ADVANCING SURVEILLANCE TEST TECHNOLOGIES

CENTER FOR APPLIED ANALYTICAL TECHNOLOGIES TEST & EVALUATION DEPT.
NSWC INDIAN HEAD DIVISION

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OUTLINE ISSUES

- Background
- Current Surveillance Test Methods
- Solutions - The New Technologies
  - MEMS
  - Chemical Sensors
  - Embedded Sensors
  - Field Monitoring Miniaturized Instrumentation
- Challenges
- Progress to date
- Summary

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BACKGROUND / ISSUES

- Safety - stability concerns
- Inventory control - throughout life cycle
- Performance/Reliability
- Service life predictions/extensions
- Waste management/Demil - Munitions Rule
- Full Life Cycle Management - O/S Cost Reduction

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SURVEILLANCE TEST METHODS

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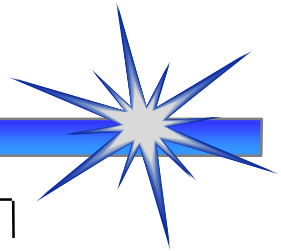


Thermal Stability Testing

- Oven Fume Test
- Differential Scanning Calorimeter (DSC)
- Accelerating Rate Calorimeter (ARC)
- Differential Thermal Analysis (DTA)
- Thermo-gravimetric Analysis (TGA) Taliani
- Vacuum Thermal Stability
- Microcalorimetry
- Thermal cook-off

Stabilizer Determination

- High Performance Liquid Chromatography
- Other Chromatographic methods (GCMS, LCMS, photodiodarray)
- Capillary Electrophoresis
- Wet chemistry (Titration techniques)
- Supercritical fluid extraction & chromatography
- Robotics

Other Tests

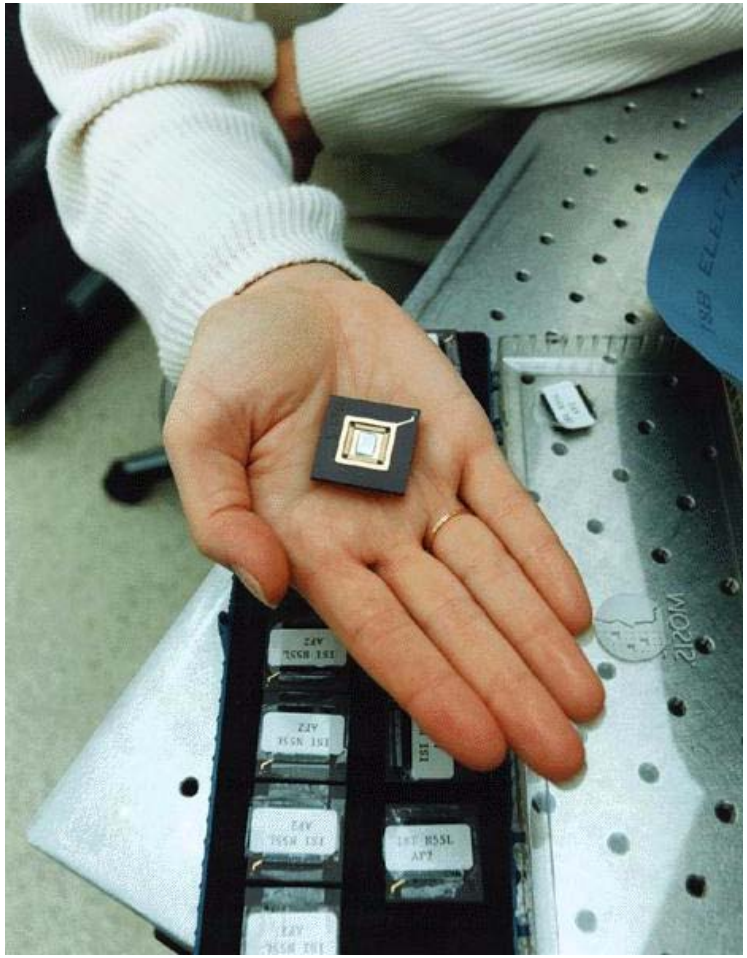
- Mechanical Properties
- Rocket motor performance
- Hybrid Tests (Aging + Stabilizer test)
- Gas analysis (FTIR, CG, etc.)
- Accelerated Aging Tests
- Chemical Migration Tests
- **Fiber optic/Spectroscopy**
- Chemical reactivity/compatibility
- **MEMS/Chemical Sensor**
- **Embedded Sensor**
- **Field monitoring MEMS Instrumentation**

Modeling & Simulation

- **Service life prediction**
- Type life
- **Shelf life prediction**
- Kinetic analysis

SOLUTIONS - THE NEW TECHNOLOGIES

- MEMS
- Chemical sensors
- Embedded sensors
- Fiber optics
- Field monitoring - miniaturized instrumentation



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MEMS: MICRO - ELECTRO - MECHANICAL SYSTEMS

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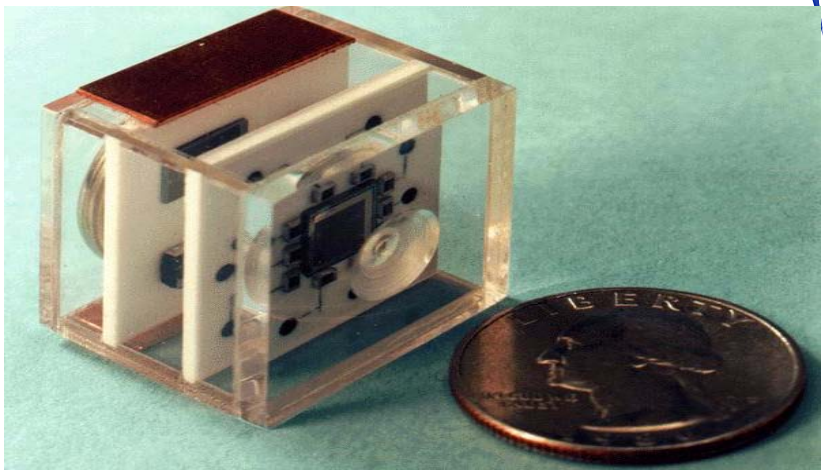
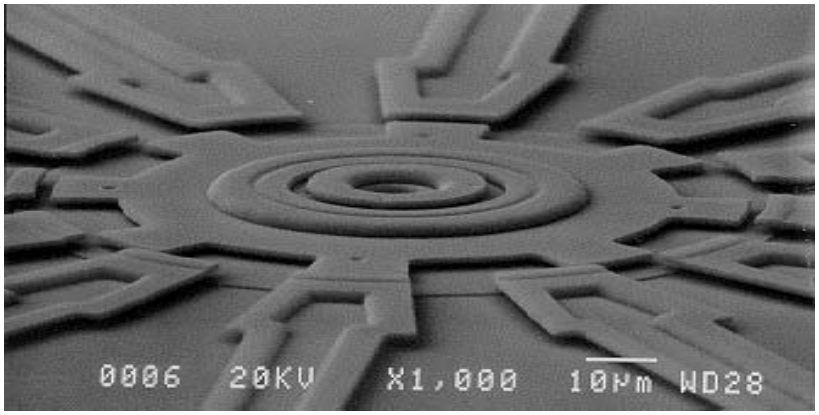
- Miniaturization plus multiple components plus microelectronics
- All components on a chip, dimensions measured in microns
- Uses and applications only limited by the imagination





MEMS INVENTORY MANAGEMENT SYSTEM

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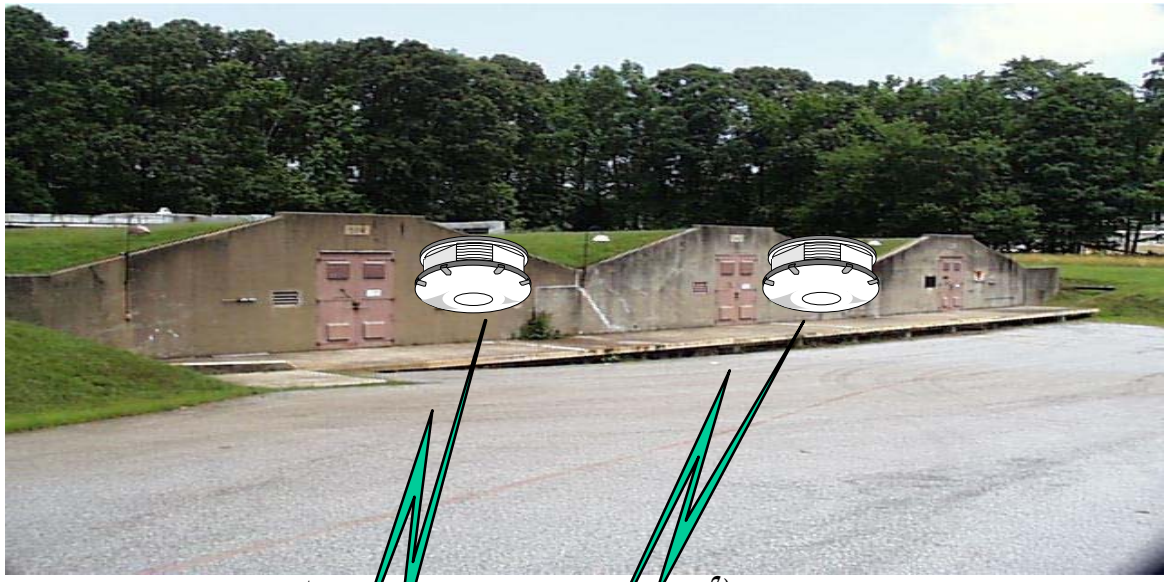

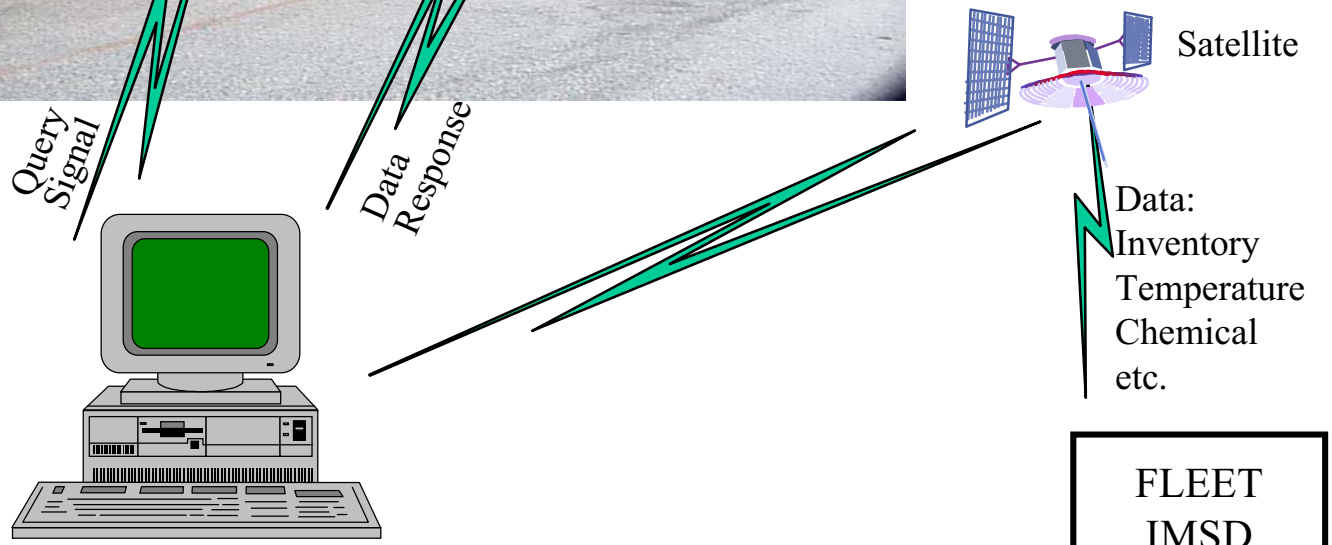

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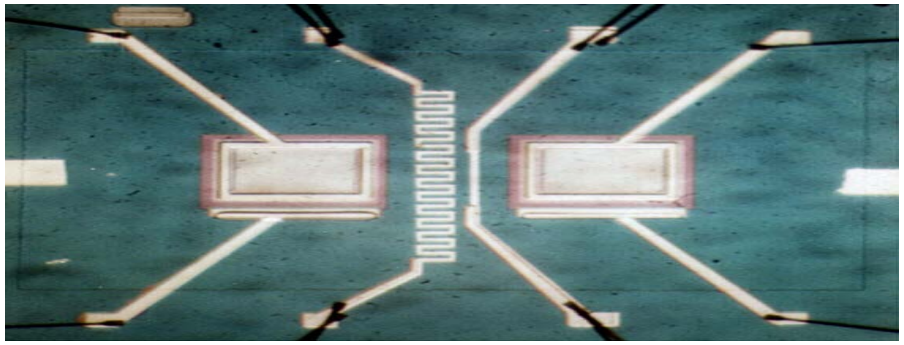
CHEMICAL SENSORS

"IN SITU" Real Time Propellant Analysis

- Current technology: electro-chemical cells
- Future technology: molecular imprinted biosensors
  - add sensors serially to MEMS chips
  - potential for embedded applications
  - highly selective for chemical species, i.e., CO Vs $C0_2$ *Vs NO Vs NO_x, etc.



NO_X SENSOR CHIP

FIELD MONITORING MINIATURIZED INSTRUMENTATION

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Bringing Surveillance to the Field

- Research ⟶ applications stage
  - UV, FTIR, NIR spectroscopy
  - Mass spectrometry
  - Chromatographic system (HPLC, IC)
  - Capillary zone electrophoresis
  - Fiber optic / spectroscopy
- Advantages :
  - > Reduces/eliminates shipping costs/transportation costs
  - > Non destructive / Non invasive
  - > Enhanced Safety
  - > Operational personnel may be able to perform
  - > Immediate results
  - > Cost reductions allow greater sample size (statistical validation)

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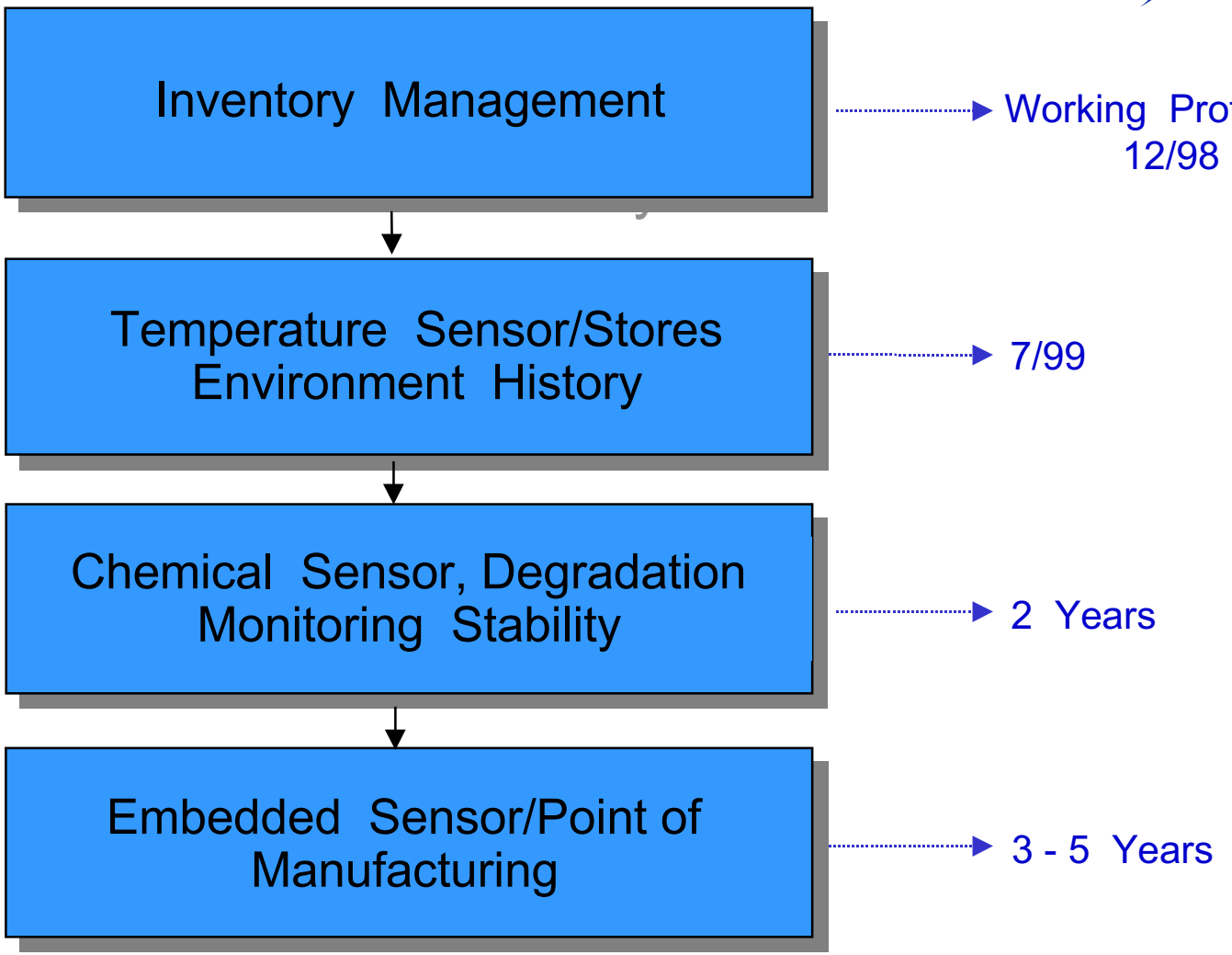
CHALLENGES

- More Engineering than R&D
  - Power issue
- Integration of sensors to MEMS devices
- Hazards (HERO, physical presence, RF interference, etc)
- Integration into weapon (mft & logistic issues)
- Correlation of chemical sensor data to safe shelf-life
- Pace of Technology advances

CHALLENGES (Cont)



PROGRESS TO DATE

- Predictive Technology Symposium - Nov 97
  - ARDEC & NSWCIHDIV co-host follow-on workshops Dec 97/May 98
- Surveillance & Predictive Technology Program established at NSWCIHDIV (Jan 98)
- Briefings given:

OSD	ARDEC	NAVSUPSYSCOM
CINCLANTFLT	DDESB	NAWC CHINA LAKE
CINCPACFLT	NSWC	PACIFIC NORTHWEST
NAVSEA	MARCORSYSCOM	NATIONAL LAB
O/EDCA	NAVORDCEN	SECNAV
OPNAV (N4)	MCPD FALLBROOK	

PROGRESS TO DATE (CONT)

- Prototype development
  - ✓Inventory MEMS by 1st qtr FY99
  - ✓Sensors (Temperature) by 3rd qtr FY99
- Proposals
  - ✓Navy AIT
  - ✓PMS 422
  - ✓PM Crusader
  - ✓Naval Explosives and Weapon System Safety Program
  - ✓CNO N86/N88 RDT&E for QE Application

PROGRESS TO DATE (CONT)

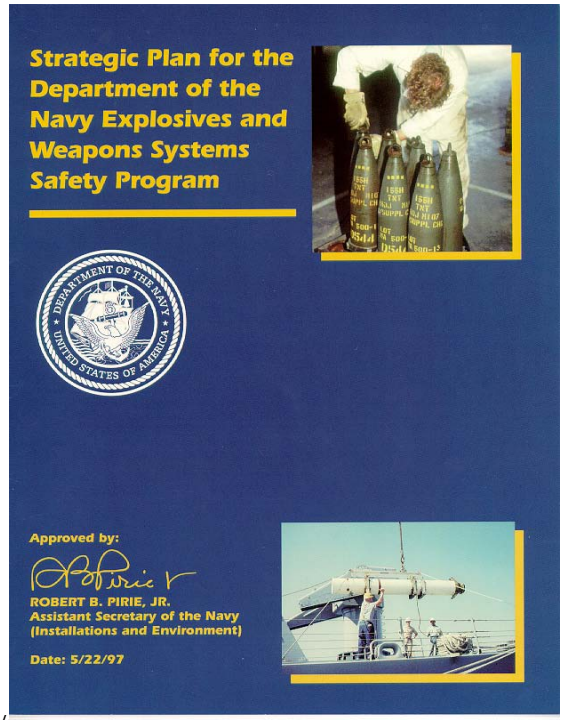
Crusader Program

- Propelling Charge Identification
- Temperature Sensor
- Integration with Fire Control Computer

PROGRESS TO DATE (CONT)

DON Explosives & Weapons System Safety Program

- 1997 Plan will advance explosives safety through six strategies
  - Strategy #3 **Technology**

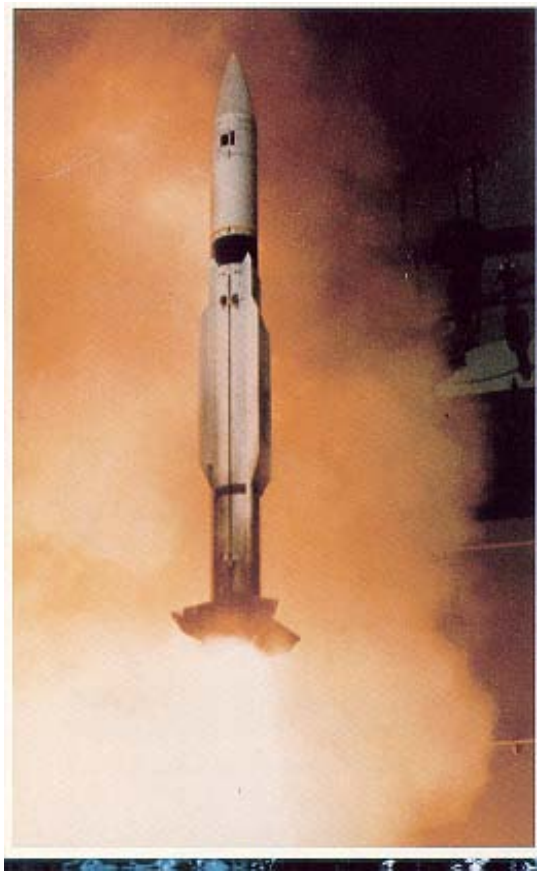


NSWCIHDIV has submitted six proposals:

- MEMS applications for real time monitoring
- MEMS sensor prototyping with communication media
- MEMS as Safe & Arm devices
- Field monitoring with miniature analytical instruments
- Computer modeling of safety characteristics
- Correlation studies for future tests

PROGRESS TO DATE (CONT)

PMS 422 Seatask (Temperature Data Logging)



- Temperature data logging
- Chemical aging analysis and modeling

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SUMMARY

- Sensor Technology progressing rapidly
  - applications limited mainly to imagination
- MEMS/Sensors major thrust at NSWCIHDIV
- Interest building Navywide
- Leveraging / teaming essential