The Livens Projector

—multiple launch concept in WWI

By CPT Mark D. Arvidson

The Multiple Launch Rocket System (MLRS) is a devastating weapon and its capabilities have added a new dimension to the Field Artillery, but the multiple launch idea is not new. Driven by necessity, the British developed a practical multiple launch system during World War I. Simple ingenuity expanded the multiple launch concept to a mobile system in the closing days of the war.

The Chemical War of 1914-1915

World War I was not the quick, offensive war that either side envisioned in 1914. The war rapidly settled into immobile trench warfare that threatened to bankrupt the economy of Europe. Both sides sought a strategic or tactical solution to restore open warfare and bring a quick end to the war. The Germans decided to use their massive chemical industry to their advantage. They filled standard high explosive (HE) shells with a small explosive charge and a tear agent, producing the first modern chemical delivery system. The Germans fired thousands of HE/tear agent shells on both the Eastern and Western Fronts through early 1915. However, the shells did not have a significant effect on their opponents due to the unfavorable weather. In many instances, the affected soldiers did not realize they had been gassed.

The inconclusive results disappointed the German planners, but many still felt the use of chemicals would be decisive. Seeking a more potent casualty agent, the Germans turned to chlorine, a lethal industrial gas common to the dye industry. They used the cylinder as the delivery means and let the wind carry the agent to the target.

The first cloud gas attack occurred at Ypres in April 1915. Chlorine released from 6,000 cylinders killed hundreds of French soldiers and disabled hundreds more. The Germans viewed the attack as an experiment and did not have sufficient troops to exploit the breach. They expected the chlorine to disable the French and make resistance difficult, but they did not expect it to kill so effectively. Despite the apparent success, the chlorine attack failed to re-establish open warfare. Successive cylinder attacks in the next few days did not gain the Germans any additional ground. Several months later, the allies each responded with cloud gas attacks of their own and the Germans lost the advantage.

Cylinder Limitations

A cloud gas attack delivered a high volume of poison gas but it had distinct limitations. First, the cloud relied on favorable wind direction and speed. Second, the intended target could frequently detect the cloud before it reached them. Third, both sides used infantry work details to carry the 180-pound cylinders from the rear and emplace them in the front line trenches. Infantry on both sides detested gas detail. Finally, the cylinders delivered only dense poison gases that hugged the ground, such chlorine or phosgene. The cylinder was incapable of delivering liquid agents and gases that were less dense which dissipated before reaching the target.

Another development that interfered with the effectiveness of chlorine from cylinders was the respirator; it offered uncomfortable, but adequate defense if put on before the cloud arrived.

The Germans and French elected to abandon the cylinder. They each returned to artillery as the primary chemical delivery means, depending on its speed and shock effect. The British, however, suffered a shortage of artillery shells and could not afford to divert production of HE. Continuing to rely heavily on the cylinder, they initiated a cottage industry for chemical weapons that had implications beyond the First World War.

Z Company

Early in 1916, the British formed a special chemical weapons company from several chemical weapons sections, designated as Z Company. The commander of Z Company was Captain William Livens, a Royal Engineer and an able inventor. Ambitious but reckless, he once tested a production gas mask against hydrogen sulfide, a highly toxic gas, and promptly collapsed while standing in the cloud. His comrades had to drag his unconscious body to safety.

Z Company first modified a series of trench flame throwers known as *flammenwerfer*. The flame throwers fired a burning stream of flammable oil ejected by non-flammable compressed gas. Both the small, portable model and the larger fixed device were short-range weapons. They were also unwieldy, unreliable, and dangerous to operate. On several occasions they failed, allowing several tons of highly flammable liquid to escape into the trenches. The

British abandoned the *flammenwerfer* after firing only a dozen shots.

The Somme Strange Gun

Despite the setback of the *flammenwerfer*, Livens and the men of Z Company continued to experiment with weapons that would deliver a flammable charge. His crew tried a series of homemade trench mortars that fired an oil drum packed with oil-soaked waste. The first projector consisted of an empty five-gallon oil drum from a scrap pile. The projectile was a two-gallon oil can wrapped in oil-soaked wadding.

A wooden block separated the two-gallon can from the firing charge. A simple cloth fuse, also soaked in oil, lit the can as it shot from the drum. When fired, the lit drum and wooden block tumbled end over end for 300 yards and crashed in a ball of flame. More humorous than effective, the soldiers called it the Somme Strange Gun after one of Livens' inventive crew, Lieutenant Harry Strange.

Intrigued and now deadly serious, Livens and his crew experimented with a number of rounds, including a gas cylinder full of chlorine. The projector found a niche in chemical warfare. It shot the cylinder about as far as the oil can. Rather than open the valve on a cylinder and let the wind carry the poison gas to the target, the gas cylinder was dropped on the enemy. Though short range, the projectile carried about 15 times as much agent as a French 75mm or German 77mm gas shell.

At first, gas cylinder proponents did not accept the projector, but could not overlook its advantages. Z Company continued development of the projector in strict secrecy. This was not necessarily to keep the development from the Germans, but from the Royal Artillery. The chemical soldiers were afraid of infringing on the domain of the artillery and having their project canceled.

The Livens Projector

The Somme Strange Gun, now officially known as the Livens Projector, became a surprisingly effective weapon. Z Company now built the projectors from ordinary drawn steel tubing about 8 inches in diameter and about a quarter-inch thick. The designers welded a rounded bottom to the tube and fitted it with a detachable steel baseplate that helped absorb the shock of firing.

The British developed two variations of the Livens Projector. The first variation consisted of a tube 2 feet, 9 inches in length with a maximum range of 1,200 meters. The second variation consisted of a tube 4 feet in length with a maximum range of 1,900 meters. The crews decreased the range accordingly by altering the firing charges. The tube for the short version weighed about 100 pounds and the 4-foot version weighed about 150 pounds.

In the early development the crew buried the projector to the end of the barrel for stability during firing. They decreased the firing depth as they became more adept. At the close of hostilities, crews secured the projector in only a shallow trench and stabilized it with sandbags and wooden beams. Under optimal conditions a crew of 4 could emplace, load, and fire 17 projectors in less than an hour.

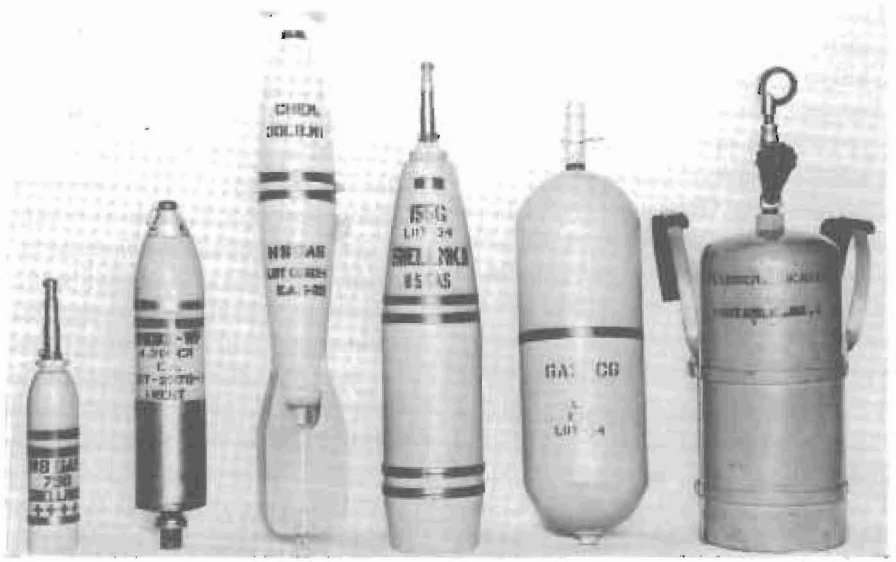
Capabilities of the Livens Projector

By mid-1916, the multiple launch concept was in full development. Z Company divided the projectors into batteries of 25 tubes laid side by side and wired to a common detonator. The crews fired the projectors remotely with an electrical lead threaded through the projector tube. The firing charge was usually amminol, bagged in individual increments.

Hundreds of projectors could fire over a wide front, impacting at the same approximate range and time. The short flight time of the bomb did not allow sufficient time for the Germans to mask. The impact usually resulted in complete surprise as hundreds of shells burst nearly simultaneously on a target area.

A Livens Projector "shoot" combined lethal agent concentrations of a cylinder cloud attack with the speed and surprise of an artillery bombardment. The projector delivered a tremendous amount of agent directly on the target area in a very short period. Mortar and artillery could deliver gas directly on point targets, but could not deliver large concentrations without massing artillery assets. The projector conserved artillery tubes and munitions and did not rely on wind direction like the cylinder.

To mimic the effect of a cylinder cloud attack, the British often fired the



A group of post-World War I chemical munitions. The phosgene projector bomb is second from right. Note the early mustard agent designation HS for "Hun Stuff."

projectors in a phased bombardment to keep a lethal concentration over a target for an extended period. The Germans suffered from fatigue, and oxygen-supplied machine gun positions would run out of breathing air after about 30 minutes. If the British maintained a sufficient chemical concentration, German respirator canisters eventually failed, causing more casualties. A phased attack also destroyed or suspended horse-drawn supply operations upon which the Germans depended for ammunition resupply.

Projector Munitions

As the Livens Projector gained formal acceptance, the British abandoned oil drums and cylinders and developed standard projector rounds called bombs. The bomb was similar to a compressed gas cylinder fitted with a time fuse and burst charge. The main chemical fill was 30 pounds of pure liquid phosgene, a proven, practical, and deadly poison gas 10 times as lethal as chlorine.

Upon impact, the shell burst and ejected liquid phosgene over a considerable area. Phosgene vaporizes immediately at temperatures above 50 degrees Fahrenheit, and can build a lethal exposure in moments. Victims suffered pulmonary edema or "dry land drowning" following a lethal dose, often collapsing without warning 4-24 hours later.

Under ideal conditions the phosgene could linger for several hours, but usually dissipated in a few minutes. Phosgene also has poor warning properties. A victim can inhale a lethal dose before detecting an odor. When supplies of phosgene were low, the British would use whatever agents were available, usually chlorine or chlorine mixtures.

Z Company developed a number of munitions for the projector, including HE, improved incendiaries such as thermite (a mixture of aluminum powder, iron oxide and an igniter), and "stinks." The stinks were essentially harassing agents, noxious chemicals such as bone oil and amyl acetate. These agents were repulsive and forced the enemy to mask, degrading his ability to resist. The harassing agents allowed the British to conserve toxic agents and yet maintain the surprise and terror of a chemical attack.

Limitations of the Projector

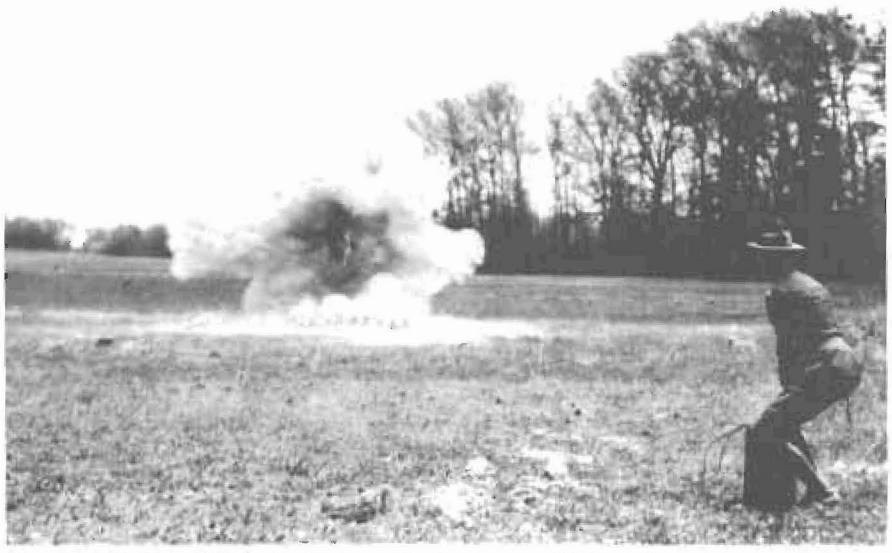
Though very successful, the Livens Projector suffered from several operational limitations. Initially, the projector battery took a great deal of time to lay, wire, and load. Emplacing a small shoot consumed hundreds of man-hours. The work was tedious and dangerous and numerous accidents occurred. An explosion at Arras killed one lieutenant and several other soldiers were badly burned when a gunner unwisely attempted to scrape powder from a tube with a metal tool.

The British carried out many experiments to conserve time and labor and many were unsuccessful. One method involved firing the projector without the baseplate, which saved a great deal of installation time. However, in soft ground the recoil drove the projector deeply into the soil, on one occasion to a depth of nine feet.

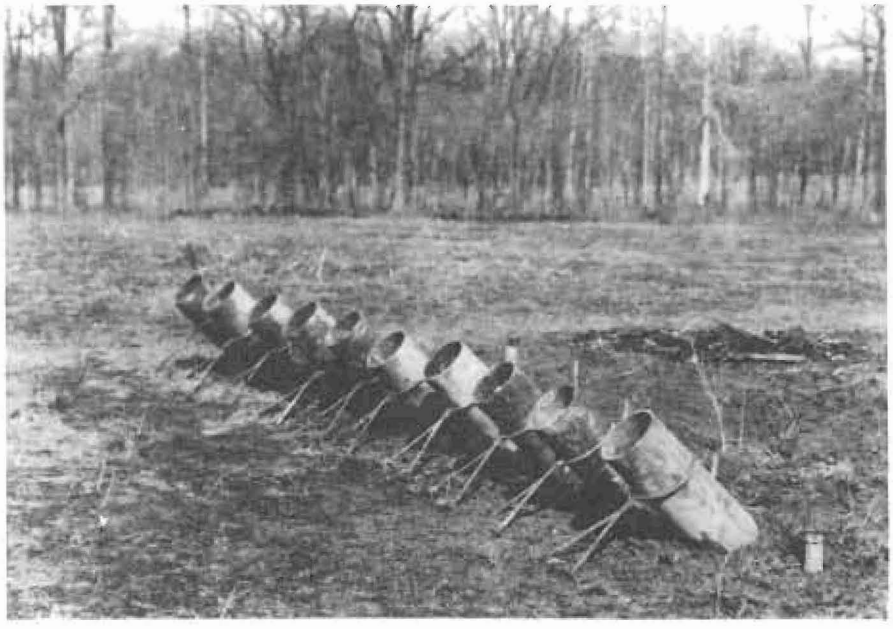
The projectors were effective area weapons but were not accurate on point targets. The tubes were smoothbore, like many early mortars, and the bombs tumbled in flight. The tumbling of the bomb greatly restricted the range and accuracy of the British projectors.

The short-range forced the British to lay the battery behind the front line trenches and within easy reach of enemy artillery. It was crucial the batteries remain out of view of enemy forward observers. The loss of surprise meant immediate German counterbattery fire and generally the end of a mission.

In May 1917, during the battle for Arras, the British were preparing for an upcoming shoot when a chance shell struck a supply wagon that contained the detonators. In answer to the secondary explosions, the German guns opened fire on the area where the British were installing the projectors. The



Test fire of a Livens Projector battery. The bombs are visible at the top of the picture. Note the bombs' tendency to tumble even at this early stage in the trajectory.



A "shoot" of ten Livens Projectors ready to be fired. The top of the projector bomb is just visible inside many of the tubes.

British lost 88 men (killed or wounded) and a great deal of equipment in the searching fire.

Gas Shoots

Z Company conducted several experimental shoots during the latter half of 1916. The first shoot at Pozieres in July 1916 used six Somme Strange Guns firing oil drums. Z Company continued experimental shoots with both drums and cylinders throughout the summer. On 3 September 1916, crews fired 20 Somme Strange Guns in combat with one of the rare *flammenwerfer* shots. The projectors fired standard chlorine cylinders up to 450 yards. Enemy machine gun fire ceased and the British considered the projector attack a success. Subsequent attacks using chlorine were equally effective and ranges steadily increased.

The first large-scale use of the Livens Projector occurred at the Battle of Arras in April 1917; 320 Livens Projectors conducted a flawless attack on April 9 and 10, supporting the opening bombardments of the battle. The British used as many as 10,000 projector bombs between 7 and 14 April containing over 50 tons of phosgene. One estimate places over 2,000 projectors in use at Arras through May.

The British projectors surprised the Germans at Arras and left them no time to mask in the bombardment. Though the estimate is high, they suffered as many as 5,000 casualties by projectors alone in early April. The Germans admitted the effects of the British projectors in a dispatch from the 111th Infantry Division. To paraphrase, the British had mastered a weapon that combined the effectiveness of gas clouds and gas shells and had succeeded in surprising them with this weapon many times. Casualties were very high; there was no time to mask during the bombardment.

The largest projector operation of the war occurred at the Battle of Lens on 31 March 1918. The British used 3,728 projectors in this operation. In all, the British conducted over 300 gas shoots during the course of the war.

The Americans adopted the projector along with a wide variety of chemical weapons from both the French and British. A and B Companies of the 1st Gas Regiment fired the first independent American projector attack on 18 June 1918. At 2230, 700 projectors firing phosgene bombs landed amidst a German mortar company and an infantry battalion. Subsequent enemy reports revealed at least 50 gas casualties, with at least 10 dead and the remainder incapacitated.

Another large American shoot took place in the Meuse-Argonne campaign in support of the French. Company F of the 1st Gas Regiment fired 230 projectors at 0330 on 16 October in a dense fog and rain. Company F attacked known enemy positions in conjunction with a French Corps Artillery bombardment. Though the phosgene probably dissipated rapidly in the rain, the Allies considered the attack a success. The 1st Gas Regiment frequently used projectors in support of French rather than American troops due to the reluctance of American maneuver commanders to use gas.

German Projectors Enter the War

The Germans copied the Livens Projector and had some success with the weapon. To save time and preserve weapons production capacity for artillery, they re-tooled their obsolescent 180mm heavy mortars. This projector hurled 3 gallons of phosgene approximately 2,000 meters.

The Germans introduced a 160mm rifled projector called the *Gaswerfer 1918* in August of that year. The *Gaswerfer 1918* hurled 13 pounds of phosgene thickened with 5 pounds of pumice about 3,500 meters. The German weapon out-performed the Livens Projector in range and accuracy.

The first German projector attack against the Americans occurred on 26 February 1918 and caused 85 gas casualties. Approximatley 250 projector bombs loaded with phosgene and chloropicrin fell across a 600-meter front in ideal weather for gas. Eight soldiers died from effects of the gas soon after the attack. The Germans launched another projector attack against the Americans of the 168th Infantry Regiment on 27 May 1918. Over 950 projector bombs filled with phosgene caught the soldiers unaware in a ravine. An artillery bombardment closed the rear of the ravine with mustard agent, trapping the regiment in the contami-

nated area. The attack gassed 236 Americans and 37 died soon after reaching field hospitals.

Mobile Multiple Launch Concept

The German trench defenses collapsed following their unsuccessful offensive in the spring of 1918. This event finally restored maneuver warfare to the Western Front. The British found gas weapons such as the cylinder and Livens Projector became practically useless in open warfare. First, they wasted hundreds of man hours setting up a shoot or a cloud gas attack, only to have the Germans fall back out of range. Second, open warfare increased the danger of gassing Allied troops that had advanced beyond the intended front.

An inter-war target practice. The Livens Projectors and bombs are to the left. The weapons in the foreground are 3- and 4-inch Stokes Mortars, precursor of the 4.2-inch chemical mortar.

Finally, unrestricted gas warfare threatened civilians caught on the battlefield after four years of relative stability. For the first time in the war the British had to rely on mortars and artillery alone to deliver gas. Unfortunately, artillery was still a small fraction of the British chemical delivery capability.

However, the innovative British were not to be deprived of a potent weapon. They now added mobility to the multiple launch concept by mounting the Livens Projector on sleds. Each sled held 16 tubes mounted upright along the side and held in place by notched wooden beams. Crews prepared the tubes in a secure rear area and mounted them on the sleds. The British rigged special towing hardware to the Mark IV tank, enabling it to tow a pair of sleds forward.

As the British met pockets of resistance, the Mark IVs pulled the sleds into a concealed firing position. The eight-man projector crews swung the sides of the sled out, braced the projectors using the notched beams, and attached the baseplates. The crew then aligned, wired, and fired the 32 projectors at the pocket of German resistance. The mobile, multiple launch concept was born.

Aftermath

Records of the success of this version are limited due mainly to the short time in which the British used the sleds. Sixteen of these sleds carrying 256 projectors were in use before the Armistice of 1918 ended the war. Despite early opposition, the projector provided a large percentage of the chemical delivery systems used by the British and Americans. The Livens Projector remained in both the British and American arsenals up to World War II. The Allies abandoned the projector with the arrival of mechanized maneuver warfare and the lack of chemical combat during World War II.

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