



Safety Review
Cincinnati Fire Department
Monday, June 4, 2001

www.skyloop.org

Selection of Taxi 2000 Personal Rapid Transit (PRT) System —

In 1998, as a result of its Elevated Rail Transit Symposium, the Sky Loop Committee (SLC) of the non-profit Forward Quest of Northern Kentucky selected the Taxi 2000 PRT system out of a field of 10 competitors for a regional downtown circulator to be called the Sky Loop:

"We believe that this system is the most thought out in terms of design, concept, computer controls, and safety features. Because of its essential advantages and the depth of its engineering, we prefer the Taxi 2000 system."

Central Area Loop Study (CALs) —

A \$625,000 12 month Major Investment Study of transit modes for a circulator connecting the riverfronts and CBDs of Covington, Newport, and Cincinnati. Started in August of 2000; will complete in August 2001. The study, managed by the Ohio-Kentucky-Indiana Regional Council of Governments (OKI), is considering several alternative transit modes including:

- Modified Southbank Shuttle bus service
- Combined Light Rail Transit (LRT)/Vintage Electric Trolleys (VT)
- Sky Loop utilizing Taxi 2000 PRT

We recommend the Central Area Loop Study Committee (CALSC) —

Maximize potential benefits and minimize interim risks as follows:

1. Choose the Sky Loop as the Preferred Alternative for the Central Area Loop
 - The Southbank Shuttle will continue in the interim as the CAL system
 - The Sky Loop will be planned to interface as a circulator with the I-71 LRT Corridor system if it is implemented
 - Initiate Phase 2 – Preliminary Engineering, Detailed Ridership Study, and Business Plan Development, without any system capital investment, when Taxi 2000 Corporation initiates prototype development
 - The Sky Loop Project will continue into Phase 3 – System Implementation – or be cancelled, depending on results of the upcoming 3-year Taxi 2000 prototype development and test program

► If the Taxi 2000 demonstration and test is not successful, the Sky Loop Project can be terminated and re-selection made in 2004; No capital investment loss.

► If the Taxi 2000 demonstration and test is successful, the Sky Loop Project will be positioned to proceed as one of the first 21st Century urban transit systems in the world.

Sky Loop – Taxi 2000 PRT

Focus on Safety

1. **Elevated System:** Taxi 2000 is an elevated transit system, running on guideways:
 - Provides (grade) separation from all other modes of transportation — surface vehicular and rail, pedestrian
 - Elevation of guideways determined by local authorities
 - Elevation over roadways is thought would be typically 16 ft
2. **Guideways:** Guideways are steel truss structure with metal or metal-coated covers:
 - Two 600V DC power rails, one on each side, near top of truss structure
 - Guideways are completely static – no moving parts – since switches are in each individual vehicle
 - Covers have 5.5” opening at top, 8.0” opening at bottom; permits rain, snow, debris to fall through
 - Covers provide protection against ice and snow, electromagnetic shielding, reduced lateral wind force, an external appearance independent of structural characteristics, and prevent differential solar heating from distorting the guideway
3. **Vehicles:** Each vehicle weighs Aprx. 1,000 lbs and carries 650 lbs or three adult passengers on a 50” bench seat; can accommodate wheel-chaired passenger by flipping up bench seat:
 - In-vehicle bi-stable fail-safe switches: inherently more reliable than in-track switches; one misdirected vehicle does not tie up entire line; permits guideway branch points to be made with simple smooth curves; reduced visual impact of guideway, increased line capacity
 - Chassis is located in covered guideway – significant separation from cabin
 - Redundant Linear Induction Motors, brakes, controllers all located in chassis; HVAC in cabin
 - Chassis will have temperature sensors; Cabin will have smoke-fire sensors
 - Hydraulic bumpers with push mode couplers front and rear on chassis
 - Cabin made of mostly non-combustible or fire retardant materials
 - Cabin will contain two-way emergency voice communication with MCF (Maintenance & Control Facility)
 - Cabin will contain an emergency stop button, which when pressed, redirects vehicle to nearest down-stream station
 - Vehicle will contain enough battery energy for normal operation of the control system, the switch, the parking brake, the door actuator or solenoid, the reading lights, and, in emergencies, for a limited time the air conditioner or the heater. Additionally, enough energy will be available to power an emergency stop and to permit the vehicle to creep into the next station.
 - Emergency door releases on the outside of the vehicle doors
4. **Controls:** System utilizes three levels of redundant cross-checking controllers (computers):
 - Central Controllers (CC), Zone & Station Controllers (ZC/SC), and Vehicle Controllers (VC)
 - Zone Controllers communicate with vehicles every 0.1 seconds

- ZCs monitor speed and location of vehicles, issue switch commands for merges and diverges; issue merge slip maneuvers to facilitate merging without collision
 - All vehicles, including immobilized or vehicles needing emergency assistance, can be pinpointed in the system at all times
5. **Redundancy:** All 3 levels of controllers use checked-redundant, fault-tolerant computers; vehicles contain redundant motors and brakes. Failure modes and effects have been primary to the design of Taxi 2000.
- Redundancy is key to providing very high level of reliability and maximized Mean Time Between Failures (MTBF):
 - MTBF for vehicle estimated conservatively at 100,000 service hours (23 years at 12 hours/day in service)
 - MTBF for Zone Controllers estimated at $0.9(10)^{16}$ years
 - MTB Vehicle-to-Vehicle Collisions estimated at once every $1.2(10)^{15}$ vehicle-km
 - MTB Merge Collisions estimated at $40(10)^6$ years
6. **Vehicle Failure Emergencies:**
- **Coupled Push Mode** – In the extremely rare circumstance a vehicle comes to a stop, all following vehicles are commanded to slow to a safe 4mph speed. Vehicle Immediately following the stopped vehicle soft engages its forward coupler with the rear coupler of the stopped vehicle, and then pushes it under central control into the nearest station.
 - **Immobilized or Other Rescue Scenario** – In the extremely rare circumstance that a vehicle becomes immobilized, an emergency roadway vehicle with platform/cage on an extendable arm (“cherry picker”), will be dispatched to the scene, either by the local fire/rescue authority or by the system operator.
 - **Coordination With Local Fire/Rescue Authorities:** All such fire/rescue procedures will be planned and exercised in conjunction with local fire/rescue agencies.
7. **Emergency Walkways:** Emergency walkways alongside the guideways will be provided on the Ohio and Licking River bridge crossings
8. **Uninterruptible Power Supply (UPS):** Entire system will be supported in case of a power failure most probably a set of diesel generators with large battery packs for the minute or so it takes for the generators to go to full power
9. **Stations:** Stations will be designed and constructed to minimize hazards and provide for emergency coverage:
- Will be well lit and not have hidden areas
 - Television and infrared monitors connected to MCF
 - Emergency voice communication devices
 - Suitable barriers to prevent falling off platforms
 - Simple construction design incorporating non-flammable and fire retardant materials