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MEMORANDUM FOR PRR (Contractor/In-House Publication)

FROM: PROI (TI) (STINFO)  

Jay Levine, “Plume Phenomenology Program”

International presentation

20 May 1999
PLUME PHENOMENOLOGY PROGRAM

ONERA

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4 June 1999
Plume-Vehicle Interactions

Jet Interaction Effects -
Body Heating, Aerodynamic Forces
# AFRL Propulsion Directorate

**Propulsion Sciences and Advanced Concepts Division**

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**Tech Advisor:** Dr. Phil Kessel  
**Secretary:** Ms. Betty Sumrow

## PRSA
**Aerophysics**  
**CHIEF:** Mr. Jay Levine
- Rocket plume phenomenology
- Combustion processes and devices
- Spray combustion
- Energetic-material decomposition
- Plasma discharges
- Computational fluid dynamics
- Supercritical fluid mechanics
- Rarefied gas dynamics
- Non-equilibrium flows

## PRSM
**Propulsion Materials Applications**  
**CHIEF:** Dr. Shawn Phillips
- Advanced polymeric components
- Hybrid polymers
- Advanced component fabrication techniques
- Carbon-carbon components
- High temperature coatings
- Nanocrystalline materials
- Functionally graded components
- Solid-propellant fracture mechanics
- Microtubes technology
- Ceramic processing

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**CHIEF:** Dr. Pat Carrick
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- Liquid rocket propellants and additives
- Solid and hybrid rocket motors and propellants
- Cryogenic propellants
- Energetic molecule synthesis and characterization
- Computational chemistry
- Analytic chemistry
- Environmental propulsion technology
- Propellant hazard analysis
- Missile safety
- Advanced propulsion concepts

## PRST-West
**Applications & Assessment**  
**ASSOC CH:** Dr. Tae Woo Park
- System-level performance analysis of aerospace vehicles
- Flight trajectory simulations
- Liquid rocket power balance analysis
- Vehicle flight performance prediction
- Propellant requirement estimation
- Technical risk assessment
- Reliability analysis
- Program cost estimation
...What We Do

- Primary U.S. Activity for Plume Related Signature Modeling and Analysis

- Develop and Validate Plume Codes for Distribution to DoD Community
  - Propulsion Performance
  - Exhaust Plume Characteristics and Signatures

- Both In-House and Contracted Work
  - Substantial In-House Computing and Scientific Visualization Capabilities
Background
Types of Plume Signatures

- Propulsion Systems Produce the Following Signatures
  - Exhaust Plumes
  - Plume/Body Interactions

- These Signatures can Impact the Effectiveness of a Missile Defense System During Boost, Ascent, and Descent Phases
Shocks, and Contamination

Vehicle/Plume Interactions

Selection, and Sensor Ranking

All Weather Detection and Tracking, Typing, Communication, Aim-Point

Active Signatures: Laser and Radar Attenuation and Backscatter

Selection, Band Pass Selection, Sensor Ranking

Detection, Acquisition, Tracking, Typing, Cueing, Handover, Aim-point

Passive Signatures: Emissions in the UV-LWIR (0.1-25 μm)

Plumes Impact Many Missile Defense Functions

Background
Plume Phenomenology Implications:
A Few Examples

- Plume Asymmetries
  - 3-D Effects (Fins, Gas Generators, TVC Vanes, etc)
  - Angle-of-Attack
- Afterburning Cessation and Shutdown
- Contamination
3-D Simulations of Plume Flows

Static Temperature Field
3-D Radiation Predictions

0° Rotation

45° Rotation

90° Rotation

2-D SPF/SIRRM Image