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DEPARTMENT OF TRANSPORTATION | NEWS

URBAN MASS TRANSPORTATION ADMINISTRATION

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TECHNICAL DESCRIPTION
MORGANTOWN, W. VA., PERSONAL RAPID TRANSIT SYSTEM

The Morgantown Personal Rapid Transit (PRT) system consists of small, automatically-controlled vehicles which operate on a dedicated guideway either on a scheduled basis or on a passenger-demand basis. The rubber-tired, electric-powered vehicles each will carry up to 21 people.

The system connects the business district of Morgantown and the widely-separated areas of the West Virginia University campuses, covering a distance of 2.2 miles. In the year-long test phase of this installation, 5 cars will operate over a network connecting 3 stations and a maintenance facility. The guideway itself will total 27,000 feet, including travel in both directions as well as those parts devoted to the maintenance area, off-and-on ramps and loops.

Until construction is completed on the two additional stations and interconnecting guideway, initial testing and demonstration of the system is being done over the mile-long section from the Engineering Station to the maintenance facility. It is this portion of the system that is in use for the dedication ceremonies and it has a total of 10,500 feet of guideway. Vehicles travel approximately 75 percent of this section at a speed of 22.5 miles per hour.

When the system is operating in the demand mode, a passenger entering a station will depress a button to call a vehicle and select a destination. The request will be processed and the vehicle routed to the main guideway to merge with other vehicles. The vehicle will travel non-stop to the requested destination. Overall control of the attendantless vehicles will be maintained from a central control facility, where vehicle and other subsystems will be monitored and controlled.

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The Morgantown PRT system has three major elements: Structures and Power Distribution; Vehicle, and Control and Communications.

STRUCTURES AND POWER DISTRIBUTION

This system includes the guideway structure, the electrical power substations, the station facilities, the central control facilities, the guideway heating and the maintenance facility. The main guideway is a double guideway with two-way travel. The guideway in the stations is single, with one-way travel. Stations are two-level for passenger and vehicle movement on a non-interference basis. The system power is 60 Hertz, 23,000 volt, provided to a main substation which distributes power to all PRT facilities and the guideway power rail. The maintenance facility includes a storage yard, a test track and a vehicle and equipment service building. The central control facility is located at the maintenance facility.

VEHICLE

The Morgantown PRT vehicles, small by mass transit standards, carry up to 21 passengers -- 8 seated and 13 standing. The vehicle size was selected to provide economical service during both peak and low periods. The vehicle is 15.5 feet long, 6 feet wide, and weighs approximately 8,700 pounds empty. Speeds up to 30 miles per hour are provided by a DC electric motor. Rubber tires and an air bag suspension system provide a quiet, comfortable ride. The vehicle responds to remote controls and commands from the computerized control and communications system -- total automatic operation. Acceleration is nominally 0.0625 g with maximum jerk of 0.10 g/sec. Steering guide wheels follow rails mounted on the side of the guideway. Either left or right steering can be used, depending on the desired route. Power is collected from a rail mounted above and parallel to the steering rail. Three phase, 575 volt power is received, rectified and then controlled for operation of the 60 horsepower DC motor. Electric power also operates the lights, air conditioner, pneumatic and hydraulic pumps and the control system.

CONTROL AND COMMUNICATIONS SYSTEM (C&CS)

The C&CS is divided into three major elements: the Central Control and Communications Subsystem (CCCS); the Station/Guideway Control and Communications Subsystem (S/GCCS), and the Vehicle Control and Communications Subsystem (VCCS). The maintenance facility houses the CCCS. Operating stations are the Engineering, Beechurst and Walnut Street stations. The CCCS computer supervises transit system operations. Separate computers in the stations and the maintenance facility control vehicle and transit operations within local control zones on the main guideway, local station guideways and the maintenance guideway. A

special purpose processor (the VCCS) onboard the vehicle controls vehicle movements and operations from commands generated by the station controllers. The link between the vehicle and the C&CS is an inductive communication network which transmits vital signals by tones and nonvital signals by digital transmission.

The central computer provides automatic control of the movements of the vehicles either through a predetermined stored program destination schedule or on a passenger-activated demand basis. The system operator, located at the central control point, monitors the system and exercises direct control during system start-up and shutdown and in case of system failure. At all other times, the central computer provides control and supervision of vehicles in the stations and maintenance area and on the guideway.

The operator can call on certain software routines by typing the required call-up message on a CRT keyboard. The software routines allow the operator to restart the system, run vehicles at a reduced performance level, assign vehicles to various locations, and perform other system control or override actions. Performance level modification involves running vehicles at speeds lower than normal and can be used during poor weather conditions, guideway maintenance operations, or under emergency conditions. Performance level modifiers available to the operator are 0.0, 0.125, 0.250, 0.500, 0.750, 0.875, and 1.0.

A synchronous speed tone generator drives inductive guideway loops and provides speed commands of 44fps, 33fps, 22fps, 8fps, 6fps and 4fps to the vehicle. The primary speed control and separation control system is the point follower or synchronous control system. In concept, the point follower system consists of moving slots circulating around the main guideway controlled by the central and station computers. The slots are established, a vehicle is dispatched into an open slot by the station computer at the direction of the central computer and the vehicle maintains position in the slot during its trip. An onboard speed and position controller maintains the vehicle velocity as required to travel specific distances in a set time interval.

Periodic calibration loops provide a reference to the onboard controller for self-calibration and removal of bias or random error. Slot allocat ion is performed by the central computer and slot monitoring is performed by the station computers. Slot monitoring includes comparing the time a vehicle arrives at a presence detector to the expected time of arrival as determined by the station computer.

SYSTEM OPERATION/CONTROL

The central console equipment permits an operator to monitor and control the transit system. The console includes operator display and control equipment. An alphanumeric CRT terminal provides detailed status reports and permits operator/computer communications. Abnormal status conditions in vehicles, the power distribution system, and other system support functions are displayed by a multiple-point annunciator panel and an audible alarm.

The computer in the station controls vehicle switching, stopping, door operations in the station, stations dynamic displays and response to inputs from the destination selection units. The computer in the maintenance facility duplicates station computer operations and controls the test track and maintenance queue slots.

Steering commands are given by the station computer to guide the vehicle through specified routes on the guideway and in the stations. Steering (switching) commands are generated by the station switch tone transmitter. Verification is received by the station when steering commands are acted on properly. If this verification is not received, the vehicle will be stopped automatically.

The station stop tone transmitter generates a reference signal to drive the vehicle to a precision stop plus-or-minus 6 inches in the station unload/load area. The loop is a figure eight pattern, with the vehicle decelerating from 4 to 2fps after entering the loop and decelerating to a stop after passing the center point of the loop crossover. The station computer commands vehicle doors to open and close for passenger loading and unloading.

Equipment installed on the guideway includes digital data cables, tone signal cables, passive presence detector heads and cables and cable tray and installation hardware. All active electronics which drive the cable are located in the station or maintenance C&CS rooms. The nonvital frequency shift keyed command data are inductively coupled to the vehicle from the guideway-mounted inductive loop cables. The FSK link can address and interrogate a specific vehicle or all vehicles on the loop. The FSK signals are driven over the same inductive cables that command vital civil speed and performance level speed commands to the vehicle. The calibration tone transmitter and loop transmit a tone signal to the vehicle antenna to provide measured distance references. This nonvital tone is used by the VCCS as a reference in calibrating the vehicle odometer. This process removes error accumulated since the last loop was passed.

The guideway Control and Communications Subsystem incorporates the Collision Avoidance System (CAS) independent of the primary control systems of the SCCS and CCCS. The CAS ensures that vehicles are spaced at safe stopping distances. The fail-safe CAS unit is responsible for overriding controlled vehicle movement along the entire guideway network to prevent collisions. The guideway is segmented into blocks. Sensors detect vehicle presence within blocks. The presence signal sets logic which is reset by the presence detector ahead of the block when the vehicle exits the block. Loss of tone signal results in emergency braking in the training vehicle. The CAS is designed for operation throughout the guideway, in the station ramps and in the maintenance facility.

The VCCS responds to guideway/vehicle inductive communication link to regulate vehicle speeds and generate commands to the vehicle. The air core inductive receiving antenna on the vehicle picks up nonvital FSK and vital modulated tone signals from the guideway control and communications loops. The communication unit which receives the information includes the fail-safe collision avoidance safe tone receiver and the switching command transceiver. The FSK transceiver is bidirectional and feeds the transmit antenna, linking asynchronous vehicle performance data to the S/GCCS. The fail-safe command speed receiver processes the civil speed tone to the command speed decoder, which inputs the command speed to the speed and position controller and the overspeed detector.

In the event of a speed change command, the profile controller modifies the speed command at a constant rate prior to processing by these units. The redundant, fail-safe overspeed detector energizes the emergency brake control if the vehicle speed exceeds civil speed by 3 fps.

The fail-safe Collision Avoidance Receiver detects the vital safe tone signal and the absence of a safe tone signal results in emergency braking. Presence of the safe tone commands "go at commanded speed". The switching command transceiver generates the vital signals to the vehicle switching control system. Once switching is accomplished, this unit sends a verification signal to the wayside switch tone unit.

The VCCS control unit includes the velocity and position error processor, the profile controller, and the stopping profile logic. These functions are performed onboard the vehicle and control speed and position relative to nominal profiles in constant speed regions, transition zones and at station stopping positions.

The VCCS data handling unit processes vehicle door control signals, signals associated with vehicle performance monitoring and C&CS status monitoring, and identifies the vehicle on the guideway to enable proper identification of data received by the stations and the central control computer.

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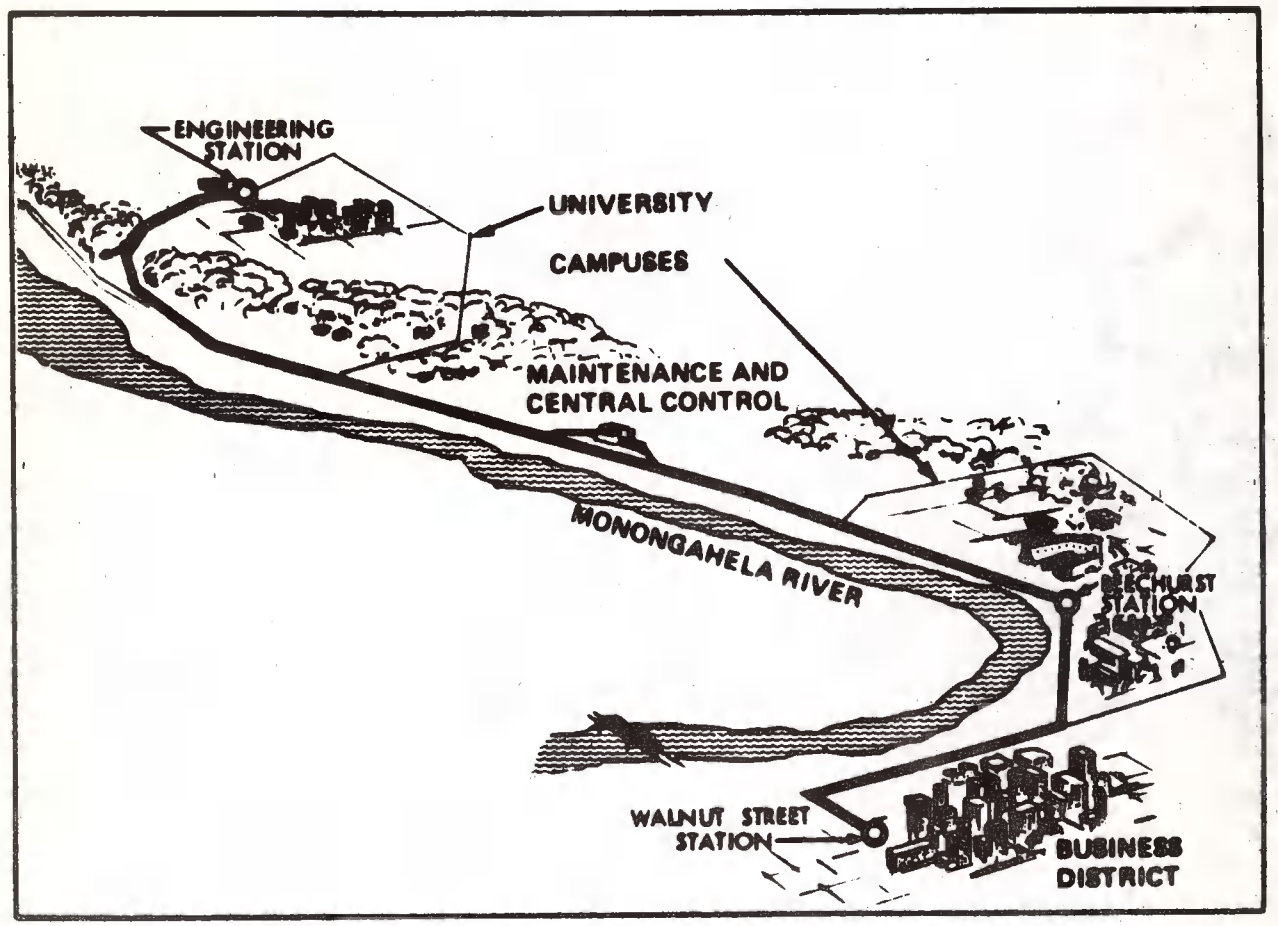
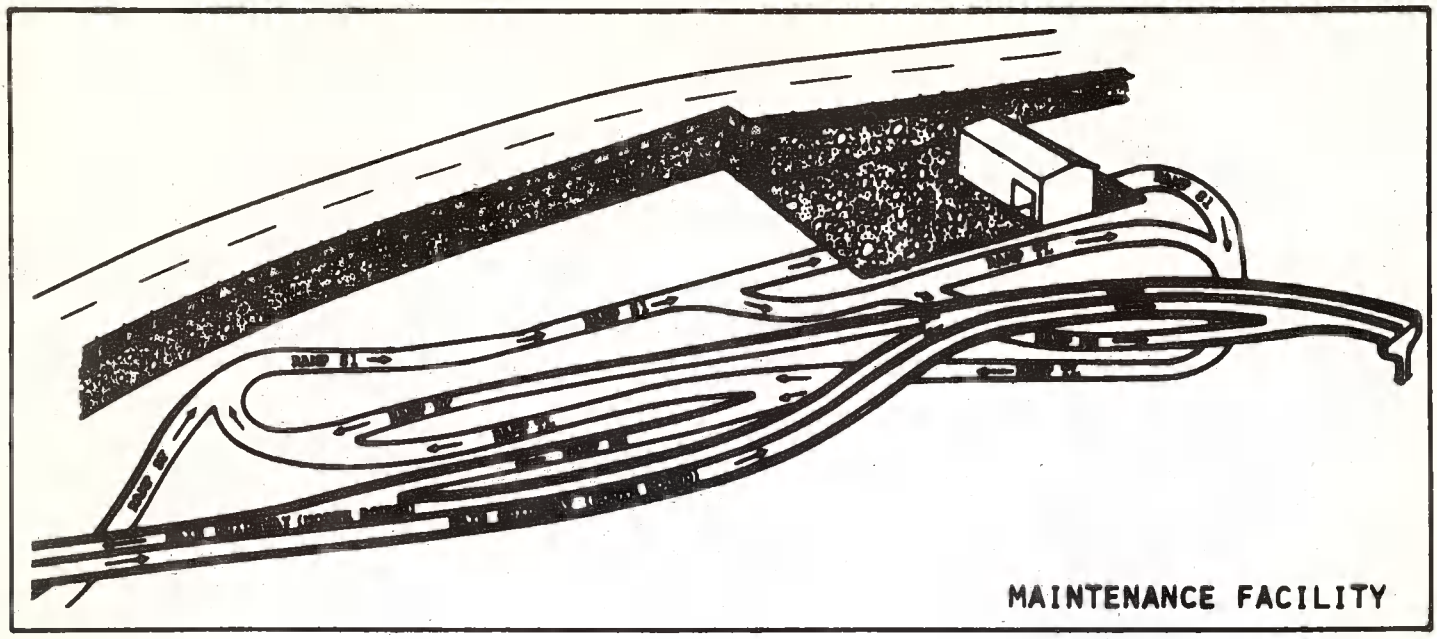
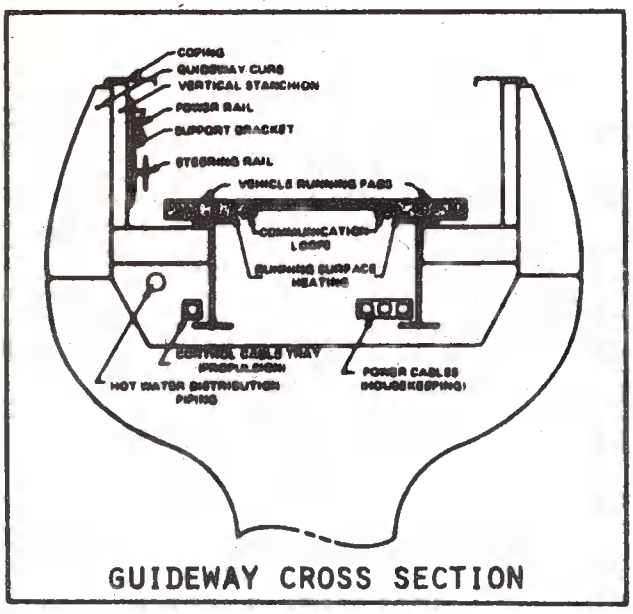


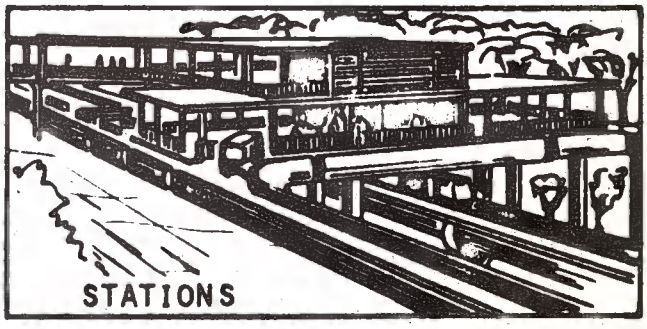
MORGANTOWN CONFIGURATION



MAINTENANCE FACILITY

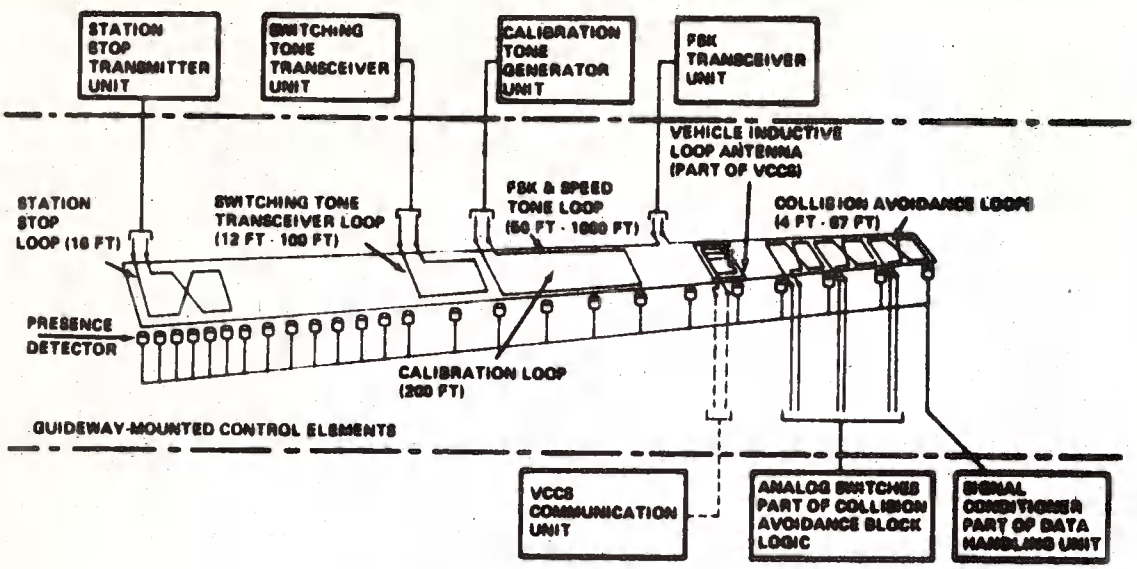


GUIDEWAY CROSS SECTION

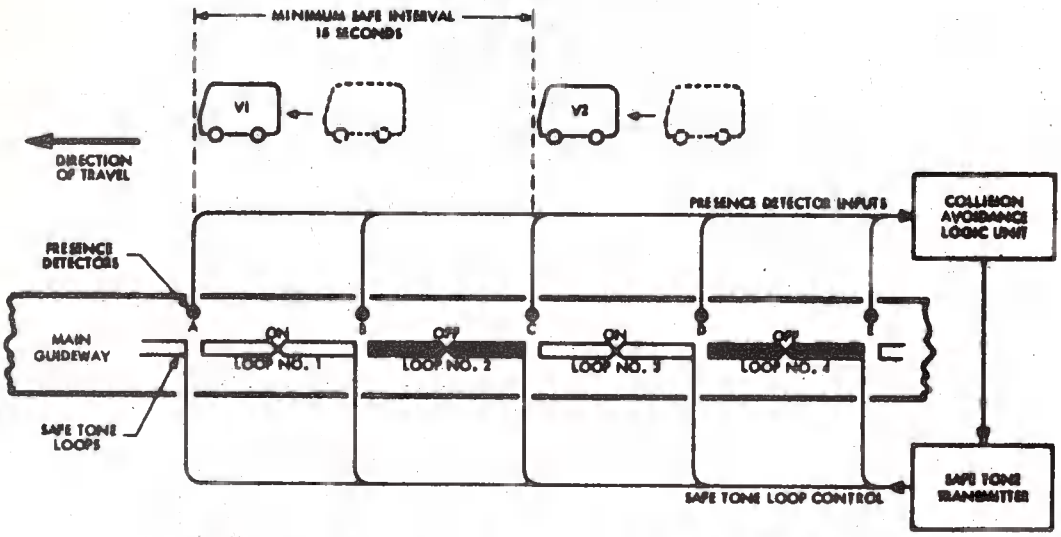


STATIONS

FACILITIES CONFIGURATION



GUIDEWAY CONTROL ELEMENTS

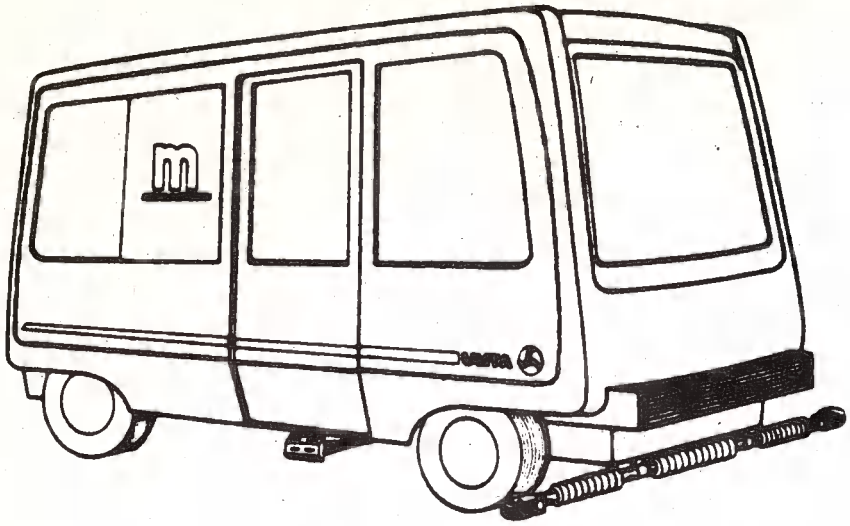


WHEN VEHICLE V1 PASSED PRESENCE DETECTOR B THE COLLISION AVOIDANCE LOGIC TURNED OFF THE SAFE TONE ON LOOP NO. 2 AND TURNED ON THE SAFE TONE ON LOOP NO. 3.

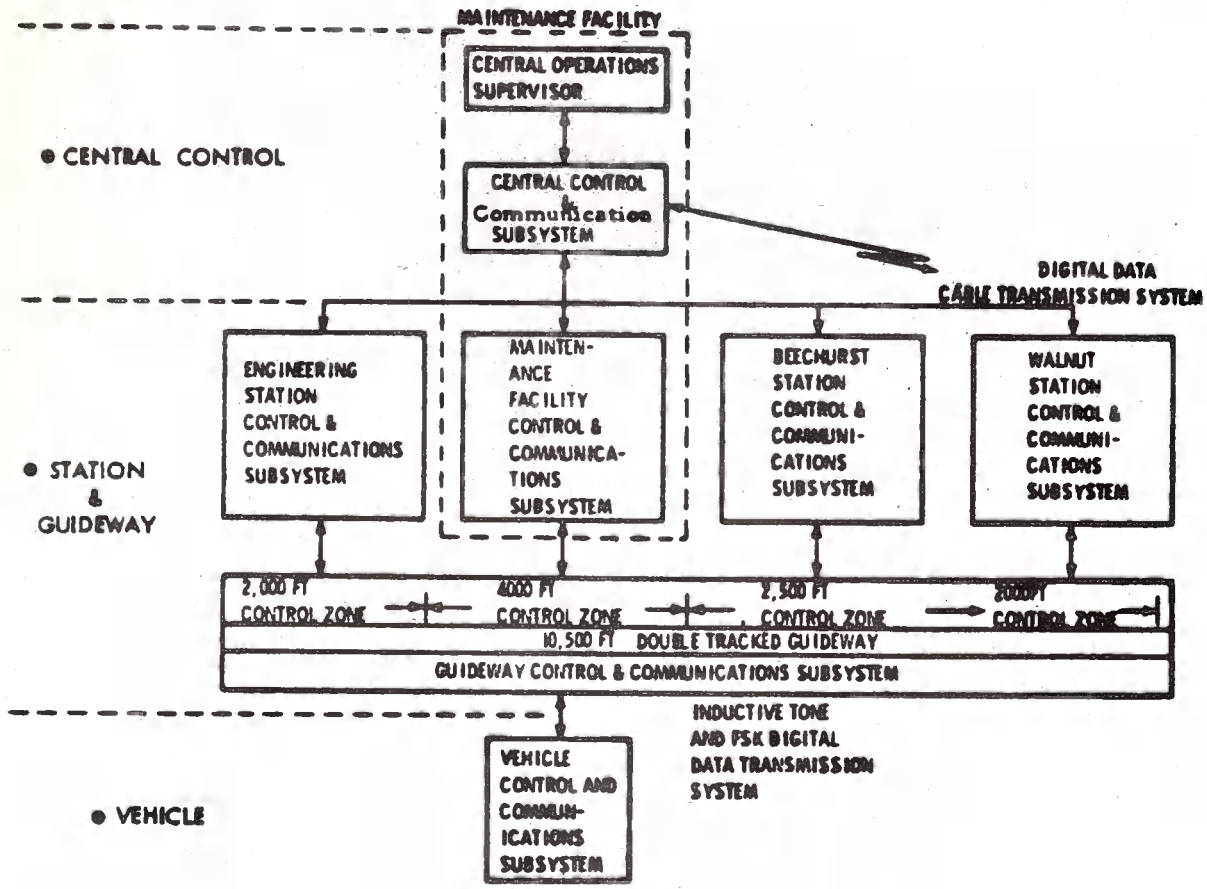
WHEN VEHICLE V1 PASSES PRESENCE DETECTOR A, THE LOGIC WILL TURN OFF SAFE TONE LOOP NO. 1 AND RESTORE TONE TO LOOP NO. 2.

IF VEHICLE V2 SHOULD ENTER LOOP NO. 2 BEFORE VEHICLE V1 PASSES DETECTOR A, THE ABSENCE OF A SAFE TONE ON LOOP NO. 2 WILL CAUSE EMERGENCY BRAKES TO BE APPLIED.

INDEPENDENT COLLISION AVOIDANCE SYSTEM



MORGANTOWN VEHICLE



C&CS CONFIGURATION