

**NJS Presents*****Museums, Archives, Artifacts, and Documents*****In This Issue:*****The 1926 Lake Denmark Explosion:******An Extraordinary Mishap That Changed Military Safety Standards*****By Rachael Winston****DOI: <https://doi.org/10.14713/njs.v7i1.230>**

*Prior to 1926, the American Table of Distances did not adequately take into consideration the potential for munition storage facilities to exceed capacities. This study aims to provide an overview of the construction and use of munition storage facilities and examine how the American Table of Distances would dramatically change due to the 1926 explosion at the Lake Denmark Naval Ammunitions Depot. The historical literature examining the correlation between the American Table of Distances and storage capacities is limited, and independent inquiries by the United States Government and first-person accounts of the explosion exist. However, these sources had not been collectively assembled into a study to provide historical context. From this research, it can be determined that it was only a matter of “when” would a disaster strike, as storage facilities up and down the eastern seaboard were experiencing exceeded capacities. This disaster, while unnecessary, provided an opportunity for the Army to respond, make changes, and ultimately allow the government to update outdated safety standards. Additionally, this study serves the dual purpose of highlighting the newly established Navy Hill Historic District associated with the unfortunate disaster and its important legacy.*

The United States had seen great military advancements in warfare due to the rapid advancement in weaponry at the end of the Civil War through the swift expansion of industrialization. Further advancement in weaponry would be brought about due to the

technologies developed during World War I. It is with these advancements in technology meant to protect soldiers on the battlefield that the innovation and extensive use of high explosives and long-range ordnances were implemented. However, these new types of munitions would pose a greater risk than previous weaponry when stored. At the end of WWI, installations across the country would experience an influx of unused munitions brought home, which posed a logistical storage nightmare. Army and Navy representatives sought a solution to these excess munitions. It was determined that one possible answer to this problem was located in a small northern New Jersey town.

Picatinny Arsenal, located in Rockaway Township, was established in 1880 by the Department of the Army as the Dover Powder Depot. This name changed to Piccatinny Powder Depot [stet] only four days later to avoid confusion with a medicinal drug called Dover's Powder.<sup>1</sup> The establishment of the Depot encompassed approximately 1,866.12 acres at that time and cost the government roughly \$62,750 or about \$34 per acre.<sup>2</sup> But in 1891, Department of the Army would transfer 315 acres of the Piccatinny property to the Navy to establish the Lake Denmark Naval Ammunitions Depot (Lake Denmark NAD).<sup>3</sup> This transfer of land enacted by Congress in April of 1890 enabled the Navy to establish greatly needed storage magazines; but this construction would be just the start of the Navy developing and maintaining munition storage facilities at Lake Denmark. By 1902, approximately 78 more acres were purchased and transferred to the Navy for these purposes.<sup>4</sup>

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<sup>1</sup> The name Piccatinny originates from the Lenni Lenape language and translates to rugged cliff by water or water by the hills, depending on the source and interpretation. Today Picatinny Peak (known as such before the Army arrived), overlooks Picatinny Lake (formerly known as Clifford Pond). It is also worth noting the spelling of "Piccatinny" would change, dropping the second C, in 1907 when the installation officially became Picatinny Arsenal.

<sup>2</sup> Today the installation is approximately 5,853 acres.

<sup>3</sup> Patrick J. Owens, *Picatinny: The First Century* (U.S. Army Armament Research, Development, and Engineering Center and Picatinny Public Affairs Office, 2015), 20.

<sup>4</sup> Jason Huggan/United States Department of the Army, *Cultural Landscape Analysis of the Former Lake Denmark Naval Ammunition Depot* (Picatinny Arsenal, Rockaway Township, New Jersey, 2015), 7.



tiered system of ammunition storage. This system included short-term ammunition storage at naval stations in major ports to off-load ammunition from naval ships, longer term storage depots near the ports where munitions were both assembled and stored, and finally depots in the third tier stored bulk ammunition and already assembled munitions.<sup>6</sup> The Navy developed this system of ammunition storage depots to support the large naval stations at the major ports including Boston, Massachusetts, Philadelphia, Pennsylvania, and Norfolk, Virginia. The Lake Denmark NAD was an example of the third type, serving as a long-term ammunition storage depot and was established to support the naval station located in New York City.

Overall by 1911, fifty-nine buildings and structures worth a total value of over \$4.8 million existed at Lake Denmark NAD. Building types included seven brick above-ground magazines, two brick fixed-ammunition houses, two cement on metal lathe high explosives houses, one brick high explosives house, two brick shell-houses, and two brick storehouses. The magazine areas also contained thirteen brick hydrant houses and four wood-framed hydrant houses. Additionally, the depot contained a brick administration building, a brick power house, machine shop, and a brick locomotive house as well as seven residence houses. These included three duplexes and four single quarters which housed Navy staff assigned to the post, including a stone Commanding Officer's House and stone stable, both which are still standing today.<sup>7</sup>

### **Post World War I, 1918-1926**

It was during WWI that the Lake Denmark NAD expanded by constructing additional above-ground ammunition storage buildings. With this expansion, the government acquired the Doland Land Tract, totaling approximately 67 acres in 1918. Throughout this time period, the

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<sup>6</sup> Kathryn M. Kuranda, Katherine Grandine, and Deborah Cannan, *Support and Utility Structures and Facilities (1917-1946): Overview, Inventory, and Treatment Plan*. Prepared for the Department of the Navy, Atlantic Division, by R. Christopher Goodwin & Associates. (Fredrick, Maryland., 1995), 82.

<sup>7</sup> Huggan, *Cultural Landscape Analysis*, 8.

Navy constructed many ammunition storage buildings and subsurface magazines, in addition to many miles of railroad track to serve as increased infrastructure and accessibility to the depot. After WWI, this recently built infrastructure was imperative, depots across the country were busy receiving and storing unused munitions for long-term storage, and Lake Denmark NAD was no different. The overstocks of ammunition exceeded storage capacity at many Army and Naval ammunition depots following the war. It was this exceeded storage that set the conditions for the event that would transform ammunition storage in the 20<sup>th</sup> century, the 1926 explosion at the Lake Denmark NAD.

Many temporary ammunition storage buildings were constructed as a long, one-story above-ground structures made from hollow clay tiles that were used to store powder, shells, or fixed-ammunition. These buildings were moderately standard with the height of the building approximately 14 feet from ground level to their roof, which was steel-truss clad with asbestos shingles. Buildings had 10-foot bays, varied in length up to 250 feet long, and were located along railroad tracks for easy loading and unloading on to concrete platforms, each were surrounded by lightning protection poles with appropriate fire protection services nearby.<sup>8</sup>

Additionally, other types of ammunitions storage were constructed. Subsurface concrete boxes were built storing black powder and other hazardous materials. These buildings measured 15-by-20 feet, had puddingstone wing-walls, metal doors, concrete roofs designed to contain explosion, and were built into the side of the hills.<sup>9</sup>

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<sup>8</sup> Kuranda, Grandine, and Cannan, *Support and Utility Structures and Facilities*, 87-88.

<sup>9</sup> *Ibid.*, 89.

Finally, long warehouse buildings referred to as “Austin Buildings” were constructed as storehouses with “concrete foundations, 9in. hollow clay tile walls with plasters under the trusses, steel trusses or girders, steel rafters sheathed with roof boards and paper roofing.”<sup>10</sup> According to the Austin Co. website, the company was started in Cleveland, Ohio in 1878 by Samuel Austin. By 1904, Samuel’s son, Wilbert J. Austin, joined his father’s company and conceived the then heretical idea of combining engineering and construction in one firm to offer a complete facility service. This concept, which became known as The Austin Method®, broadened the traditional approach to construction by offering contracts that started with architecture and engineering, and ended with the finished building.<sup>11</sup>



*Storehouse No 3, from the collection of the National Archives at New York City.*

### **The 1926 Explosion**

After WWI, the Lake Denmark NAD had a surplus of munitions inadequately stored throughout its installation. Enormous quantities of ammunition destined for France piled up on the Atlantic seaboard and were eventually diverted to the nearest depot. This led to what ultimately

<sup>10</sup> Dr. Patrick Owens, email message to Jason Huggan, February 2013.

<sup>11</sup> “Honoring Our Past, Growing into the Future: From Humble Beginnings”, Austin Past and Present, The Austin Co., accessed November 18, 2020, <http://theaustin.com/austin-company-history>.

occurred on Saturday, July 10, 1926 at approximately 5:15pm. A major explosion occurred at Lake Denmark NAD from a lightning strike at Temporary Magazine Number 8 causing a fire in the above-ground magazine, and resulting in an explosion that would lead to a series of explosions and additional fires in other nearby and adjacent magazines.<sup>12</sup>



*Construction of Temporary Magazine Number 8 during 1917, from the collection of the National Archives at New York City.*

Temporary Magazine Number 8 was a typical, aboveground, 150-by-200-foot clay tile, storage structure overloaded with leftover ordnance. After about ten minutes from the first report of a fire, only a crater remained where the magazine once stood. Missiles could be found up to a mile away, while fifteen miles away in Pompton Lakes embers and ash were reported by

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<sup>12</sup> Joseph Murphey, et al, U.S. Army Corp of Engineers Fort Worth Dallas and Geo-Marine Inc., Special Publications Number 7, *Army Ammunition and Explosive Storage in the United States: 1775-1945* (Fort Worth, Texas, July 2000), 23.

townspeople.<sup>13</sup> It was also reported that the first blast was so powerful that it had stopped the tower clock at the First Methodist Episcopal Church in Rockaway Borough, as well as shook the ground and shattered glass in the central business district.<sup>14</sup> As a result of the initial explosion, two more major explosions detonated in the adjacent Magazine Number 9, and forty-five minutes later at Shell House Number 22.



**A large crater where Temporary Magazine 8 once stood, from the collection of U.S. Army Combat Capabilities Development Command (DEVCOM) Armaments Center Historian Jeff Ranu.**

The direct effect of the blasts caused the complete and total annihilation of structures within a radius of 2,700 feet and damaged buildings up to 8,700 feet away. Nineteen people died, mostly Marines, while fighting the various fires. Over 50 more were injured from the blasts. The damage

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<sup>13</sup> A. W. Tissell, *Observations at Picatinny Arsenal and Lake Denmark Naval Depot* (Lake Denmark, New Jersey, July 10, 1926), 1-5 and 8.

<sup>14</sup> Owens, *Picatinny: The First Century*, 117.

to munitions and other stores exceeded \$40,000,000.<sup>15</sup> These intense explosions and fires also devastated the adjoining Picatinny Arsenal and caused major damage to most of the buildings.<sup>16</sup> While Picatinny Arsenal did have ammunition stores buildings, the bulk of the damage came from the three large explosions due to items stored at Lake Denmark NAD detonating.



**Flyover of Lake Denmark after the explosion, from the collection of DEVCOM Armaments Center Historian Jeff Ranu.**

At the time of the explosion, CPT Otto Dowling was the Commanding Officer for Lake Denmark NAD while MAJ Norman F. Ramsey was Commanding Officer of Picatinny Arsenal. However, it was under MAJ Ramsey's authority that investigations into the disaster were performed by a board of inquiries ordered by the Secretary of the Navy and separately for Picatinny

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<sup>15</sup> Murphey, *Army Ammunition and Explosion Storage*, 22.

<sup>16</sup> J.J. Manning, et al/Department of the Navy: Bureau of Yards and Docks, *Building the Navy's Bases in World War II: History of the Bureau of Yards and Docks and the Civil Engineer Corp 1940-1946* (U.S. Government Printing Office, Washington D.C., 1947), 32.

Arsenal by the Army. These investigations revealed that the storage of WWI ammunition in the magazines surpassed reasonable storage limits.

### **The Aftermath: Investigation, Rebuilding, and Remembering**

Both Picatinny Arsenal and the Lake Denmark NAD required extensive rebuilding following the 1926 explosion. The direct aftermath of the explosion resulted in a board of inquiry that conducted a thorough review of previously existing conditions that caused the disaster, an examination of adverse effects of the disaster on other installations, and the development and implementation of safety regulations to avoid and to contain future accidents at both Army and Navy ammunition depots.

Reports submitted to the Army by A.W. Tissell determined that numerous hydrant houses were placed throughout the storage areas and lightning protection poles were installed around magazines. The installation was supported by a complement of support buildings such as quarters, stables and chicken houses, along with a Marine Corps barracks. Administration buildings included office buildings, a medical dispensary, as well as shops. Finally, utility structures included a powerhouse, a Marine Corps incinerator, pump-houses, a reservoir, and a standpipe.

The study determined that overall, the explosions, aftershocks, and fires meant that substantial changes in ammunition depot storage practices after the 1926 explosion needed to take place. Safety measures were adopted for ammunition depots with increased distances between types of magazines, installation of grounded lightning masts around above-ground high explosives buildings, increased fire protection, and the adoption of the earth-covered, arched, concrete igloo.<sup>17</sup>

A determination was made during the investigation that American Table of Distances did not take into account storage of munitions greater than 500,000 pounds. It was concluded the initial

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<sup>17</sup> Kuranda, Grandine, and Cannan, *Support and Utility Structures and Facilities*, 83.

explosion at Lake Denmark NAD was due to an excess of 1,600,000 pounds of TNT stored in a single building.<sup>18</sup> Investigators also discovered that a new set of standards would be best suited which resulted in magazines and shell-houses being widely dispersed throughout the southwestern section of the installation and accessed by an internal rail system.

The biggest change came in the form of a new design for naval ammunition depots going forward by increasing the distances between magazines and the developing of the arched earth-covered ammunition storage bunker. The new safety requirements would essentially make older depots obsolete for high-capacity, long-term ammunition storage. In comparison, today's American Table of Distances has greater limits on storage of highly explosive material. The table's specifically outlined instructions state that,

when two or more storage magazines are located on the same property, each magazine must comply with the minimum distances specified from inhabited buildings, railways, and highways, and, in addition, they should be separated from each other by not less than the distances shown for "Separation of Magazines," except that the quantity of explosives contained in cap magazines shall govern in regard to the spacing of said cap magazines from magazines containing other explosives. If any two or more magazines are separated from each other by less than the specified "Separation of Magazines" distances, then such two or more magazines, as a group, must be considered as one magazine.<sup>19</sup>

The table clearly states magazines can no longer exceed 300,000 pounds of explosive material in any storage facility and any inhabited building must be a minimum of 2,275 feet away regardless if the storage structure is barricaded or unbarricaded.<sup>20</sup>

Following the investigation, the War Department Appropriations Act approved by Congress for the fiscal year of 1928, approved February 23, 1927, allowed the Treasury to

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<sup>18</sup> Tissell, *Observations at Picatinny Arsenal and Lake Denmark Naval Depot*, 38.

<sup>19</sup> "Table of Distances", Tools and Services for Explosives Industry, Bureau of Tobacco, Alcohol, Firearms, and Explosives, accessed November 18, 2020, <https://www.atf.gov/explosives/table-distances>.

<sup>20</sup> "555.518 Table of Distances for storage of explosive materials (high)," Tools and Services for Explosives Industry, Bureau of Tobacco, Alcohol, Firearms, and Explosives, accessed November 18, 2020, <https://www.atf.gov/explosives/555218-table-distances-storage-explosive-materials-high>.

appropriate funds for the expenditure of removing projectiles from Lake Denmark to Picatinny Arsenal at a cost of \$37,000.<sup>21</sup> Within that same act, with a second approval on March 3, 1927, Picatinny was granted the necessary expenditure for construction to repair and rebuild as well as install machinery and equipment and purchase 350 acres of land at a cost of \$2,300,000 in the vicinity of the arsenal, likely for clean-up.<sup>22</sup>

Even after the investigation, Lake Denmark NAD would still hold value as a storage depot due to the convenience of its direct access to the port of New York City (although the Navy did look for other large tracts of land inland areas such as Hawthorne, Nevada; McAlester, Oklahoma; Crane, Indiana; and Hastings, Nebraska since it was difficult to find the acreage to physically expand the installation's boundaries to meet this storage criteria). However, Lake Denmark NAD did proceed with substantial construction by 1932, resulting in the completion of five additional smokeless powder magazines, two high explosives magazines, four shell-houses, and the rebuilding of twenty-eight storehouses.

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<sup>21</sup> U.S. Congress. *Congressional Record: Congressional Appropriations, Ordnance Department*, 1927. Seventieth Congress Sess. I. Chap. 5, 36.

<sup>22</sup> U.S. Congress. *Congressional Record: Act the Rehabilitate Picatinny Arsenal*, 1927. Sixty-Ninth Congress. Sess. II. Vol. 44 Chap. 368, 1397.

It was also during the rebuilding process that a monument was placed at Lake Denmark NAD's Marine Barracks, to honor the Marines that died fighting the fires of the 1926 explosion. Today, the monument is located near the former Marine barracks and is a stark reminder of the events that happened that fateful day.



**1926 Explosion Monument (obelisk in upper right) honoring the sacrifices of the Marines who gave their lives fighting the fires from the explosions, from the collection of DEVCOM Armaments Center Historian Jeff Ranu**

Lake Denmark would continue to see further construction of buildings during WWII, which included a heavy ordnance storehouse completed in 1942, additional storage buildings, and a new naval personnel barracks. The construction of the barracks marked a nationwide change in

the Navy's staffing at ammunition depots as what had primarily been a civilian staff (at the depot) supervised by a few officers was augmented by naval enlisted personnel during the war.<sup>23</sup>



*Aerial View of Navy Hill circa 1940s, from the collection of  
DEVCOM Armaments Center Historian Jeff Ranu.*

After WWII and with the onset of the Cold War and nuclear arms race, the Navy began supporting the research and development of liquid rocket motors at the Lake Denmark NAD, officially changing their name to the U.S. Naval Aeronautical Rocket Laboratory (NARL) in 1942 and then again in 1946 to the U.S. Naval Air Rocket Test Station (NARTS). With these name changes also meant the transfer of approximately 191 acres for the construction of rocket testing facilities.<sup>24</sup> The Navy saw great success with the program. They would lease land and its use of

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<sup>23</sup> Bureau of Yards and Docks, 331-332, 335.

<sup>24</sup> Huggan, *Cultural Landscape Analysis*, 38.

the buildings to companies like Reaction Motors who were responsible for creating and developing some of the most advanced rocket motors of the time for rockets like the X-15, Bell XS-1, and many more. But by 1960, the Navy would close all projects and transfer the land back to Picatinny Arsenal where continued research and development would take place under a separate Army based solid rocket motor testing program that began in approximately 1946.<sup>25</sup>

Today, Lake Denmark NAD, most commonly referred to as Navy Hill by employees and tenants, remains a part of Picatinny Arsenal. Most recently, Lake Denmark NAD was evaluated during a Cultural Landscape Analysis survey. It was determined that because of the continued Navy presence, past and present use of the buildings, as well as building architecture, Lake Denmark NAD is historically significant. In December 2015, a Historic District designation from the New Jersey State Historic Preservation Office was granted forming the Navy Hill Historic District. It was also determined that roughly 36 buildings within the Lake Denmark NAD survived the explosion and are still actively used today. The buildings of Lake Denmark NAD and its history provide a reminder of what took place that Saturday in July, cementing its mark on installation history and changing munitions storage standards forever across the military.

#### *About Picatinny Arsenal*

*Picatinny Arsenal remains today an active military installation serving as the Joint Center of Excellence for Guns and Ammunition, providing products and services to all branches of the U.S. military. Nestled in the northern New Jersey Highlands, our team of more than 6,000 personnel includes Soldiers, Sailors, Airmen, Marines, U.S. Federal employees and contractor personnel who lead in the research, development, acquisition and lifecycle management of*

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<sup>25</sup> "Role of NARTS," NARTS Test Area D & E, Exploring Picatinny's History in Buildings and Landscapes, accessed November 25, 2020, <https://www.pica.army.mil/ead/Cultural/PicatinnyHistoricDistricts/NARTS/index.html>.

*advanced conventional weapon systems and ammunition. Picatinny's portfolio comprises nearly 90 percent of the Army's lethality and all conventional ammunition for joint warfighters.<sup>26</sup> Picatinny Arsenal is located about 35 miles west of New York City and has approximately 600 plus permanent structures across the installation. For more information about Picatinny Arsenal and its diverse military history, check out "Exploring Picatinny's History in Buildings and Landscapes," <https://www.pica.army.mil/ead/Cultural/PicatinnyHistoricDistricts/index.html>.*

*Rachael Winston serves as Cultural Resources Manager for USAG Picatinny Arsenal, following best practice guidelines set forth by the Secretary of the Interior and Department of the Army for the preservation and rehabilitation of historic structures and archaeological sites across the installation. Prior to joining Picatinny's Directorate of Public Works: Environmental Affairs Division in 2020, she worked as a museum professional for several years in two New Jersey museums; Liberty Hall Museum at Kean University in Union as a Museum Educator and the Thomas Edison Center at Menlo Park in Edison as a Museum Curator and Educator. She also serves as a museum consultant for the Slate Belt Heritage Center in Bangor, Pennsylvania. Rachael holds a B.A. degree in History from East Stroudsburg University of Pennsylvania and a M.A degree in Applied History from Shippensburg University of Pennsylvania.*

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<sup>26</sup> "About Picatinny", Picatinny Arsenal, accessed November 25, 2020, <https://www.pica.army.mil/Picatinny/about/default.aspx>.