ISO 9001 Certified
BSI FS15149

PRESENTATION TO THE 38th NDIA GUNS & AMMO SYMPOSIUM

26 MARCH 2003

ADAPTATION OF AN M67 RECOILLESS RIFLE TO FIRE WATER SLUGS

DAVID A. NELSON, NAVEODTECHDIV
PHONE: (301) 744-6850 x223
EMAIL: NelsonDA@eodpoe2.navsea.navy.mil

DAVID C. SMITH, BENET LABS
PHONE: (518) 266-4741
EMAIL: dcsmith@pica.army.mil

WHY A WATER CANNON?

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- **WATER CANNON IS A COMMON TOOL TO PROVIDE THESE FUNCTIONS IN EXPLOSIVE ORDNANCE DISPOSAL.**

FUNCTION / LIED THREAT	ACCESS	GENERAL DISRUPTION	PRECISION DISRUPTION
MAN PORTABLE	Vantrepan Hydra-Jet Magic Cube	Bootbanger Exit Charge Hydra-Jet MDET	Shock Tube Wire Cutter Detonator Wire Cutters
SMALL VEHICLE	Vantrepan Bootbanger Exit Charge Hydra-Jet Magic Cube	Bootbanger Exit Charge MDET	Shock Tube Wire Cutter Hydra-Jet MDET Detonator Wire Cutters
LARGE VEHICLE	Vantrepan Bootbanger Exit Charge Hydra-Jet Magic Cube MDET	Bootbanger Exit Charge	Shock Tube Wire Cutter Bootbanger Exit Charge Hydra-Jet MDET Detonator Wire Cutters

M67 RECOILLESS RIFLE ADAPTATION OBJECTIVES & REQUIREMENTS

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- IN 2001, NAVEODTECH DIV BEGAN PROGRAMS TO REDUCE WEIGHT OF CURRENT WATER CANNON DEVICES.
- BENET LABS WAS CONTACTED TO SUPPORT CONCEPT OF ADAPTING M67 RECOILLESS RIFLE TO FIRE WATER SLUGS.
- REQUIREMENTS:
  - DEVELOP A NUMERICAL ANALYSIS OF THE FLUID PRESSURE CAPABILITY OF THE (M67) PRESSURE VESSEL.
  - DEVELOP A FIRST ORDER AXISYMMETRIC PRESSURE-TIME ANALYSIS OF THE FLUID DURING THE BALLISTIC EVENT.
  - DEVELOP AN INTERIOR BALLISTIC ANALYSIS SHOWING PRESSURE TIME CURVE OF THE PROPELLING CHARGE AND A PREDICTION OF IMPULSE.
  - DEVELOP A MODIFICATION DESIGN FOR THE 90 MM M67 RECOILLESS RIFLE.

CURRENT DESIGN
M67 RECOILLESS RIFLE ADAPTATION

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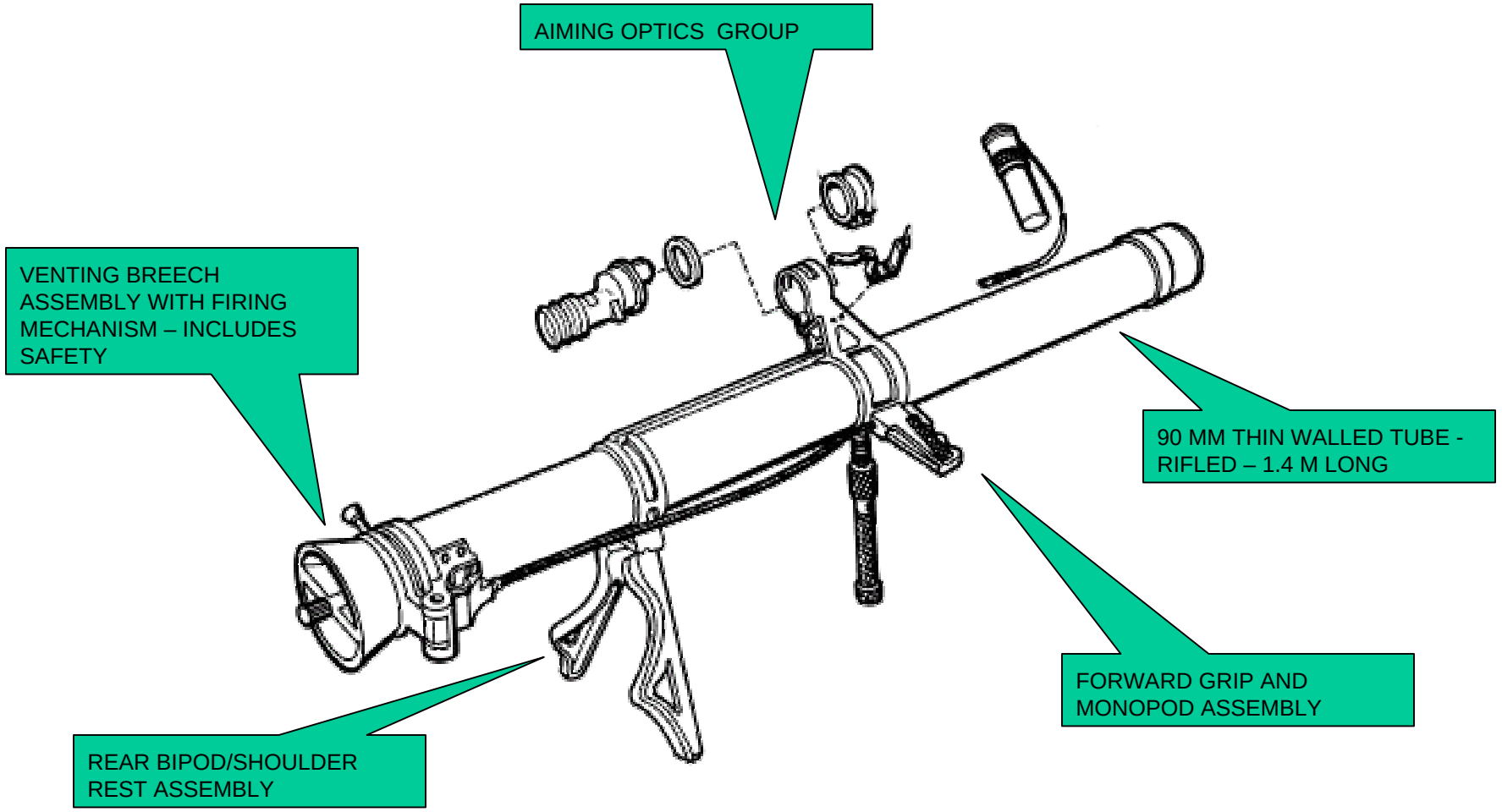

CONCEPT
M67 RECOILLESS RIFLE ADAPTATION

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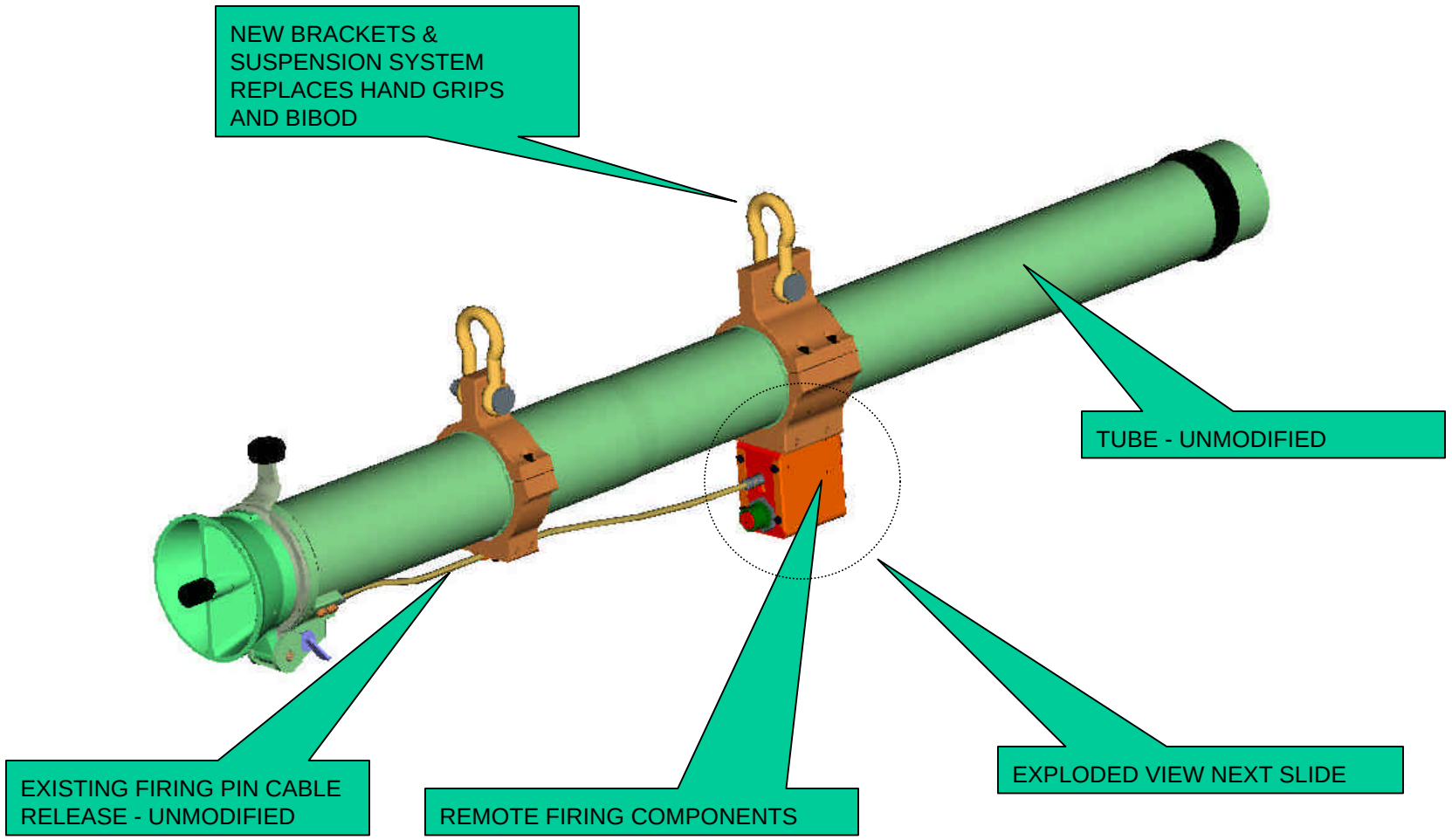

EXPLODED VIEW
M67 RECOILLESS RIFLE ADAPTATION

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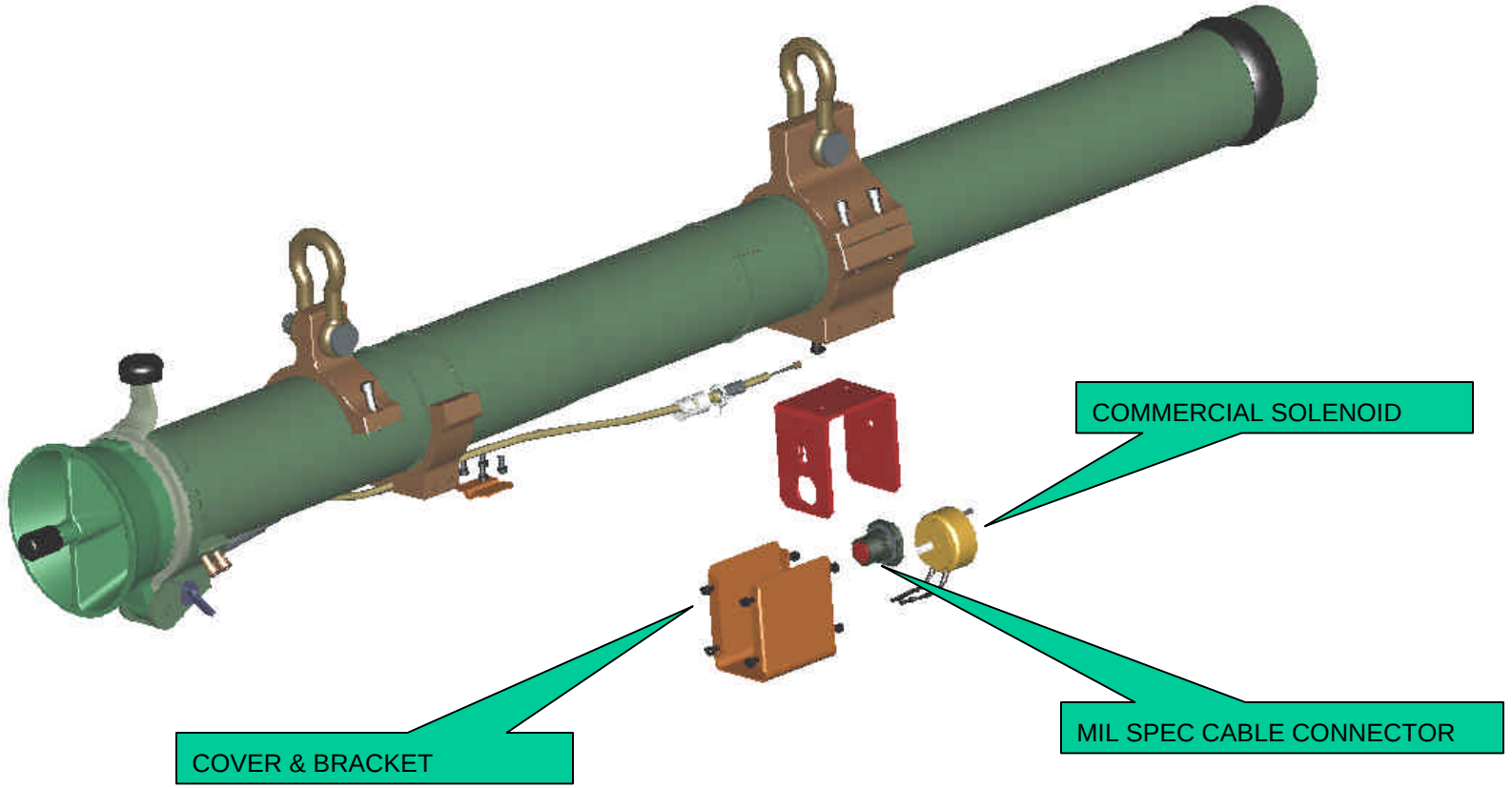

WATER SLUG/PROJECTILE
M67 RECOILLESS RIFLE ADAPTATION

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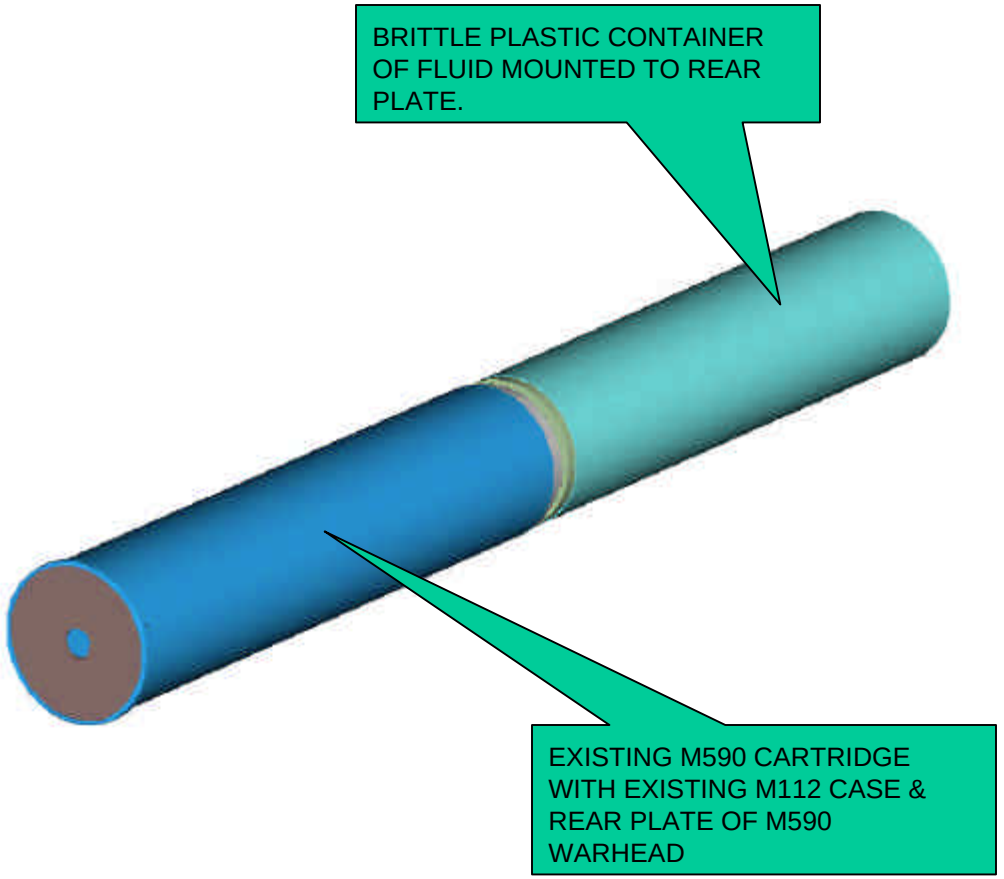

ANALYSIS
M67 RECOILLESS RIFLE ADAPTATION

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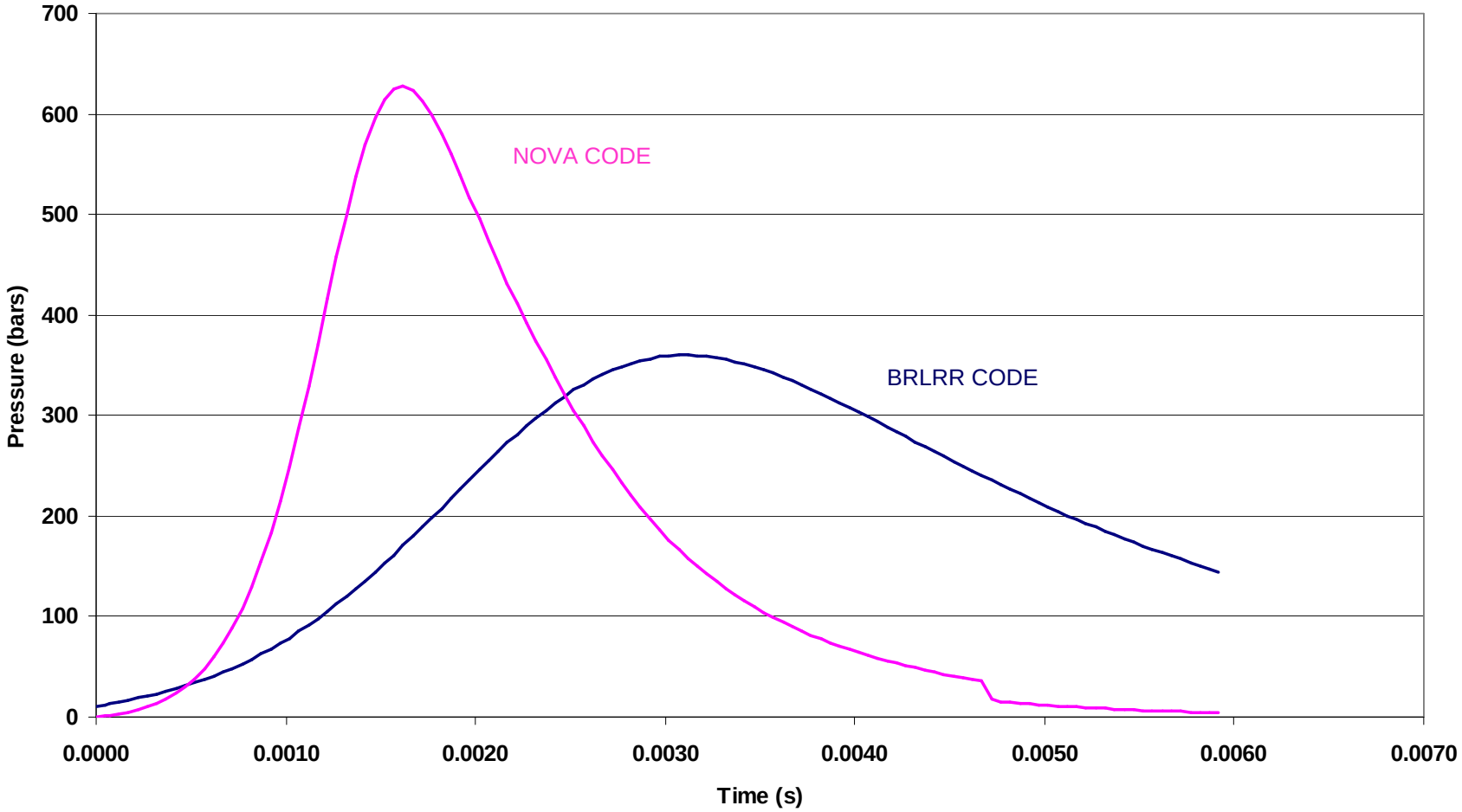
PRESSURE-TIME OFM590 CARTRIDGE IN M67 RECOILLESS RIFLE



ANALYSIS
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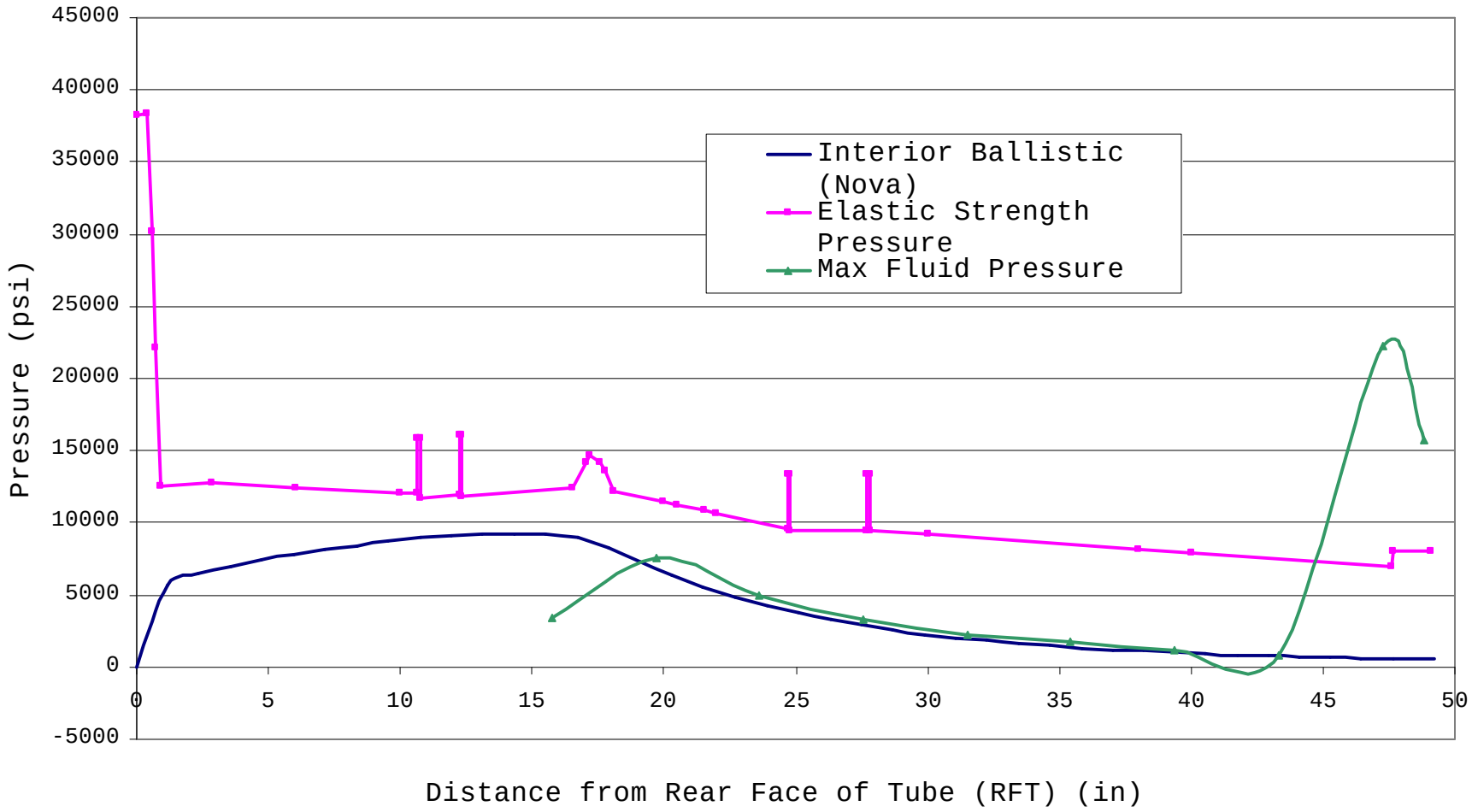
ELASTIC STRENGTH PRESSURE OF M67 RECOILLESS RIFLE



ANALYSIS
M67 RECOILLESS RIFLE ADAPTATION

- CFD MODELING
  - FLUENT USED TO COMPUTE NEAR WALL PRESSURE
    - 2-PHASE VOLUME OF FLUID (VOF) MODEL.
    - COMPRESSIBLE AIR AND INCOMPRESSIBLE WATER
    - TURBULENCE MODELED WITH K-E MODEL
  - VELOCITY PROFILE ON PISTON FACE
    - NOVA GENERATED VELOCITY VS. TIME PROFILE APPLIED TO M590 PISTON FACE
  - MOVING DYNAMIC MESH (MDM) USED TO HANDLE PISTON MOTION.
    - SLIDING, NON-CONFORMAL INTERFACE AT BARREL WALL AND OUTSIDE BARREL.
    - MESH DESTROYED AT PISTON FACE AND TARGET.
  - UNSTEADY, SEGREGATED, IMPLICIT SOLVER.

ANALYSIS
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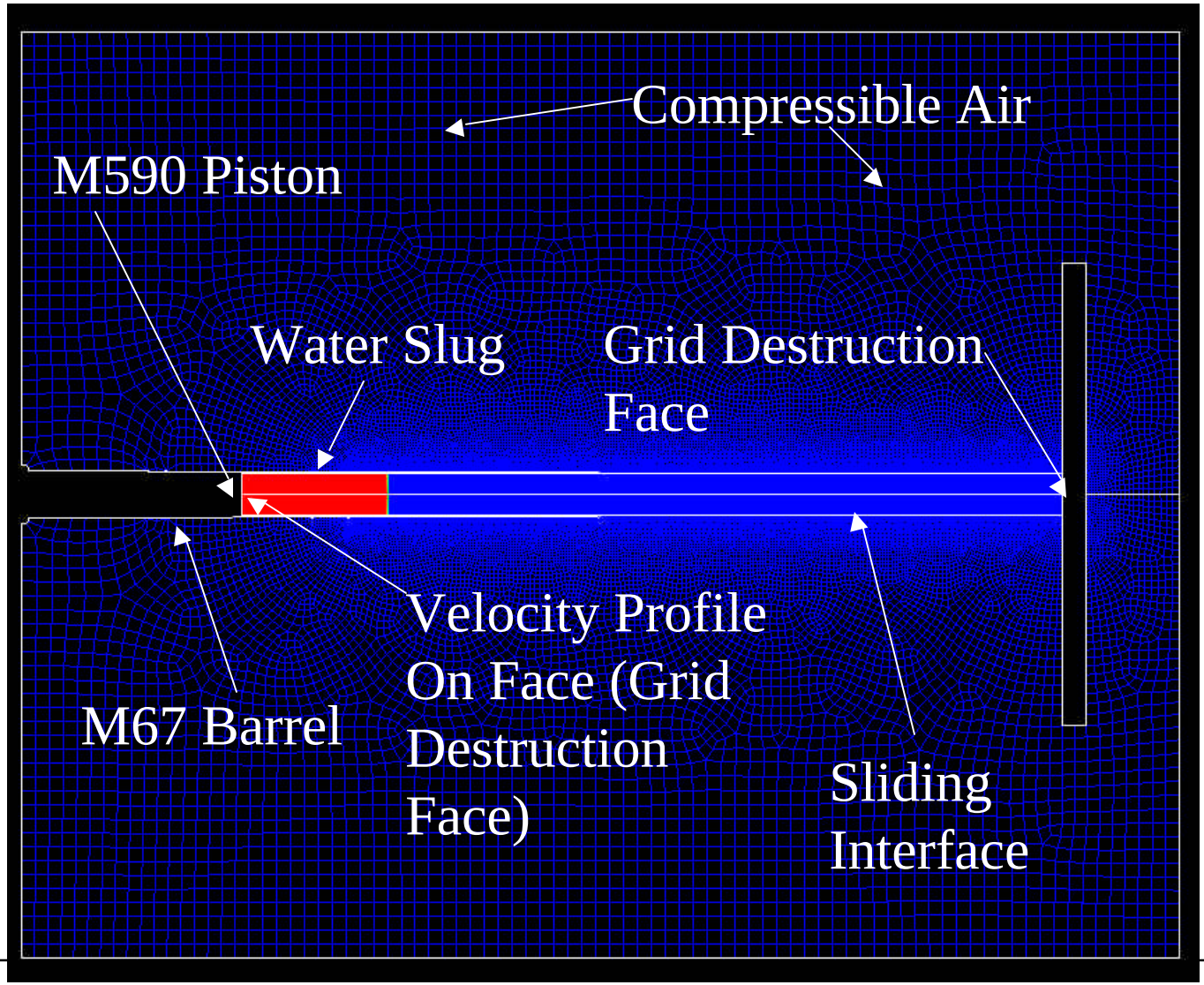

ANALYSIS
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NAVSEA
NAVAL SEA SYSTEMS COMMAND
EOD Technology Division

BENÉT Labs
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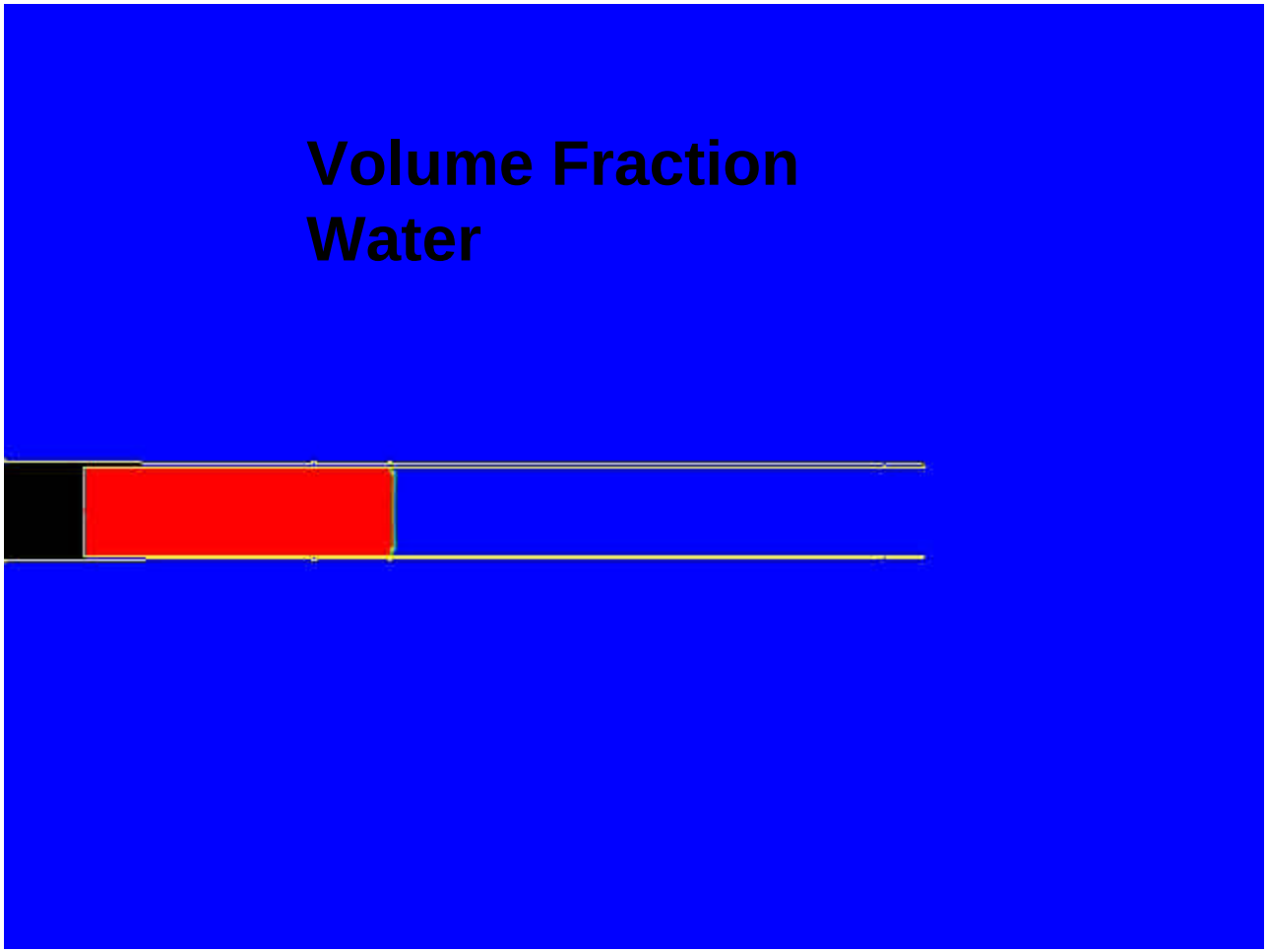

ANALYSIS
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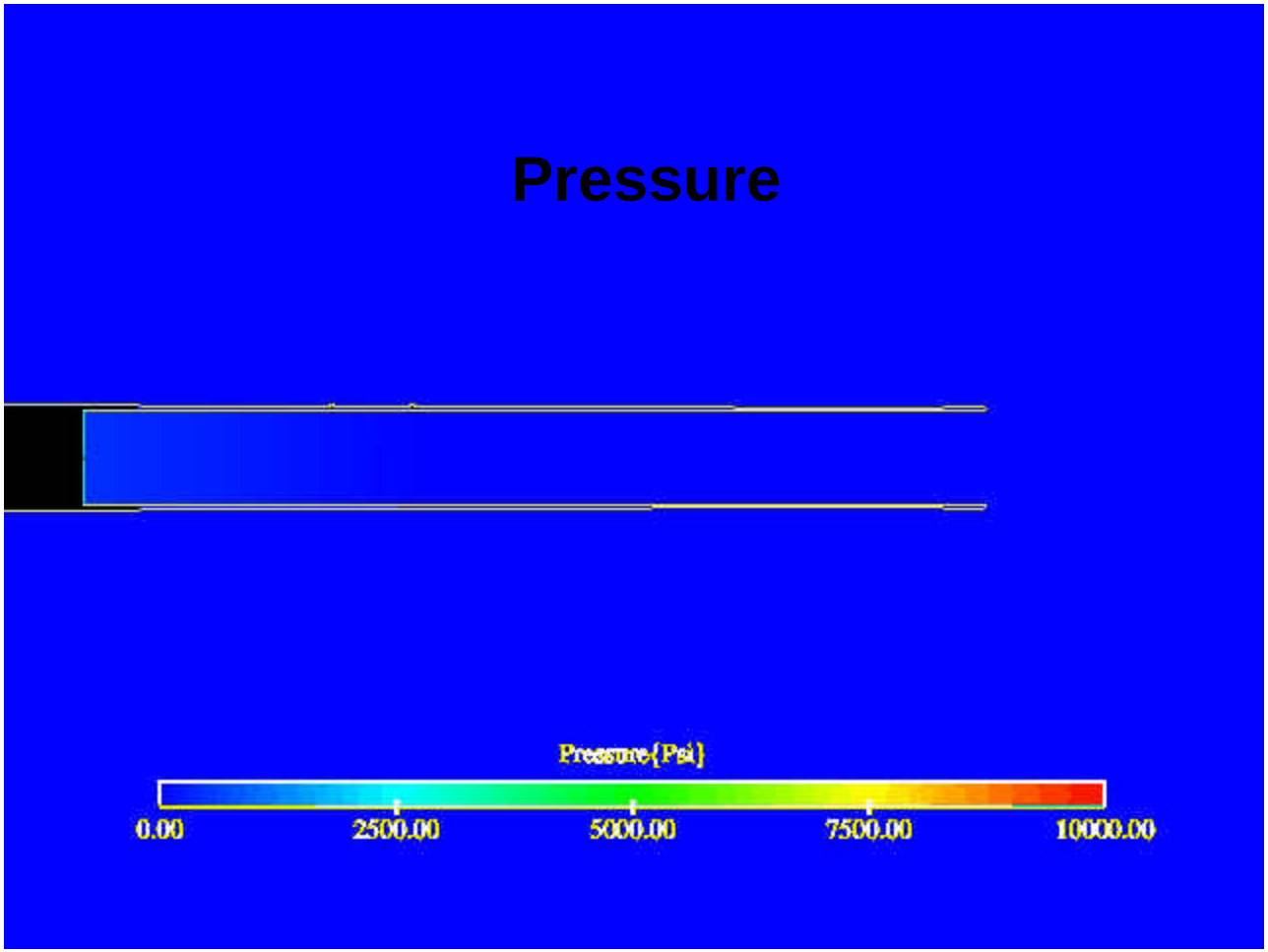

ANALYSIS
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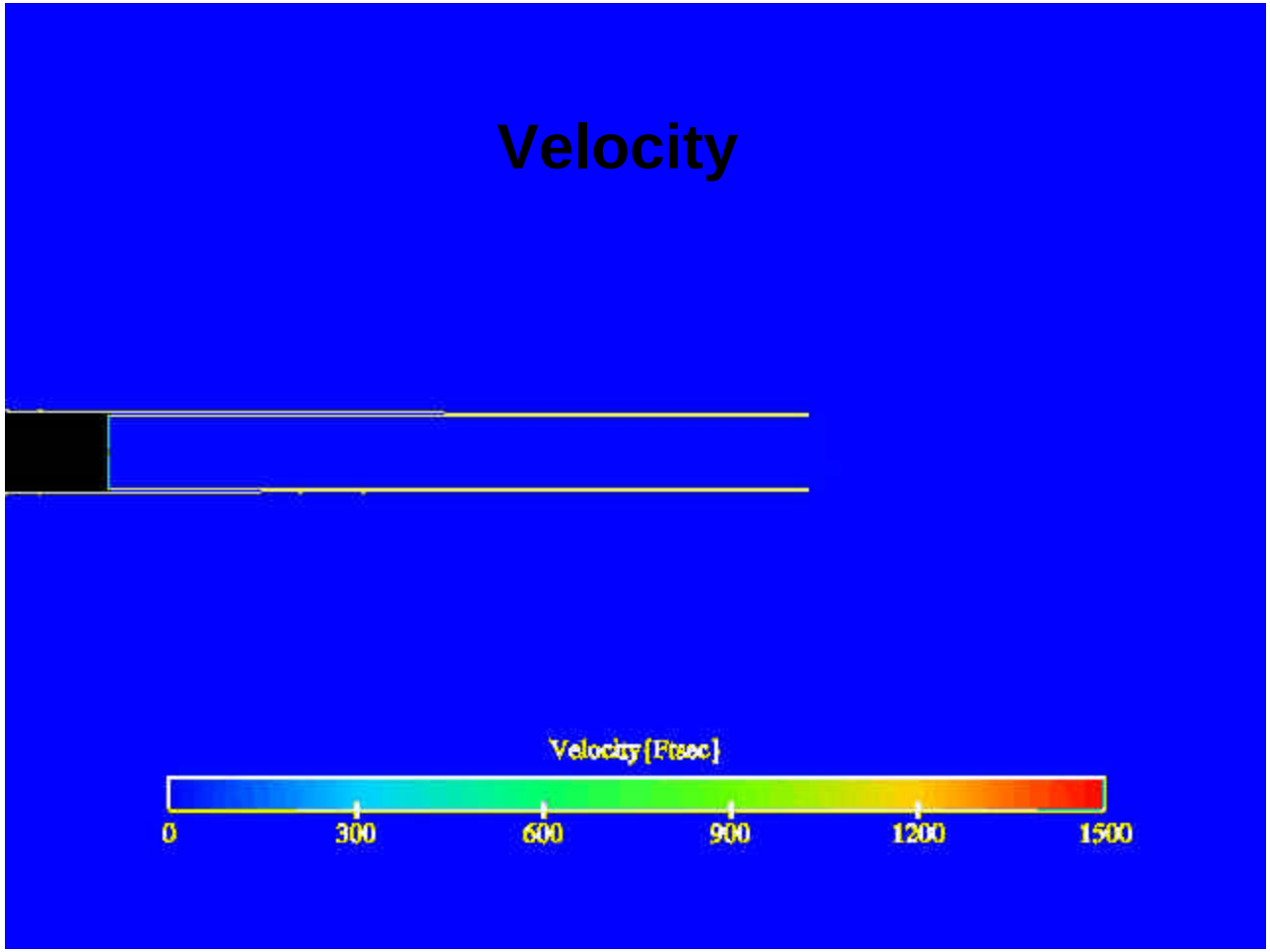

DESIGN CONCLUSIONS
M67 RECOILLESS RIFLE ADAPTATION

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- THE M67 CAN BE MODIFIED TO FIRE WATER SLUGS AT OR ABOVE 1000 FPS EXIT VELOCITY. (1200 FPS PREDICTION)
- THE MODIFICATIONS APPEAR TO RESULT IN A SYSTEM WITH NO APPARENT SAFETY HAZARDS (EXCEPTION – NEXT BULLET)
- THE INTERIOR BALLISTICS AND FLUID ANALYSIS INDICATE THAT THE MODIFIED M67 HAS A MINIMAL RISK OF FAILURE. POSSIBLE THAT WATER HAMMER COULD OCCUR AS THE WATER SLUG EXITS FROM THE BARREL.
- THE COMPUTATIONAL FLUID DYNAMICS MODELS ARE INCONCLUSIVE FOR PRESSURES AT SHOT EXIT. IF THE PRESSURES ARE CLOSE TO THE LEVELS SHOWN BY THE ANALYSIS, FAILURE OF THE GUN TUBE MAY OCCUR.

FINAL TEST SET UP
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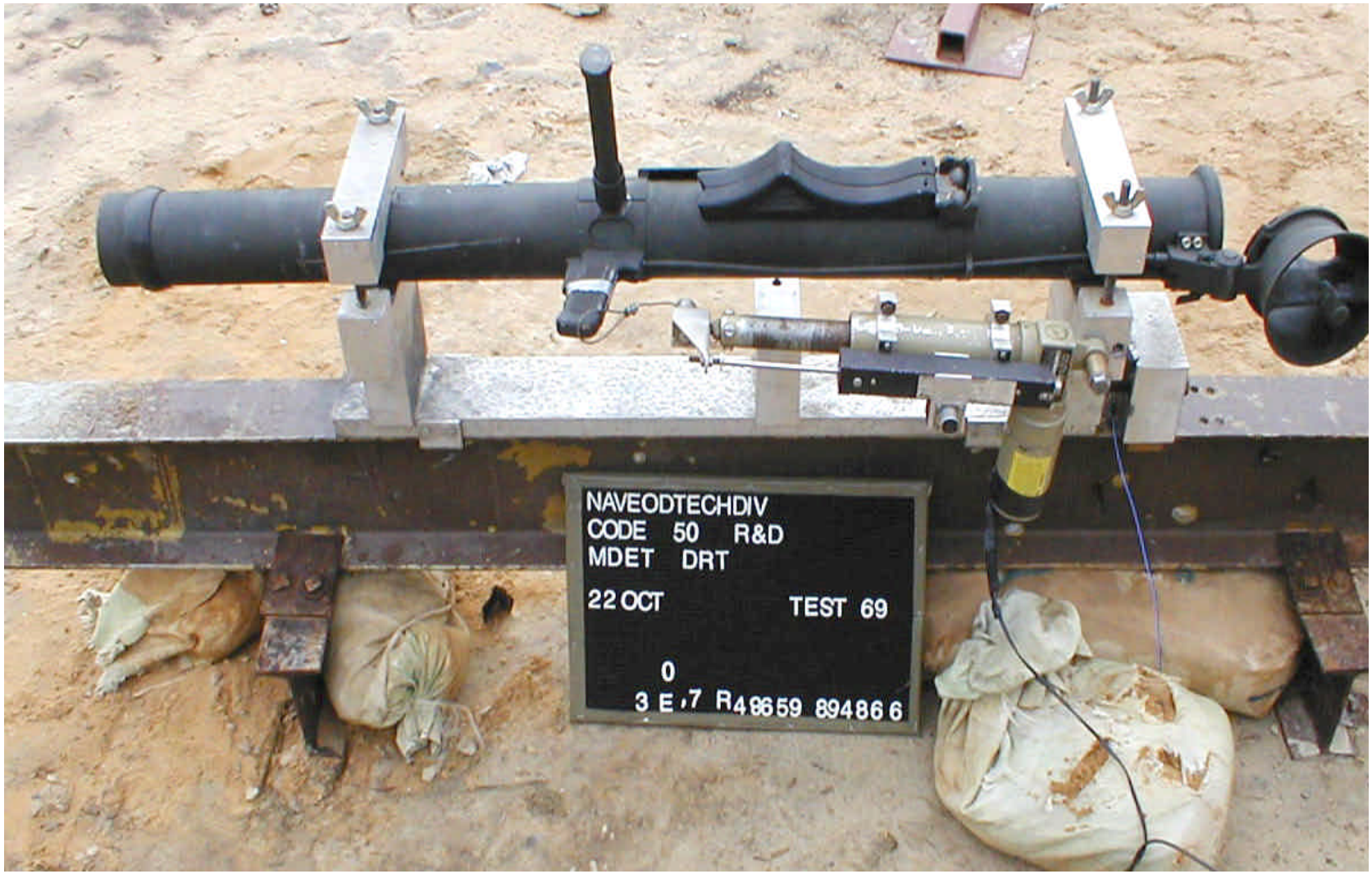

EFFECTIVENESS TESTING (DISRUPTION)

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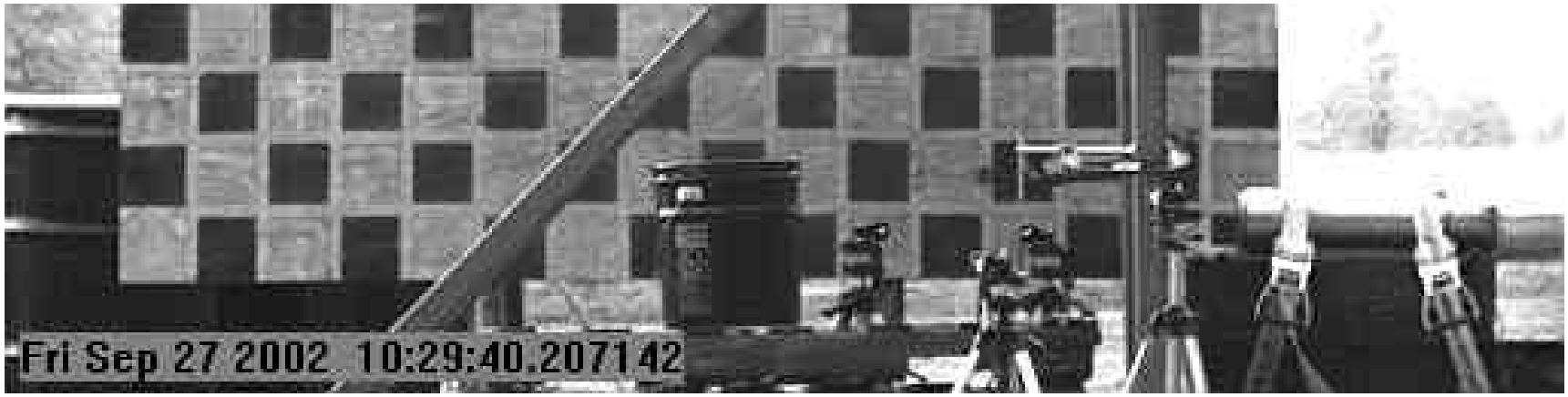

NAVY EOD WATER CANNON CONCLUSIONS

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- **BENET MODELING OF M67 AND ANALYSIS OF OTHER (WATER DRAGON) SYSTEMS COMBINED WITH NAVEODTECHDIV TESTS INDICATE:**
  - **LIGHTER SYSTEMS ARE FEASIBLE (M67 RECOILLESS)**
  - **LIGHTER SYSTEMS CAN PERFORM SAME FUNCTIONS AS CURRENT SYSTEMS.**
  - **MORE EFFICIENT MATERIALS AND DESIGN TECHNIQUES CAN CREATE SYSTEMS WITH SIMILAR DURABILITY AT ONLY MODERATE COST INCREASES.**

WATER CANNON
FUTURE DEVELOPMENT

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- **NAVEODTECHDIV HAS DEVELOPED CONCEPT FOR 'MEDIUM DIRECTED ENERGETIC TOOL (MDET) AS NEXT GENERATION PROGRAM & RETAINED BENET TO SUPPORT DESIGN EFFORTS**