee (GRSG), is considering a new proposal for rollover tests, a regulation that would apply to all Class I, II, and III vehicles. This proposed regulation, called the Enhanced Coach and Bus Occupant Safety (ECBOS) study, was undertaken to update rollover test standards relative to current bus dimensions, technology, and safety features. The proposed regulation would require a test of each vehicle type with passengers aboard to gauge the impact on individual passengers of different sizes using different restraints. The original standards did not measure the impact on passengers. In addition, after July 2005, two-point safety belts will be required in Class B and Class III buses.

Like many transit agencies worldwide, Vasttrafik is adding hardware and software to rolling stock to deal with safety and security issues. The use of surveillance cameras is strictly regulated in Sweden. Vasttrafik's program for security cameras recently completed its year-long test regarding the use of digital video cameras in two M3, Class I, light-rail vehicles. Both graffiti and threats of violence were greatly reduced. However, exterior graffiti remains a problem. As a result of the test, plans are underway to equip all light-rail buses and selected other buses with digital video technology. In some cases, the systems have already been installed. In a 30-m M3, Class I, vehicle, 10 cameras are used, with 2 cameras always in operation. In the event that vandals destroy 1 of the cameras in operation, the other will photograph the event.

Bus manufacturers, including Volvo, have active safety research and development programs to seek better safety solutions. The Volvo representatives presented the group with information on safety developments in three areas: door safety, side impact safety, and safety belt safety. For example, door safety was being improved with the addition of electrically sensitive rubber to existing pressure-sensitive door seals on some buses. Boarding ramps are also being tested for bus rapid transit applications.

Side impact safety is being pursued, partly in response to the additional demands of the Netherlands government. Volvo is using standards developed by APTA, which set a maximum allowable 3 inches of deformation of the side of a bus after being struck by an 1,800-kg car traveling at 40 km/h. Safety belts, particularly for Category M3, Class III, touring coaches, are an area of emphasis for Volvo. Extensive testing that measures injury limitation has been ongoing for some time.

Design Life of Buses

The EU currently does not mandate the useful life or design life for vehicles, since the EU does not supply funding for the vehicles. However, the various agencies are not precluded from implementing a required vehicle life.

STIB's main consideration for bus life and replacement is the availability of funding for new buses. The average bus age in STIB's 571-bus fleet is 12 years. To keep maintenance costs more manageable, STIB prefers to keep the fleet age at or below 8 years.

SSB is mandated by its funding agency to keep the vehicles a minimum of 10 years. Because of the current lack of funding, 12-year-old buses continue to operate. In 2003, the average bus age in SSB's 240-bus fleet was 6.4 years.

Although Vasttrafik does not operate bus transport directly (it privatizes that portion of transit), the most recent tender indicated that buses cannot be more than 10 years old. The entire fleet needs to have an average bus age of 5 years.

Straeto did not have a standard for design/useful life. The average bus age in its 75-bus fleet is approximately 12 years. The replacement schedule is strictly based on availability of funds.

Environmental Issues

All transportation, including private vehicles, account for 30% of the total EU energy consumption. Member states of the EU are 98% dependent on oil. Oil consumption for transportation increased 50% between 1985 and 1998, with transportation demand forecasted to grow 2% per year over the next decade. By 2010, passenger transport is predicted to increase by 19% because of a 16% increase in road traffic and a 90% rise in air traffic. Transportation of goods should increase by 38% by 2010. The average fuel consumption is assumed to be 30,000 liters per bus per year. This equates to 4.5 billion liters annually.

EU Emission Standards

The engine emission requirements are EU standards. Any fuel can be used to meet these standards. The EU allows regional and national directives to require alternative fuels, but these directives must also meet the EU emission standards. In some areas, alternative fuels were adapted voluntarily because it was unclear if conventional diesel engines would be capable of meeting the new EU emission requirements.

The EU emission standards have so far been met by the use of diesel engines. There has been a gradual change in the sulfur content of the EU diesel fuel to help meet the EU standards. Particulate filters have also been implemented in many countries to meet or exceed the standards.

To meet the upcoming EU 5 standard, Volvo representatives expressed that Europe will most likely embrace the Selective Catalytic Reduction (SCR) technology. SCR is a system that injects ammonia or urea into the exhaust stream in order to react with the nitrous oxide (NO_X). The reaction converts the NO_X pollutant to nitrogen and water.

Biofuels

A biofuel is a fuel made from a renewable resource such as corn, grasses, and wood. These fuels can be used alone or blended with other conventional fuels. Examples of biofuels are ethanol or biodiesel.

The EU believes that in order to meet the Kyoto protocol objectives, carbon dioxide (CO_2) emissions need to be reduced further. Biofuels are generally thought to reduce CO_2 or be CO_2 neutral. Burning conventional fuel releases CO_2. Burning a biofuel still releases CO_2, but the process of growing the crops to produce the fuel absorbs the CO_2.

The EU has recently passed Directive 2003/30/EC to promote the use of biofuels. This new directive allows each member state to set its own targets for biofuel usage. However, the member states must meet the minimum requirements set forth by the EU. The EU requires that biofuels make up 2% (based on energy content) of all fuel used by 2005 and 5.75% by 2010.

Hydrogen Fuel Cell Bus Project

The EU has funded a project for the testing and development of fuel cell buses and hydrogen-fueling infrastructure in Europe. Two of the cities visited—Stuttgart, Germany, and Reykjavik, Iceland—are participating in this project. The Clean Urban Transport for Europe (CUTE) and Ecological City Transport System (ECTOS) are the official project initiatives. CUTE is heading the project for Stuttgart, Germany, and eight other European cities, and ECTOS is sponsoring the project in Reykjavik, Iceland. The project entails 33 fuel cell–powered transit buses operating over a period of 2 years in these 10 European cities to evaluate different operating conditions. Figure 3 shows a fuel cell bus operating in Stuttgart, Germany.

Stuttgart and Reykjavik have different methods of obtaining the hydrogen fuel. Stuttgart operates three hydrogen cell fuel buses and uses a steam reformer that converts natural gas to hydrogen. Reykjavik uses electrolysis of water to create hydrogen. Electrolysis uses electricity to break apart water molecules into hydrogen and oxygen. The hydrogen is captured and the oxygen is released into the atmosphere. Electrolysis can be a very clean and environmentally friendly method of hydrogen production if electricity is not produced from fossil fuels. Since the electricity in Iceland is generated from very clean, renewable sources such as geothermal energy and hydroelectric dams, there are no emissions from the production of the electricity and hydrogen. The fuel cell used in the test buses is a proton exchange membrane (PEM) type.

The electricity provided from the fuel cell powers an electric motor that supplies the power to the wheels through a transmission. A mechanical transmission was used on the buses to allow the use of a power take-off to supply various belt-driven components such as the air compressor and the power steering.

The hydrogen fuel used in the vehicle is stored in cylindrical tanks on the roof of the bus. The hy-

Figure 3 Fuel cell bus operating in Stuttgart, Germany.

drogen is stored in a gaseous form compressed to approximately 5,000 lb/in.^{2}

The fuel cell project in Iceland is part of a larger national effort to transform the country into a hydrogen-based society by replacing fossil fuels with hydrogen. The country hopes to realize this transformation by 2050. The national goals include gaining experience in establishing a new infrastructure, gaining public acceptance of using an alternative energy source, and analyzing the life cycle analysis of the equipment (buses and filling stations) and the fuel production chain. The experience gained from this transit experiment in hydrogen technology will further the overall goals of the use of alternative fuel for Iceland.

Straeto has in service three hydrogen-powered buses manufactured by Daimler Chrysler. The units are fueled at a remote Shell hydrogen retail station that was inaugurated on April 24, 2003. Figure 4 shows a Straeto hydrogen fuel cell bus. Figure 5 shows a hydrogen fuel pump. Figure 6 shows a hydrogen fueling station.

Alternative Fuels and Environmentally Friendly Technologies in Use

STIB operates approximately 20 compressed natural gas (CNG) buses. In addition, it operates two diesel-electric hybrid buses. SSB AG mainly operates diesel buses with ultra low sulfur diesel and particulate filter technology.

Vasttrafik has privatized its bus services. The contracts for bus services require the contractor to meet more stringent requirements, such as the use of renewable/alternative fuels, or emission reduction technologies, such as particulate filters or hybrids. Renewable fuels, such as biogas and rapeseed methyl ester (RME), are used in Gothenburg. In addition, CNG powers approximately 50 of the buses operated

Figure 5 Hydrogen fuel pump in Reykjavik, Iceland.

Figure 4 Straeto hydrogen fuel cell bus in Reykjavik, Iceland.

Figure 6 Hydrogen fueling station in Reykjavik, Iceland.

by Vasttrafik's subcontractors. In 1998, the city government banned the use of diesel buses. However, because of the capability of the improved diesel technology to meet and exceed the emission standards, this ban was lifted. Ultra-low sulfur diesel and particulate filters have been in use since 1993.

Straeto primarily operates diesel buses in addition to the three fuel cell buses.

Performance Standards

The EU is developing a standard method of testing performance and energy use.

Energy Use

The EU is in the conceptual stages of developing a performance standard for energy use of transport. The overall goal will be to try to improve efficiency of vehicles through the use of innovative technologies or incentive-based programs to encourage the use of more efficient vehicles.

The International Union of Public Transport (UITP) Bus Committee is working on its Standardize On-Road Test (SORT) project. The goal of this project is to develop a standardized duty cycle for on-the-road testing. Use of standardized cycles for fuel economy and other performance testing will allow all buses to be evaluated on an equal basis. The standardized tests include three different cycles to simulate most types of transit operation: heavy urban, easy urban, and easy suburban.

Overall Vehicle Performance

Vasttrafik and STIB have incorporated vehicle performance requirements into their specifications. The requirements specified a percentage for daily and/or annual availability of the vehicles for revenue service. This concept is relatively new for both transit agencies.

Performance/Functional versus Design Specifications

STIB representatives stated that they use detailed design specifications. STIB has a dedicated group for coordination, technical studies, procurement, and technical services to write the detailed specifications.

Vasttrafik officials stated that they prefer performance/functional specifications. Because Vasttrafik lacks an in-house engineering staff, it primarily uses outside consultants to assist with any specifications. Subjects covered in the specifications are comfort, accessibility, air, lighting, and seating.

In Stuttgart, SSB AG staff stated that, rather than designing their own vehicle and issuing a request for proposals (RFP), they generally purchase the manufacturer's standard vehicle and then select from various options, such as type of seat and interior signing.

Straeto staff stated that they use detailed specifications for procurement of buses. However, they choose a "standard bus," and the detailed specification only covers specific options.

Bus Technology Initiatives

Vasttrafik has been leading Europe with technological innovations that are designed to improve customer service. Current and planned improvements—for both buses and stations—are in the areas of ticketing systems, voice-activated automatic timetable information, Internet information, intelligent speed adaptation, and automatic passenger counting.

New Ticketing Systems for Buses

Vasttrafik recently entered into a contract to furnish new ticketing machines for 1,700 vehicles for a total cost of 13 million euros. It is a contactless card system with proven technology. Future plans include using the cards for parking, taxi rides, or purchases in the passenger terminals. Arrangements are underway to make it possible to add money to the cards at business locations via the phone or the Internet. It is expected that the new ticketing system will be operational by the end of 2005.

Voice-Activated Automatic Timetable Information at Bus Stops

For the past year, Vasttrafik has used a voice-activated timetable information service. Currently, there are 3,500 stops installed with this system in the greater Gothenburg area. Vasttrafik uses a computerized synthetic voice that is trained to understand human speech. Thus far, the system is meeting expectations.

Real-Time Departure Information via the Internet

Since 1995, the vehicle control and passenger information system—referred to as KOMFROM—has been connected to the Internet. Customers, logging onto a web page, can obtain real-time departure times

from all stops on the bus system. In addition, information may be obtained regarding services offered at different participating municipalities. On a new beta-test website for Vasttrafik, customers can now track buses on the red express line to determine if the buses are running on time. Final implementation will follow.

Intelligent Speed Adaptation for Buses

Using innovative technology that was adapted for automobiles in Sweden, intelligent speed adaptation is now being tested on buses in the Vasttrafik system on a single route. The purpose of the new system—referred to as "Zero Vision"—is to reduce the speed of vehicles in order to prevent personal injuries.

A global positioning system (GPS) transmitter, installed on each bus, talks to a database that contains stored speed restriction data. The database computer server compares the driver's speed with the stored speed restriction data. If the driver at any time exceeds the speed limit, he or she will feel a resistance in the accelerator. The driver can override the system, but the purpose of the technology is to assist the driver in maintaining the correct speed. All information is stored in a black box in the vehicle and is used for planning new timetables. The new technology, so far, has shown a calming effect on the driver, and passengers have not noticed any changes in driving patterns. Decisions have not been made if this technology will expand to other routes.

APPENDIX A—STUDY MISSION TEAM MEMBERS*

Peter Cannito, Team Leader, President, MTA Metro-North Railroad, New York, New York
Paul Como, Vice President, Procurement and Materials, Metropolitan Transit Authority, Houston, Texas
David Gionet, General Manager, Fort Wayne Public Transportation Corporation/Citilink, Ft. Wayne, Indiana
John S. Holak, Jr., Senior Director of Procurement, Southeastern Pennsylvania Transportation Authority, Philadelphia, Pennsylvania
Donald Hyde, Contracting Manager, Capital Projects, New Orleans Regional Transit Authority, New Orleans, Louisiana
Charles Kalb, Procurement and Materials Director, AC Transit, Oakland, California
Robert Kielba, Assistant Chief Rail Equipment Engineer, Chicago Transit Authority, Skokie, Illinois
Henry Kolesar, Group Manager, Vehicle Maintenance Engineering, San Francisco Bay Area Rapid Transit District, Hayward, California
Richard Leary, Director of Vehicle Engineering, Massachusetts Bay Transportation Authority, Everett, Massachusetts
Kenneth McDonald, Director of Operations Capital Programs, Metropolitan Atlanta Rapid Transit Authority, Atlanta, Georgia
Ricardo Sanchez, Director of Special Projects, Corpus Christi Regional Transportation Authority, Corpus Christi, Texas
Jacqueline Tjards, Purchasing Manager, Spokane Transit Authority, Spokane, Washington
Karen Walton, Executive Director, Mat-Su Community Transit, Wasilla, Alaska
Kathryn Harrington-Hughes, Mission Coordinator, Vice President, Eno Transportation Foundation, Washington, DC

*Titles and affiliations are as of the time of the mission.

APPENDIX B—STUDY MISSION HOST AGENCIES/COMPANIES

BRUSSELS, BELGIUM
European Commission
Société des Transports Intercommunaux de Bruxelles (STIB)

BRUGES, BELGIUM
Bombardier Transportation

STUTTGART, GERMANY
Stuttgarter Straßenbahnen AG (SSB AG)

GOTHENBURG, SWEDEN
Vasttrafik
Volvo Bus Corporation

REYKJAVIK, ICELAND
Greater Reykjavik Transport (Straeto)

APPENDIX C—LIST OF ABBREVIATIONS

CEN—European Committee for Standardization
CENELEC—European Committee for Electrotechnical Standardization

CNG—Compressed natural gas
CO_2—Carbon dioxide
CUTE—Clean Urban Transport for Europe
EC—European Commission
ECBOS—Enhanced Coach and Bus Occupant Safety
ECTOS—Ecological City Transport System
EEC—European Economic Commission
ERRAC—European Rail Research Advisory Council
EU—European Union
GRSG—Working Party on General Safety Provisions of the UN/ECE Inland Transport Committee
HVAC—Heating, ventilation, and air conditioning
NO_X—Nitrous oxide
PEM—Proton exchange membrane
RAMS—Reliability, Availability, Maintainability, Safety
RME—Rapeseed methyl ester
SCR—Selective Catalytic Reduction
SORT—Standardize On-Road Test
SRRA—Strategic Rail Research Agenda
SSB AG—Stuttgarter Straßenbahnen AG
STIB—Société des Transports Intercommunaux de Bruxelles
UITP—International Union of Public Transport
UNECE—UN Economic Commission for Europe
UNIFE—Union of the European Railway Industries
VDV—Verband Deutscher Verkehrunternehmem (German Association of Transport Operators)

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