POLICE CAR IMPROVEMENT PROGRAM CONFERENCE

JANUARY 1975

AEROSPACE CORPORATION

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Conference for Planning an Evolutionary Police Car Improvement Program

MONDAY, JANUARY 13, 1975

2:00	INTRODUCTION	E.H. KRAUSE, SR VICE PRESIDENT, DEVELOPMENT THE AEROSPACE CORPORATION
2:05	PRIORITIES FOR IMPROVING POLICE CAR SYSTEMS	R.W. VELDE, ADMINISTRATOR LAW ENFORCEMENT ASSISTANCE ADMINISTRATION
2:15	LEAA SPONSORED EQUIPMENT DEVELOPMENTS	W.G. NANCE, ASSOC. GROUP PLANNING AND EVALUATION GROUP LAW ENFORCEMENT AND TELECOMMUNICATIONS DIVISION THE AEROSPACE CORPORATION
2:35	AN EVOLUTIONARY POLICE CAR IMPROVEMENT PROGRAM	J.B. WOODFORD, ASSOCIATE GENERAL MANAGER LAW ENFORCEMENT AND TELECOMMUNICATIONS DIVISION THE AEROSPACE CORPORATION
4:15	RATIONALE OF THE PROGRAM	J.C. DALY, GROUP DIRECTOR PLANNING AND EVALUATION GROUP LAW ENFORCEMENT AND TELECOMMUNICATIONS DIVISION THE AEROSPACE CORPORATION
5:00	DISCUSSION BY ATTENDEES OF HOW THE PROGRAM MEETS POLICE REQUIREMENTS	

Summary of Briefing Presented to the Conference on an Improved Police Car Development Program

JANUARY 13 1975

Summary of LEAA Sponsored Equipment System Improvements

Attendees

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E-0110

NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

Statuatory Objectives

1968 ". . . . TO ENCOURAGE RESEARCH AND DEVELOPMENT TO IMPROVE AND STRENGTHEN LAW ENFORCEMENT"

1973 "TO ENCOURAGE RESEARCH AND DEVELOPMENT TO IMPROVE AND STRENGTHEN LAW ENFORCEMENT AND CRIMINAL JUSTICE;

TO DISSEMINATE THE RESULTS OF SUCH EFFORTS TO STATE AND LOCAL GOVERNMENTS;

TO DEVELOP AND SUPPORT PROGRAMS FOR THE TRAINING OF LAW ENFORCEMENT AND CRIMINAL JUSTICE PERSONNEL."

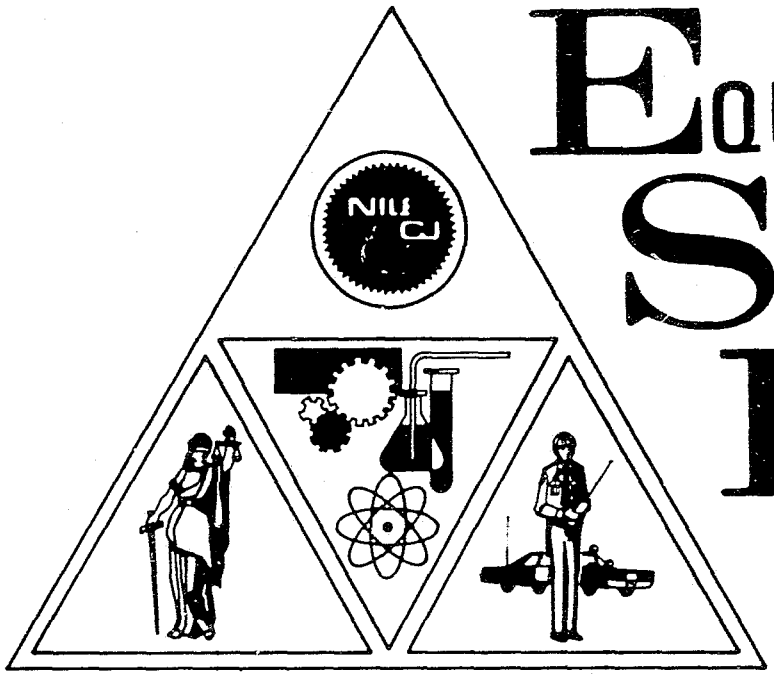
SOURCE: PL 90 - 351; PL 93 - 83

V-82381

Law Enforcement Assistance Administration

National Institute of Law Enforcement and Criminal Justice

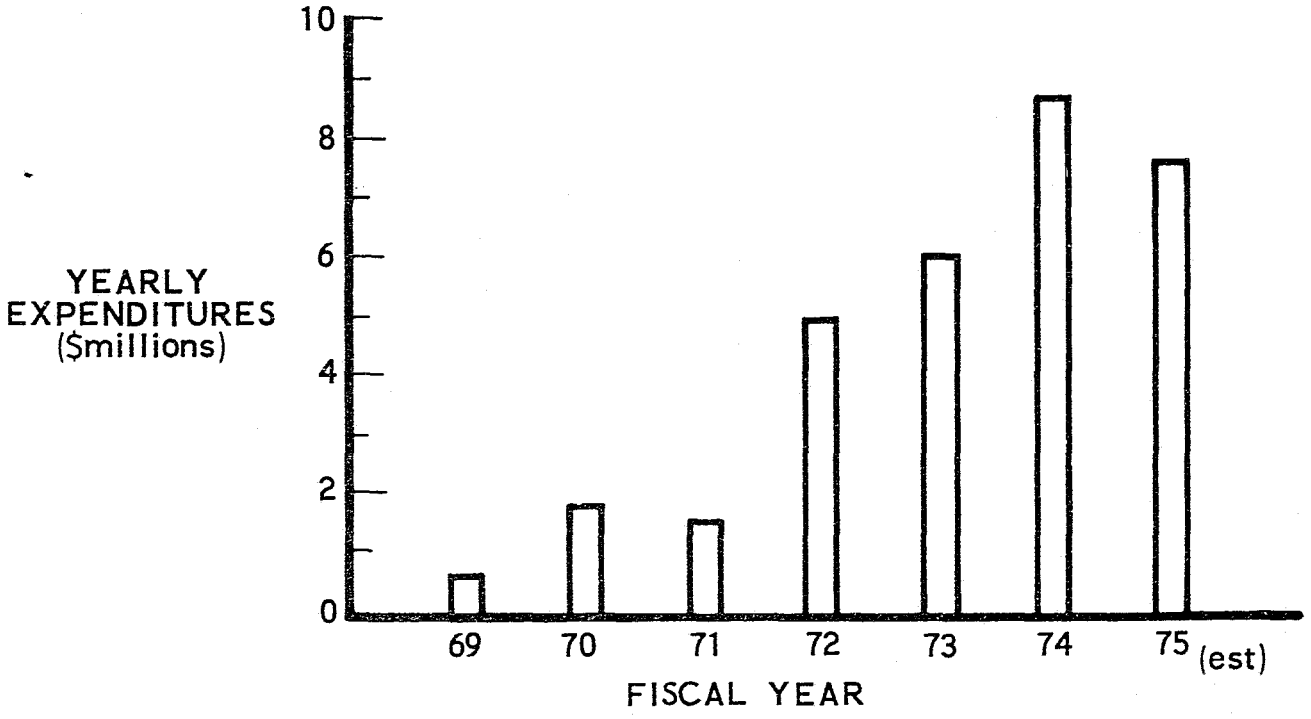
Advanced Technology Division



EQUIPMENT SYSTEM IMPROVEMENT PROGRAM

NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

Advanced Technology Division



TOTAL TECHNOLOGY AND EQUIPMENT RELATED EXPENDITURES

NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

Advanced Technology Division

- ANALYZE CRIMINAL JUSTICE PROBLEMS AND DETERMINE OPERATIONAL REQUIREMENTS
- DEVELOP AND TEST NEW HARDWARE SYSTEMS
- DISSEMINATE EQUIPMENT STANDARDS AND GUIDELINES

NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

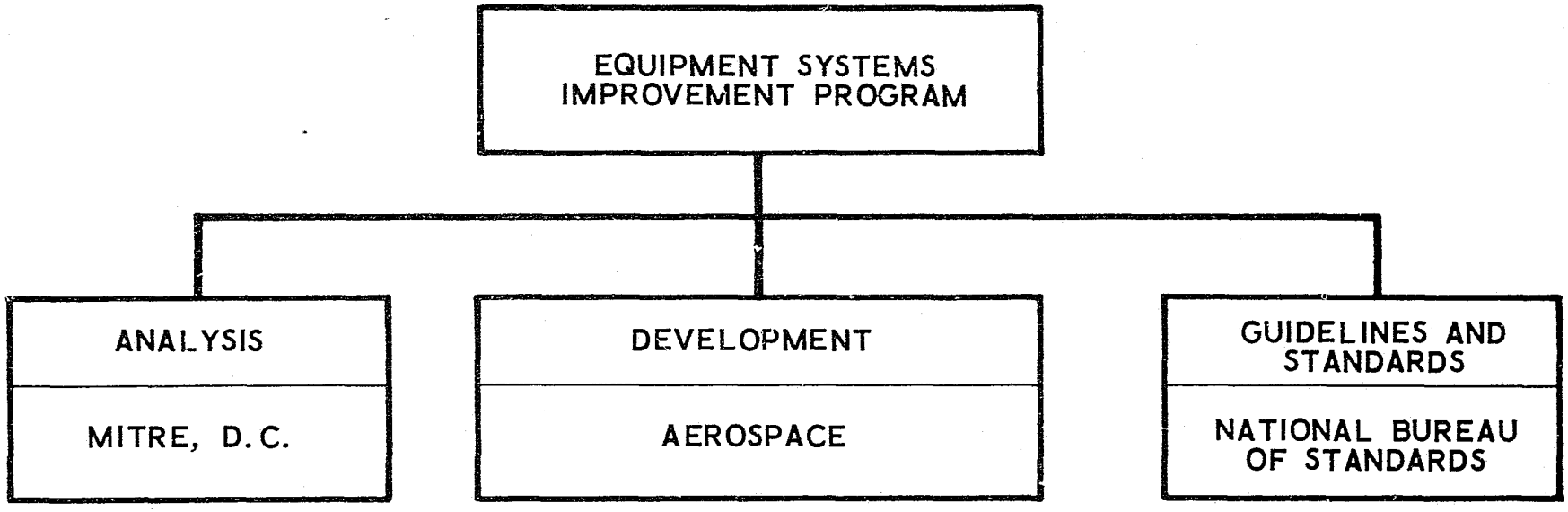
Analysis Group

MITRE CORPORATION SELECTED TO

- DEFINE OPERATIONAL REQUIREMENTS
- IDENTIFY PROBLEM AREAS AND RELATIVE PRIORITIES
- PUBLISH PROBLEM IDENTIFICATION REPORTS

FOURTEEN MITRE ANALYSTS SPENT UP TO TWO YEARS WITH REPRESENTATIVE POLICE, COURTS, AND CORRECTION AGENCIES

Initial Organization of ESIP



- PROBLEM DEFINITION
- OPERATIONAL REQUIREMENTS

- PROBLEM SOLUTION
- DEVELOPMENT SUBCONTRACTS

- STANDARDS
- GUIDELINES

NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

Law Enforcement Standards Laboratory

NATIONAL BUREAU OF STANDARDS ASSIGNED RESPONSIBILITY TO

- TEST OFF-THE-SHELF HARDWARE AND EQUIPMENT
- DEVELOP GUIDELINES DESCRIBING PERFORMANCE; INFORMATION ON USE AND MAINTENANCE
- PUBLISH STANDARDS FOR SELECTION AND PROCUREMENT OF EQUIPMENT

BY FY 1974 55 STANDARDS AND 12 GUIDELINES IN PREPARATION

- SECURITY SYSTEMS
- COMMUNICATION SYSTEMS
- INVESTIGATIVE AIDS
- PROTECTIVE EQUIPMENT AND WEAPONS
- COURTROOM EQUIPMENT

NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

Development Group

GENERAL OBJECTIVE OF LAW ENFORCEMENT DEVELOPMENT GROUP

". . . To Develop Improved or New Equipment Systems to Solve Law Enforcement and Criminal Justice Problems . . . "

PROGRAM RESPONSIBILITIES

". . . Propose Solutions to the Problems . . . Analyze Programs to Determine Relative Priority . . . Group Responsible for the Development of Equipment -- From Defining System Requirements to Completing Field Tests . . . "

- DEVELOP DETAILED SYSTEM REQUIREMENTS AND SPECIFICATIONS
- GENERATE CONCEPTUAL DESIGNS AND PERFORM TRADEOFF ANALYSIS
- RECOMMEND SYSTEM CONCEPTS
- PERFORM OR SUBCONTRACT SELECTED FEASIBILITY DEMONSTRATIONS
- PERFORM OR SUBCONTRACT SYSTEM DEVELOPMENT, FABRICATION AND LABORATORY TESTING

Development Projects

FY 73 PROJECTS

- LIGHTWEIGHT BODY ARMOR
- CITIZEN ALARM SYSTEM
- BURGLARY ALARM
- SPEAKER IDENTIFICATION
- ANTIHIJACKING SYSTEM
- AERIAL VEHICLE
- BODY MOUNTED ANTENNA
- REMOTE VEHICLE DISABLING

FY 74 PROJECTS

- LIGHTWEIGHT BODY ARMOR
- CITIZEN ALARM SYSTEM
- BURGLARY ALARM
- SPEAKER IDENTIFICATION
- ANTIHIJACKING SYSTEM
- BLOOD ANALYSIS
- EXPLOSIVES DETECTION
- GUNSHOT RESIDUE
- POLICE VEHICLES
- FINGERPRINT
- 911

FY 75 PROJECTS

- LIGHTWEIGHT BODY ARMOR
- CITIZEN ALARM SYSTEM
- BURGLARY ALARM
- SPEAKER IDENTIFICATION
- ANTIHIJACKING SYSTEM
- BLOOD ANALYSIS
- EXPLOSIVES DETECTION
- GUNSHOT RESIDUE
- POLICE CAR SYSTEMS
- FIELD EVALUATIONS
  - BODY ARMOR
  - CITIZEN ALARM

Typical Candidate Development Projects

COST-EFFECTIVE SECURITY ALARM SYSTEM
IMPROVED HARDENED DOORS AND WINDOWS
RESIDENCE BUSINESS LOCK SYSTEMS
ARCHITECTURAL DESIGN CONCEPTS
POLICE EMERGENCY CALL WARNING SYSTEM
STOLEN GOODS DETECTION SYSTEM
INTEGRATED POLICE CAR EQUIPMENT SYSTEMS
HARDENED CASH REGISTERS
MODULARIZED COMMAND AND CONTROL SYSTEM
COMMAND AND CONTROL EQUIPMENT SIMULATION
CITIZEN'S ALARM SYSTEM
GUARD AND INMATE SECURITY SYSTEM
LIGHTWEIGHT BODY ARMOR
BLOOD AND BLOODSTAIN ANALYSIS
INTEGRATED POLICE CAR DESIGN
POLICE AND WITNESS PAGING SYSTEM
COURT VIDEO RECORDING SYSTEM
CRIME LAB-COURT COMMUNICATIONS SYSTEMS
IMPROVED INSTITUTIONAL LOCKING SYSTEMS
AUTOMATED INMATE ACCOUNTABILITY SYSTEM
PROPERTY TAGGING AND IDENTIFICATION SYSTEMS
911 SYSTEM
POLICE VEHICLE RF SIREN
ADVANCED FINGERPRINT HOLOGRAPHY
ADVANCED DIGITAL FINGERPRINT ENCODING
CONVERSION OF NON-SECURE BUILDINGS
COMMUNICATIONS HELMET
AUTOMATIC POLICE CAR LOCATION SYSTEM
SPRAY FILM EVIDENCE COLLECTION
ACTIVE METAL-WEAPON DETECTION SYSTEM
X-RAY WEAPON DETECTION
IMPROVED CRIME SCENE RECORDING EQUIPMENT
INDIVIDUALIZATION OF HAIR
PERIMETER SECURITY
SATELLITE APPLICATIONS FOR LAW ENFORCEMENT
900 MHz TECHNOLOGY
IMPROVED AIRBORNE POLICING
SPEAKER IDENTIFICATION
EXPLOSIVES VAPOR DETECTION

MOBILE DETENTION FACILITY
VEHICLE EMERGENCY CALL SYSTEM
DETECTION OF GUNSHOT RESIDUE
INDIVIDUAL PATROLMAN LOCATION SYSTEM
BULLET TRACING AND IDENTIFICATION
LIGHTWEIGHT POWER SOURCES
DATA SECURITY TECHNIQUES
FREQUENCY MANAGEMENT STUDY
TRUCK ANTIHIJACKING SYSTEM
ROBBER TAGGING
AUTO THEFT PREVENTION
IMPROVED FINGERPRINT LIFTING TECHNIQUES
EXPLOSIVES TAGGING AND DETECTION
POSITIVE IDENTIFICATION CREDIT CARDS
EVENT DATING TECHNIQUES
AUTOPSY TECHNOLOGY
THERMOLUMINESCENT TECHNIQUES
POLICE WEAPON SAFETY SYSTEM
TRAFFIC LIGHT REGULATION SYSTEM
DIGITAL COMMUNICATIONS SYSTEM
MOBILE VIDEO COMMUNICATION SYSTEM
STEERABLE 450 MHz ANTENNA
LOW-COST SECURE COMMUNICATIONS
LESS-LETHAL WEAPONS
LOW-COST TRANSMITTER IDENTIFIER
ION MICROPROBE ANALYSIS
REMOTE BOMB DISPOSAL TECHNIQUES
MATERIAL COVERT TAGGING TECHNIQUES
ANALYSIS OF NON BLOOD BODY FLUIDS
RAPE COCOON
UNDERCOVER AGENT COMMUNICATIONS
SNIPER DISABLING AND APPREHENSION
HIGH INTENSITY PORTABLE LIGHTS
INTEGRATED LETHAL LESS-LETHAL WEAPONS
NIGHT VISION AIDS
NEW MASS SPECTROMETRY METHODS
COMPUTER AIDED FACIAL FEATURE IDENTIFICATION
REMOTE WEAPON ARMING SYSTEM
CONCEALED RECORDING SYSTEM

BODY ARMOR FIELD EVALUATION

OBJECTIVE

Evaluate the performance and user acceptability of limited protection, continuous wear protective armor under operational conditions

GENERAL GARMENT TYPES

UNDERWEAR

INTEGRATED UNIFORMS

PLAIN CLOTHES

EVALUATION TEST PLAN

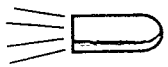
- Fifteen urban police departments
- Approximately 3000 garments to be evaluated for one year
- FY 75 Implementation

PROTECTIVE ARMOR DEVELOPMENT

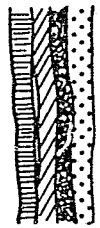
OBJECTIVE

Develop light weight, inconspicuous protective garments for law enforcement and public officials that protect against common handgun threats

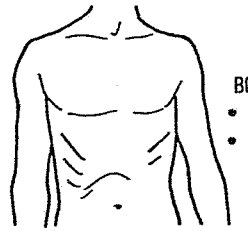
KEY PARAMETERS



BALLISTIC LOADING
- MASS
- SHAPE
- VELOCITY



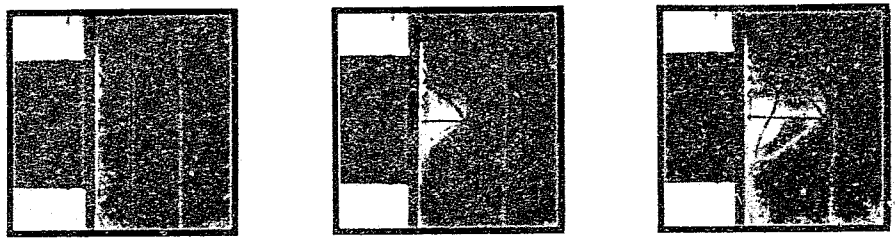
NON-PENETRATING DYNAMICS
- MATERIAL
- WEIGHT
- WEAVE



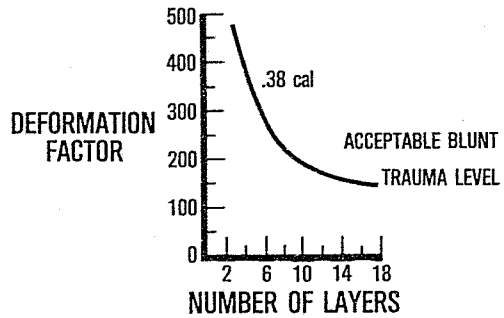
BODY LOADING
- DECELERATION
- DEFORMATION

BLUNT TRAUMA
- MEDICAL ANALYSIS

TEST DATA—HIGH SPEED PHOTOS



DEFORMATION CURVES



ACCOMPLISHMENTS

Penetration protection and acceptable blunt trauma demonstrated for the .38 caliber handgun threat class at low armor weights (less than two pounds)

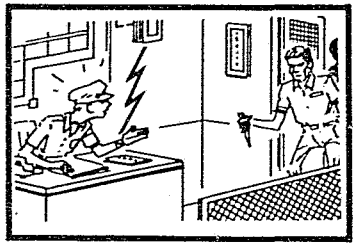
CITIZEN ALARM FIELD EVALUATION

OBJECTIVE

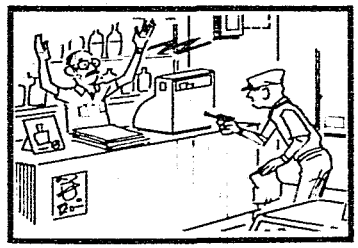
Evaluate system performance, effectiveness, and user/response agency acceptance in realistic scenarios

TEST SCENARIOS

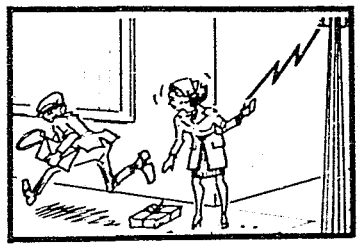
RESIDENTIAL



INSTITUTIONS



COMMERCIAL



PUBLIC AREAS

EVALUATION TEST PLAN

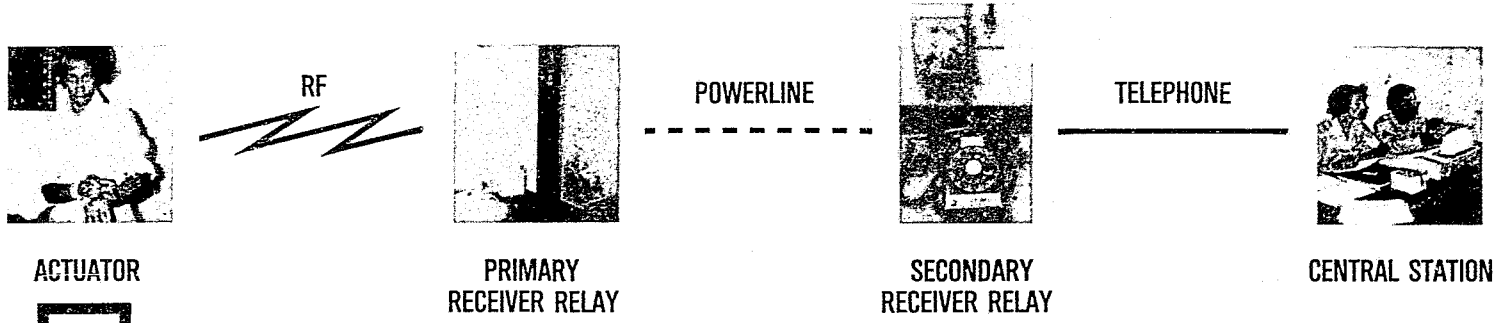
- Multiple scenario types and locations
- Approximately 2,000 - 10,000 user units to be evaluated
- FY 76 implementation

CITIZEN ALARM DEVELOPMENT

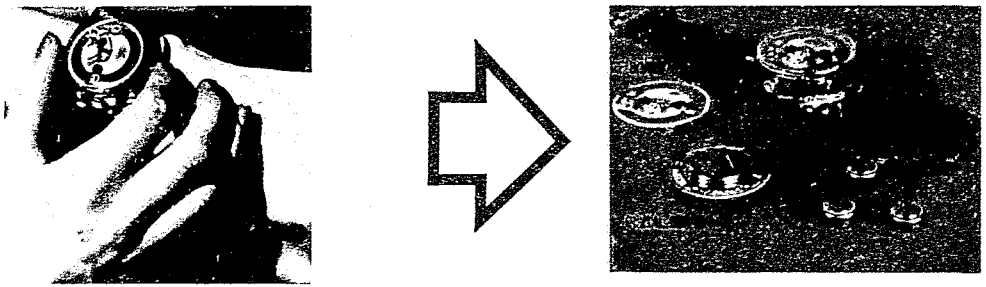
OBJECTIVE

Develop a personal means by which citizens may call for emergency assistance at the onset of a crime or other emergency occurring in either inbuilding or outside areas

SYSTEM CONCEPT



KEY FEATURES



DESIGN FEATURES

- INCONSPICUOUS ACTUATION
- USER IDENTIFICATION
- AESTHETICALLY ACCEPTABLE
- LOW COST
- HIGH RELIABILITY

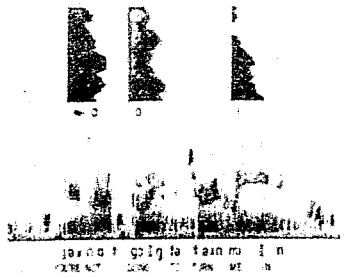
PROTOTYPE HARDWARE FABRICATED AND TESTED – FY 76 FIELD EVALUATION

SPEAKER IDENTIFICATION PROGRAM

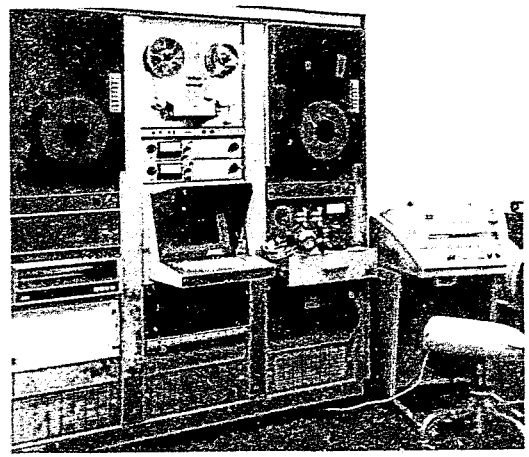
OBJECTIVE

Develop computer assisted speaker identification system to accurately identify specific individuals from recorded speech

SYSTEM CONCEPT



CRIMINAL RECORDING IS COMPARED WITH SUSPECT EXEMPLARS USING QUANTITATIVE STATISTICAL TECHNIQUES



COMPUTER CALCULATES PROBABILITY THAT SUSPECT'S VOICE MATCHES CRIMINAL RECORDING

ADVANTAGES:

- Repeatable
- Quantitative
- Objective
- Faster and Cheaper

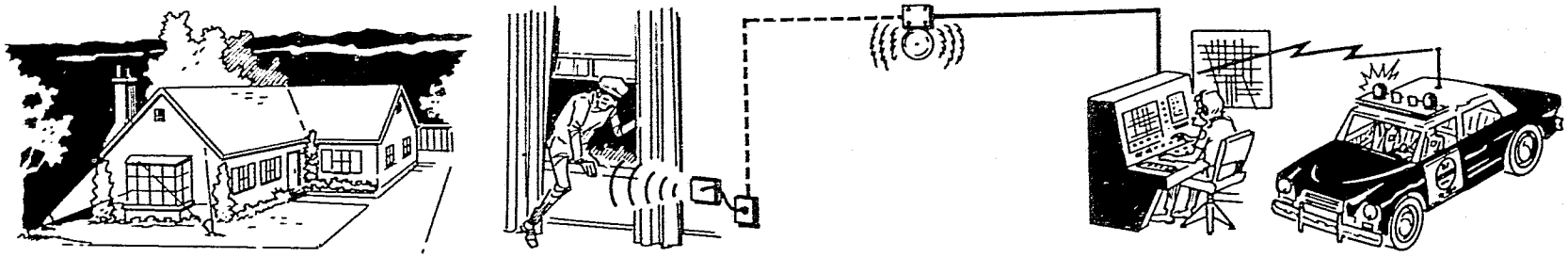
SYSTEM PRESENTLY UNDERGOING FEASIBILITY TESTS

COST EFFECTIVE BURGLARY ALARM SYSTEM

OBJECTIVE

Develop a low cost, low false alarm reliable, burglary alarm system for application to residential and small business needs

SYSTEM PARAMETERS



DETERRENCE
- DOORS/WINDOWS/LOCKS
- LIGHTING
- SECURITY MARKINGS

DETECTION
- POINT OPENING
- LINE/AREA
- VOLUMETRIC

INTER. TRANS./CONTROL
- HARDWIRE/POWER LINES
- CONTROL BOX LOGIC
- LOCAL ALARM

EXTER. TRANS./RESPONSE
- HARDWIRE/TV/RF/TELEPHONE/POWER LINES
- CENTRAL ALARM AGENCY/POLICE

DEVELOPMENT EFFORTS

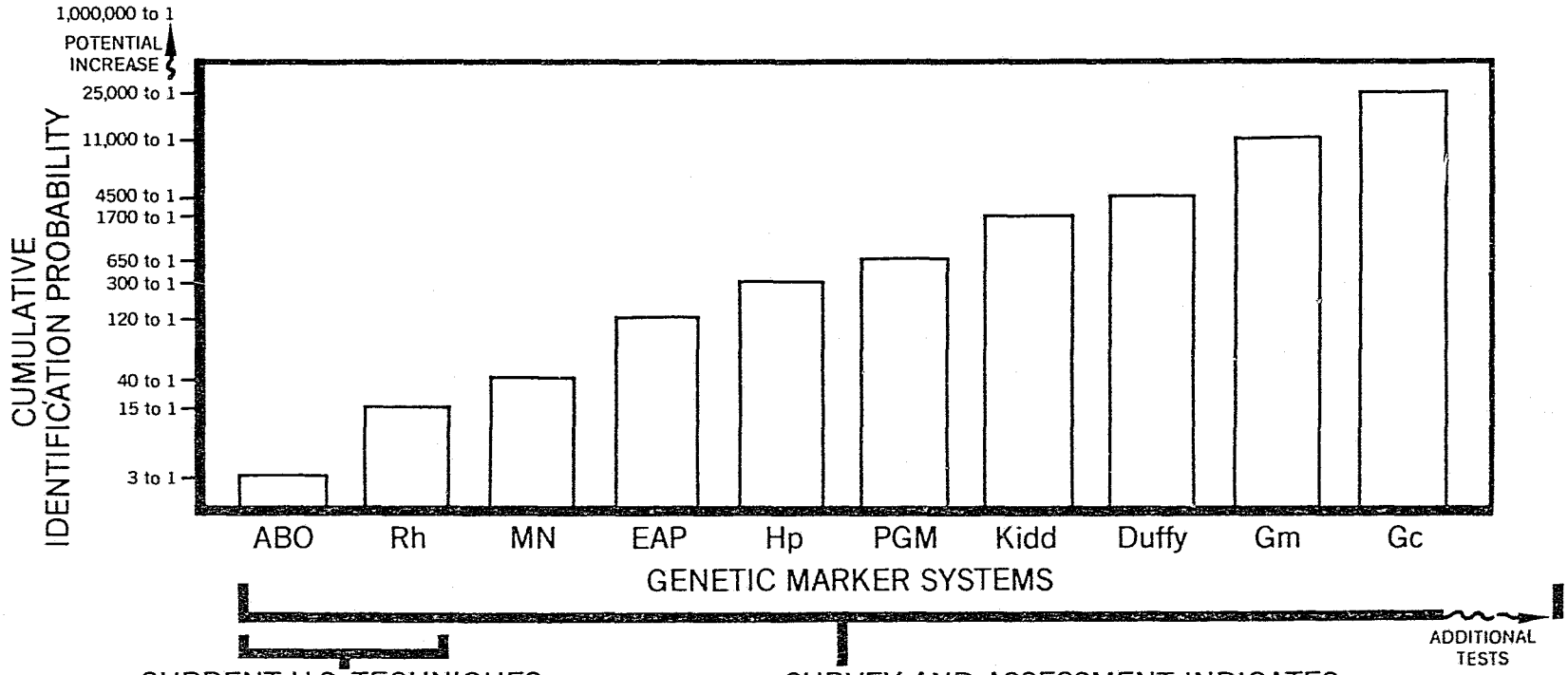
- Burglary alarm system development contract integrates several subcontract efforts
- New sensor types to improve reliability and reduce false alarms
- Utilization of building power lines to reduce installation costs
- External transmission tradeoff study

BLOOD AND BLOODSTAIN ANALYSIS

OBJECTIVE

Develop improved techniques to identify an individual by analysis of key genetic markers in blood and bloodstains

POTENTIAL IMPROVEMENTS



SEMI-AUTOMATIC ANALYSIS METHODS FOR HIGH ID PROBABILITY UNDER DEVELOPMENT

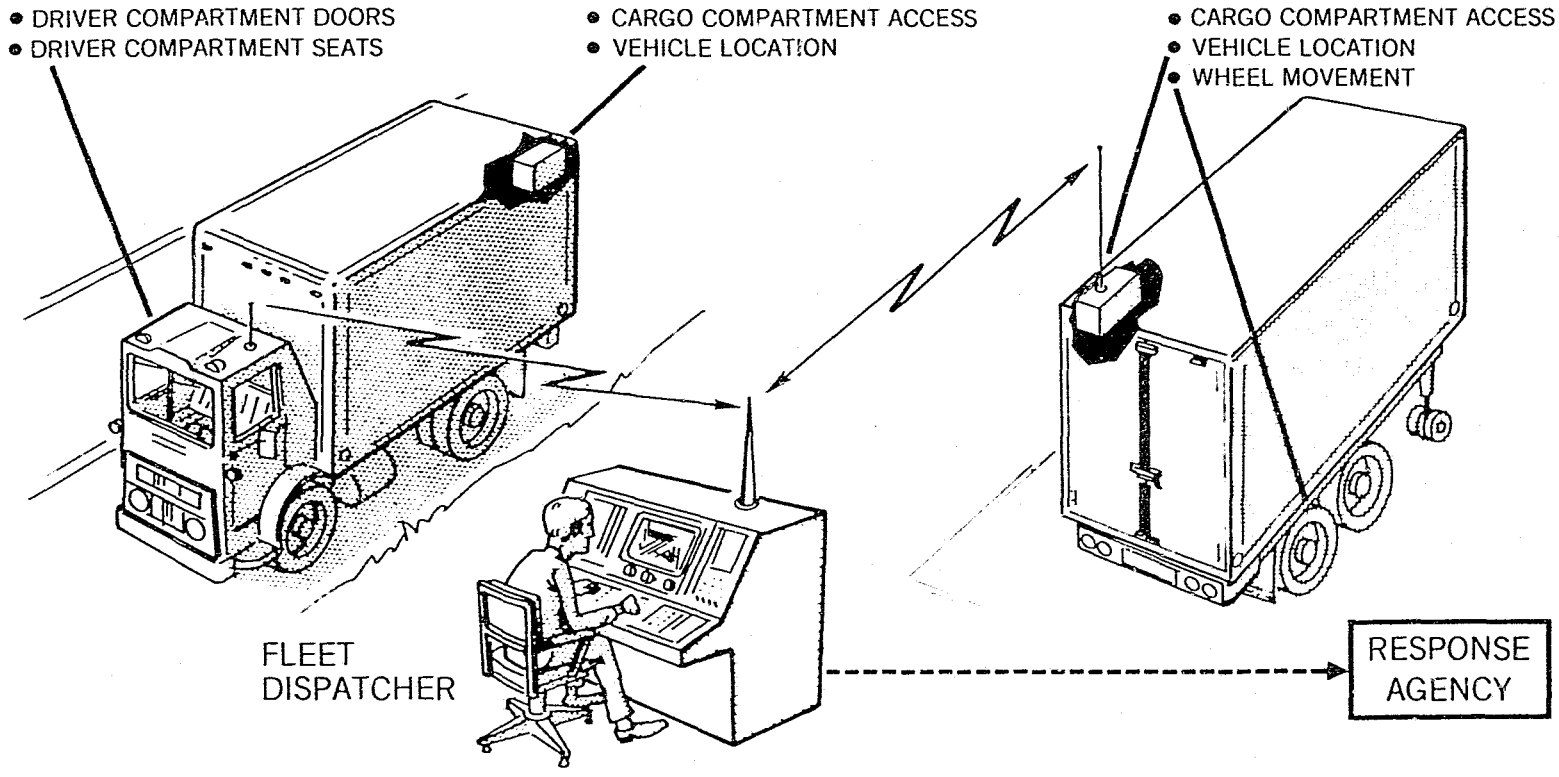
CARGO SECURITY SYSTEM

OBJECTIVE

Develop cost effective means to improve cargo security and reduce cargo losses in the trucking industry

SYSTEM CONCEPT

Monitor location and status of moving and parked vehicles



HARDWARE SYSTEMS CURRENTLY UNDERGOING FEASIBILITY TESTING

DETECTION OF GUNSHOT RESIDUE

OBJECTIVE

Develop improved methods to reliably determine whether a suspect fired gun

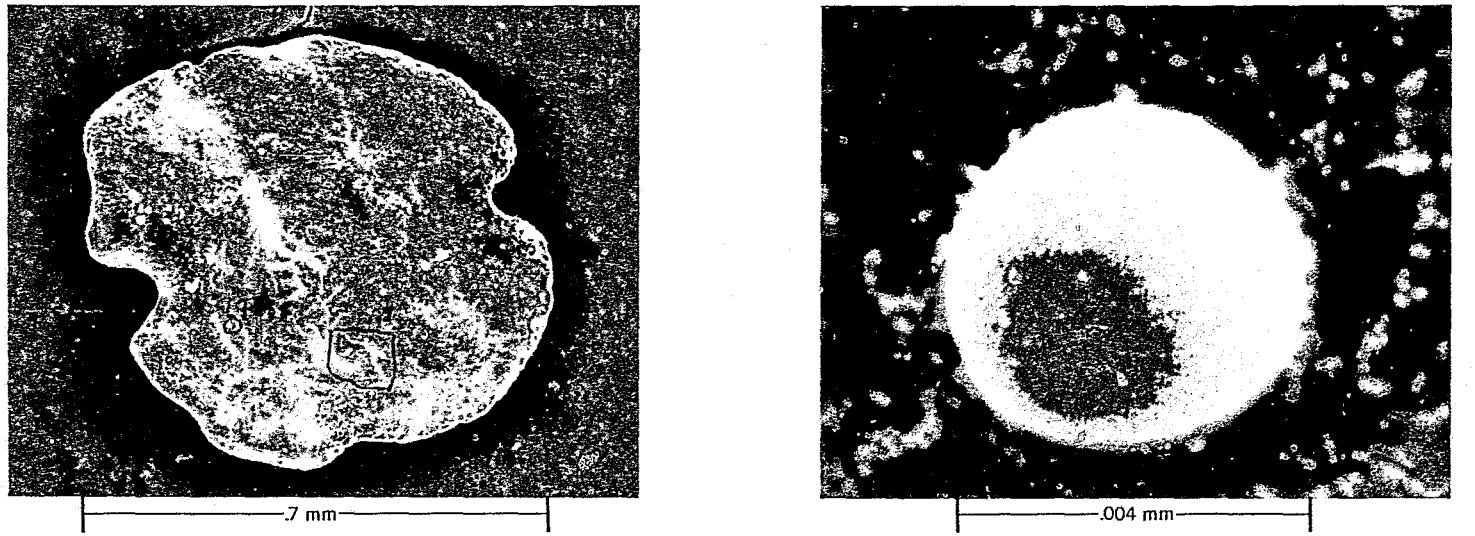
ONE APPROACH

Subparticle analysis

WHOLE RESIDUE PARTICLE (100x)

SUBPARTICLE WITHIN RESIDUE PARTICLE (10,000x)

(RESIDUE OF BROWNING .380 AUTOMATIC)



WHILE THE WHOLE PARTICLE PROVIDES INCONCLUSIVE DATA

SUBPARTICLE SHAPE AND COMPOSITION PROVIDES CLEAR IDENTIFICATION

THESE AND OTHER METHODS ARE IN RESEARCH AND DEVELOPMENT

V-88121

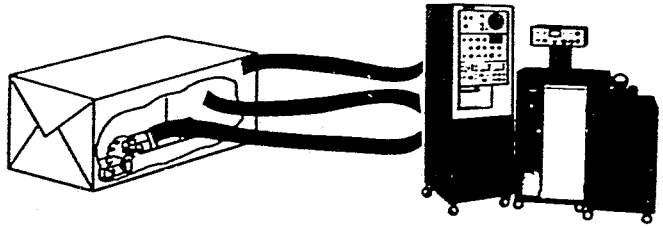
CONTROL OF THE ILLEGAL USE OF EXPLOSIVES

OBJECTIVE:

To develop technology and equipment systems for the detection, identification and disposal of tagged and untagged explosives

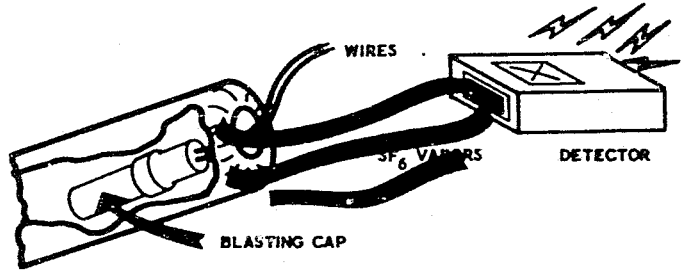
PROJECTS:

VAPOR CHARACTERIZATION STUDY

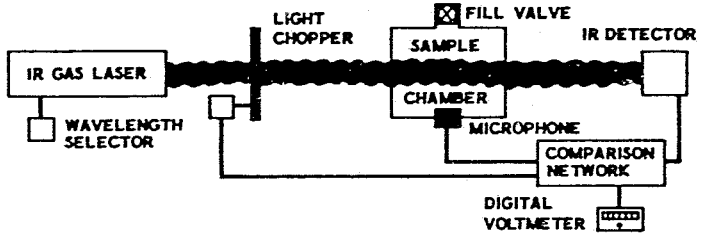


LABORATORY GAS CHROMATOGRAPH MASS SPECTROMETER

SULFUR HEXAFLUORIDE (SF_6) TAGGING FOR DETECTION

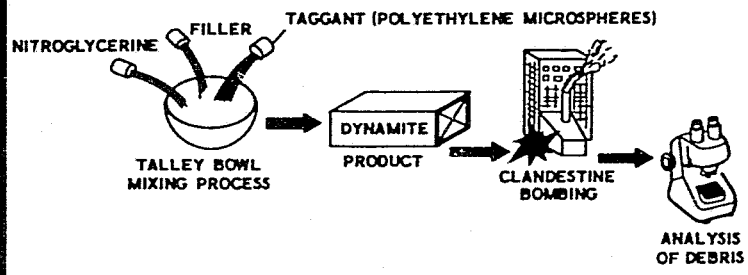


UNTAGGED DETECTION – LASER OPTOACOUSTIC CONCEPT



- Selected laser wavelengths excite corresponding infrared absorbtion wavelengths of explosive vapors
- Modulated laser beam creates pressure fluctuations detected by sensitive microphone

TAGGING FOR IDENTIFICATION



Police Patrol Car System Improvements

LONG RANGE OBJECTIVES

IMPROVE COST EFFECTIVNESS OF POLICE CAR OPERATIONS

- SAFETY AND RELIABILITY
  - ANTI-LOCK BRAKES
  - IMPROVE WARNING
  - VEHICLE CONDITION MONITORING
- VEHICLE ECONOMY
- OFFICER EFFECTIVENESS
  - ACCESS TO DATA BASE
  - AUTOMATED COMMAND AND CONTROL
  - COMPUTER-AIDED REPORTING
  - EASE OF INTERFACING WITH CAR SYSTEMS
- SECURITY OF CAR AND DATA
  - PROTECTION OF DATA FROM UNAUTHORIZED USE
  - PROTECTION OF CAR WHEN OFFICER IS AWAY
- CHANNEL CONSERVATION
  - WIDE USE OF DATA TRANSMISSION
  - FORMATTING - CODING
  - DATA COMPRESSION
- [illegible]
  - [illegible]

Proposed Police Car Improvement Program

Police Patrol Car System Improvements Program

PHASED APPROACH

PHASE I

- MINIMUM TIME TO DEMONSTRATION
- OFF-THE-SHELF HARDWARE
- INCLUDES FULL DATA SYSTEM, IN-CAR DATA BASE EXPERIMENTS
- FIELD TEST TO DETERMINE BENEFITS, DESIRED REDESIGNS
- TRANSITION TO OPERATIONAL USE

PHASE II

- STATE-OF-THE-ART TECHNOLOGY
- REPACKAGING/RE-ENGINEERING FOR POLICE CAR APPLICATION
- INCLUDES SLOW-SCAN TV, IN-CAR DATA BASE
- FIELD TEST
- TRANSITION TO OPERATIONAL USE

PHASE III

- ADVANCED TECHNOLOGY FOLLOW-ON
- FLAT TV DISPLAYS
- VERY LARGE ($\approx 10^9$ word) IN-CAR DATA BASE
- REAL TIME IN AVAILABLE
- MODULARITY BEGUN IN PHASE I KEEPS OBSOLESCENCE TO A MINIMUM

Police Patrol Car System Improvements

SHORT RANGE OBJECTIVES

- DEMONSTRATE QUICKLY WHAT PRESENT EQUIPMENT/TECHNOLOGY CAN DO AND WHAT LIMITATIONS ARISE
- PLAN FOLLOW-ON PHASES TO UTILIZE RESULTS OF FIRST DEMONSTRATION, REDESIGNED EQUIPMENT, AND NEW TECHNOLOGY
- UTILIZE FLEXIBLE, MODULAR APPROACH WITH STANDARDIZED INTERFACES TO MINIMIZE OBSOLESCENCE AT EACH STAGE
- GET DESIRABLE DEVICES QUICKLY INTO OPERATIONAL USE AT EACH STAGE

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Vehicle and Safety

PHASE I

- FUEL ECONOMY INDICATOR
- VEHICLE SENSOR AND DIAGNOSTIC SENSORS
- IMPROVED WARNING SYSTEM -- BEST AVAILABLE
- SEAT DESIGN
- ANTI-SKID BRAKES ON REAR WHEELS
- LIGHTWEIGHT CAR -- OPTIONAL

PHASE II

- MODIFY CAR BODY AND INTERIOR TO MEET SPECIFIC POLICE REQUIREMENTS
- IMPROVED COOLING
- DUAL MODE AIR-FUEL MIXTURE RATIO
- ANTI-SKID BRAKING -- 4 WHEELS
- UPDATED PHASE I SENSORS

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Vehicle Safety and Economy

Status of Anti-Skid Brakes

- SEVERAL FOREIGN AND DOMESTIC SYSTEMS FOR PASSENGER CARS IN DEVELOPMENT OR PRODUCTION

TOYOTA	FORD
HONDA	GENERAL MOTORS
MERCEDES-BENZ	

- FORD, GM APPLICATIONS ON LARGE, LUXURY MODELS ADAPTABLE TO OTHER, SMALLER MODELS FOR REAR WHEEL CONTROL (at present)
  - KELSEY-HAYES (Ford line) DEVELOPING FOUR WHEEL HYDRAULIC ANTI-SKID BRAKE SYSTEM

- ANTI-SKID BRAKES MOST APPLICABLE TO LIGHTER CARS DUE TO HIGHER LIGHT/LADEN LOAD RATIO
  - COST MAJOR DETERRENT

Anti-Skid Brakes

- PROVIDES IMPROVED BRAKING PERFORMANCE
  - STABILITY FROM REAR WHEEL CONTROL
  - STEERABILITY FROM FRONT WHEEL CONTROL
  - REDUCED STOPPING DISTANCE UNDER MOST CONDITIONS WITH EITHER REAR OR FOUR WHEEL CONTROL

- FEDERAL REGULATIONS HAVE STIMULATED DEVELOPMENT
  - STANDARD 121 FOR AIR BRAKE VEHICLES REQUIRES ANTI-SKID BRAKING FOR WET AND DRY SURFACES
  - STANDARD 105 FOR HYDRAULIC BRAKE VEHICLES (passenger cars, light trucks) REQUIRES ANTI-SKID BRAKING ON DRY SURFACE ONLY (effective September 1975)
  - LIGHT TRUCKS EXPECTED TO NEED ANTI-SKID CONTROL DUE TO HIGH LIGHT/LADEN LOAD RATIO

Warning System Selection

PHASE I

- COMPARE EXISTING SYSTEMS TO NBS STANDARDS AND EVALUATE
- USE TOP RANKED COMPONENTS FOR PROGRAM
- DESIGN INTEGRALLY PACKAGED SUBSYSTEM

PHASE II AND III

- ASSESS ALTERNATIVE CONCEPTS AND DEVELOP IMPROVED SYSTEM
  - PROVIDE DIRECTIONALITY AT INTERSECTIONS
  - TRAFFIC LIGHT REGULATION
  - RADIO FREQUENCY SIREN

Emergency Vehicle Warning Systems

- SYSTEM OBJECTIVES
  - ALERT DRIVERS AND PEDESTRIANS — DETECT WARNING AND GIVE ATTENTION TO PROBLEM
  - CLEAR PATH FOR EMERGENCY VEHICLES — DRIVERS AND PEDESTRIANS TAKE APPROPRIATE ACTION

- EFFECTIVENESS OF DETECTION AND ATTENTION PHASES OF WARNING SYSTEMS ARE IMPACTED BY:
  - PHYSICAL CONDITIONS
    - ROAD AND TRAFFIC
    - TYPE OF DEVICE
    - WEATHER
    - VEHICLE DESTINATION
  - LIGHT AND NOISE DISTRACTIONS
    - FLASHING NEON LIGHTS
    - CAR RADIOS AND TAPES
    - AIR CONDITIONERS
    - CLOSED WINDOWS

- PROBLEMS IN SIGNAL INTERPRETATION AND INITIATION OF APPROPRIATE ACTION RELATED TO:
  - MOST WARNING SIGNALS ARE NON-DIRECTIVE
  - INAPPROPRIATE OBSERVER INTERPRETATION
  - NO CLUE TO APPROPRIATE ACTION

Instrumentation Applications on Police Cars

- USE SAFETY, PERFORMANCE/ECONOMY RELATED SENSORS ON VEHICLE
  - CANDIDATE SENSORS
    - BRAKE LINING TEMPERATURE AND WEAR
    - ENGINE COOLANT TEMPERATURE
    - ENGINE OIL TEMPERATURE, LEVEL
    - TIRE PRESSURE
    - BATTERY VOLTAGE
    - DWELL/TIMING

- USE PREVENTIVE MAINTENANCE/DIAGNOSTIC SENSORS ON FIXED STATION SYSTEM
  - "AUTOSENSE" SYSTEM ONLY IDENTIFIED SYSTEM AVAILABLE
  - COST ABOUT $8K

Instrumentation Systems

- INSTRUMENTATION SYSTEMS CAN PROVIDE A COMPREHENSIVE INDICATION OF THE OPERATIONAL CONDITION OF A VEHICLE
  - PROVIDES SAFETY RELATED WARNINGS
  - WARNS OF IMMINENT COMPONENT WEAROUT/FAILURE
  - MONITORS STATE-OF-TUNE FOR GOOD PERFORMANCE, FUEL ECONOMY, LOW EMISSIONS
  - PROVIDES DIAGNOSTIC CAPABILITY FOR FAULT ISOLATION

- TWO BASIC APPROACHES TO VEHICLE SENSOR USE FOR MONITORING/ DIAGNOSING CONDITION OF VEHICLE
  - ON-BOARD SENSORS - DISPLAYS
  - FIXED STATION SYSTEMS - COMPUTER AND PRINTER

Patrol Vehicle Economy

- ECONOMY CONSIDERATIONS INCLUDE INITIAL COST, OPERATING COST, MAINTENANCE, RESALE VALUE
- ENERGY CRISIS STIMULATED INTEREST IN SMALLER CARS
- STUDY PERFORMED TO ASSESS USE OF SMALLER CARS FOR POLICE
  - COMPACT NOW NEARLY AS LARGE AND HEAVY AS STANDARD 10 YEARS AGO
  - REDUCED VEHICLE WEIGHT IS PRIMARY FACTOR IN IMPROVED FUEL ECONOMY (beyond driver)
  - COMPACT SEDAN FOUND SUITABLE FOR URBAN, SUBURBAN APPLICATIONS
- LOS ANGELES COUNTY SHERRIFF/MOTOR TREND TESTS OF COMPACT CARS SHOW SUITABILITY FOR POLICE PATROL
  - CHEVY NOVA ONLY DOMESTIC COMPACT WITH POLICE PACKAGE

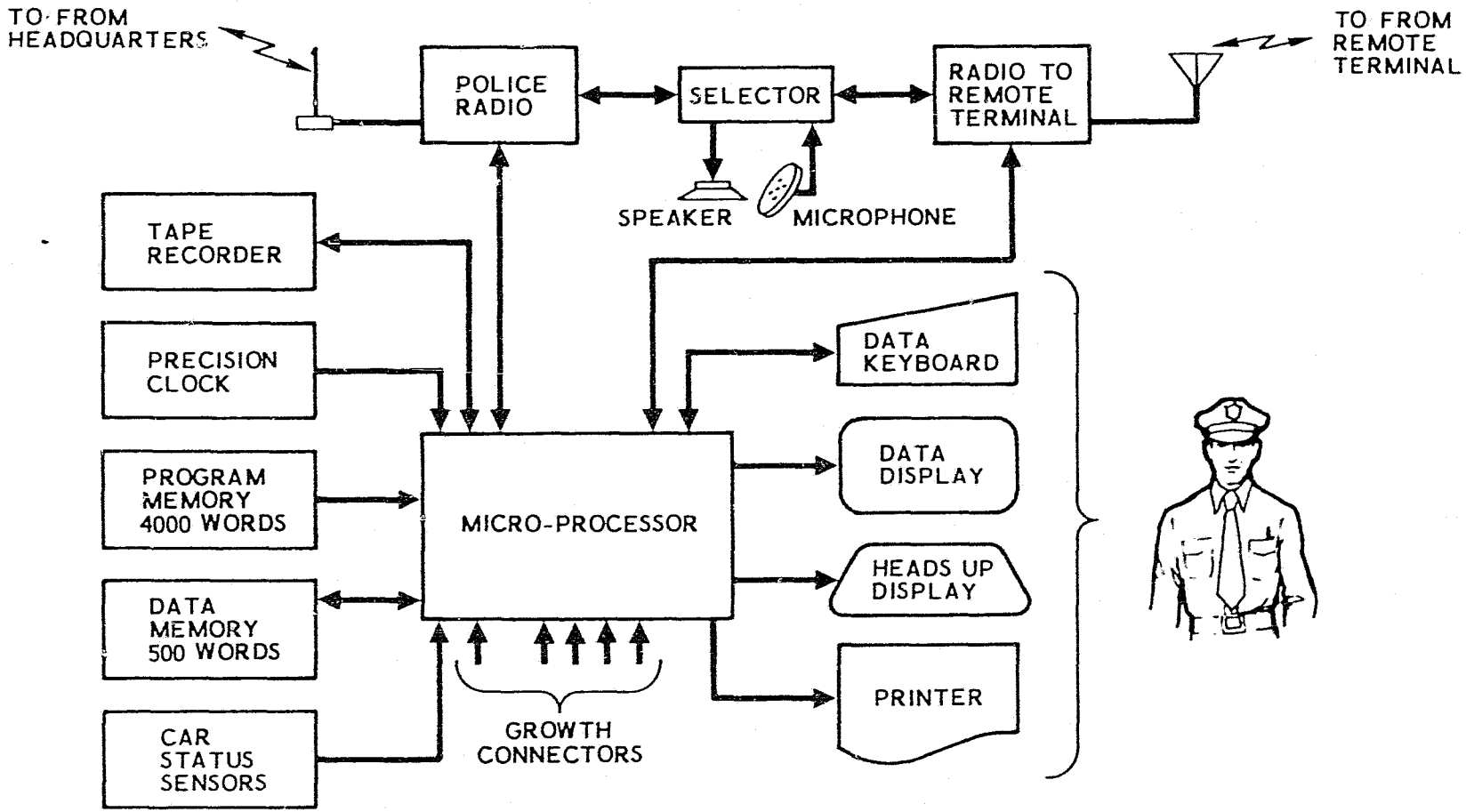
Driver Station Seat Design

- POTENTIAL IMPROVEMENTS IN SEAT DESIGN FOR SAFETY, COMFORT
  - INTEGRAL SEAT BELT AND SEAT
  - ADEQUATE SEAT ADJUSTMENT TRAVEL
  - PROVISIONS FOR OFFICER BELT-GEAR AND INSTALLED EQUIPMENT
  - OPTIMUM POSTURE CONTROL
  - CONTOURING FOR LATERAL STABILITY

- NO IDENTIFIED SOURCE FOR SPECIAL POLICE CAR SEAT PROCUREMENT
  - DEMONSTRATION UNIT COST ESTIMATED AT $5,000
  - LOW VOLUME PRODUCTION ESTIMATED AT $250-500

- INFORMATION OBTAINED FROM MAN-FACTORS, INC
  - HUMAN ENGINEERING R&D FIRM
  - SUPPORTS SAN DIEGO POLICE DEPARTMENT

In-Car Data System – Phase I



Integrated Data System

- OFFICER EFFECTIVENESS
- SECURITY
- CHANNEL CONSERVATION
- GROWTH

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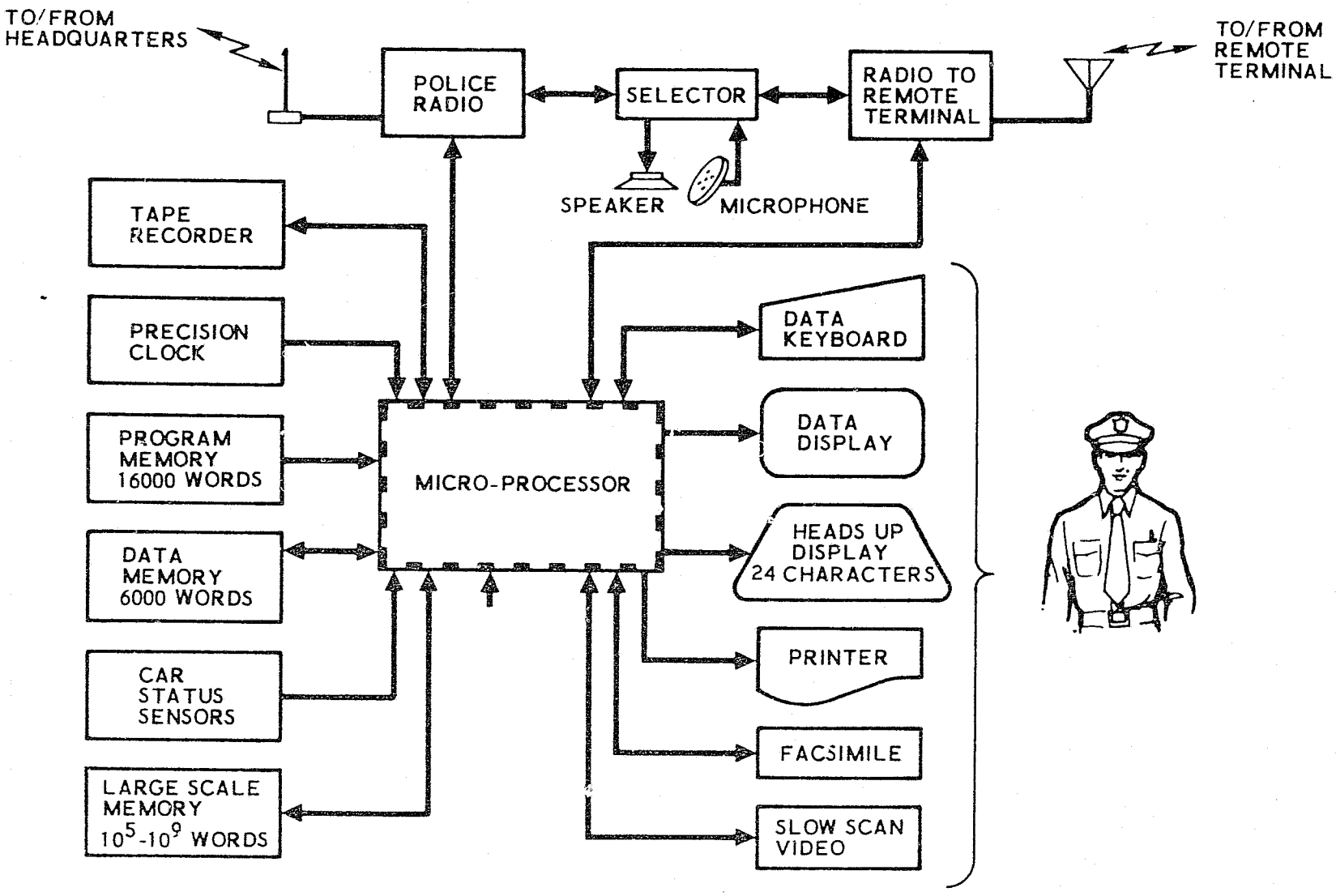
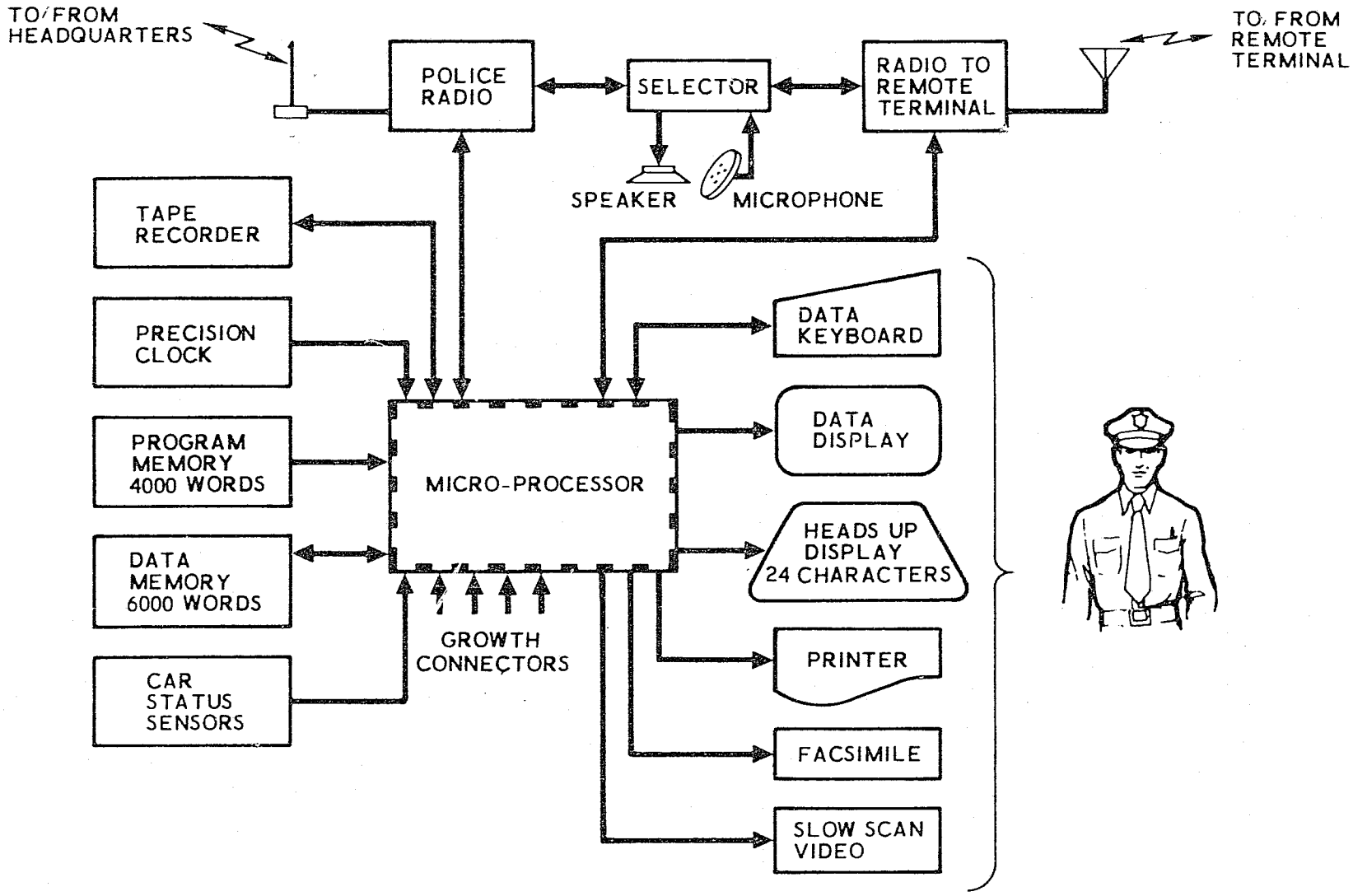
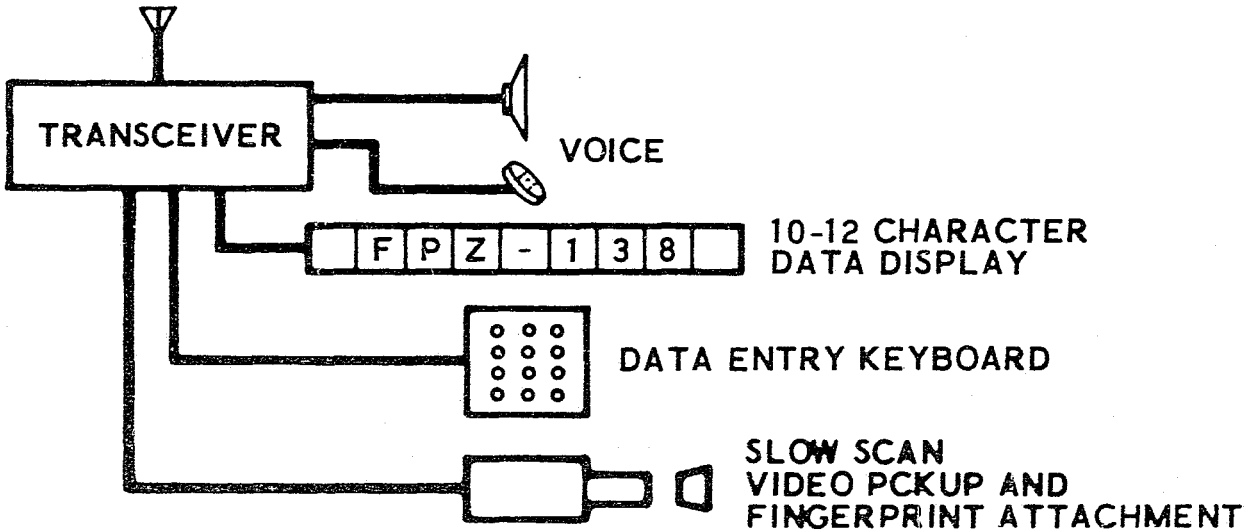
In-Car Data System — Phase III



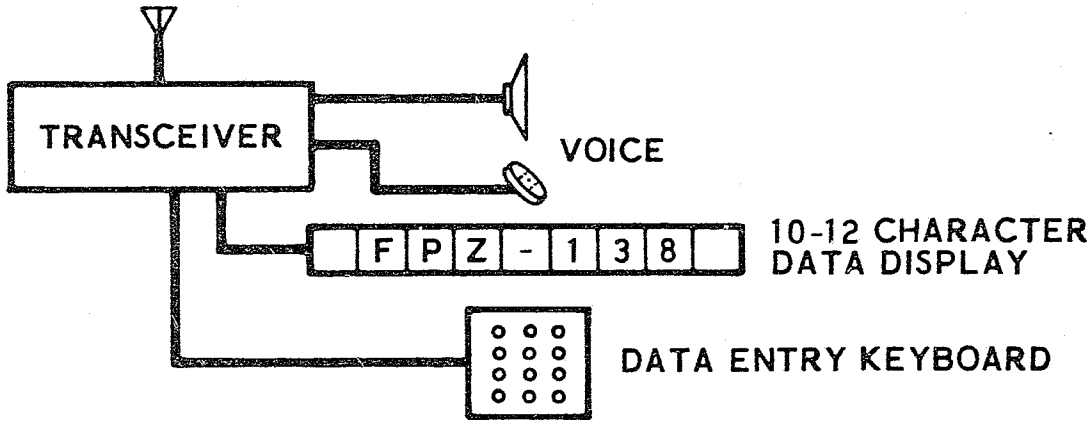
In-Car Data System – Phase II



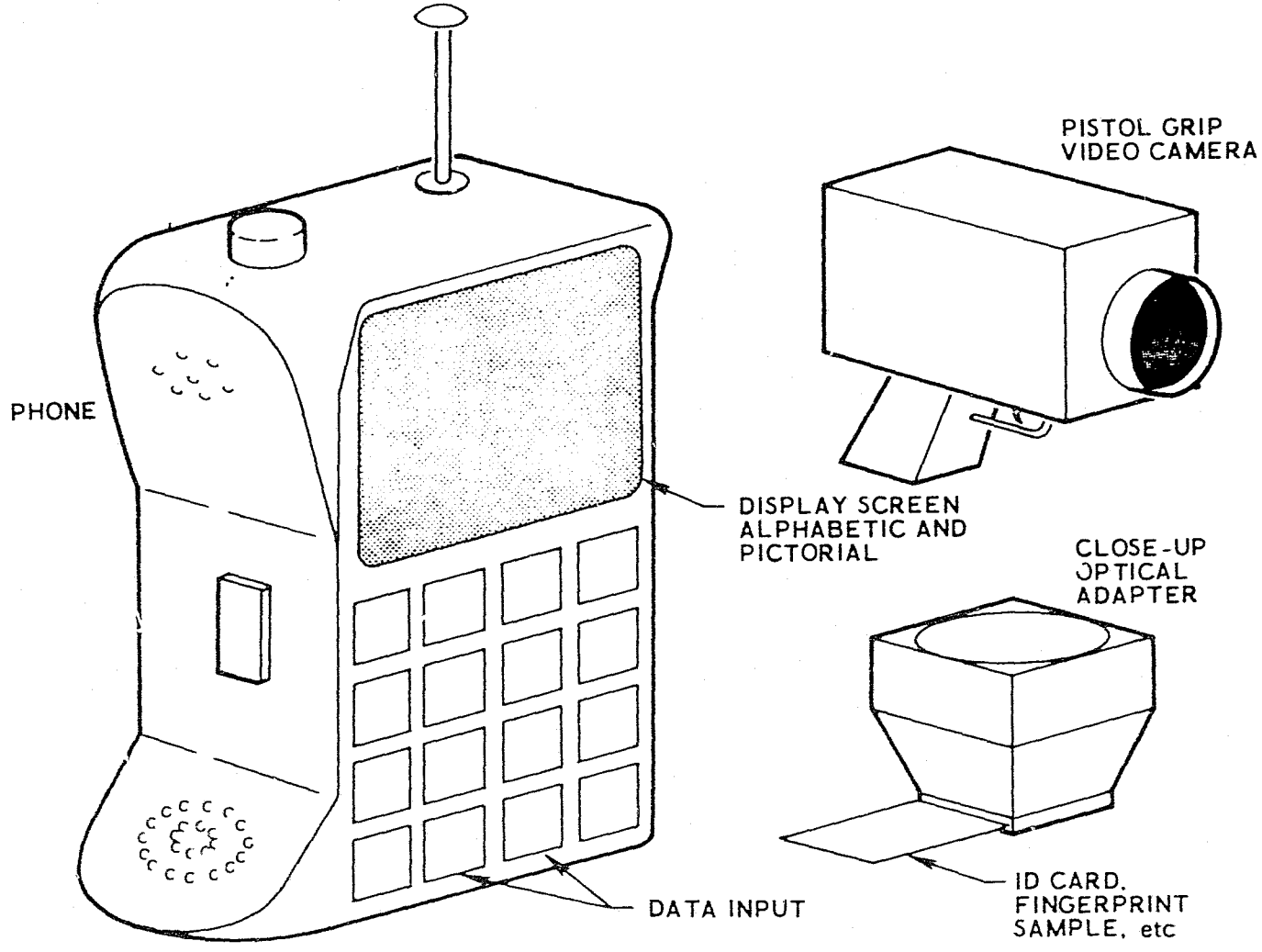
Remote Terminal – Phase II



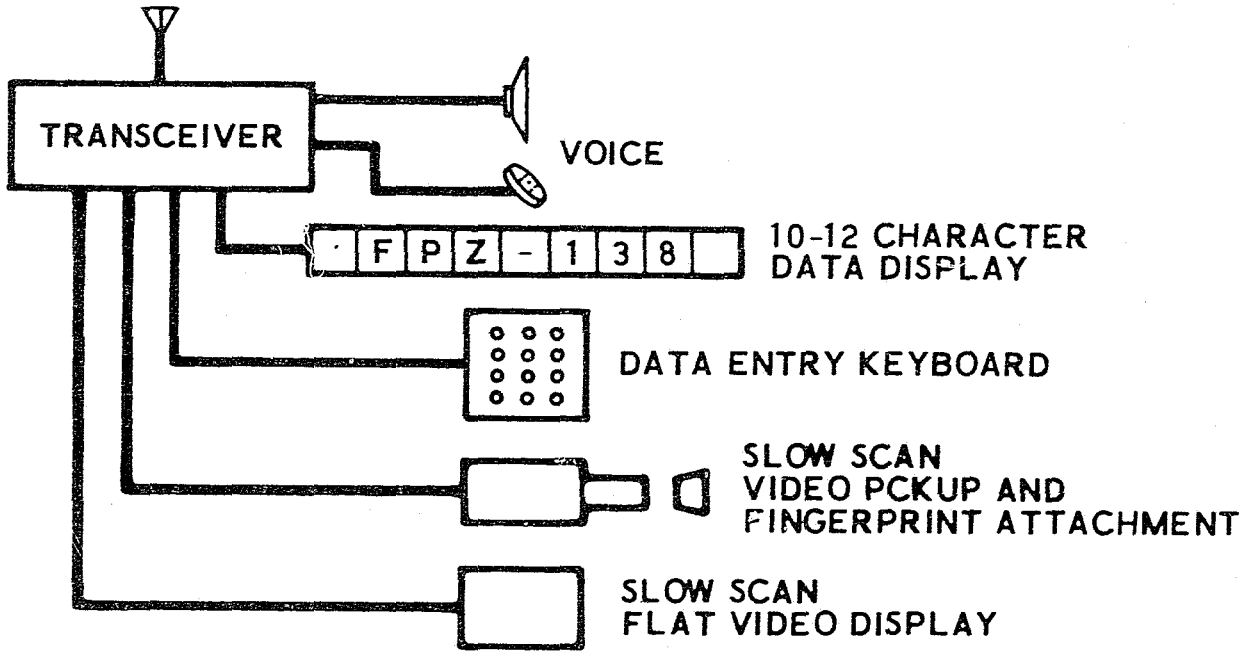
Remote Terminal – Phase I



Remote Terminal



Remote Terminal – Phase III



Data Bases Accessed by LAPD Field Officer

- AUTOMATED WANT/WARRANT SYSTEM (LA county wide)
- STOLEN VEHICLE SYSTEM (California DOJ data base)
- CALIFORNIA DMV INFORMATION SYSTEM
- NCIC

Total Potential Data File Storage

- STOLEN/WANTED AUTO LICENSES 10^9-10^{10} BITS
- ALL AUTO LICENSES 10^{11} BITS
- WANTED/MISSING PERSONS 10^8 BITS
- STOLEN PROPERTY (non-auto) 10^9-10^{10} BITS
- FIREARM REGISTRATION 10^9 BITS
- PERSON IDENTIFICATION 10^{12} TO 10^{15} BITS
  - NAME, ALIAS
  - SOCIAL SECURITY
  - DRIVER'S LICENSE
  - MILITARY RECORD
  - FINGERPRINTS
  - PHYSICAL DESCRIPTION, MARKINGS
  - PHOTOGRAPH(S)
  - VOICE
  - BLOOD, HAIR, ETC
- CRIMINAL RECORDS 10^{10} BITS
  - HISTORY
  - MODUS OPERANDI
- REAL PROPERTY 10^9 BITS
  - OWNERSHIP
  - STATUS
- CRIMINAL INTELLIGENCE
- POLICE SYSTEM COMMAND AND CONTROL
  - ASSESSMENTS
  - STATUS OF CARS
  - SPECIAL TEAMS
  - COURT CALENDAR
  - COMPLAINTS OUTSTANDING
  - DAILY LOG
- ANALYZED DATA AND STATISTICS
  - CRIME STATISTICS
  - HIGH RISK AREAS
  - TRAFFIC STATISTICS
  - REPORT COMPILATION
  - EFFECTIVITY EVALUATION
- TRAFFIC CONDITIONS
- WEATHER AND WEATHER FORECAST
- UP-TO-DATE CITY MAP (including construction)

Applications of Modest In-Car Data Base

- REVIEW OF INFORMATION ISSUED AT ROLL CALL
  (data media given to officer at roll call)
- PROVIDE OFFICER WITH AUTOMATED QUESTIONNAIRE FOR MOST SITUATIONS
- STORE ROUTINE BROADCAST DATA FOR REVIEW AND REFERENCE
- ACCEPT AND STORE UNIT ACITIVITY REPORT FOR AUTOMATIC PRINTING (data media returned to headquarters)
- LOG ALL MESSAGE TRAFFIC FOR REFERENCE
- PROVIDE TRAINING MATERIAL FOR PERIODS OF LOW ACTIVITY

Examples of Inquiry to Data Bases

1. ENTER: VEHICLE LICENSE NUMBER ABC 123 (CA assumed)
   ABC 123 NJ (NJ specified)

   OBTAIN RESPONSE FROM RCF, SVS, NCIC, AWWS, OR DMV AS APPLICABLE

   DELAY 5-30 sec

2. ENTER: DRIVER LICENSE NUMBER AND/OR NAME PLUS ID DATA

   OBTAIN RESPONSE FROM AWWS, APIF, AS APPLICABLE

   DELAY 10-30 sec

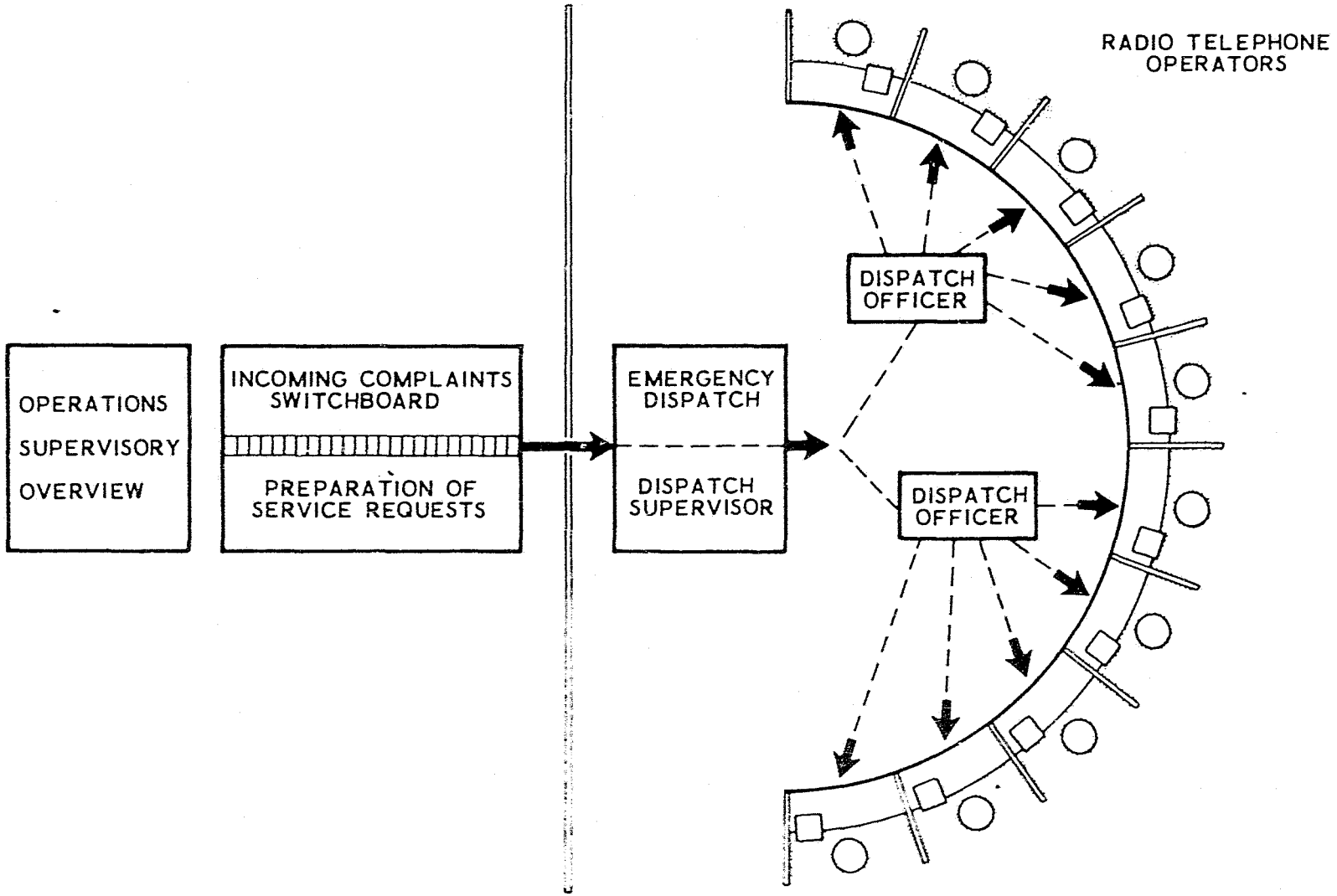
3. ENTER: BICYCLE ID NUMBER

   OBTAIN RESPONSE FROM DOJ

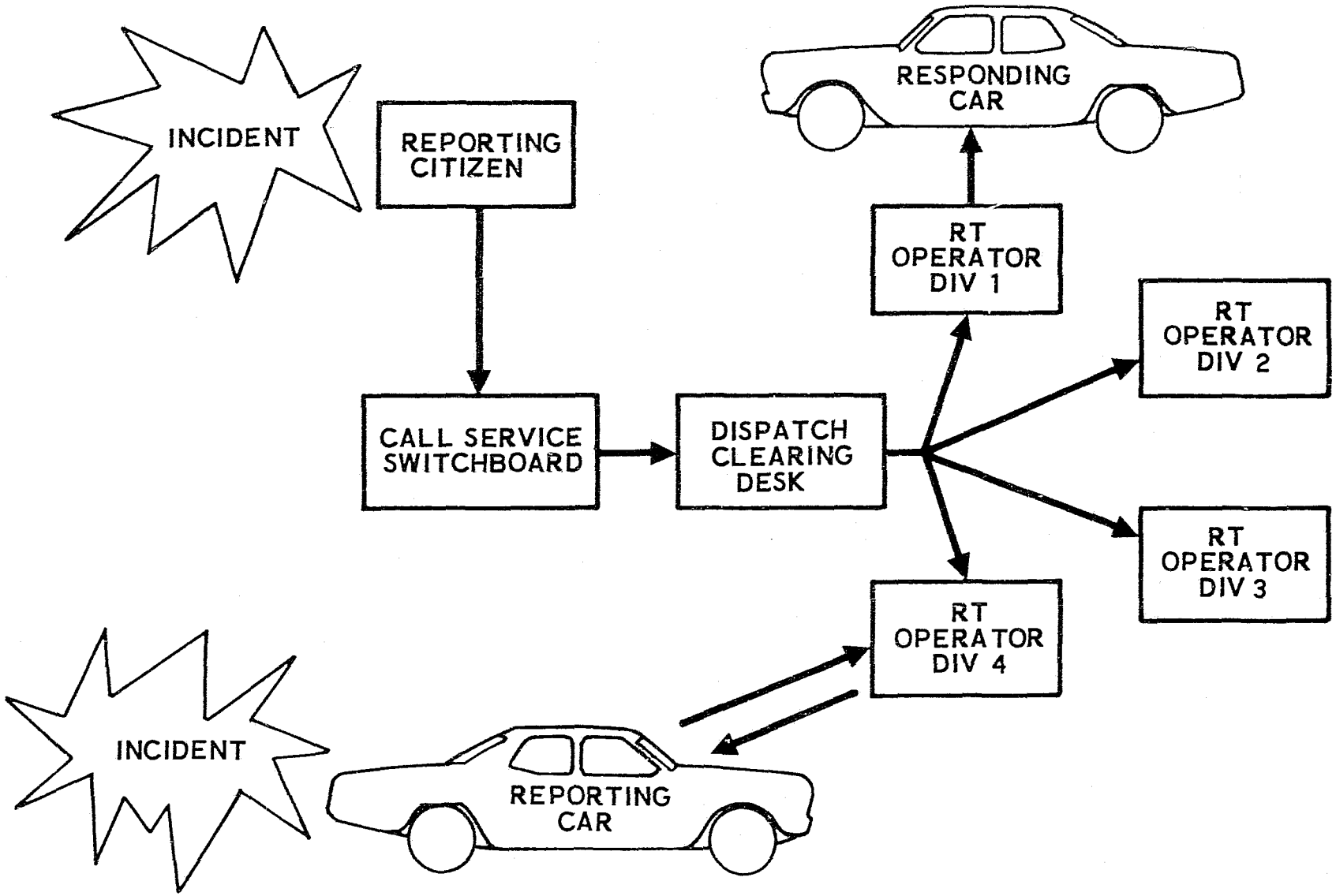
4. ENTER: VEHICLE IDENTIFICATION NUMBER

   OBTAIN RESPONSE FROM SVS, NCIC, DMV

Los Angeles Police Department Dispatch Center



Command and Control



Mobile Keyboard/Display Terminals

STATUS, INQUIRY, AND DISPATCH

MANUFACTURER	PD LOCATIONS	SIZE (cu in.)	FUNCTION KEYS	DISPLAY CHARACTERS	OPTIONS	PRICE
ATLANTIC RESEARCH	DEARBORN HEIGHTS, MICH.	902	10	16	PRINTER	$4000
E SYSTEMS		1543	12	64	PRINTER	2900
KUSTOM	BROWARD CITY, FLA CLEVELAND LAS VEGAS NEW YORK, N.Y. OAKLAND PINELLAS CTY, FLA SARASOTA, FLA	1349	13	256	PRINTER	3200
MOTOROLA	ATLANTIC CITY HAMPTON, VA	579	10	32	PRINTER	3175
SUNRISE	TRIAL - LAPD	468	5	32		2095

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Proposed Data System Experimental Developments

BASE STATION

- EQUIP ONE RADIO TELEPHONE OPERATOR WITH CAPABILITY FOR
  - MESSAGE ENTRY
  - MESSAGE DISPLAY
  - STATUS DISPLAY
  - RECORDING PRINTER
- PROVIDE DATA PROCESSOR AND SOFTWARE WITH CAPABILITY FOR
  - IN-OUT INTERFACES
  - STORE AND FORWARD OF DOWN LINK AND UPLINK MESSAGES
  - STATUS MONITORING
  - ERROR CONTROL/SECURITY
  - MESSAGE FORMATTING FOR INQUIRY TO L.A. BASES
- DEVELOP COMMUNICATIONS
  - UTILIZE APPROPRIATE AVAILABLE RADIO
  - PROVIDE MODEM

A Standardized Interface

1. PIN CONNECTION	No. (to be specified) OR EQUIV. 25 PIN LOCKING CONNECTOR
2. SIGNAL LEVEL	LOGIC TRUE 10 MA, 4.5 volts LOGIC FALSE 1 MA, 0.5 volts } ISOLATED FROM GROUND ON INPUT
3. CHARACTER CODE	8 BIT ASCII PARALLEL (1 parity bit), PARALLEL TO EACH PORT
4. DEVICE ENABLE/STROBE	1 BIT, SEPARATE TO EACH PORT
5. DEVICE READY TO TRANSMIT	1 BIT
6. DEVICE READY TO RECEIVE	1 BIT

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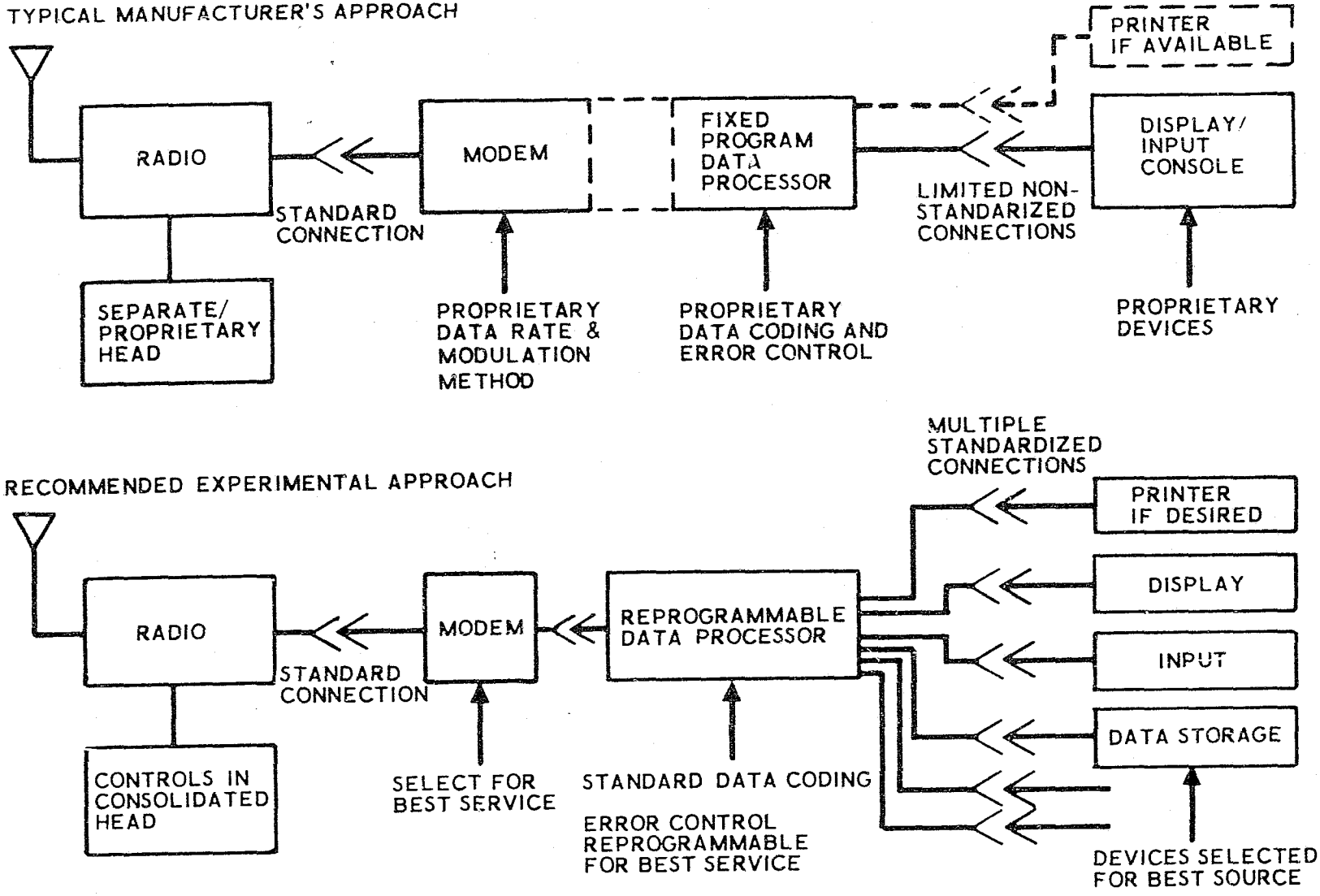
Comparison of Manufacturers and Experimental In-Car Data System



Integration of Car Subsystems

- THE FOLLOWING SPECIAL CONTROLS COMPETE FOR SPACE IN THE CAR:
  - RADIO CHANNEL, ON/OFF, MODE
  - SIREN
  - EMERGENCY LIGHTS
  - PUBLIC ADDRESS
  - DATA LINK CONTROLS

- THE COMPUTER CAN INTEGRATE CONTROL, AS DESIRED, THROUGH SPECIALIZED BUTTONS ON THE DATA TERMINAL OR THROUGH TYPED-IN COMMANDS

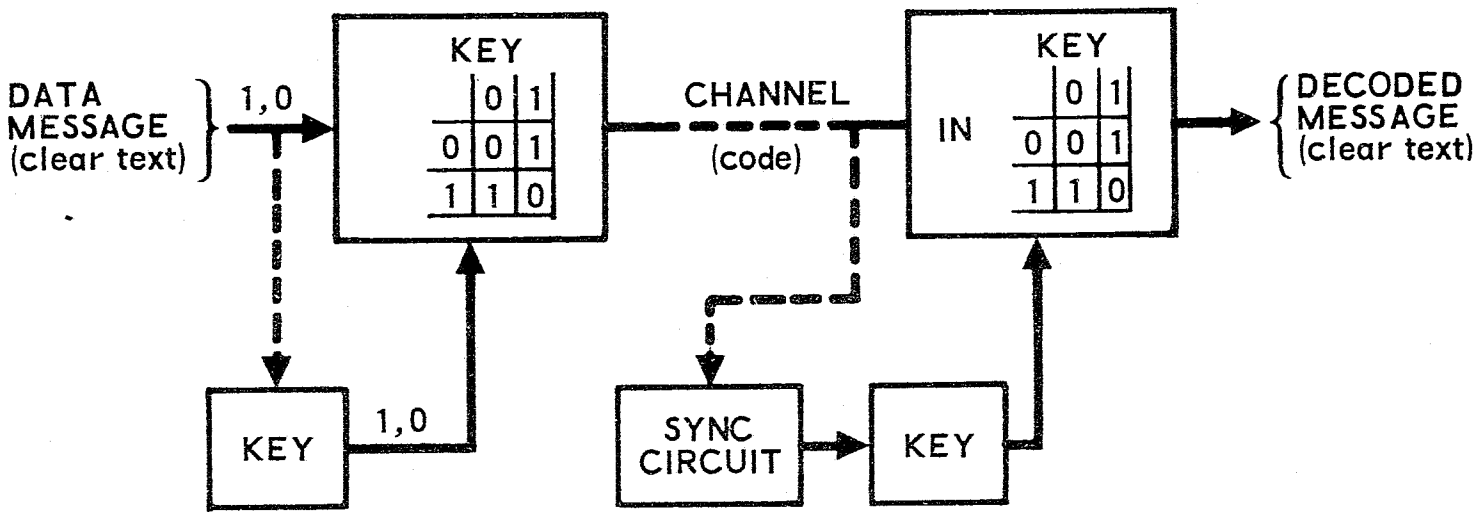
Advantages of Standardization of Interfaces

- EQUIPMENT FROM DIFFERENT MANUFACTURERS CAN BE INTERCONNECTED
- INDIVIDUAL EQUIPMENTS CAN BE REPLACED WITH IMPROVED VERSIONS
- NEW TYPES OF DEVICES CAN BE ADDED AS DEVELOPED
- INSTALLATIONS CAN BE TAILORED FOR SPECIAL PURPOSE VEHICLES

THE ABOVE SAVES MONEY BECAUSE OF

- INCREASED COMPETITION IN FOLLOW-ON PROCUREMENTS
- INCREASED FLEXIBILITY
- DECREASED OBSOLESCENCE
- RAPID UTILIZATION OF NEW DEVELOPMENTS
- EASIER MAINTENANCE

Communication Security

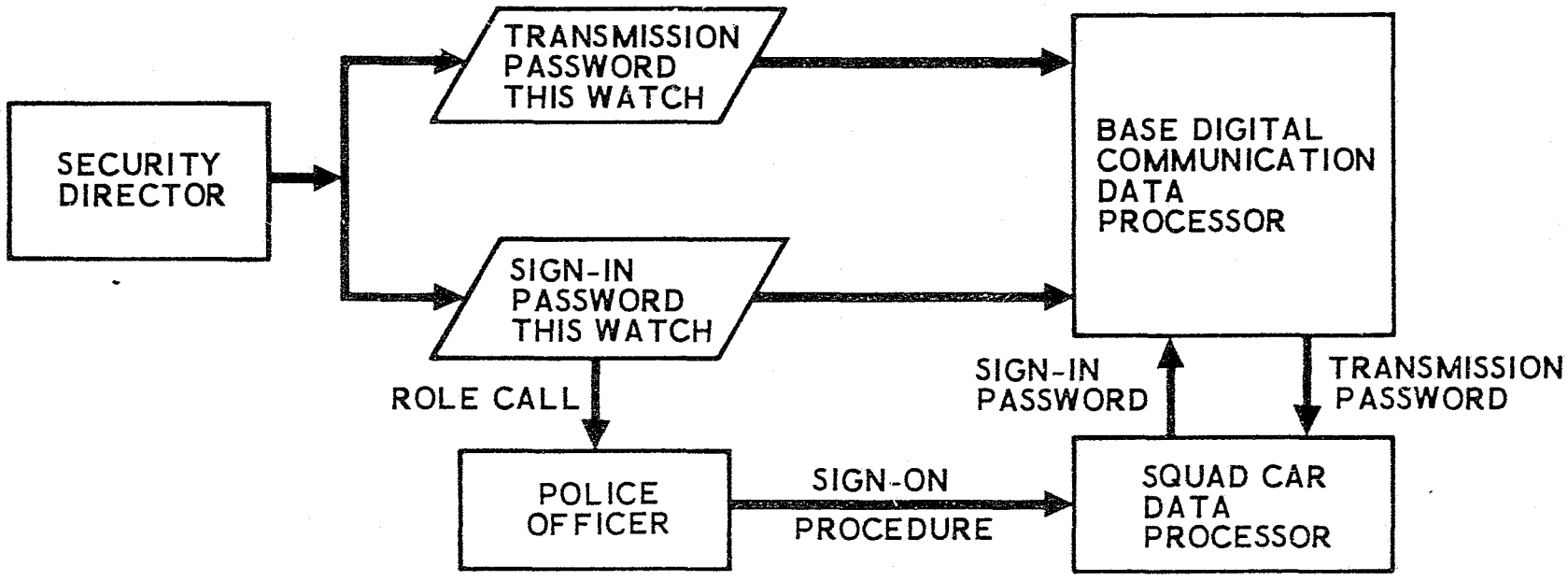


- CLEAR TEST + KEY = CODE
  CODE + KEY = CLEAR TEXT
- PROCESS CAN BE IMPLEMENTED IN A COMPUTER

Car Security

- COMPUTER INTEGRATION OF:
  - ELECTRICALLY CONTROLLED WINDOWS AND DOOR LOCKS
  - STATUS TRANSMISSION TO HEADQUARTERS
  - ACCESS BY KEY OR VIA HAND-HELD DATA TERMINAL
  - BREAK-IN ALARM TRANSMISSION TO HEADQUARTERS
  - COUPLED CAR LOCATOR SYSTEM (when available)

A Procedure for Preventing Unauthorized Use



- ALL CAR TRANSMISSIONS EXCEPT SIGN-ON REQUIRE CORRECT TRANSMISSION PASSWORD
- ALL SIGN-ONS MUST CONTAIN CORRECT PASSWORD FOR THE WATCH
- TRANSMISSIONS WITHOUT CORRECT PASSWORDS WILL BE ANSWERED WITH STALLING DECOY MESSAGES

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Error Detection - Simple Example

ALLOWABLE CODES		INTERPRETATION	
A	101	101 →	A
B	010	010 →	B
		000	
		001	
		011	ERROR
		100	REPEAT MESSAGE
		110	
		111	

- ERROR DETECTION CAN BE READILY IMPLEMENTED IN A COMPUTER

Software

Channel Conservation

- NEW RADIO CHANNELS ARE DIFFICULT TO OBTAIN
- DATA TRANSMISSION AT LEAST 20 TIMES AS EFFICIENT AS VOICE (1/20 the duration per message)
- CAREFUL FORMATTING OF THE MESSAGES CAN MAKE FURTHER IMPROVEMENTS
- IN-CAR DATA BASE CAN BE ARRANGED TO HANDLE MOST FREQUENT DATA NEEDS
- ADVANCED DATA COMPRESSION METHODS CAN MAKE FINGERPRINT AND/OR PHOTOGRAPH TRANSMISSION OVER PRESENT LINKS FEASIBLE

Software Development — Base System

OPERATING SYSTEM

- INTERRUPT, SCHEDULING, TIMING, POWERFAIL, DEVELOPMENT AIDS, BOOTSTRAP

INPUT DRIVERS AND PROCESSORS

- RADIO FROM CAR, INCLUDING ERROR DETECTION
- OPERATOR CONSOLE INPUT
- RESPONSES FROM FECS
- SUPERVISOR CONSOLE INPUT
- EMERGENCY DISCRETES

OUTPUT DRIVERS AND PROCESSORS

- RADIO TO CAR, INCLUDING MESSAGE ASSEMBLY
- DISPATCHER DISPLAY - MESSAGES, STATUS, HITS FROM CAR INQUIRIES
- SUPERVISOR DISPLAY - STATUS
- INQUIRY TO FECS
- TRANSACTION LOG
- PRINTER

SUBSYSTEMS

- EDIT REPORTS FOR LENGTH
- GENERATE PROMPTERS
- SIGN-ON AUDIT
- INTERPRET KEYBOARD INPUT
- ERROR CORRECTION - REQUEST FOR CAR TO RETRANSMIT
- ERROR CORRECTION - RETRANSMIT LAST TRANSMITTED MESSAGE
- BUFFER MANAGEMENT
- COMMUNICATIONS SECURITY
- MESSAGE FORWARDING TO OTHER MOBILES

Software Development – Car System

OPERATING SYSTEM

- INTERRUPT, SCHEDULING, STATE MONITORING, TIMING, POWERFAIL

INPUT DRIVERS AND PROCESSORS

- RADIO FROM BASE, INCLUDING ERROR DETECTION
- KEYBOARD, INCLUDING VERIFY MEANINGFUL ENTRY
- RADIO FROM REMOTE TERMINAL
- STATUS DISCRETES
- MONITORING DEVICES

OUTPUT DRIVERS AND PROCESSORS

- RADIO TO BASE, INCLUDING MESSAGE ASSEMBLY
- DATA DISPLAY
- PRINTER
- SWITCH DISCRETES
- RADIO TO REMOTE TERMINAL

SUBSYSTEMS

- COMMUNICATIONS SECURITY
- ERROR CORRECTION - REQUEST FOR BASE TO RETRANSMIT
- ERROR CORRECTION - RETRANSMIT LAST TRANSMITTED MESSAGE
- GENERATE TROUBLE INDICATORS
- INTERPRET KEYBOARD INPUT
- MESSAGE LOGGING
- GENERATE PROMPTERS
- SIGN-ON PROCESSOR
- ACTIVITY LOGGING
- MESSAGE FORWARDING TO REMOTE TERMINAL

RECORDER HANDLER

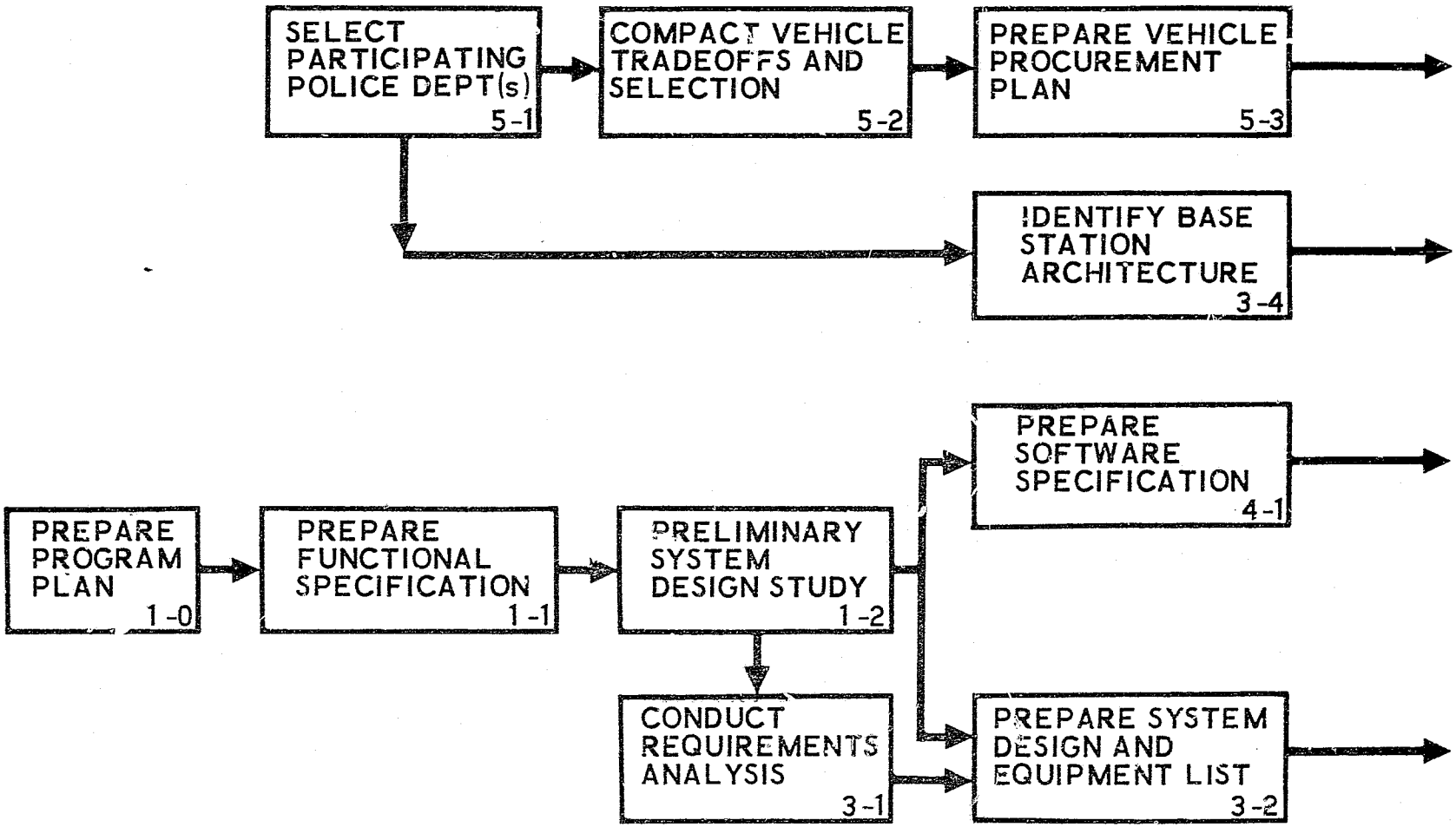
- WRITE OPERATION
- READ OPERATION

Capabilities to be Demonstrated

	PHASE I	PHASE II	PHASE III
IDENTIFICATION - PERSONAL			
DESCRIPTION	X	X X	X
VOICE	X	X	X
FINGERPRINT		X	X
PHOTOGRAPH		X	X
SLOW SCAN TV		X	X
HAND HELD TERMINAL	X	X	X
SLOW SCAN TV PICKUP		X	X
SLOW SCAN TV DISPLAY			X
IDENTIFICATION - PROPERTY			
AUTO	X	X	X
FIREARMS	X	X	X
REGISTERED ARTICLES	X	X	X
COMMAND CONTROL	X	X	X
OBSERVED CAR SPEED	X	X	X
TIME TAGGING OF EVENTS	X	X	X
PROMPTERS FOR OFFICER INPUT	X	X	X
FLEXIBILITY TO ADD EQUIPMENT	X	X	X
CAR LOCATION		X	X
CAR STATUS	PARTIAL	X	X
FUEL ECONOMY	X	X	X
EASE OF MAINTENANCE	PARTIAL	X	X
SAFETY ENHANCEMENT	PARTIAL	X	X
ANTI-SKID BRAKES	STUDY/EXPERIMENT	X	X
HUMAN ENGINEERED CAR INTERIOR		X	X
REDUCED COMMUNICATION LOAD	PARTIAL	PARTIAL	X
DIGITALLY CODED FINGERPRINTS			X
DIGITALLY PROCESSED VIDEO			X
MODEST IN-CAR DATA BASE		X	X
LARGE IN-CAR DATA BASE			X

Police Patrol Car System Improvements Program Schedule

Phase I – Specification Preparation



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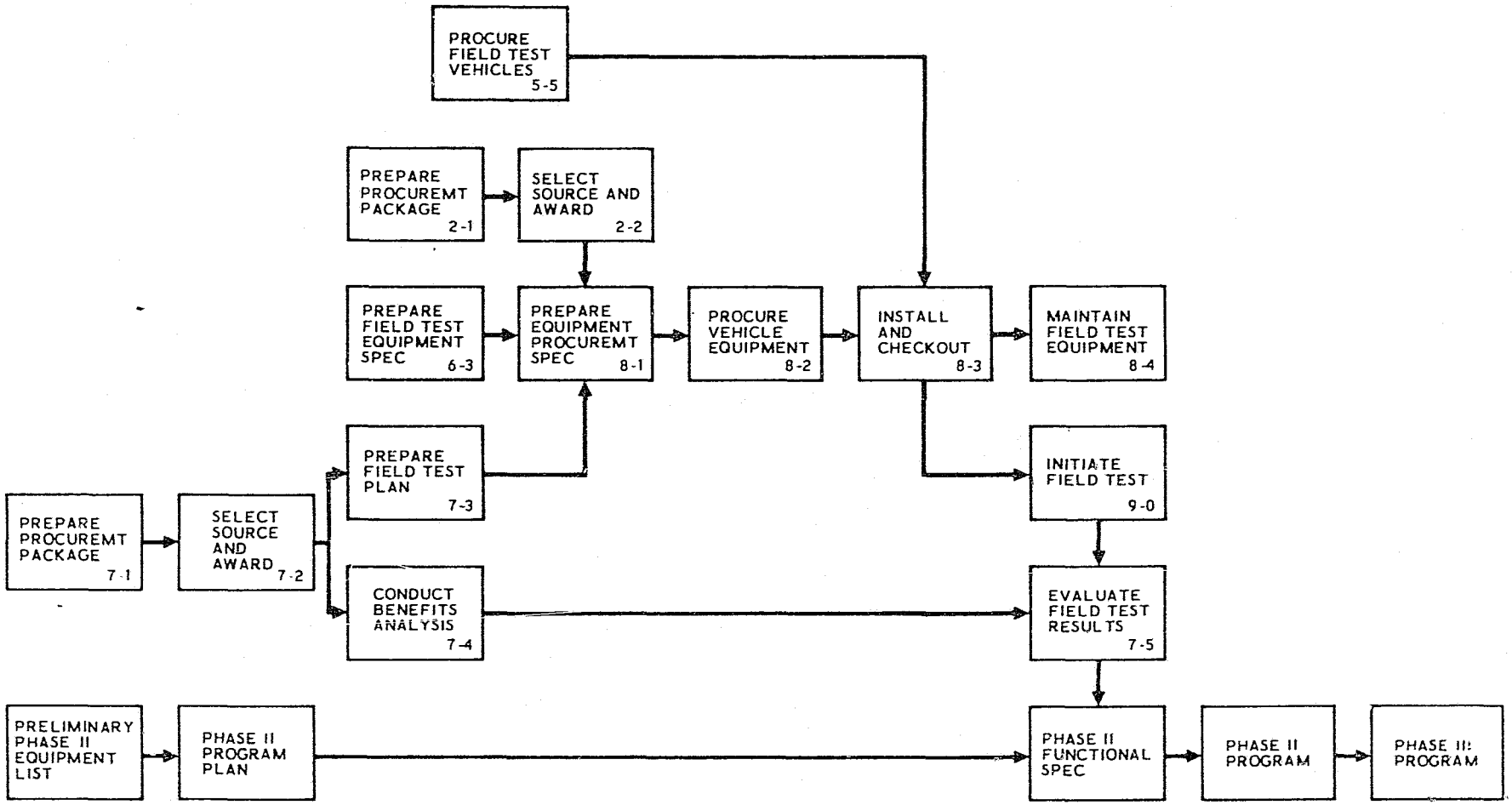
Phase I – Test and Demonstration Objectives

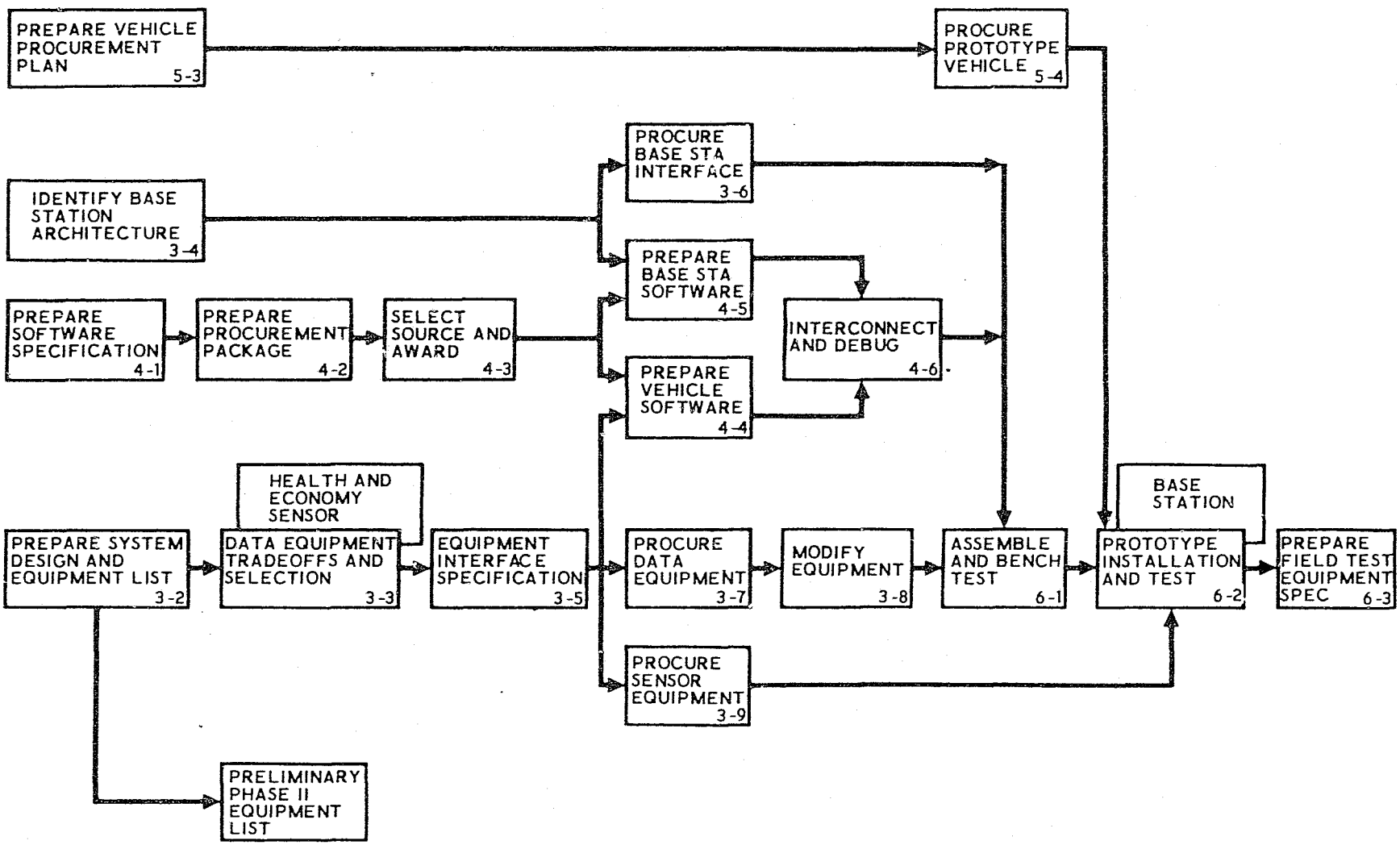
- POLICE VEHICLE
  - EFFECTIVENESS OF:
    - COMPACT CAR AND DRIVER TRAINING IN REDUCING GASOLINE CONSUMPTION
    - MAINTENANCE AND CONDITION SENSORS
    - ANTI-LOCK BRAKES
  - ACCEPTABILITY OF:
    - COMPACT SIZED CAR
    - NEW SEAT
  - DESIGN CRITERIA FOR:
    - CAR INTERIOR
    - SEAT
    - HUMAN ENGINEERING OF CAR

- INTEGRATED DATA SYSTEM
  - ACCEPTABILITY OF CONCEPT
  - UTILITY OF HAND-HELD REMOTE TERMINAL
  - DEMONSTRATION OF IN-CAR DATA BASE
  - FLEXIBILITY AND GROWTH
  - DEMONSTRATION OF NEW FUNCTIONS:
    - SECURITY
    - AIDED REPORTING
  - AREAS OF IMPROVEMENT NEEDED

Phase I — Field Test



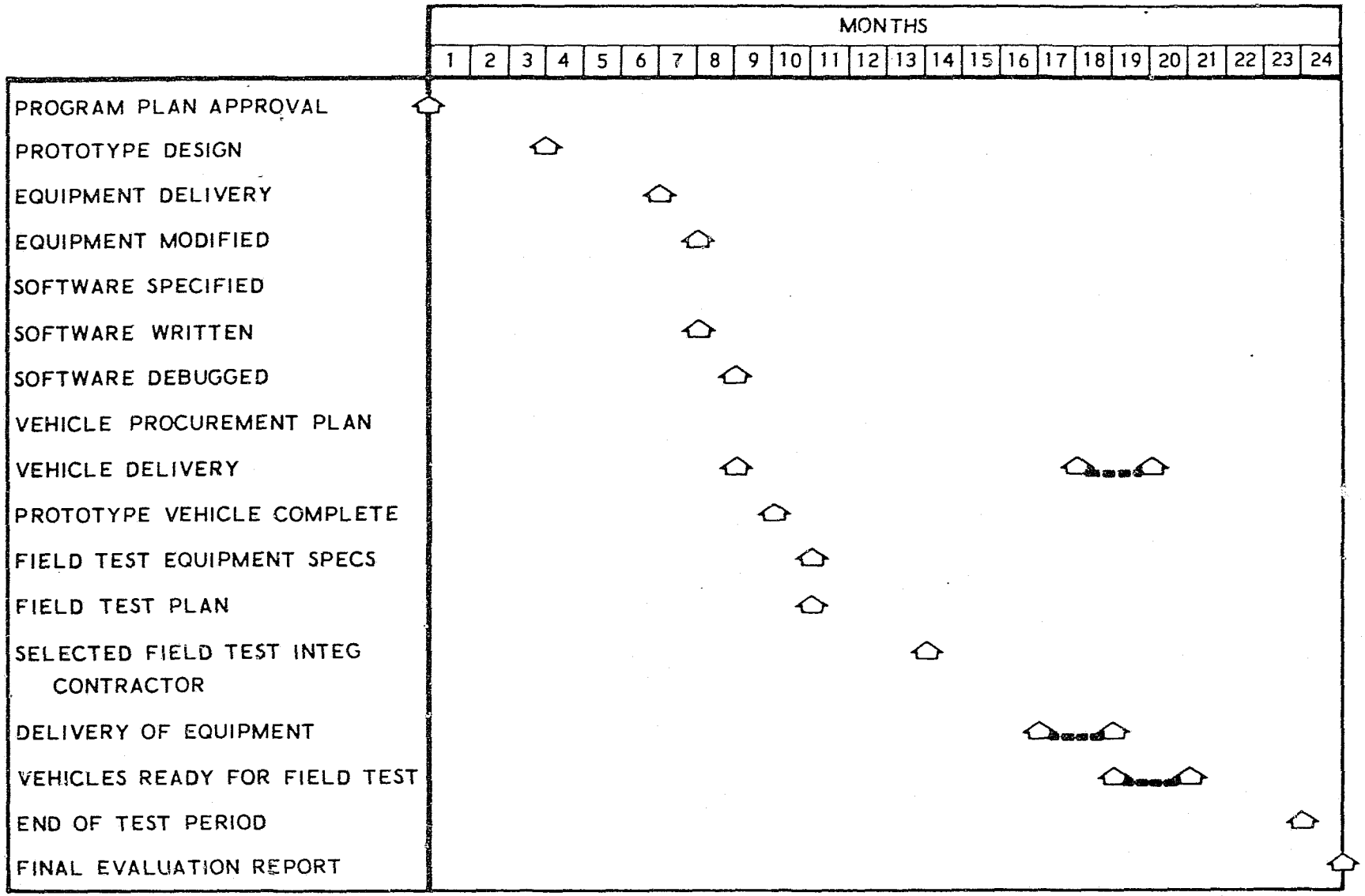
Phase I – Prototype Procurement and Test



Equipment Cost Estimates

ITEM	COST	ONE-TIME COST	LARGE BUY COST
POLICE CAR	4000		4000
WARNING SYSTEM	300		300
DIAGNOSTICS	100	10,000	50
ECONOMY GAUGE	100		50
RADIO	1800		1800
COMPUTER	4300	14,000	2000
SELECTOR	300	1,400	100
KEYBOARD-DISPLAY	3500		2500
HEADS UP DISPLAY	3000	20,000	700
PRINTER	1800		1800
REMOTE TERM RADIO	2500		2500
PORTABLE RADIO	1000		700
PORTABLE DATA TERM	700		500
TAPE RECORDER	2000		1500
BASE STATION PROCESSOR		26,000	
	25,400	71,400	18,500

Program Schedule



7c

Definitions

- WHAT IS A MICROPROCESSOR?
  - CPU PORTION OF COMPUTER ON A CHIP
  - INCLUDES REGISTERS, ARITHMETIC LOGIC UNIT, BUS STRUCTURE, CONTROL LOGIC
  - COST RANGE $5 TO $300
- WHAT IS A MICROCOMPUTER?
  - [illegible]

Microprocessor Technology

Microcomputer Survey

MANUFACTURER/MODEL	TYPE	ADD TIME (Reg to Reg)	MOST COMMON APPLICATION	BOARD SIZE	PRICE
APPLIED COMPUTING TECHNOLOGY/UMPS-4	4-BIT PMOS	15 μs	INTELLIGENT TERMINAL	5 x 7	$695
COMPUTER AUTOMATION LSI-1	16-BIT SLICE, PMOS	9.6 μs	NEW PRODUCT	4.5 x 4.5	$950
COMSTAR SYSTEM 4	4-BIT PMOS	10.8 μs	PROCESS CONTROL	4.5 x 4.5	$950
DIGITAL EQUIPMENT MPS	8-BIT PMOS	10 μs	PROCESS CONTROL	10.4 x 8.5	$410
DIGITAL EQUIPMENT PDP-8/A	12-BIT, TTL BIPOLAR	3 μs	PDP-8/E COMPATIBLE	15.75 x 8.5	$895
INTEL 8-83	8-BIT NMOS	2 μs	TERMINALS	6.18 x 8.0	$590
NATIONAL IMP-16C	4-BIT SLICE, PMOS	4.2 μs	PROCESS CONTROL	8.5 x 11	$950
PRO-LOG MPS-800	8-BIT PMOS	14 μs	TERMINALS	4.5 x 6.5	$700
TELEDYNE TDY-52A	4-BIT PMOS HYBRID	10.8 μs	MILITARY	2 x 2	$995

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E0339

Microprocessor Chronology

FIRST GENERATION CHIP -- MARCH 1971

INTEL 4004 -- 4 BIT PMOS, 20 μs

SECOND GENERATION CHIP -- DECEMBER 1973

INTEL 8080 -- 8 BIT NMOS, 2 μs

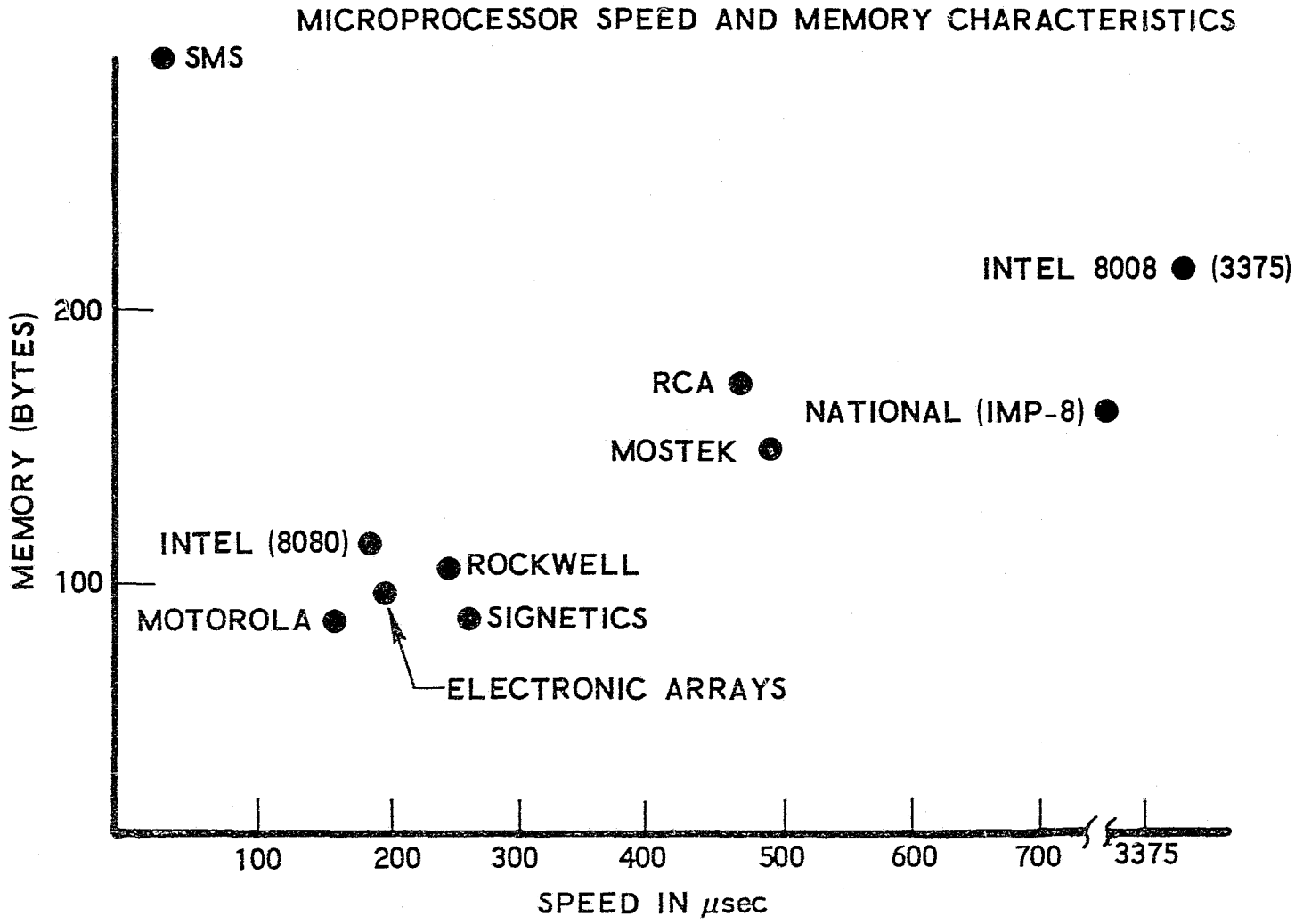
THIRD GENERATION CHIP -- JULY 1974

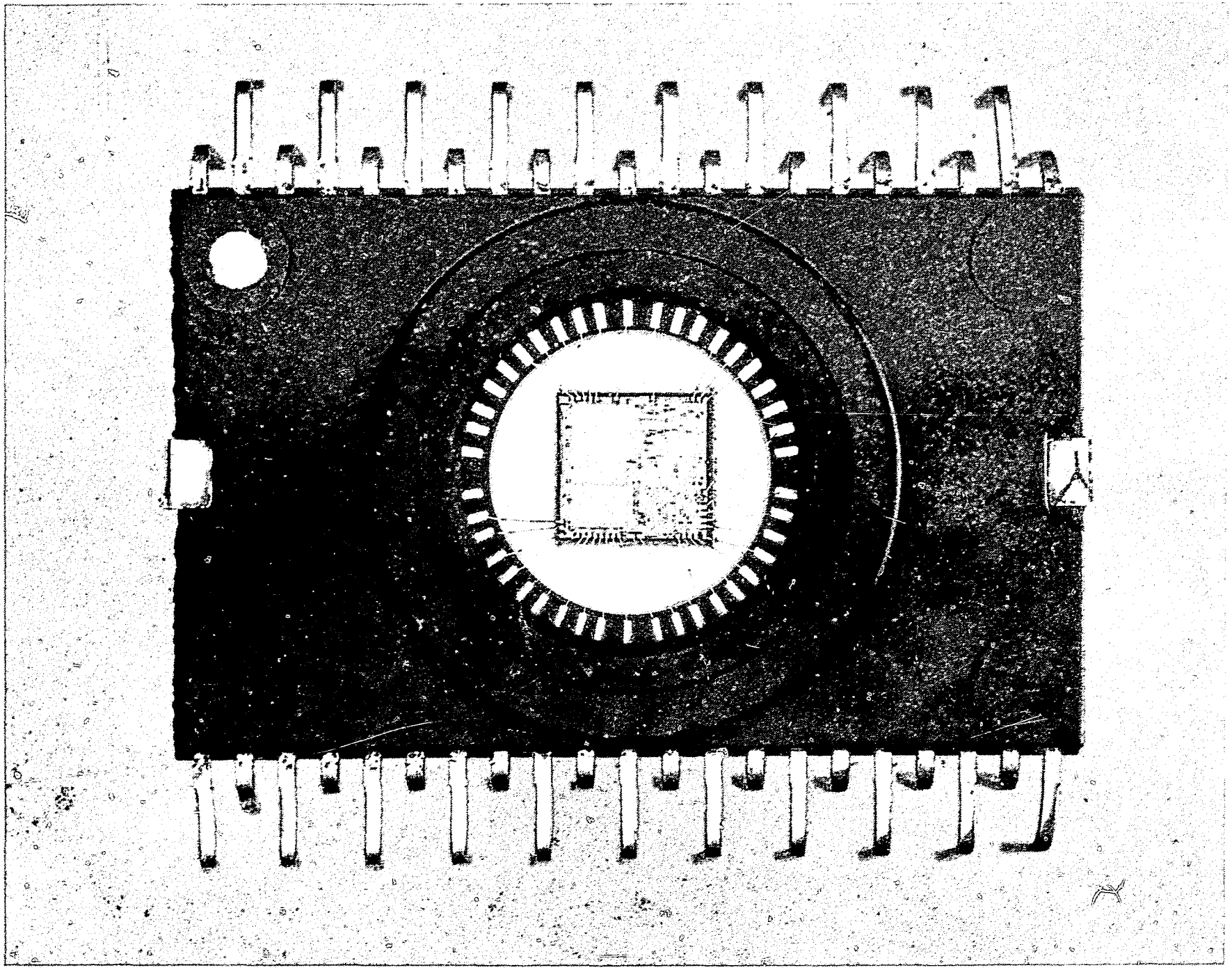
INTEL 3000 -- 2 BIT SLICE, BIPOLAR, 20 NS

80

E0337

Benchmark Programming Results

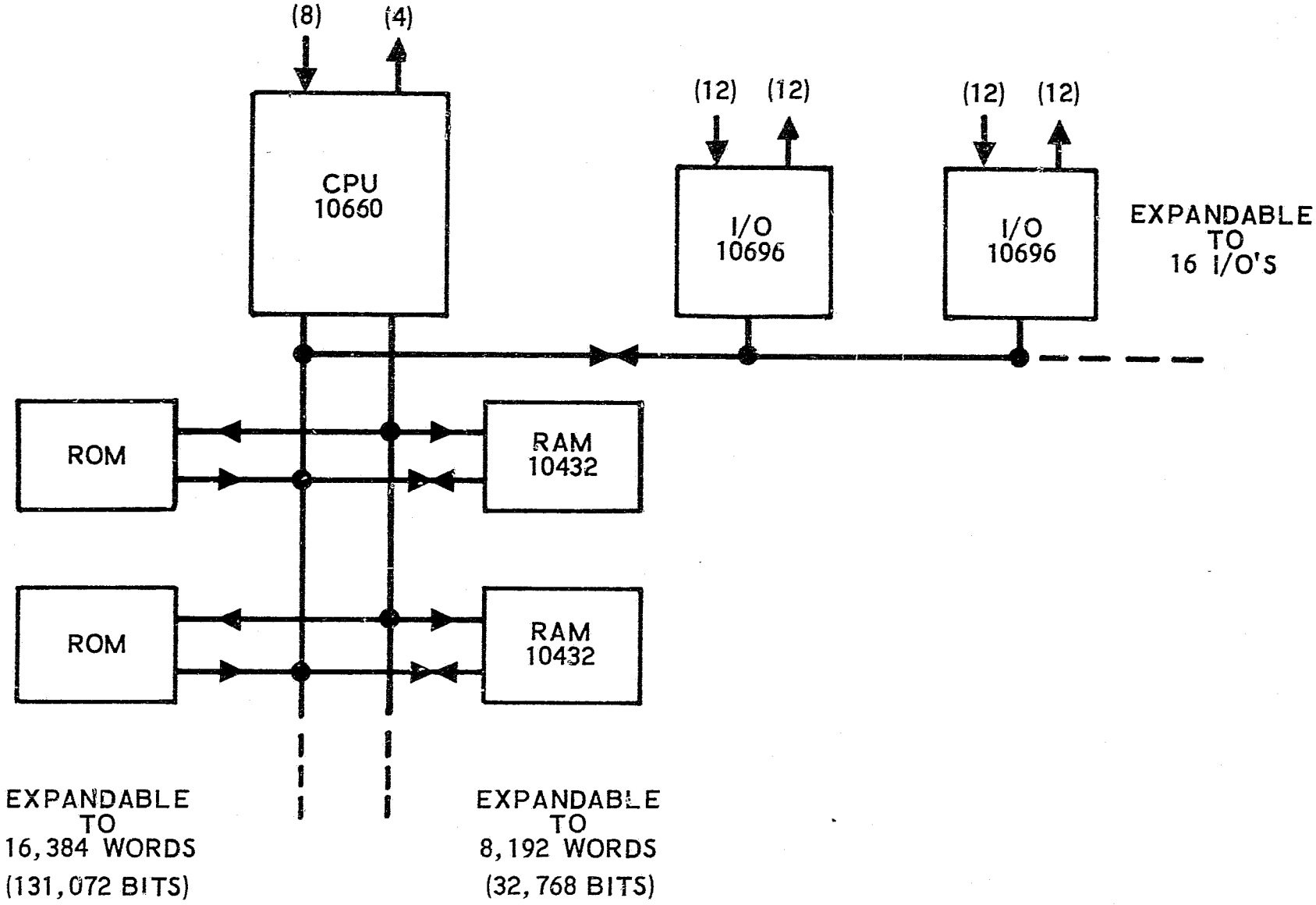




Microprocessor Survey

COMPANY	MODEL No.	TECHNOLOGY		ARCHITECTURE	INSTR CYCLE TIME
		TYPE	No. CHIPS		
AMERICAN MICRO SYSTEMS	7300	PMOS	2	8 bit PARALLEL	4.0 μs
FAIRCHILD	F8	NMOS	1	8 bit PARALLEL	2.0 μs
GENERAL INSTRUMENTS	CP-1600	NMOS	3	16 bit PARALLEL	1.6 μs
INTEL	8080	NMOS	1	8 bit PARALLEL	2.0 μs
INTEL	3000	BIPOLAR	1	2 bit SLICE	200 ns
INTERSIL	ISD-8	CMOS	1	12 bit PARALLEL	2.5 μs
MONOLITHIC	6701	BIPOLAR	4	4 bit SLICE	300 ns
MOTOROLA	M6800	NMOS	1	8 bit PARALLEL	2.0 μs
NATIONAL	IMP	PMOS	1	4 bit SLICE	4.0 μs
RCA	COS MAC	CMOS	2	8 bit PARALLEL	4.0 μs
ROCKWELL	PPS-8	PMOS	1	8 bit PARALLEL	4.0 μs
RAYTHEON	RP-16	BIPOLAR	7	4 bit SLICE	4.0 μs
SIGNATICS	2650	NMOS	1	8 bit PARALLEL	5.0 μs

Computer Type Bus Design



Program Rationale

Future Trends

- LARGE COMPUTERS CHALLENGING MAINFRAMES - PERHAPS SIGNIFICANT
- TODAY $8,000 MINI AND 16K CALCULATOR CHIPSET
- BY 1977 THERE WILL BE 1M TERMINALS USING MICROPROCESSORS
- INSTRUCTION TIMES 20-30 nsec WITH I²L BIPOLAR BY 1977
- COMPLETE COMPUTER SYSTEM ON ONE PC CARD
  - 160 nsec ADD TIMES
  - 64K WORDS (16 BITS)
  - 5M BITS DISK EQUIVALENT WITH CCD
  - $500 (in quantity of 100)

Avionics Equipment and Computation
(OPTIONS)

NAV & COMM
- INERTIAL REF UNIT
- REF UNIT INTERFACE
- NAV COMPUTATIONS
- KALMAN FILTERING & PROCESSING
- GUIDANCE & FLIGHT PATH CONTROL
- RADAR INTERFACE
- NAV AIDS (Vor, Tacan, Loran)

WEAPON DELIVERY
- FIRE CONTROL SIGHT
- WEAPON DELIVERY COMPUTATIONS
- MISSILE & GUN CONTROL
- AIR/GROUND & AIR/AIR RADAR INTERFACE

ELECTRONIC WARFARE
- RADAR WARNING THREAT SITUATION
- JAMMING CONTROL & BLANKING
- COUNTERMEASURE CONTROL (IR disposable)

COCKPIT CONTROLS & DISPLAYS
- PREPROGRAMMED CONTROL LOGIC
- KEYBOARDS, SHARED & DEDICATED
- WARNING INDICATORS
- INTEGRATED DISPLAYS
- EXCEPTION DISPLAYS
- SYMBOLOGY GENERATION
- FLIGHT INSTRUMENTS
- ENGINE, FUEL & OIL INDICATORS

COMMUNICATIONS DATA LINK
- DIGITAL COMM
- VOICE COMM
- CRYPTO, SECURE DATA EXCHANGE
- IDENTIFICATION (IFF A/A & A/G)
- SATELLITE (Comm/NAV)
- ALL WEATHER LANDING AIDS
- COMMAND & CONTROL INTERFACE

FLIGHT CONTROLS
- FLIGHT CONTROL COMPUTER
- FAILURE ANNUNCIATION
- REDUNDANCY MANAGEMENT
- AIR DATA COMPUTER
- INERTIAL SENSOR INTERFACE
- ENGINE SYSTEM INTERFACE
- POWER ACTUATORS INTERFACE

ENERGY MANAGEMENT
- ENGINE CONTROL
- THRUST LEVEL CONTROL
- FUEL MANAGEMENT
- WEIGHT & BAL, C.G. CONTROL
- OPTIMUM ENERGY MANAGEMENT CRUISE CONTROL
- AVOIDANCE OF STALL CONDITION

OTHER SYSTEMS
- ELECTRICAL POWER CONTROL
- LANDING GEAR
- ENVIRONMENTAL CONTROL
- STORES MANAGEMENT
- INTEGRATED TEST

Trends in Avionics Procurement Cost
FLY-AWAY

WWII	TOTAL COST (millions)	ELECTRONICS (avionics)
MUSTANG	.10	1-3%
HELL CAT		
CURRENT		
F-4Es	2.5	15%
F-15	7.0	30%
F-16/17	4.5	10% - 30% (options)

Patrol Car Applications

ADVANCED SENSOR/COMPUTER

- MECHANICAL OPERATION
  - ECONOMY GAUGE
  - MONITORING/DIAGNOSTIC CAPABILITY
- SAFETY
  - ANTI-LOCK BRAKES
  - IMPROVED EMERGENCY WARNING (siren)
  - EMERGENCY CALL -- REMOTE
  - VOICE TO DIGITAL
- PERSONNEL EFFICIENCY
  - SUSPECT IDENTIFICATION
    - SUSPECT DESCRIPTION
    - SUSPECT MODUS OPERANDI
    - SUSPECT PHOTOGRAPH
    - SUSPECT FINGERPRINT
    - SUSPECT VOICE
  - PROPERTY IDENTIFICATION
    - PROPERTY AUTO AND CYCLES
    - PROPERTY FIREARMS -- REGISTERED PROPERTY
  - CAR LOCATION
  - TIME TAGGING
  - AUTOMATIC REPORT GENERATING
  - IMPROVED TWO-WAY COMMUNICATION
  - IMPROVED SEAT DESIGN

Automated Avionics Functions
TYPICAL

MECHANICAL OPERATION

- ENGINES
- SENSORS (e.g. radar)
- WEAPONS AND WEAPONS AUXILIARIES
- POWER SYSTEMS
- FUEL MANAGEMENT (gal, time, radius)

SAFETY

- WARNING (sensing, computing, display)
  - ENGINES
  - FLIGHT CONDITIONS
  - WEAPONS

PERSONNEL EFFICIENCY

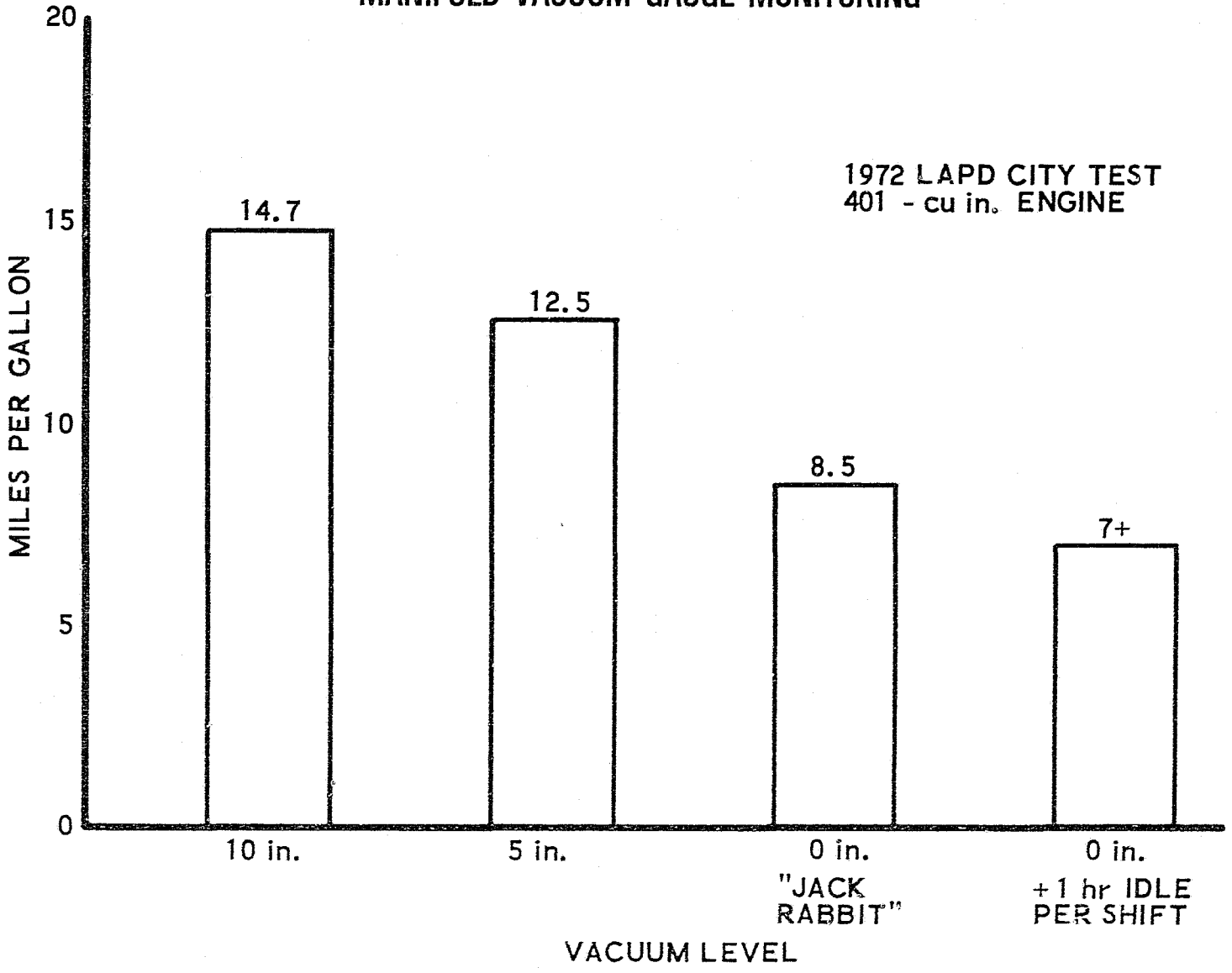
- NAVIGATION
  - FLIGHT CONTROL - HANDS-OFF
  - INERTIAL GUIDANCE - CONTINUOUS POSITION LOCATION
  - TERRAIN AVOIDANCE - PILOT RELIEF - ALL WEATHER
  - LANDING - GLIDE SLOPE/FLARE OUT
- WEAPONS
  - SEARCH, ACQUISITION, LOCK-ON
  - TARGET I.D.
  - ATTACK ENVELOPE
  - READINESS STATUS
  - LAUNCH

COMMUNICATION

- STATUS REPORTING AND UPDATING

Fuel Economy

MANIFOLD VACUUM GAUGE MONITORING



Patrol Car Annual Cost Breakdown

REF: NBS

	EXISTING	ADDITION PROPOSED
EXISTING HARDWARE		
VEHICLE DEPRECIATION	$ 1800	
COMMUNICATIONS, etc DEPRECIATION	200	
GASOLINE	1800	
MAINTENANCE AND REPAIR	1000	
OIL AND TIRES	200	
	$ 5000	
PROPOSED IMPROVEMENTS		
COMMUNICATION AND DATA SYSTEM (at 7 year lifetime)		$ 2000
PERSONNEL		
1 MAN/UNIT (24 hours)	$ 100,000	
2 MAN/UNIT (24 hours)	$ 200,000	
EXISTING TOTAL (Personnel, Equipment, Overhead, etc)	$ 258,000	

A 40% IMPROVEMENT IN MECHANICAL OPERATOR OR

A 1% TO 2% INCREASE IN PERSONNEL EFFICIENCY JUSTIFIES THE IMPROVEMENT

Digital Communications

			TIME SAVINGS	
	VOICE	DIGITAL	PATROLMAN	RADIO CHANNEL
STATUS CODES* (e.g. 10-4)	3.6 sec	.9 sec	75%	95%
LICENSE PLATE** CHECK	2 min	10 sec	92%	93%

* "Locates" System - Montclair Calif.

** New Jersey Experience

CURRENT EXPERIENCE INDICATES A 400 - 1000 PERCENT INCREASE IN TRANSACTIONS WITH MOBILE DIGITAL TERMINALS (Ref JPL Study: 1974)

Projected Annual Mechanical Costs

	STANDARD	COMPACT
VEHICLE DEPRECIATION	$ 1 800	$ 1,000
EQUIPMENT DEPRECIATION	200	200
GASOLINE	1,800	1,200
MAINTENANCE AND REPAIR	1,000	900
OIL AND TIRES	200	180
TOTAL	$ 5,000	$ 3,480

PROJECTED SAVINGS - 1530 (31%)

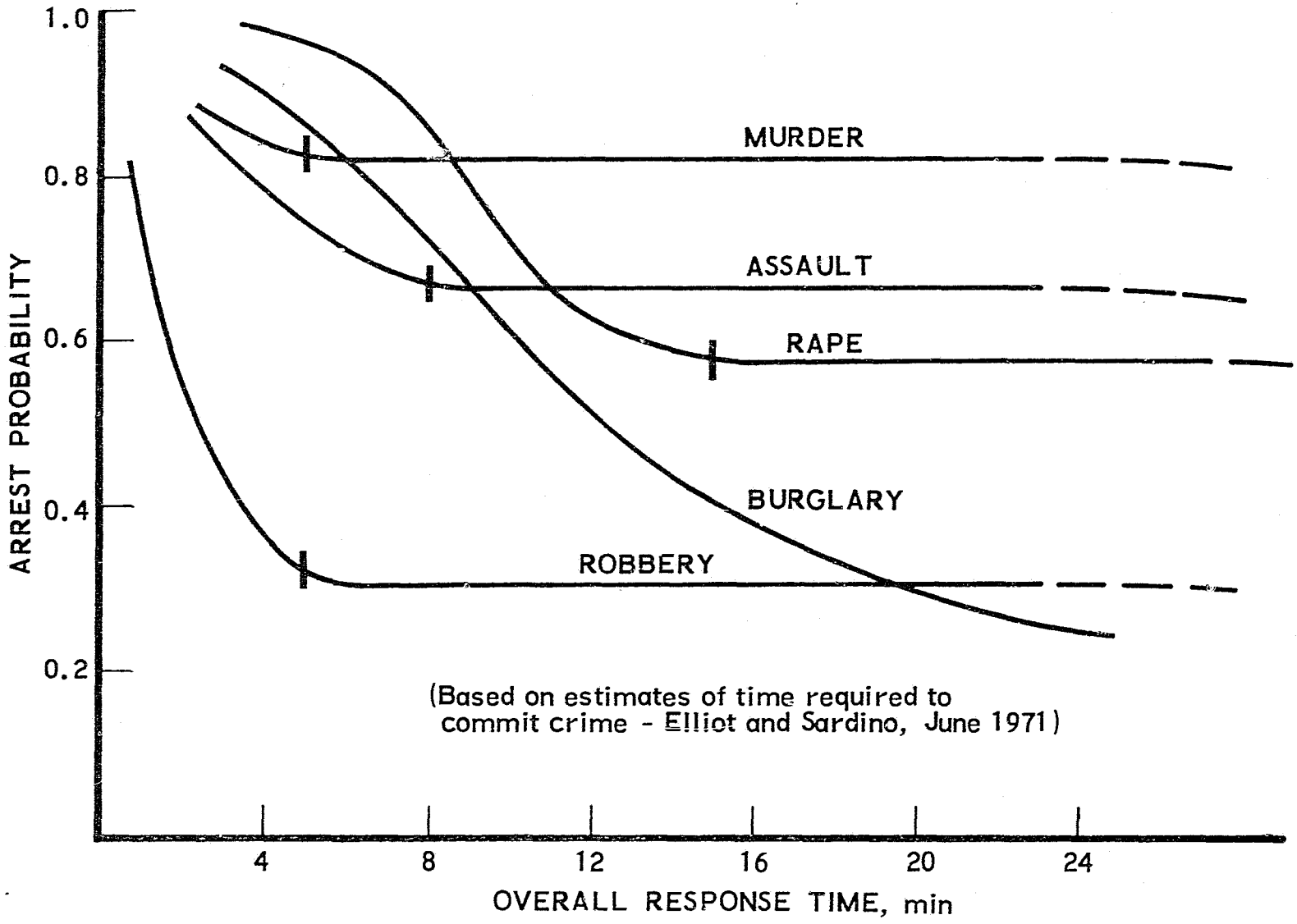
Vehicle Locator System "Locates" - Montclair California

- DISPATCH REACTION TIMES ~ LESS THAN 1 min
  - CRITICAL EVENTS 64% → 86%
  - TOTAL EVENTS 63% → 81%

- MOBILE RESPONSE TIMES ~ LESS THAN 3 min
  - CRITICAL EVENTS 50% → 82%
  - TOTAL EVENTS 61% → 80%

- TOTAL RESPONSE TIMES ~ LESS THAN 4 min
  - CRITICAL EVENTS 58% → 78%
  - TOTAL EVENTS 60% → 83%

Estimated Arrest Probability vs Police Responsiveness



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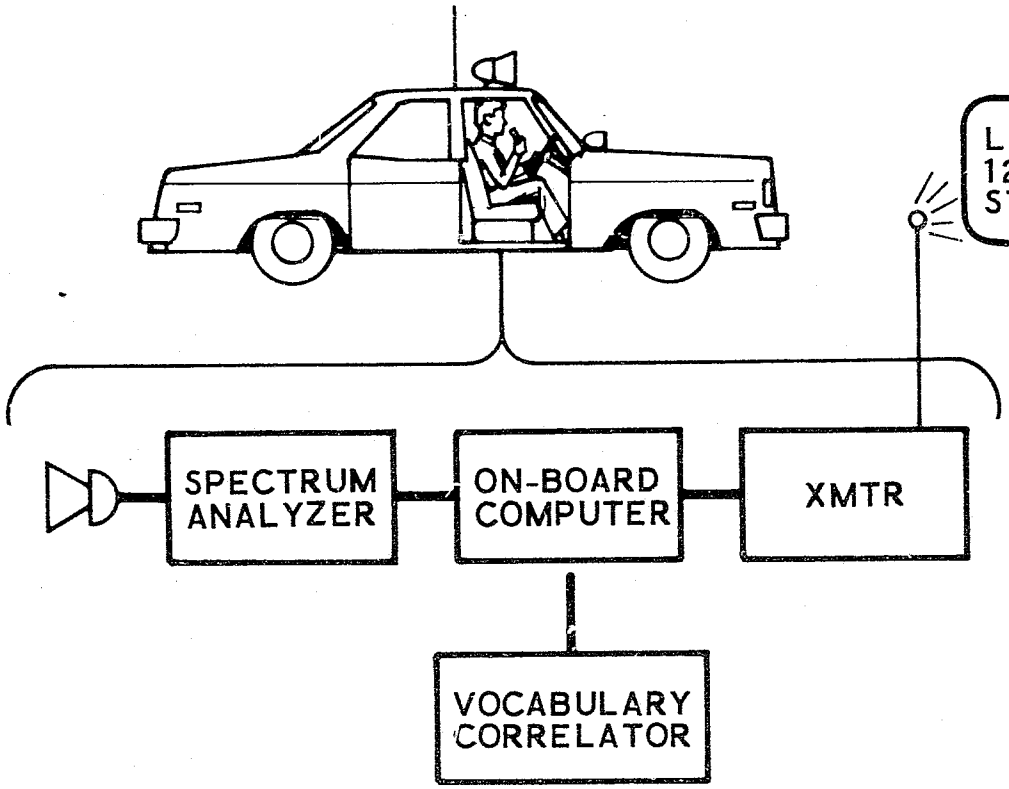
1 OF 2

Voice to Digital Application



RESEARCH

ARPA - SINCE MID 1960s

CURRENT DEVELOPMENT

GROUND CONTROL APPROACH SIMULATOR - LOGICON

82 PHRASE VOCABULARY

APPLICATIONS

STOLEN AUTOS

STOLEN PROPERTY ID

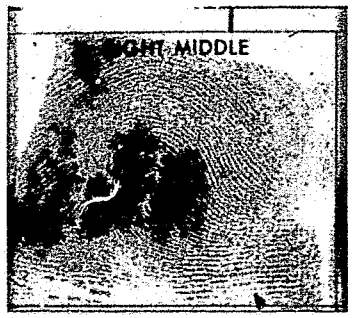
DRIVERS LICENSE

STATUS CODES

EMERGENCY CALL

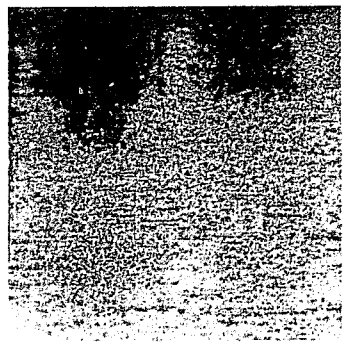
Fingerprint Transmission

EFFECT OF PRE-PROCESSING



FACSIMILE

360,000 BITS
150 sec TRANSMISSION



HADAMARD TRANSFORM

COMPRESSED TRANSFORM

QUANTIZED TO:
2000-3000 BITS
≈1 sec TRANSMISSION

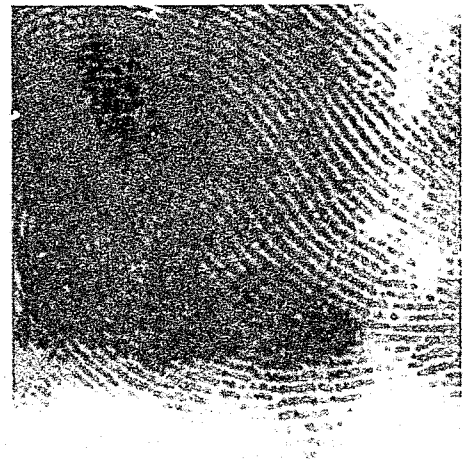
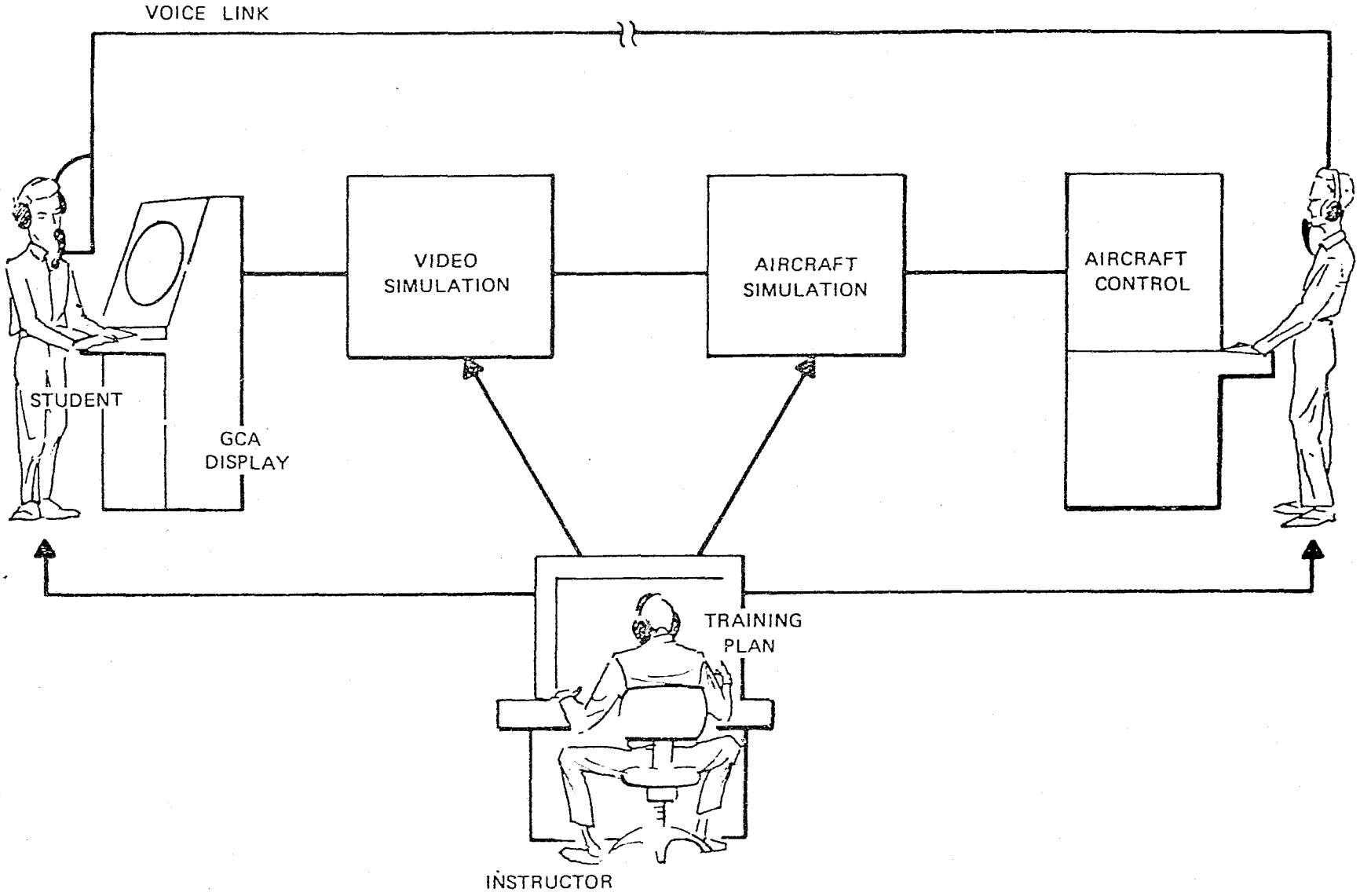


IMAGE CODING

BANDWIDTH REDUCTION
60,000 BITS
25 sec TRANSMISSION

Typical GCA Controller Training System



Summary

- MAJOR COST OF PATROL OPERATIONS IS PERSONNEL - NOT EQUIPMENT, HENCE ANY INCREASE IN PERSONNEL EFFICIENCY HAS SIGNIFICANT PAYOFF

  - DIGITAL COMMUNICATIONS CAN REALIZE A 95% IMPROVEMENT IN RADIO CHANNEL CAPACITY AND A SUBSTANTIAL REDUCTION IN INQUIRY/RESPONSE DELAY

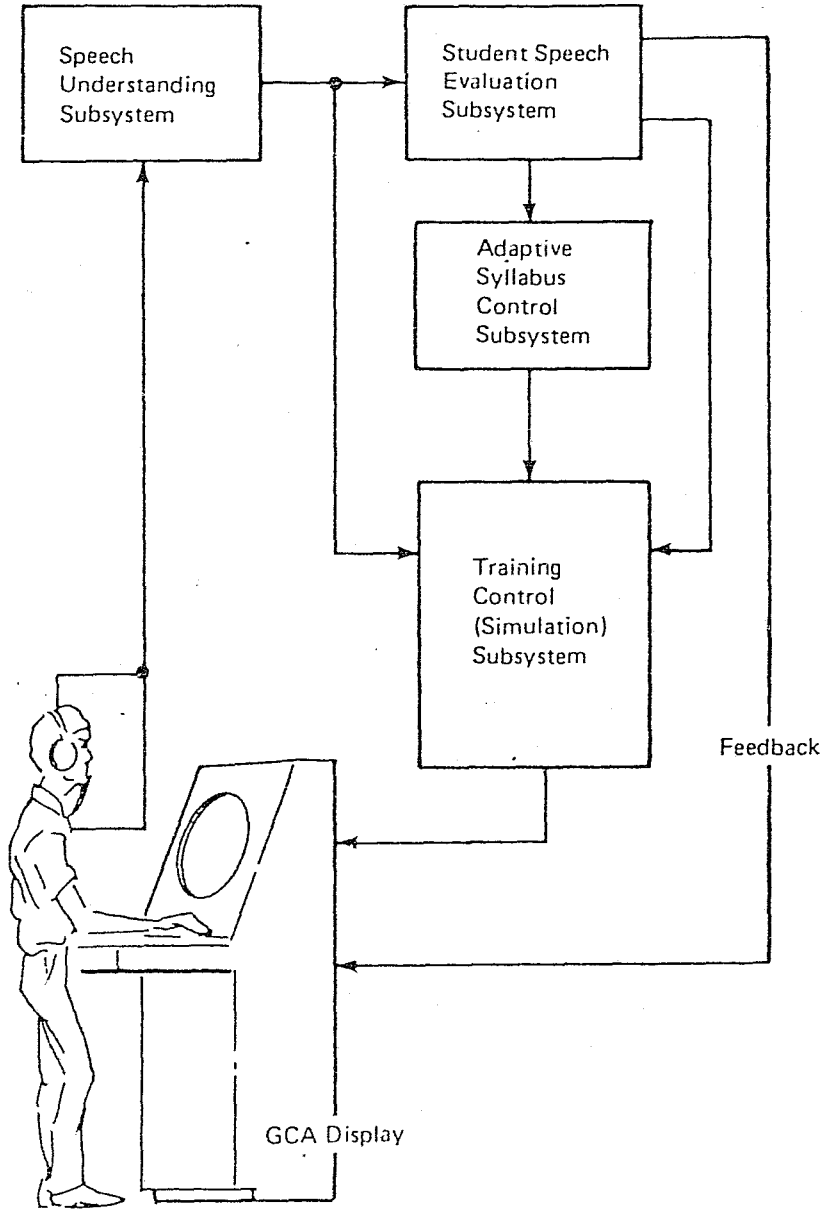
  - ON-BOARD COMPUTER PROCESSING HAS POTENTIAL ENHANCED CAPABILITY PRESENTLY NOT ACHIEVABLE

Par Phrase List With Criteria

Regular PAR Approach	Criteria for Issuance
Approaching glidepath	top of target touches glidepath cursor (10-30 sec prior to intercept)
Begin descent	target intercepts glidepath cursor
On glidepath	target bisected by glidepath cursor
Going above glidepath	center of target leaves the glidepath cursor (upward)
Going rapidly above glidepath	center of target leaves the glidepath cursor (upward), rapidly
Going slowly above glidepath	center of target leaves the glidepath cursor (upward), slowly
Slightly above glidepath	2/3's of target above glidepath cursor
Slightly above glidepath and holding	2/3's of target above glidepath cursor, unchanged
Slightly above glidepath and coming down	2/3's of target above glidepath cursor, with movement toward cursor
Slightly above glidepath and coming rapidly down	2/3's of target above glidepath cursor, with rapid movement toward cursor
Slightly above glidepath and coming slowly down	2/3's of target above glidepath cursor, with slow movement toward cursor
Slightly above glidepath and going further above	2/3's of target above glidepath cursor, movement from slightly above to above
Slightly above glidepath and going rapidly further above	2/3's of target above glidepath cursor, rapid movement from slightly above to above
Slightly above glidepath and going slowly further above	2/3's of target above glidepath cursor, slow movement from slightly above to above
Well above glidepath	bottom of target breaks contact with glidepath cursor
Well above glidepath and holding	bottom of target breaks contact with glidepath cursor, unchanged
Well above glidepath and coming down	bottom of target breaks contact with glidepath cursor, with movement toward cursor
Well above glidepath and coming rapidly down	bottom of target breaks contact with glidepath cursor, with rapid movement toward cursor
Well above glidepath and coming slowly down	bottom of target breaks contact with glidepath cursor, with slow movement toward cursor
Well above glidepath and going further above	bottom of target breaks contact with glidepath cursor, movement from well above to beyond
Well above glidepath and going rapidly further above	bottom of target breaks contact with glidepath cursor, rapid movement from well above to beyond
Well above glidepath and going slowly further above	bottom of target breaks contact with glidepath cursor, slow movement from well above to beyond
Going below glidepath	center of target leaves glidepath cursor (downward)
Going rapidly below glidepath	center of target leaves glidepath cursor (downward), rapidly
Going slowly below glidepath	center of target leaves glidepath cursor (downward), slowly
Slightly below glidepath	2/3's of target is below the glidepath cursor
Slightly below glidepath and holding	2/3's of target is below the glidepath cursor, unchanged
Slightly below glidepath and coming up	2/3's of target is below the glidepath cursor, movement toward cursor
Above glidepath	bottom of target touches glidepath
Below glidepath	top of target touches glidepath

*Target refers to radar return of controlled aircraft as shown on CRT

GCA Controller Training System Block Diagram



Par Phrase List With Criteria (Cont)

Regular PAR Approach	Criteria for Issuance
Slightly below glidepath and coming rapidly up	2/3's of target below glidepath cursor, rapid movement toward the cursor
Slightly below glidepath and coming slowly up	2/3's of target below glidepath cursor, slow movement toward the cursor
Slightly below glidepath and going further below	2/3's of target below glidepath cursor, movement from slightly below to below
Slightly below glidepath and going rapidly further below	2/3's of target below glidepath cursor, rapid movement from slightly below to below
Slightly below glidepath and going slowly further below	2/3's of target below glidepath cursor, slow movement from slightly below to below
Well below glidepath	top of target breaks contact with glidepath cursor
Well below glidepath and holding	top of target breaks contact with glidepath cursor, unchanged
Well below glidepath and coming up	top of target breaks contact with glidepath cursor, movement toward cursor
Well below glidepath and coming rapidly up	top of target breaks contact with glidepath cursor, rapid movement toward cursor
Well below glidepath and coming slowly up	top of target breaks contact with glidepath cursor, slow movement toward cursor
Well below glidepath and going further below	top of target breaks contact with glidepath cursor, movement from well below to beyond
Well below glidepath and going rapidly further below	top of target breaks contact with glidepath cursor, rapid movement from well below to beyond
Well below glidepath and going slowly further below	top of target breaks contact with glidepath cursor, slow movement from well below to beyond
On course	target bisected by azimuth cursor
Turn right heading _____	target left of desired course
Turn left heading _____	target right of desired course
Heading is _____	establish heading
Going right of course	target center leaves the azimuth cursor, right
Going left of course	target center leaves the azimuth cursor, left
Going rapidly right of course	target center rapidly leaves the azimuth cursor, right
Going slowly right of course	target center slowly leaves the azimuth cursor, right
Going rapidly left of course	target center rapidly leaves the azimuth cursor, left
Going slowly left of course	target center slowly leaves the azimuth cursor, left
Right of course	left edge of cursor touches azimuth cursor
Left of course	right edge of cursor touches azimuth cursor
Slightly right of course	2/3's of target is right of azimuth cursor
Slightly right of course and holding	2/3's of target is right of azimuth cursor, unchanging
Slightly right of course and correcting	2/3's of target is right of azimuth cursor, movement toward cursor
Slightly left of course	2/3's of target is left of azimuth cursor
Slightly left of course and holding	2/3's of target is left of azimuth cursor, unchanging
Slightly left of course and correcting	2/3's of target is left of azimuth cursor, movement toward cursor

Par Phrase List With Criteria (Cont)

Regular PAR Approach	Criteria for Issuance
Right of course and holding	left edge of target touches azimuth cursor, unchanged
Right of course and correcting	left edge of target touches azimuth cursor, movement toward cursor
Left of course and holding	right edge of target touches azimuth cursor, unchanged
Left of course and correcting	right edge of target touches azimuth cursor, movement toward cursor
Well right of course	target breaks contact with azimuth cursor (right)
Well right of course and holding	target breaks contact with azimuth cursor (right), unchanged
Well right of course and correcting	target breaks contact with azimuth cursor (right, movement toward cursor
Well left of course	target breaks contact with azimuth cursor (left)
Well left of course and holding	target breaks contact with azimuth cursor (left), unchanged
Well left of course and correcting	target breaks contact with azimuth cursor (left), movement toward cursor
Wind is ___ ___ ___ at ___ ___.	surface wind
Cleared to land runway ___ ___ right.	tower clearance given, 3–4 miles from touchdown
Cleared to land runway ___ ___ left.	tower clearance given, 3–4 miles from touchdown
At decision height	2/3 miles from touchdown (published decision height)
No glidepath information available	loss of altitude information (glidepath)
_____ miles from touchdown	range at point where leading edge to target touches mile marker
Over landing threshold, centerline is right/left	approximately 1/3 mile from touchdown
Over approach lights	approximately 1/2 mile from touchdown
Execute missed approach	a. safety limits are exceeded b. radical aircraft maneuver is observed c. position of aircraft is in doubt d. identification of aircraft is in doubt e. radar contact is lost f. bad airport conditions g. bad airport traffic

END