A SURVEILLANCE AND TARGETING SYSTEM
FOR AN
UNMANNED GROUND VEHICLE

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Naval Ocean Systems Center
San Diego, CA

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Standard Form 298 (Rev. 8-98)  
Prescribed by ANSI Std Z39-18
ROLES FOR RSTA PACKAGE

- DAY/NIGHT SURVEILLANCE
- REMOTE FORWARD AREA FIRE CONTROL
  - FOR ARTILLERY AND AIR SUPPORT MISSIONS
- TARGET IDENTIFICATION AND TRACKING
- ACTIVE TARGET DESIGNATION
  - HELLFIRE MISSILE
  - COPPERHEAD SMART MUNITION
MAJOR SYSTEM ELEMENTS

- SCISSORS LIFT
- PAN/TILT MOTION PLATFORM
- SENSOR SUITE
- PROCESSING/COMMUNICATIONS
SYSTEM DESIGN CONSTRAINT

USMC DIRECTION:
USE EQUIPMENTS IN THE INVENTORY WHERE AVAILABLE
- TO MINIMIZE LOGISTICAL SUPPORT REQUIREMENTS
- TO MINIMIZE SYSTEM TRAINING REQUIREMENTS

SYSTEM DESIGN CHALLENGE:
- EQUIPMENTS NOT DESIGNED FOR REMOTE OPERATION
LIFT DESIGN

- SCISSORS DESIGN
- ELECTRIC: DC BALL LINEAR ACTUATORS
- FOOTPRINT: 47" LONG BY 24.5" WIDE
- STOWED HEIGHT: 20"
- LIFT WEIGHT: 470 LB
- RATED PAYLOAD WEIGHT: 250 LB
  (WITH 2:1 DESIGN MARGIN)
LIFT PERFORMANCE

VARIABLE DEFILADE DEPLOYMENT:
- 15 FEET MAX HEIGHT (EURO THEATER STUDIES)
- 9.25 FEET TRAVEL

SPEED (200 LB LOAD):
- RAISE IN 31 SECONDS
- LOWER IN 28 SECONDS

STABILITY IN 20 KNOT GUSTING WIND:
- DESIGN GOAL: 300 MICRORADIANS
- MEASURED: < 50 MICRORADIANS
MOTION PLATFORM DESIGN

ELECTRIC PAN/TILT DRIVE
- DC SERVO GEARED DRIVES
- 14 BIT POSITION RESOLUTION

FOUR CONTROL MODES:
- POSITION CONTROL (HIGH/LOW GAIN)
- VELOCITY CONTROL (HIGH/LOW GAIN)
- TRACKING OUTPUT
  (TO ALLOW SLAVING, POSITION REPORTS)
MOTION PLATFORM PERFORMANCE

MAXIMUM PAN/TILT SLEW RATE
- DESIGN GOAL: 28 DEG/SEC, CORRESPONDING TO 100 KM/HR TARGET AT 100 METERS RANGE
- MEASURED: 26 DEG/SEC

MINIMUM CONTROLLABLE SLEW RATE
- DESIGN GOAL: 0.1 DEG/SEC, CORRESPONDING TO 2 KM/HR TARGET AT 3 KM RANGE
- MEASURED: 0.15 DEG/SEC
SENSOR SUITE

LASER RANGER/DESIGNATOR
AN/PAQ-3 MULE (MFR: HUGHES)

FLIR
AN/TAS-4 (MFR: KOLLMORGEN)

ACOUSTICAL DETECTION SYSTEM
ADS (MFR: NOSC)

LLL/ZOOM VIDEO
(MFR: NOSC)
AN/PAQ-3 MULE CHARACTERISTICS

- LASER
  NDYAG LASER, 1060 NM (1.06 MICRONS)
  80 MILLIJOULES/PULSE, NOT EYE SAFE

- TIME-OF-FLIGHT RANGER
  MAXIMUM RANGE: 10 KM
  MINIMUM RANGE: ADJUSTABLE DOWN TO 170 M
  PRECISION: 10 M

- DESIGNATOR: PROGRAMMABLE CODING
  30 PULSES/SEC MAX

- CONTROL INTERFACE: RANGE/DESIGNATE MODE,
  MULE POWER ON/OFF, CAMERA POWER ON/OFF,
  TRIGGER ON/OFF, RANGE DATA ACQUISITION
AN/TAS-4 FLIR CHARACTERISTICS

- 128 ELEMENT ARRAY
  MECHANICALLY SWEPT TO GENERATE 2-D IMAGE
- CENTER FREQUENCY: APPROX 10 MICRON
- FIELD OF VIEW (FOV): APPROX 20 DEG
- MECHANICALLY BORESIGHTED TO MULE
- CONTROL INTERFACE: LOCAL/REMOTE,
  NORM/FREEZE, FIELD/FRAME, RETICLE ON/OFF,
  HOT BLACK/WHITE, FOCUS IN/OUT, CONTRAST
  IN/OUT, BRIGHTNESS IN/OUT
LOW LIGHT LEVEL VIDEO CHARACTERISTICS

- SWITCHABLE SUPER-INTENSIFIED TV (S.I.T)
  GOAL: SURVEILLANCE WITH 1/4 MOON
- CCD ARRAY, 2/3 INCH FORMAT
  LINE RESOLUTION: 800 (COHU) OR 480 (PULNIX)
- ZOOM RATIO: 20:1
- COMPUTER GENERATED RETICLE
- REMOTE CONTROL OF ZOOM, FOCUS, BRIGHTNESS
  (AUTOMATIC IRIS IN NORMAL OPERATION)
- MECHANICALLY BORESIGHTED TO MULE
- CONTROL INTERFACE: POWER ON/OFF, ZOOM IN/OUT, FOCUS IN/OUT
ACOUSTICAL DETECTION SYSTEM CHARACTERISTICS

- SELECTABLE INFRASONIC AND ULTRASONIC FREQUENCY SHIFTING CAPABILITY
- SUPER-BINAURAL CONFIGURATION
  ANGLE AND PICKUP SEPARATION GREATER THAN HUMAN HEAD
- VARIABLE GAIN WITH CLIPPING
- INTEGRATABLE INTO TOV OPERATOR HELMET
- CONTROL INTERFACE: VOLUME UP/DOWN, SONIC ON/OFF, ULTRA ON/OFF, INFRA ON/OFF, BOOST HI/MED/OFF
LASER SAFETY IMPLICATIONS

IMPLICATIONS FOR DESIGN:
- POWER UP SEQUENCE
- ABORT/RECOVERY SEQUENCE
- COMPLEMENTARY TRIG/TRIGBAR SIGNAL PAIR

IMPLICATIONS FOR DEVELOPMENT PROGRAM:
- TEST LASER ONLY ON GUNNERY RANGE
  - COMPETE WITH USMC, HUNTERS, BISON
### SURVEILLANCE SYSTEM WEIGHT BUDGET

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<tr>
<th>Item</th>
<th>Weight (lbs)</th>
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<tr>
<td>FLIR</td>
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<tr>
<td>MULE</td>
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<td>MULE SUPPORT</td>
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<td>ADS</td>
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<td>TOTAL SENSORS</td>
<td>65</td>
</tr>
<tr>
<td>CABLE ASSEMBLIES</td>
<td>25</td>
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<tr>
<td>MOTION PLATFORM</td>
<td>98</td>
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<td>TOTAL LIFT PAYLOAD</td>
<td>190</td>
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<tr>
<td>WEIGHT OF LIFT</td>
<td>470</td>
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<td>TOTAL SURVEILLANCE SYSTEM</td>
<td>660 POUNDS</td>
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SURVEILLANCE SYSTEM POWER BUDGET

LIFT:
- 30 A @ 24 V PEAK
- 15 A @ 24 V AVERAGE
FAIL-SAFE BRAKE: HOLDS POSITION WITH ZERO POWER

PAN/TILT MOTION PLATFORM:
- 4A @ 24 V PEAK, < 0.5 A TYPICAL
- < 0.05 A STANDBY

MULE:
- RANGING MODE: 2 A @ 24 V
- DESIGNATION MODE: 4 A @ 24 V AVG, 20 A PEAKS

FLIR:
- 16 A @ 24 V (PRIMARILY COOLING LOAD)
FIBER OPTIC COMMUNICATIONS LINK

- VIDEO
  2 CHANNELS, 6 MHZ B/W, 7 BIT ENCODING
- AUDIO
  2 CHANNELS, 18 KHZ B/W
- SERIAL DATA
  8 CHANNELS, 38.4 KBPS MAX

- 200 MBPS TOTAL
RV COMPUTER RESOURCES

- 3 PROCESSORS: RV, SURVEILLANCE, MULE
- MODIFIED STD BUS FORMAT (AIRBORNE CONNECTORS)
- CPU CARDS:
  WIN SYSTEMS SBC80C88
  32KB EPROM, 32 KB RAM
- MEMORY & I/O CARDS:
  1 MB RAM
  8 CHANNEL 12 Bit A/D
  8 CHANNEL 12 Bit D/A
  PARALLEL I/O: 32 BITS IN, 32 BITS OUT
CONCLUSIONS

- IT WORKS (SUCCESSFUL DEMONSTRATIONS)

- LESSONS LEARNED:
  - COMPUTERS ARE OUR FRIENDS
  - CABLING CAN KILL YOU
  - ARCHITECTURE IS IMPORTANT
    (CONTROL/PROCESSING/COMMUNICATIONS)