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Bringing into Focus the Relationship
between Underwater Munitions and Their
Environment

Croatia Mine Action Symposium, April 11, 2024

<http://jmu.edu/cisr>

Project Background

- Began work in 2022 on a report to better understand factors involved in aging of munitions under water and practical implications for detection, classification, and remediation, as well as risk management and resource allocation.
- Set out to observe and characterize the visual and structural changes that occur to munitions as a result of aging in an underwater environment.
- Building on existing evidence, previous land-based studies on munitions aging
- Performers:
 - Center for International Stabilization and Recovery (CISR) at James Madison University (JMU)
 - Explosives experts from Fenix Insight Ltd.
 - JMU faculty with scientific backgrounds in chemistry, physics, geology, biology, and environmental and materials sciences
- Sponsored by the US Department of Defense's Strategic Environmental Research and Development Program



FENIX
INSIGHT



JAMES MADISON UNIVERSITY.

Problem

Little formal knowledge exists on:

- Visual and structural changes to munitions as a result of aging in an underwater environment
- Details on what factors lead to those effects

Assessing residual risk of interacting with underwater munitions requires understanding physical changes they experience and what causes them

Has important implications for prioritization, identification, detection, disposal, safety, and cost efficiency

Assumptions often treat these munitions as more unstable than other UXO, but we are hoping to provide evidence-based information in this area.



Photo courtesy of DOD Environment, Safety & Occupational Health Network and Information Exchange (DENIX)

Considerations

Our work focused on 4 main areas:

- Predisposition to aging
- Factors involved in aging
- Changes due to aging
- Creation of new hazards



Predisposition to Aging

Influences include inherent characteristics:

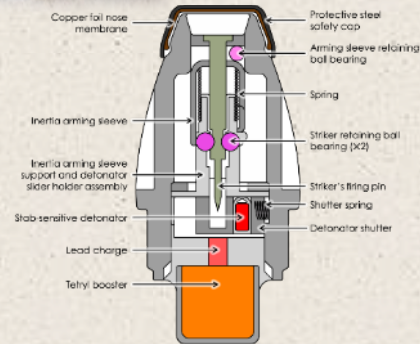
- **Materials**
- **Design**

If the ages and types of munitions are known, these features can be fairly easily identified

Other effects based on their handling prior to exposure to water:

- **Pre-deployment (storage and maintenance)**
- **Deployment (manner, damage sustained)**

This information would be useful, but is largely unknowable for any given munition encountered in an underwater setting



Factors Involved in Aging

Many are well-documented already in regards to munition aging:

- Water
- Rusting
- Soil
- Mobility
- Sunlight

One notable phenomenon unique to underwater settings is concretion



Changes due to Aging

- Warhead casing
 - Predictable corrosion/concretion of ferrous metals and aluminum
 - Copper and brass often remain well-preserved
 - Breached casings release explosive fillings
- Fuzing mechanism
 - Initiation systems are prone to multiple failure mechanisms; therefore unlikely to function as designed
 - Potential for alternative initiation systems to form through chemical reaction or physical change
- Explosive train
 - Failure of a single key component usually prevents munition from functioning as designed
- Energetic materials
 - Secondary HE: Stable; predictable
 - Primary HE: Unstable; uncertain



Creation of new hazards

- **Physical hazards** include failure of casings, components, and other safety-critical elements.
- **Chemical hazards** relate primarily to either the energetic compositions or degradation of batteries.
- **Environmental hazards** primarily involve the leakage of energetic materials, with a smaller concern of leaking corrosion products.



Conclusions

Our report highlights conclusions in a few categories

Things we know:

- Limited information/Problematic research
- Trend toward failure
- AXO and UXO



Conclusions

Our report highlights conclusions in a few categories

Areas with some knowledge but that need to be further explored:

- Non-functional does not equal safe
- External impetus
- Exposure to air



Conclusions

Our report highlights conclusions in a few categories

Where there is much unknown:

- Predictability
- Unintended mechanisms
- Climate change



Recommendations/Next Steps

With relatively little awareness or understanding surrounding the effects of aging on ammunition underwater, further information gathering and study is warranted.

Recommendations include:

- Communication of issues to key stakeholders
- Coordination and cooperation on these issues
- Systematic collection of further data by those encountering underwater ordnance
- Investigation of accidents and incidents involving underwater munitions
- Further targeted research, including detection trials using aging inert ammunition





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