Magnetic Levitation

This is a technology that uses magnetic force to support the vehicle above guide rails and linear induction motors to propel them. Power is obtained from a third rail. As related to other MAGLEV applications, the technology under consideration in this study is "low speed MAGLEV" which has a top speed of about 80 to 100 kilometers per hour (50 to 62 miles per hour).

China Low-Speed MAGLEV
Courtesy of Transrapid International

Rapid Rail Transit

This is a steel rail-based technology category that features vehicles 15 to 23 meters (50 to 75 feet) in length, without articulations, that can be combined into long trains operating at high speeds. Medium and large versions of these vehicles also exist with the difference being the individual vehicle lengths. Power is usually obtained from a third rail.

Red Line (Los Angeles Metro)
Courtesy of AnsaldoBreda

Commuter Rail

This is a rail technology with trains consisting of one or more non-powered passenger cars pulled by a locomotive. The locomotive is typically a diesel-electric. Station spacing is typically four or more miles apart. The trains are compatible with freight rail trains (track gauge) and typically operate in mixed-rail traffic over track owned by others.

Technology Screening

All potential technologies were assessed in a screening process against criteria derived from the stated goals and objectives. Listed below are some of those objectives:

- Technical maturity: The technologies to be selected for combining with specific alignments must minimize risk from technical, schedule and cost perspectives. Technical maturity is measured in terms of operating service years, number of operating applications and reliability of operating systems. This criterion supports the goals of cost-effectiveness and feasibility by providing an indication of the cost certainty and schedule risk.

- Line capacity: Selected technologies must have the capacity to accommodate the travel demand for the planning horizon of year 2030. At this stage of the project a detailed travel-demand estimate has not been produced; however, from earlier work in the corridor it is assumed that a minimum threshold of between 3,000 and 5,000 pphpd will have to be accommodated by the technology. Capacity will be measured for a technology's minimum and maximum train length. This criterion relates to the goal of mobility by identifying whether the projected number of transit riders in the corridor can be accommodated by a given technology.

- Performance: Because of the distances between various activity centers being connected by the project, technologies should achieve relatively fast travel times. Higher operating speeds will result in faster travel times which, in turn, will promote system use. This criterion relates to the goal of improved mobility.

- Maneuverability: Technologies must be able to physically operate within the corridor. Maneuverability relates to the right-of-way requirements for a technology given its performance capabilities and constraints with regard to the geometry of proposed alignments. This is measured in terms of a technology's achievable minimum curve radius for the horizontal alignment and by the maximum grade for the vertical alignment. This criterion was derived from the goal of feasibility. In order for the technology to be feasible, it must be able to maneuver through the corridor within the natural and man-made constraints and work within the potential alignment elevations so it will not limit the alignment options.

- Costs/Affordability - The selected technologies should be cost-effective given the type of service (mixed traffic versus exclusive ROW) they provide. Costs are considered in terms of general annualized capital costs, O&M costs, cost variability (technologies' ability to be at-grade as well as elevated) and the cost of extension (supplier competition for system extensions). This criterion provides an indication of the technologies' ability to be both cost-effective and financially feasible.

- Environmental- The resulting exhaust and noise emissions generated by the technology should be acceptable within the corridor. This criterion measures the technologies' ability to have minimum community or environmental impact.

- Safety - Technologies must meet local and national life/safety requirements. The transit operations should be inherently safe or the design of the system can accommodate safety concerns in a cost-effective manner. This is measured in terms of right-of-way exclusivity. This criterion relates to the technologies' ability to have minimum community or environmental impact.

- Supplier Competition - A sufficient number of suppliers of the technology need to be available to foster price competition on the project to obtain a cost-effective system. This criterion provides one indication of the potential cost-effectiveness of a technology.

- Implementation Time - This criterion considers the relative time for planning, design, permitting/funding and construction of the system. This criterion relates to the accomplishment of the goal of being feasible in terms of political and public acceptance of the implementation time.

- Accessibility - Selected technologies must comply with the Americans with Disabilities Act requirements. Vehicle boarding ease is another measure within this criterion and considers whether "level-boarding" occurs with a given technology. This criterion relates to how well a technology will allow the project to achieve the goal of equity by allowing equal access to the technology for disabled users.

Independent Selection Panel

In 2008 a five member panel made the selection of the technology based on the screen process and alternatives analysis. The system characteristics that were identified by the alternatives analysis were used by the Independent Selection Panel to evaluate the available technology. The following parameters were used to determine the system to be used by HART:

- System Characteristics

  -Required train service speed of 55 mph
  -Must be able to navigate through 150 ft. radius horizontal curves within the maintenance facility, 400 ft. radius horizontal curves on the mainline (elevated structure)
  -Maximum grade of 6%
  -Stations lengths will not exceed 300 ft.
  -Line capacity - 9,000 passengers per hour
  -End to end trip time in the range of 40 minutes
  -Emergency evacuation in all areas of the system
  -3rd Rail or equivalent (no overhead contact system)
  -Fully automatic train operations
  - Low noise and vibration requirements
  -ADA compliance at all stations

- Vehicle Characteristics

  -Electric propulsion
  -High floor
  -Dynamic and regenerative braking
  -Fire performance to National Fire prevention Association (NFPA) 130
  -High reliability/high availability
  -Minimum vehicle life of 30 years
  -Ergonomic design to accommodate US 5th percentile female to 95th percentile male
  -Attractive appearance
  -ADA compliant

- Functionality of the Proposed System

  -Special guideway requirements
  -Maintenance facility requirements

-Proprietary components or subsystems that restrict or limit competition
-Interoperability of the system to accommodate different manufacturers in the future
-Availability of long term engineering and maintenance support
-Representative costs for similar systems
-The technological maturity of the proposed system

Also, a working group determined fully driverless was needed to meet the objectives of the project. Where trains are completely unstaffed having fewer people on the payroll has financial advantages as staff represent a significant part of the cost of running a transport system.

The working group also sited other advantages of not requiring staff to be available to drive the trains include the ability to provide far more frequent services at quiet times (such as evenings and weekends) when passenger levels are lower and the revenue earned would not justify the costs of employing a full complement of train drivers, and the ability of train operators to vary the service frequency to meet a sudden unexpected demand - such as to instantly put extra trains into service when torrential rain interrupts an outdoor event and everyone decides to go home at 5 pm instead of 7 pm. The working group also mentioned in their report that some automated systems still carry staff on their trains, if only to operate the doors and generally reassure nervous passengers that there is someone 'onboard' who can take control in the (unlikely) event of a fault; others are fully driverless. However even these may have staff at busier stations and all have operations watching the platforms, etc,. via closed circuit television systems. Automation offers financial savings in both energy and wear & tear costs because trains are driven to an optimum specification - instead of according to each motorman's style. For the same reasons rush-hour services can be slightly more frequent as the automatic train control system can allow trains to travel at closer intervals.

Guideway & Station Equipment Concerns

Guideway

In order to keep the elevated guideway substructure and superstructure as simple as possible the traction power is located at ground level (see Figure 2-1 Figure 2-2). Also, equipment for third rail electrification in the track switches is contained in these Traction Power System Substations (TPSS) site locations.

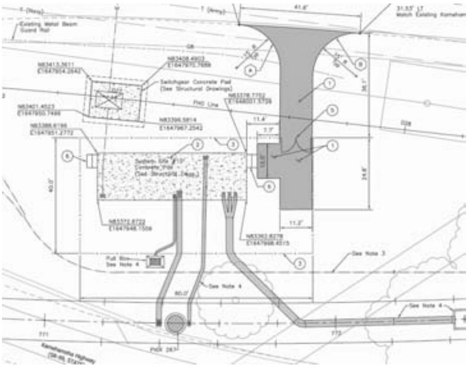

Figure 2-1 - Typical Site Plan for TPSS
Courtesy of HART

Figure 2-2 - Typical TPSS
Courtesy of HART

Station

Typically systems such as this require signaling and communication houses along the guideway. On the Light Metro for Honolulu it was determined to have rooms in the stations to accommodate such equipment. Listed below is a typical Station design and a Train Control & Communications Room (TCCR) layout (see Figure 2-3 and 2-4).

Figure 2-3 - Typical Elevated Station
Courtesy of HART

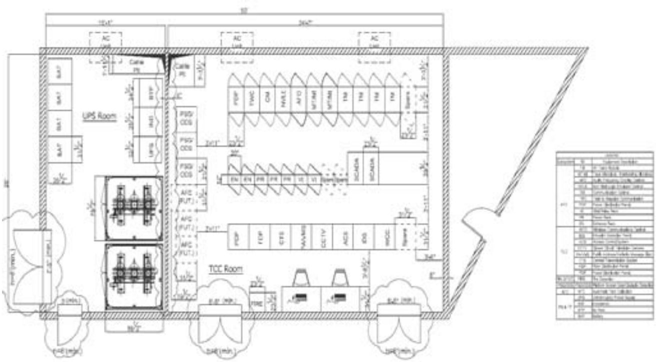

Figure 2-4 - Typical TCCR in Elevated Stations
Courtesy of HART

Per the system site map listed below (see Figure 2-5) there will be 13 system site locations and 21 stations all having differences depending on the location, surrounding infrastructure and land restrictions.

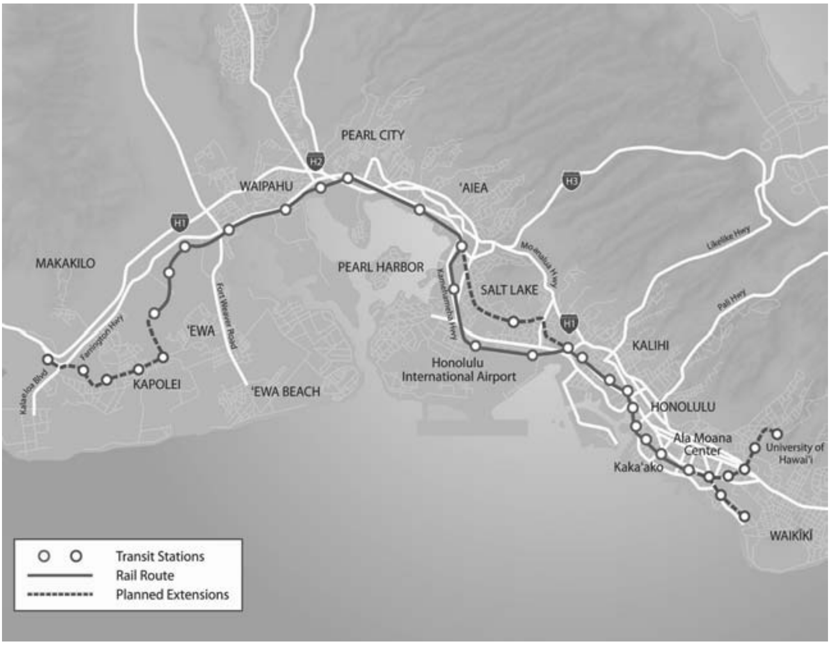

Figure 2-5 - System MAP
Courtesy of HART

Developing interfaces

The HART approach to developing interfaces between contractors was quite unique. For example a matrix approach was developed to have certain items provided by each contractor and others contracts buy material for others in order to take advantage of mill runs and economy of scale for other such items. For example, see Figure 3-1 - Interface Responsibility.

IC Item Number	**Interface** S=Specify requirements, D=Design, F=Furnish, I=Install, C=Construct, R=Requires coordination	Core Systems Contract #	W. O'ahu/ Farr. and Kamehameha Guideway DB	MSF (DB-200)	CM/GC	Guideway Design Contract	Guideway Construction Contract	Station Design Contract	Station Construction Contract	Escalator/ Elevator	Reference Drawing Number
	GUIDEWAY										
	Trackwork										
1	Running rail and special track work	R	I	F			I				
2	Track structure	R	D,I			D	I				
3	Insulated joint		F,I				F,I				
4	Limits of all track sections		R	R	R	R	R				
5	Structure borne noise and vibration	R	R			R	R				
	Electrification										
6	Contact rail assemblies	R	I	F			I				
7	Contact rail system	R	D,I	F		D	I				
8	Cable connections to contact rail	F,I	R	R		R	R				
9	Deck penetration sleeves for feeder cables	S	D,F,I			D	F,I				
10	Walkway sleeves for crossbonds	D	F, I				F,I				
11	Exposed raceway support elements	S	D,F,I			D	F,I				
12	Underground raceways	S	D,F,I	D,F,I							

Figure 3-1 - Interface Responsibility *Courtesy of HART*

Listed below (see Figure 3-2 – Interface to Outside Agencies) are the agencies that interfaces needed to be coordinated and developed. There were many working sessions and coordination meeting to iron out all the concerns and needs related to the rail system infrastructure.

1. **Electrical power feeds** (FFC / Hawaiian Electric Company)
2. **Telephone connections** (CSC , FFC / Hawaiian Telcom)
3. **Public Telephones** (CSC, FFC / Hawaiian Telcom)
4. **Direct line telephones** (CSC, FFC / Hawaiian Telcom, Various Emergency Agencies)
5. **Master Fire Alarms** (CSC, FFC /Hawaiian Telcom, Fire Dept.)
6. **Facility water and sewage** (CSC, FFC / Board of Water Supply)
7. **Storm drains** (CSC, FFC / Local Municipalities, Honolulu Department of Environmental Services)
8. **Street Lighting** (FFC / Hawaiian Electric Company)
9. **Maintenance of Traffic** (FFC / HDOT-State of Hawaii and DTS-City & County of Honolulu)
10. **Public Rerouting (**FFC / TBD)
11. CCTV (CSC / Honolulu Police Department)

Figure 3-2 - Interface to Outside Agencies

Contract Packaging

A mix of Design-Build (DB) and traditional Design-Bid-Build (DBB) delivery methods are being used on the Project to provide HART with greater economic and schedule advantages. A major portion of the work is requiring the procurement of individual design organizations under Final Design (FD) contracts who are preparing design documents for individual construction packages which are being procured using the Design-Bid-Build (DBB) approach. Procurement of the Core Systems (including Passenger Vehicles) is being accomplished through a Design-Build-Operate-Maintain (DBOM) contract that will improve integration and coordination of system elements with the fixed facilities, as well as, the transition to system-wide operations. Manufacture-Install-Maintain (MIM) contract(s) are being used for project-wide Elevators and Escalators. Trackwork and Contract Rail for the entire Project is being provided through the Maintenance & Storage Facility (MSF) Design-Build Contract. Each individual line segment contractor will obtain these materials at the MSF Site for installation in their respective line sections. Construction Engineering and Inspection Services (CE&I) contracts will be procured to provide contract quality control (inspection) of the construction contracts procured through the traditional design-bid-build approach. All of the various methods of contracting are being overseen by the GEC. There are currently forty-six (46) separate contracts identified.

As described above a variety of contracting approaches have been selected for implementation of the Project. These forms include:

- Fixed Price Proposals (D-B best value selection) for guideway first segments and the MSF
- Fixed Price Bidding for construction of guideway last segments and stations
- Design-Build-Operate-Maintain Proposals (best value selection) for Core Systems
- Competitive Proposals for professional services, except design
- Qualifications Selections for engineering and design services

Selection of contract packages and contract forms began during the Alternatives Analysis phase of the project and continues to the present day. In analyzing contracting approaches, HART used the services of its own staff, the Program Management Support Consultant (PMSC) and the GEC. Schedule needs, contracting risk, ease of administration, availability of qualified contractors and other aspects of contracting were considered. The procurement team also undertook consultations with a variety of industry sources.

- HART convened a Technology Selection Panel consisting of experts in the implementation of fixed guideway transit projects. While selection of the system technology was the primary function of this panel, they also provided input on the various approaches to project implementation.