

# INSENSITIVE MUNITIONS?



FULMINATION 2022

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BOFORS TEST CENTER

AS LONG AS THERE HAVE BEEN EXPLOSIVES...

...THERE HAVE BEEN ACCIDENTS

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# ROYAL SHIP KRONAN

1 JUNE 1676

800 KILLED

40 SURVIVORS



# HMS HOOD

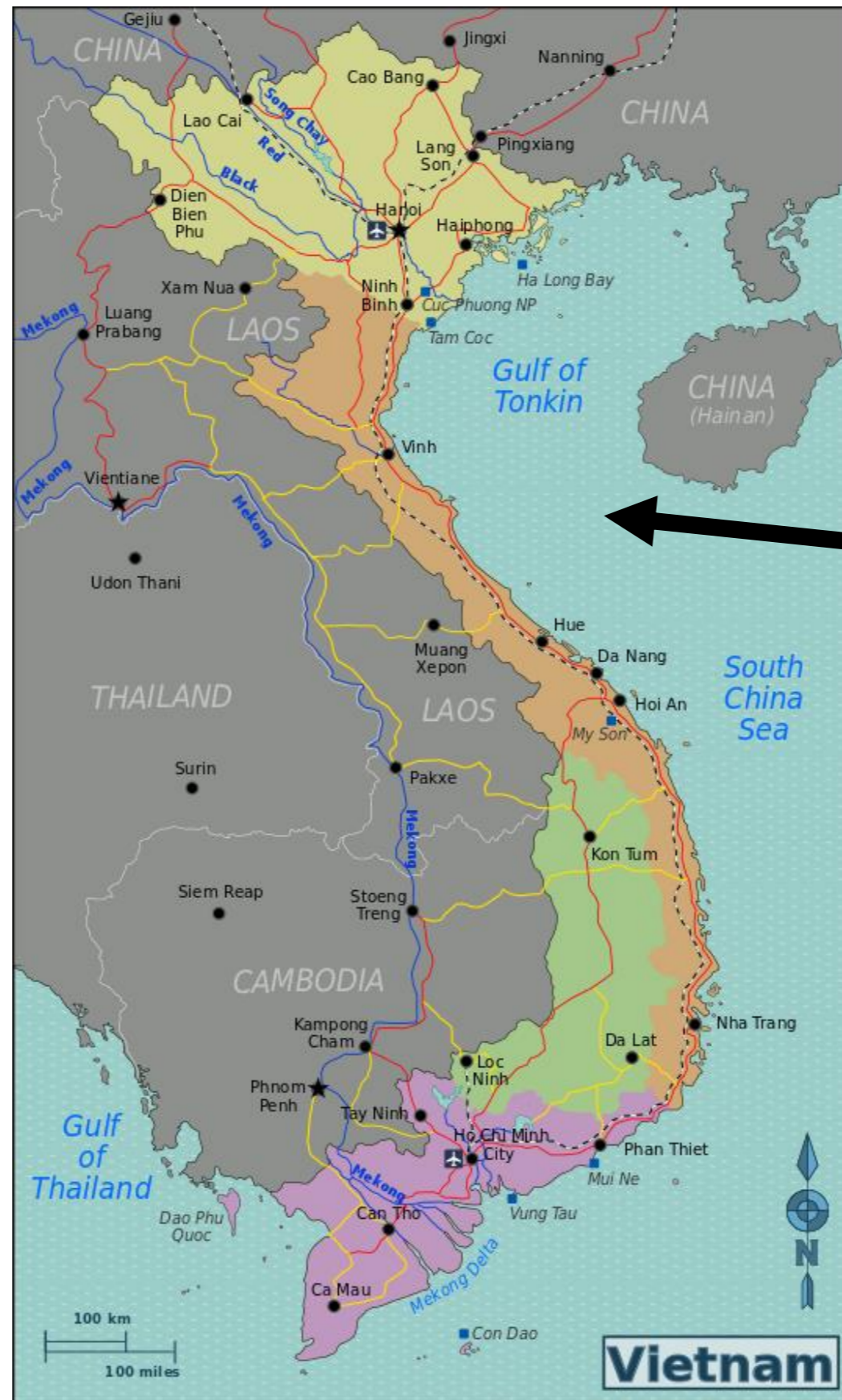
24 MAY 1941

1,415 KILLED

3 SURVIVORS

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# VIETNAM 1967



YANKEE STATION

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# USS FORRESTAL

DISPLACEMENT: 82,402 TONS  
(FULL LOAD)

LENGTH: 325 M

SPEED: 33 KNOTS (61 KM/H)

POWER: 260,000 HP

CREW: 5,540



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**29 JULY, 10:51AM**

ONE MK-32 ZUNI ROCKET ACCIDENTALLY  
LAUNCHED FROM AN F4 PHANTOM

HITS A 1,500 L EXTERNAL FUEL TANK ON AN A4  
SKYHAWK

AFTER 1 MINUTE AND 35 SECONDS ONE 1,000 LB  
BOMB DETONATES

FIRE ENTERS LOWER DECKS

IN LESS THAN FIVE MINUTES, SEVEN OR EIGHT  
1,000 LB BOMBS, ONE 750 LB BOMB, ONE 500 LB  
BOMB, AND SEVERAL MISSILE AND ROCKET  
WARHEADS HEATED BY THE FIRE EXPLODED  
WITH VARYING DEGREES OF VIOLENCE

AFTER 14 HOURS ALL FIRES WERE CONTROLLED

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**134 KILLED**

**161 INJURED**

**OF 73 AIRCRAFTS:**

**21 DESTROYED**

**40 DAMAGED**

**REPAIR COSTS (1968):**

**\$72 MILLION**

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# THE AIRCRAFT CARRIER SAFETY REVIEW PANEL

DEVELOPMENT OF A REMOTE-CONTROL FIRE-FIGHTING SYSTEM FOR THE FLIGHT DECK

IMPROVEMENT IN SURVIVAL EQUIPMENT

INCREASED TRAINING IN FIRE SURVIVAL

DEVELOPMENT OF MORE STABLE ORDNANCE

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## USS ORISKANY

26 OCTOBER 1966

44 KILLED

156 INJURED



## USS ENTERPRISE

14 JANUARY 1969

28 KILLED

344 INJURED

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# AND AMMUNITION RELATED ACCIDENTS STILL HAPPENS...



EVANGELOS FLORAKIS NAVAL BASE,  
CYPRUS

11 JULY 2011

485 TONS TNT EQUIVALENT

13 KILLED

62 INJURED

COSTS: \$2.83 BILLION

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ACCIDENTS WILL ALWAYS HAPPEN!



BUT WITH INSENSITIVE MUNITIONS,  
THE NUMBER OF ACCIDENTS AND  
THEIR CONSEQUENCES WILL BE  
SIGNIFICANTLY REDUCED!



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YES, BUT WHAT ARE INSENSITIVE MUNITIONS?



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# WHAT ARE THE THREATS TO ORDNANCE, MUNITIONS AND EXPLOSIVES?

FIRE

FIRE IN ADJACENT STORAGES

VIOLENT REACTION OF AN ADJACENT MUNITION

FRAGMENTS

SMALL ARMS PROJECTILES

SHAPE CHARGE WEAPONS



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# TEST METHODS

FIRE – FAST HEATING (FAST COOK-OFF): AOP-4240

FIRE IN ADJACENT STORAGES – SLOW HEATING (SLOW COOK-OFF): AOP-4382

VIOLENT REACTION OF AN ADJACENT MUNITION – SYMPATHETIC REACTION: AOP-4396

FRAGMENTS – FRAGMENT IMPACT: AOP-4496

SMALL ARMS PROJECTILES – BULLET IMPACT: AOP-4241

SHAPE CHARGE WEAPONS – SHAPED CHARGE JET: AOP-4526

OK, BUT HOW TO CARRY THEM OUT?



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**SRD AOP-39.1**

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# SUITABLE GENERIC TEST EQUIPMENT

A LARGE, FLAT AND UNOBSTRUCTED AREA

VIDEO CAMERAS

HIGH SPEED VIDEO CAMERAS

AIR BLAST PRESSURE GAUGES

WITNESS PLATES

WEATHER STATION

GPS SYSTEM

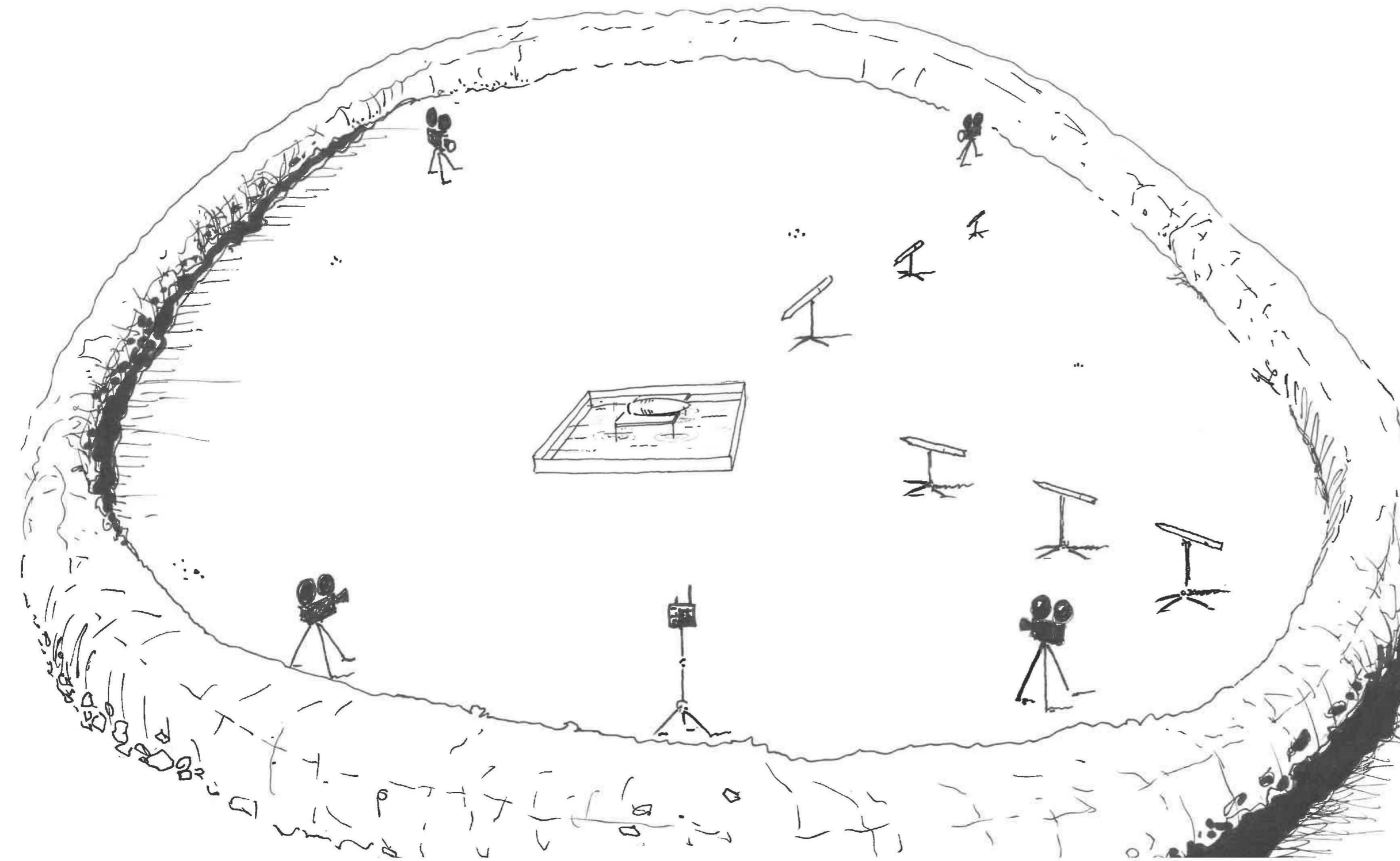
DOPPLER RADAR

THERMOCOUPLES

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# TEST SETUP; FAST COOK-OFF



HEARTH

JET FUEL (AND WATER) OR  
PROPANE

STEEL TABLE

IGNITERS

THERMOCOUPLES

WEATHER STATION

VIDEO CAMERAS

AIR BLAST PRESSURE GAUGES

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# TEST SETUP; SLOW COOK-OFF

OVEN

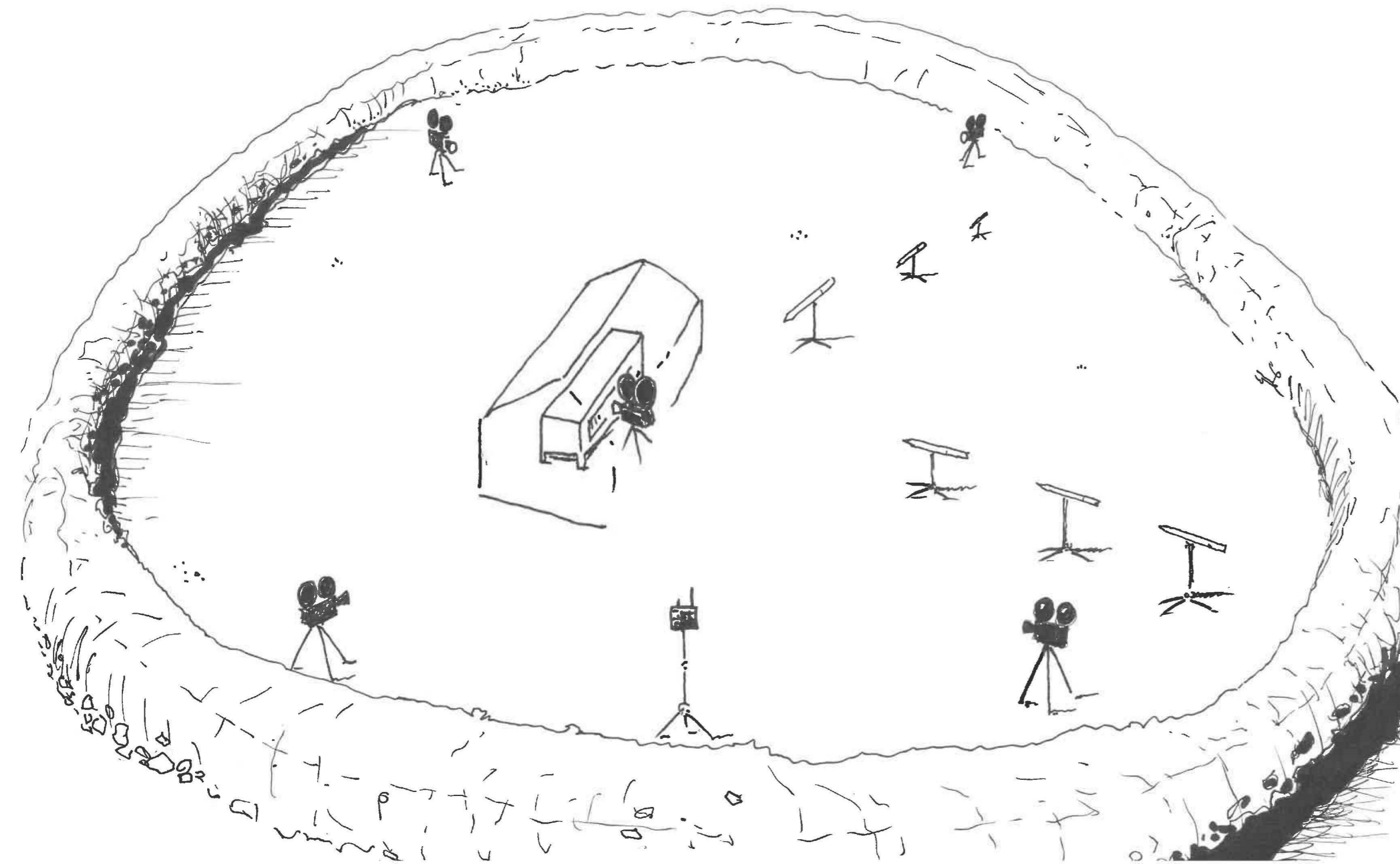
TENT

THERMOCOUPLES

VIDEO CAMERAS

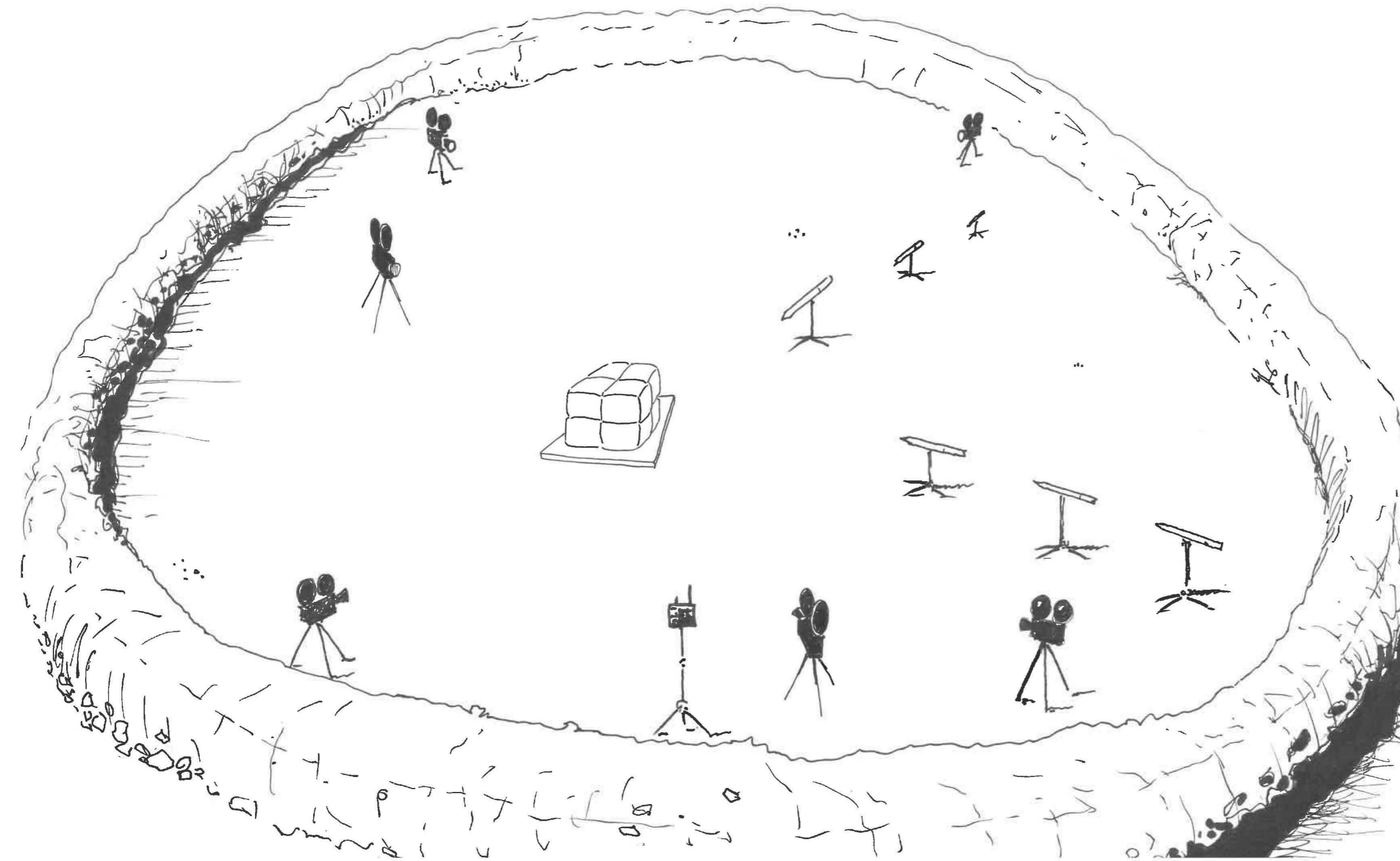
(WEATHER STATION)

(AIR BLAST PRESSURE GAUGES)



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# TEST SETUP; SYMPATHETIC REACTION



WITNESS PLATE

HIGH SPEED VIDEO CAMERAS

VIDEO CAMERAS

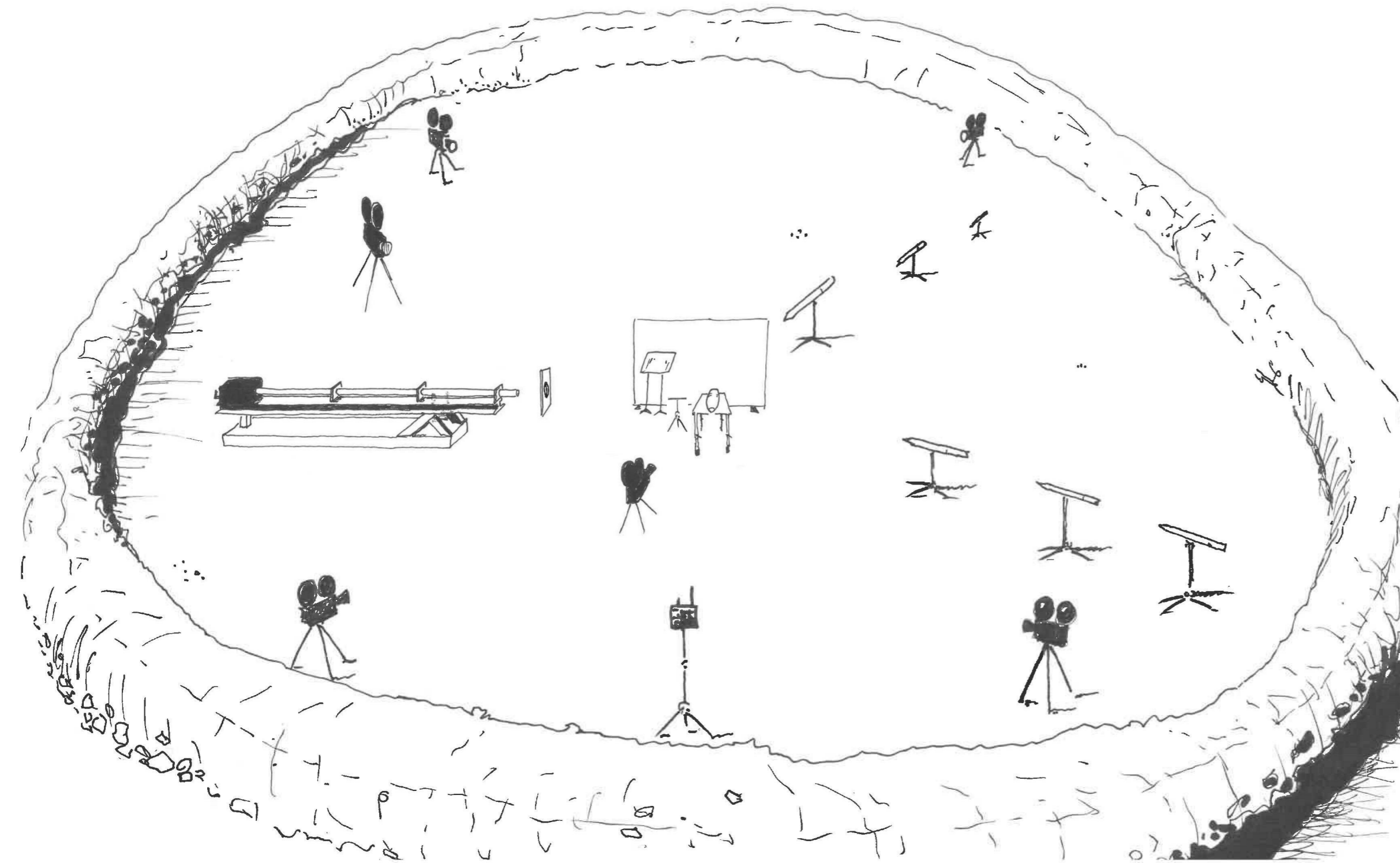
AIR BLAST PRESSURE GAUGES

WEATHER STATION

(EXTERNAL CONFINEMENT)

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# TEST SETUP; FRAGMENT IMPACT



GUN

SABOT CATCHER PLATE

STEEL TABLE

WITNESS PLATE

MIRRORS

PHOTO BACKGROUND SCREEN

DISTANCE REFERENCE

HIGH SPEED VIDEO CAMERAS

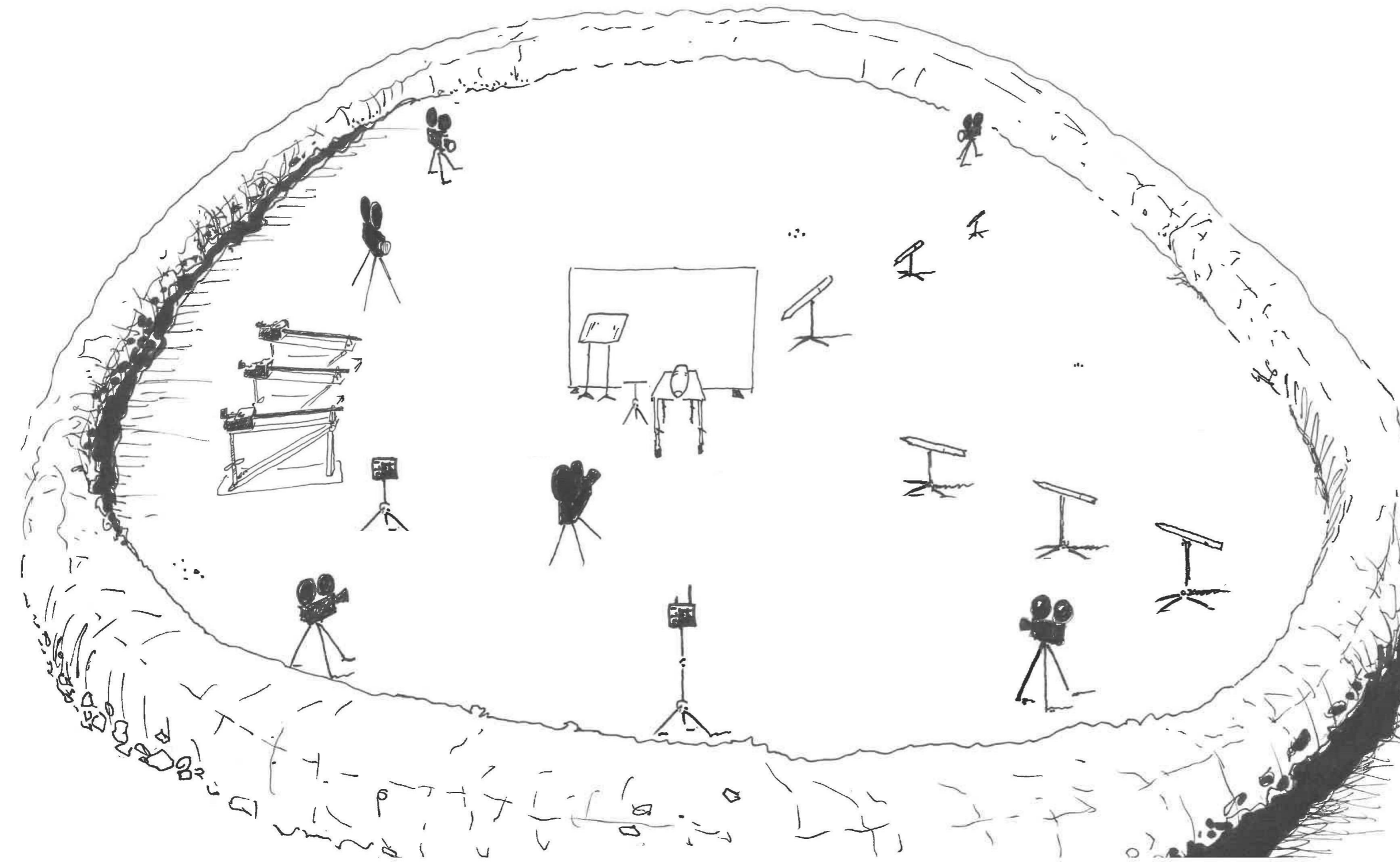
VIDEO CAMERAS

AIR BLAST PRESSURE GAUGES

WEATHER STATION

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# TEST SETUP; BULLET IMPACT



GUN(S)

DOPPLER RADAR

STEEL TABLE

WITNESS PLATE

MIRRORS

PHOTO BACKGROUND SCREEN

DISTANCE REFERENCE

HIGH SPEED VIDEO CAMERAS

VIDEO CAMERAS

AIR BLAST PRESSURE GAUGES

WEATHER STATION

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# TEST SETUP; SHAPED CHARGE JET



SHAPED CHARGE JET (RPG)  
CONDITIONING PLATE

STEEL TABLE

WITNESS PLATE

HIGH SPEED VIDEO CAMERAS

VIDEO CAMERAS

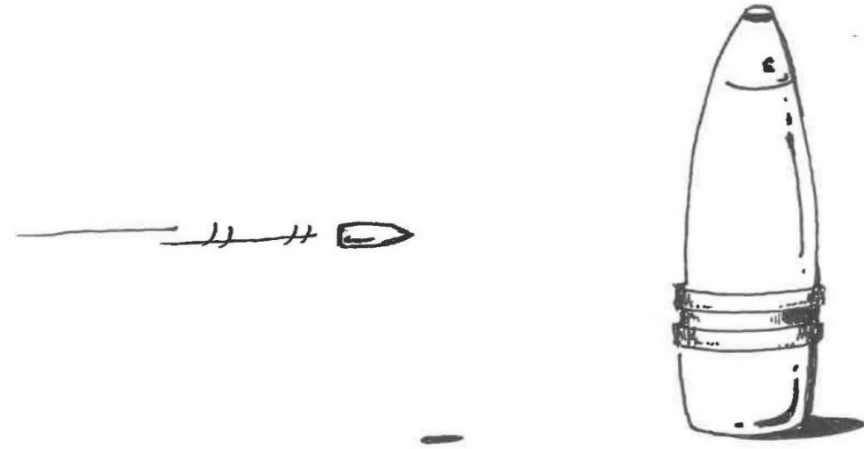
AIR BLAST PRESSURE GAUGES

WEATHER STATION

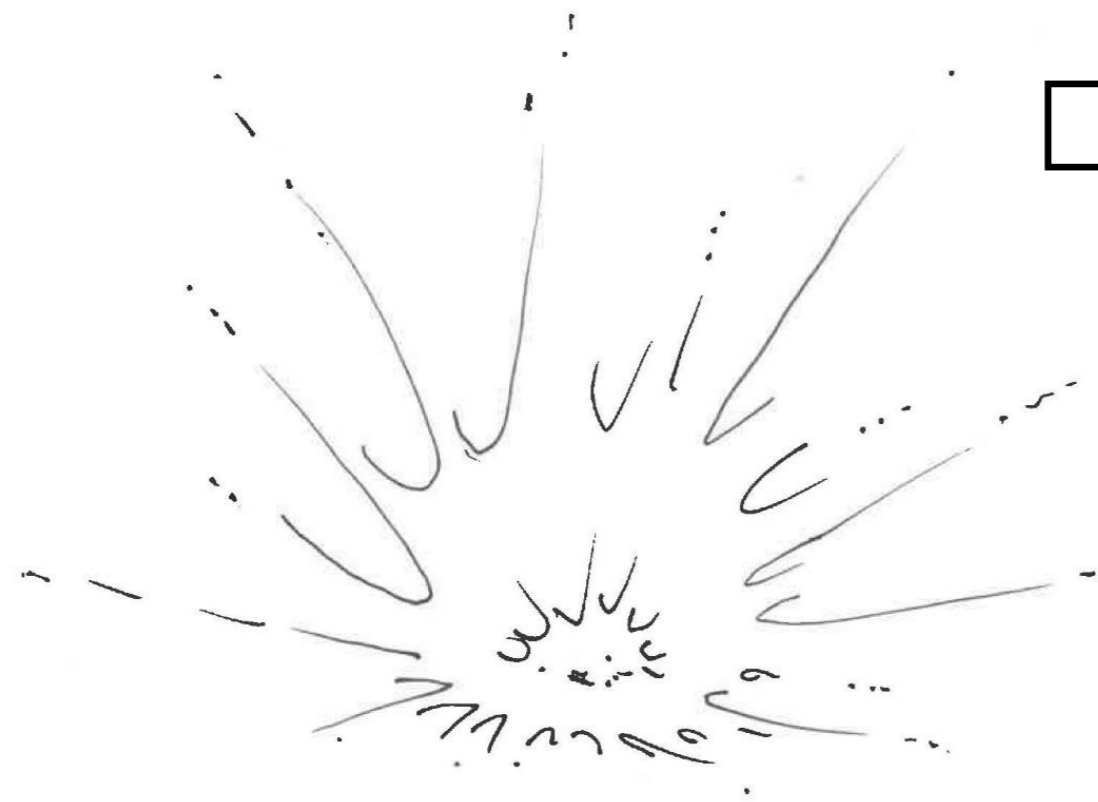
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# CONDUCT BASELINE TESTS!

SRD AOP-39.1



SHOOT AT AN INERT TEST ITEM



INITIATE A LIVE TEST ITEM TO FULL REACTION

COMPARE:

- THE SIZE AND SHAPE OF THE FRAGMENTS
- THE SCATTERING OF DEBRIS
- THE AIR BLAST PRESSURES

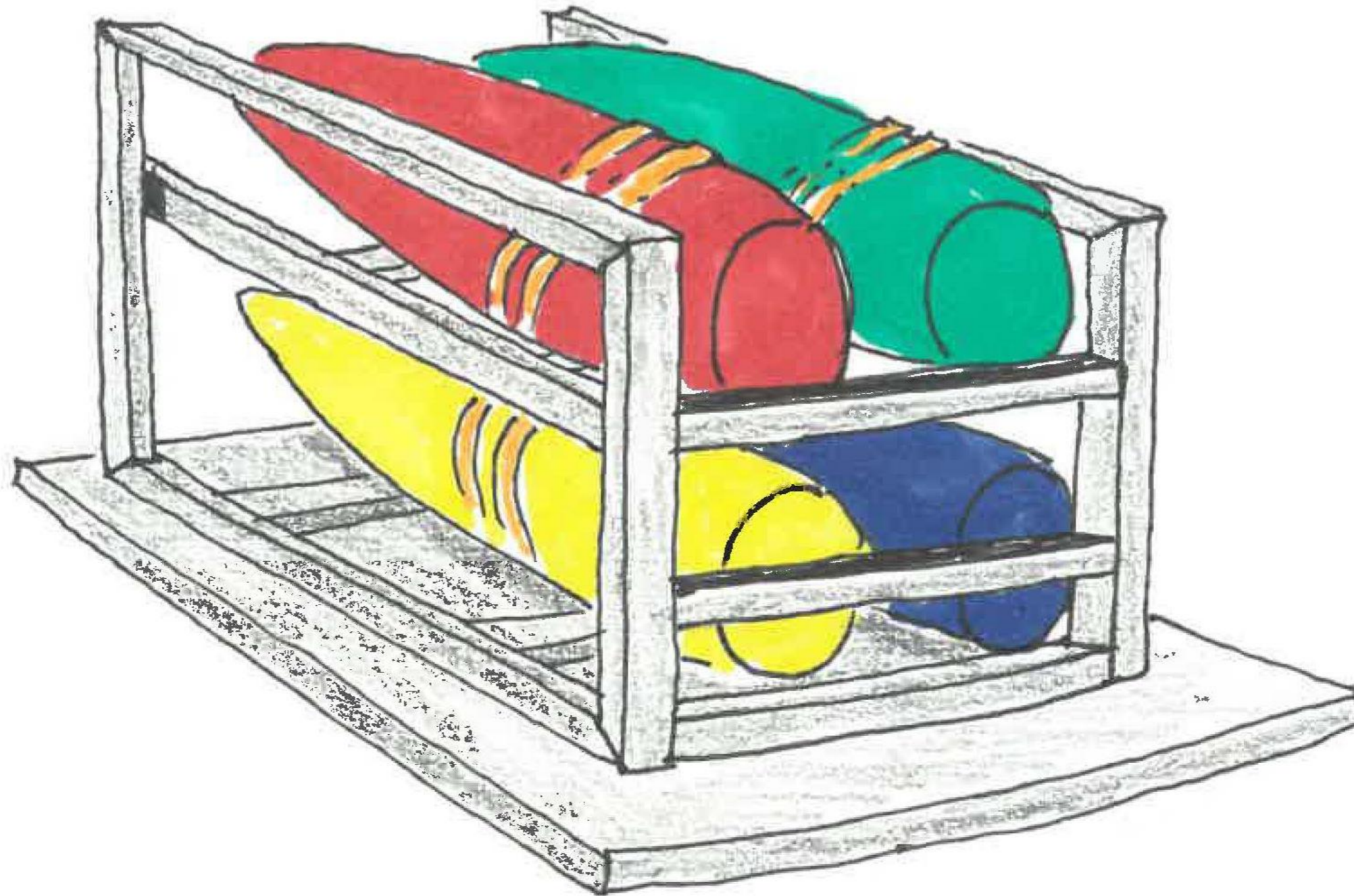
WITH THE RESULTS OF YOUR LIVE TESTS

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# PAINY YOUR TEST ITEMS!

SRD AOP-39.1



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THE RESULTS?

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# THE ASSESSMENT.

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# TYPE OF RESPONSE

TYPE I – DETONATION

TYPE II – PARTIAL DETONATION

TYPE III – EXPLOSION

TYPE IV – DEFLAGRATION/PROPULSION

TYPE V – BURN

TYPE VI – NO REACTION

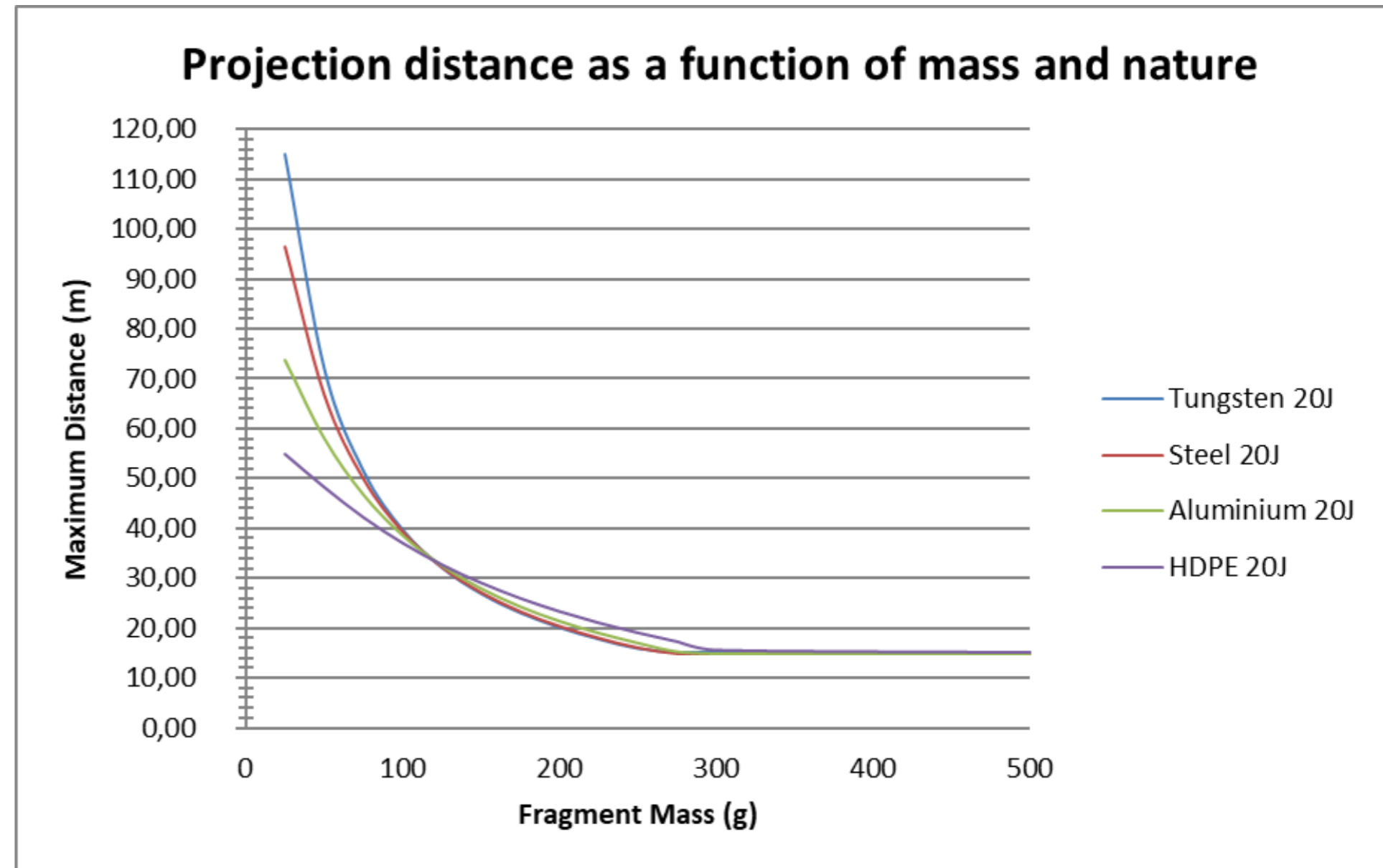
**AOP-39**

WHAT IS IMPORTANT?

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# EVIDENCE

1. FRAGMENTS; SHAPE, SIZE AND DISTRIBUTION
2. WITNESS PLATES; PERFORATION, PLASTIC DEFORMATION
3. ENERGETIC MATERIAL; BURNED OR UNBURNED, DISTRIBUTION
4. PROJECTION DISTANCE
5. AIR BLAST PRESSURES



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# REQUIREMENTS

NO RESPONSE MORE SEVERE THAN...

FAST HEATING (FAST COOK-OFF)

SLOW HEATING (SLOW COOK-OFF)

FRAGMENT IMPACT

BULLET IMPACT

SYMPATHETIC REACTION

SHAPED CHARGE JET

TYPE V (BURNING)

TYPE III (EXPLOSION)

**AOP-39**

OR

**THA**

(THREAT HAZARD ASSESSMENT)

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# IM SIGNATURE

Colour Coding	IM Compliance	
Green	IM requirement fulfilled.	Pass (P)
Yellow	IM requirement not fulfilled. One response level difference between the assessed response level and the IM requirement.	Fail (F)
Red	IM requirement not fulfilled. Two and plus response levels difference between the assessed response level and the IM requirement.	
White	Not Assessed (N/A)	Not assessed

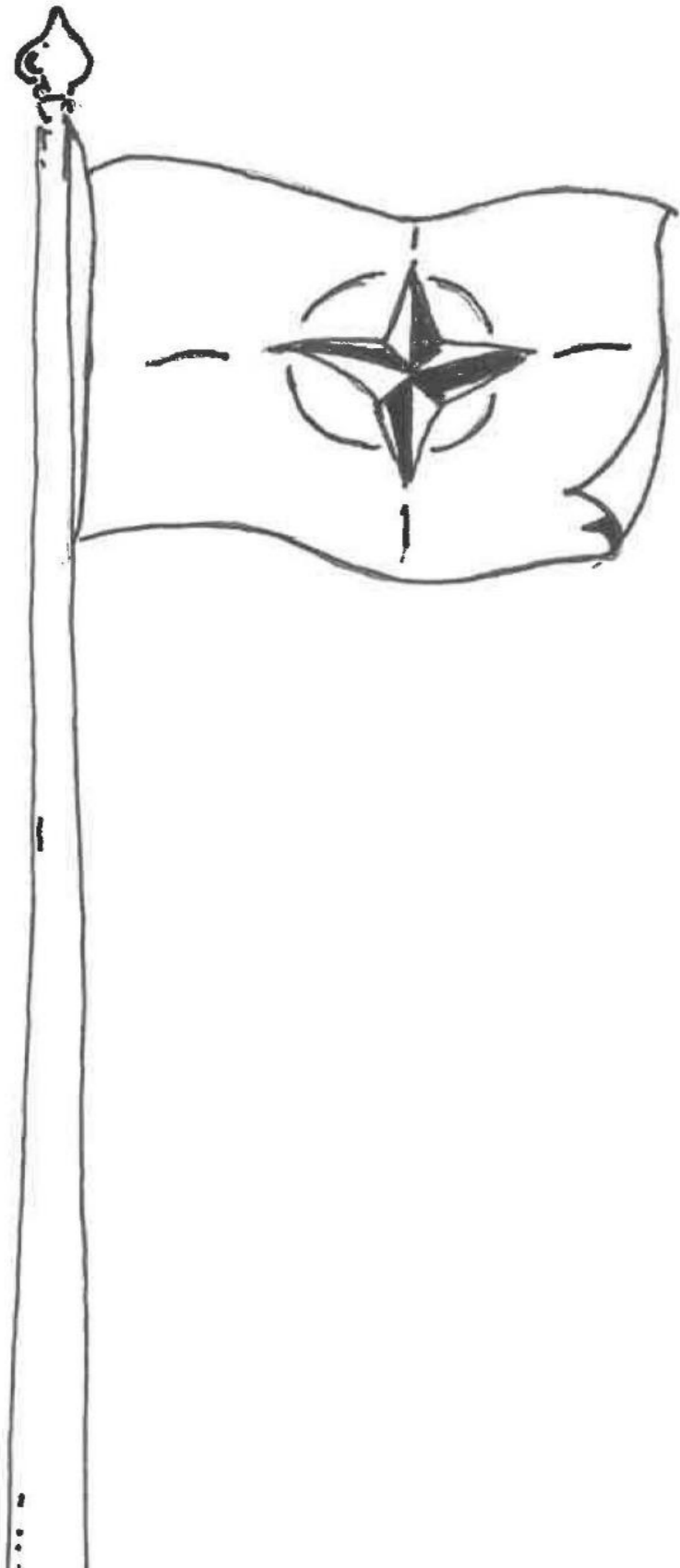
		FCO	SCO	BI	FI	SR	SCJ
Configuration 1		V	V	NR	IV	N/A	III
Configuration 2		III	IV	IV	N/A	N/A	I
Configuration 3	Warhead	(I)	N/A	NR	V Main Charge III Booster	III	I
	Propulsion Unit	IV	V	V .50 AP IV 7.62 Ball	N/A	N/A	III
	All-Up Round	(I)	V	IV	III	III	I

( ) - Analysis

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# WHAT INSENSITIVE MUNITIONS ARE:



“A MUNITION THAT RELIABLY FULFILLS ITS PERFORMANCE, READINESS AND OPERATIONAL REQUIREMENTS ON DEMAND AND THAT MINIMIZES THE PROBABILITY OF INADVERTENT INITIATION AND SEVERITY OF SUBSEQUENT COLLATERAL DAMAGE TO WEAPON PLATFORMS, LOGISTIC SYSTEMS AND PERSONNEL WHEN SUBJECTED TO SPECIFIED ACCIDENTAL AND COMBAT THREATS.”

*NATO Term*

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**BUT WHO CAN CARRY OUT THE TESTS?**

**AND MAKE THE ASSESSMENTS OF THE RESULTS?**

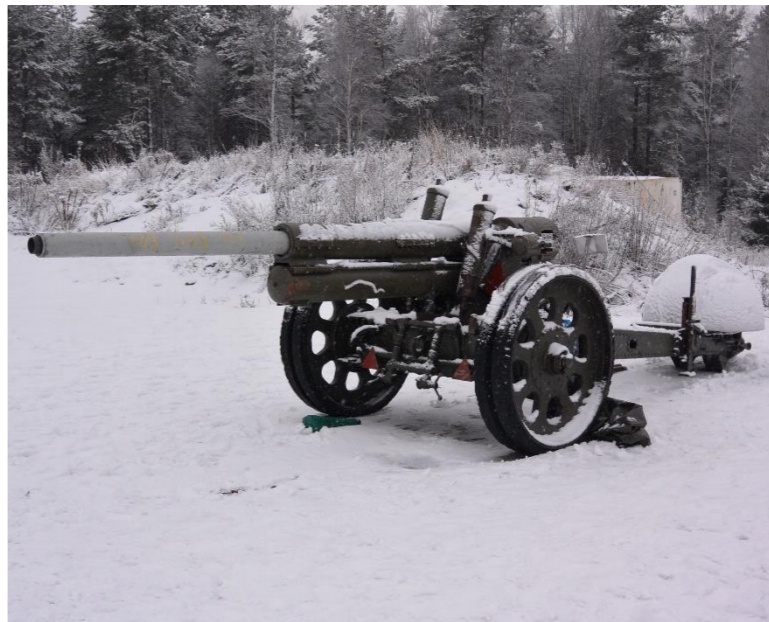
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**WE CAN.**

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# BOFORS TEST CENTER'S COMPLETE IM-TEST PROGRAM



FAST COOK-OFF

SHAPED  
CHARGE JET

SYMPATHETIC  
REACTION

FRAGMENT IMPACT

SLOW COOK-OFF

BULLET IMPACT

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# FROM PLANNING TO REPORT

TEST PLANNING; WHAT TESTS SHALL BE CONDUCTED AND HOW SHALL THEY BE CONDUCTED

TEST PLANS

CONDUCT THE TESTS; IN ACCORDANCE WITH AOP OR TAILOR MADE

RESULT ASSESSMENT

TEST REPORTS

PRESENT THE IM SIGNATURE

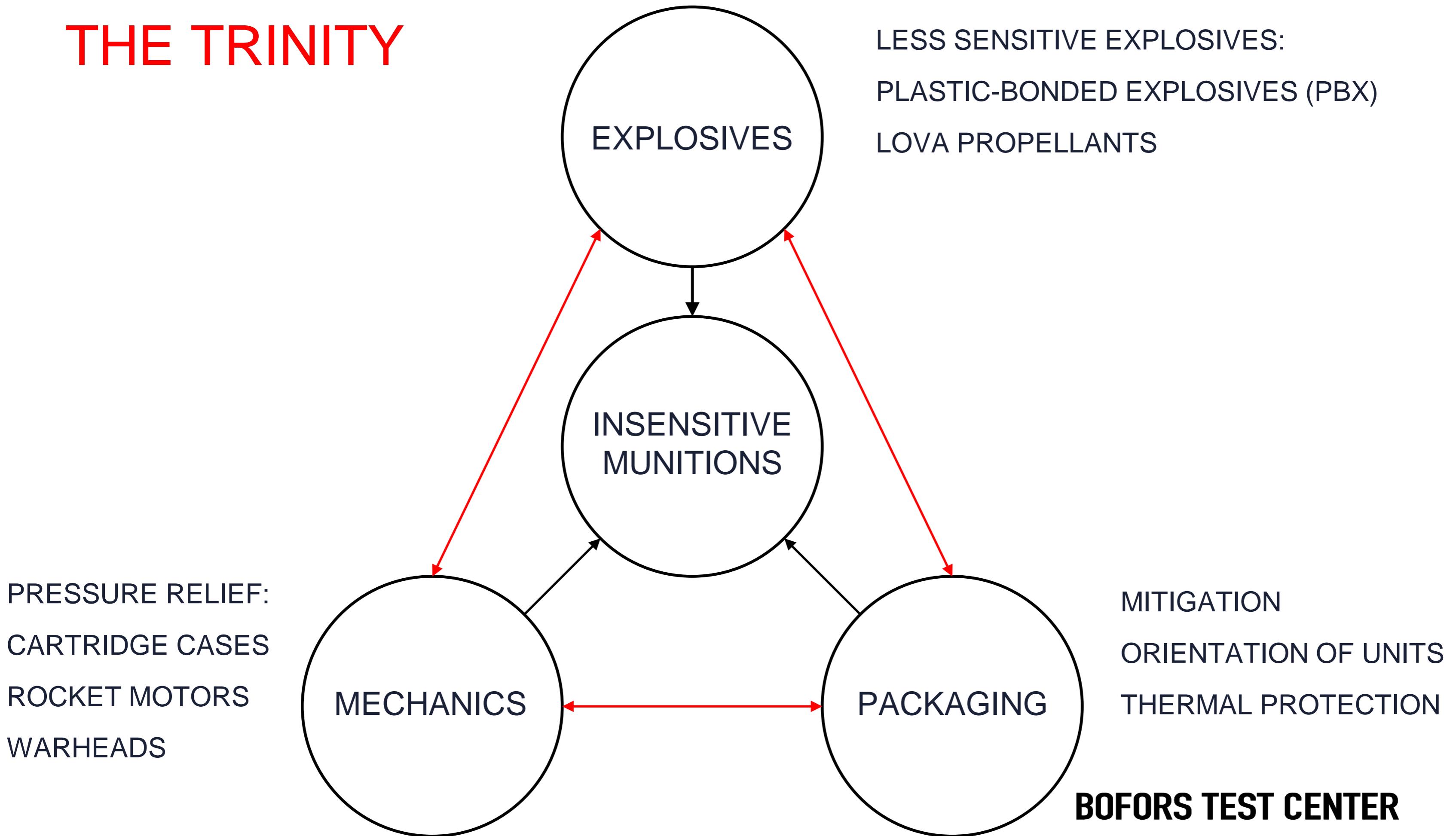
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# HOW TO DESIGN INSENSITIVE MUNITIONS?



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# THE TRINITY



# ARE INSENSITIVE MUNITIONS WORTH THE EXTRA COSTS AND EFFORTS?



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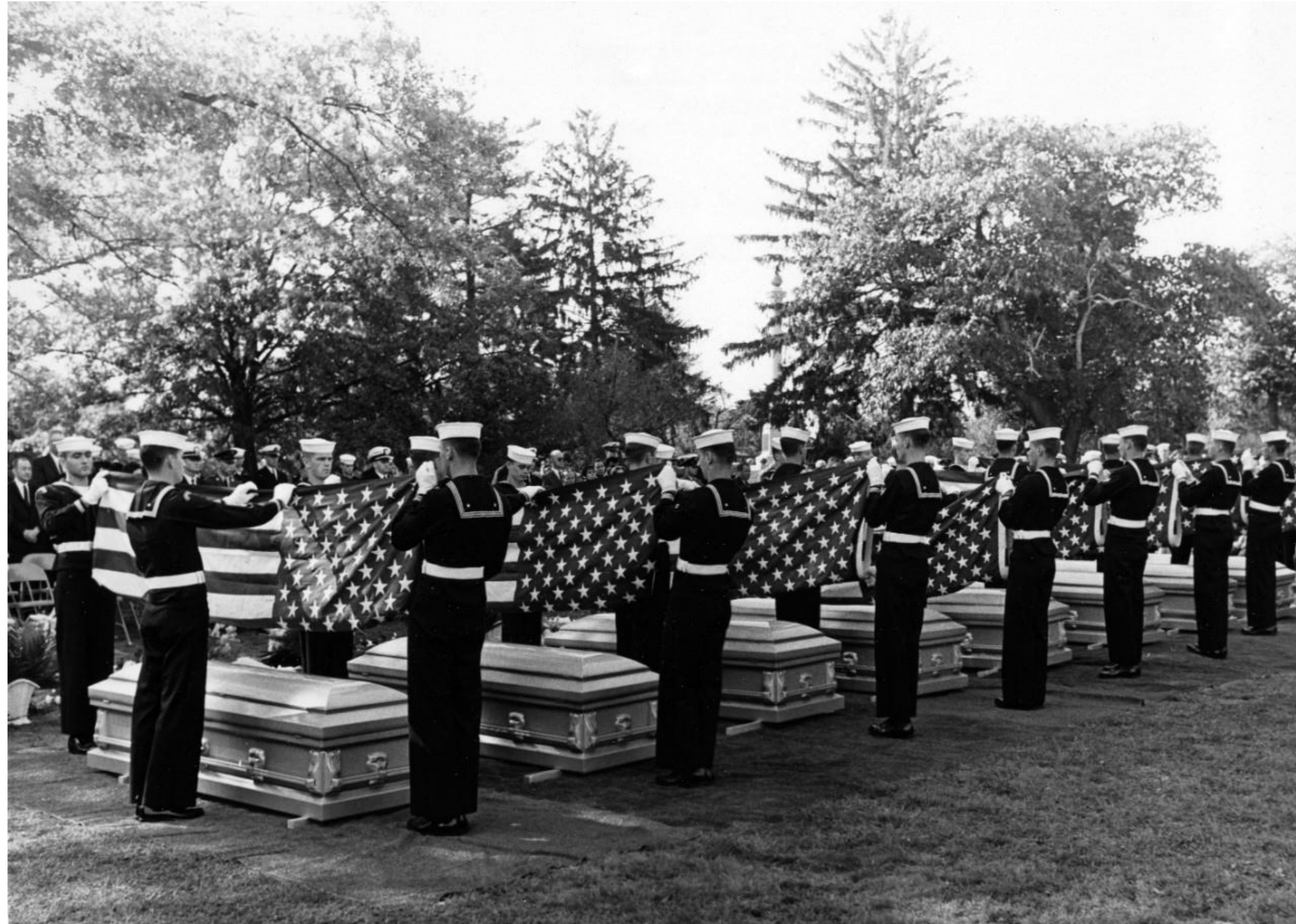




**YOU  
BET THEY ARE!**

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OR IS THIS AN ACCEPTABLE ALTERNATIVE?



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# QUESTIONS?



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**WELCOME  
TO HELL**

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