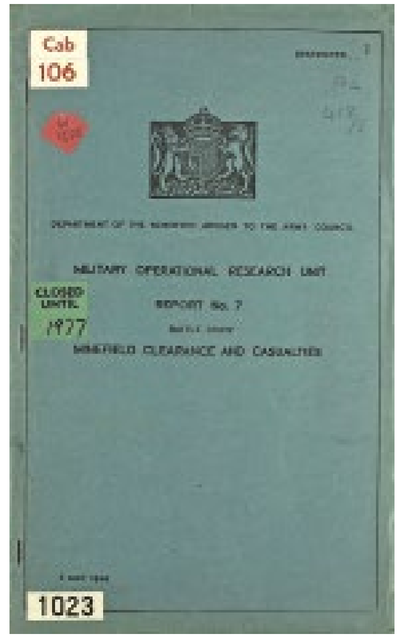

Image 1. Military Operational Research Unit Report No.7 – Minefield Clearance and Casualties front cover.
Image courtesy of The National Archives.

Lessons from the Past:

Minefield Clearance and Casualties – Holland 1945 – Military Operational Research Unit Report No.7

by Roly Evans
[Geneva International Centre for Humanitarian Demining]

In June and July 1945, two Royal Canadian Engineer officers, on their own initiative, carried out a review of the ongoing minefield clearance in Holland. The local military authorities deemed the review to be of significant value and therefore directed the Military Operational Research Unit to take up the study and "carry out a complete survey and analysis of all aspects of minefield clearance and casualties."[1] The study, entitled Military Operational Research Unit Report No.7 – Minefield Clearance and Casualties, Holland 1945, was initially intended to gather lessons about minefield clearance casualties in relation to combat. It became a significant study of demining during peace time. The resulting fifty-seven page document remains one of the best analyses of minefield clearance, time, and resulting casualties ever conducted. Arguably, it has not been equaled or surpassed since. To this day, few in mine action are even aware of it.

Mine Clearance in the Netherlands

As in other liberated European countries, wide-ranging mine clearance in the Netherlands started remarkably quickly after the cessation of hostilities on 7 May 1945.[2] Some limited clearance, mainly of routes, had taken place in southern Holland during the previous winter; however, concerted efforts only started when the occupying German 25th Army surrendered. By 20 May 1945, the Canadian and British military authorities, represented by the Allied 6th Army Headquarters, had overseen the formation of the German Draeger Brigade, named after its commander, Oberstleutnant (Lieutenant Colonel) Rudolf Draeger. The brigade's 105 officers and 3,244 other ranks were formed from seven pioneer (engineer) battalions, a battalion of fortress troops already stationed in Holland and some other

Image 2. Oberstleutnant Rudolf Draeger briefs Captain Misseldine, Royal Engineers, on clearance in the Hook of Holland area, August 1944. Draeger was widely deemed to have commanded the clearance efforts in a highly competent manner, albeit his soldiers, categorized as Surrendered Enemy Personnel rather than prisoners of war, sustained casualties that would be unacceptable in modern mine action.
Image courtesy of Nationaal Archief.

Image 3. Draeger Brigade personnel count disarmed S-Mines beside a road in the Hook of Holland, August 1945. By this time, the clearance of mines from the Atlantic Wall minefields was nearing completion. Units of the Draeger Brigade had started to move south of the River Mass to clear minefields on the old winter frontline between the Allies and the Germans. Accounting for 11.8 percent of all mines found, 127,591 S-Mines were eventually removed by the Draeger Brigade in 1945. Relative to the number removed, the S-Mine was known to cause the highest fatality rate during accidents.
Image courtesy of Nationaal Archief.

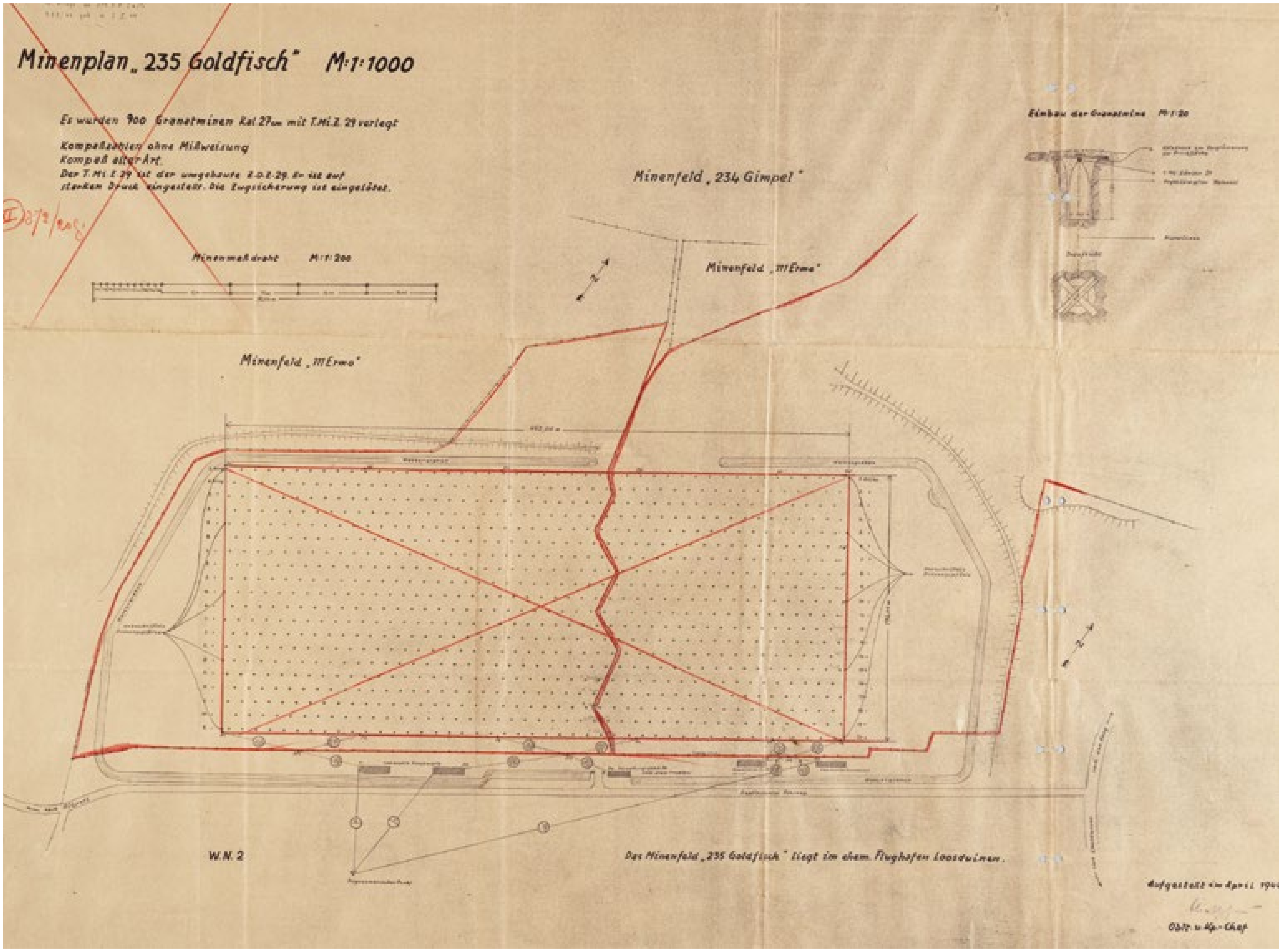

Image 4. Minenplan 235 Goldfisch, 2 May 1944, showing 900 Granatminen improvised from 270 mm artillery projectiles and T.Mi.Z.29 pressure fuzes. Artillery projectiles fuzed in this way were common as early anti-tank mines during World War I. As with many Wehrmacht minefield records, to the quality and detail of this record enabled rapid clearance after the end of the conflict. The minefield of 87,688 sq m (104,874 sq yd) was cleared in two days by a Fallschirmjäger pioneer platoon in late July 1944.
Image courtesy of Defense Expertise Center, Explosive Ordnance Disposal, the Netherlands.

assorted units. Notably, given the subsequent casualties, a German military hospital and staff at Bloemendaal, west of Amsterdam, was included within the organization of the brigade from the beginning.[3]

The Draeger Brigade would be responsible for the vast majority of mine clearance in the Netherlands. Of the 1,377,898 mines cleared by 23 November 1947, the Draeger Brigade had cleared 1,079,857 mines by as early as 31 December 1945.[4] Some assistance was provided by the Netherland Mine Clearance and Bomb Disposal Company (BD) along with the 2nd Dogs Platoon, Royal Engineers (British Army). Dutch members of the Waffen SS imprisoned in a former concentration camp in Vught, near 's-Hertogenbosch, given the opportunity of better treatment if they participated, were also involved in clearance in the south of Holland.[5]

The Draeger Brigade established its headquarters in Delft, between Rotterdam and The Hague. Work concentrated on the northern half of the country until August 1945, with most effort focused on clearing the Atlantic Wall minefields on the coast. By October, all Draeger Brigade units had moved south of the river Maas to clear the minefields that resulted from the fighting between the Allies and the Germans. A replacement German military hospital at Sterksel, near Eindhoven, was placed under the Draeger Brigade's responsibility at this time. On 1 October 1945, the Dutch Mijn Opruimings Dienst (Mine Clearance Service, MOD) took control of demining operations in Holland. Eventually approximately 1,800,000 landmines would be cleared in the Netherlands, some 422,102 cleared by the Dutch.[6]

The Pioneer Battalions worked extremely fast, especially when compared with modern day clearance efforts. In part they were enabled to do this by the generally excellent minefield records kept by the 25th Army. One example is Minefield 235 Goldfisch, (renamed Minefield 20 in Dutch records) in The Hague. The minefield of nine-hundred 270 mm artillery projectiles (Geschossminen), adapted to be mines by fitting T.Mi.Z.29 pressure fuzes (which had anti-personnel and anti-tank weight settings), was laid by the Pioneer Battalion of the 719th Infantry Division in five days during 18–22 April 1944. Covering an area of 87,688 sq m (104,874 sq yd) with a 194 m (212.2 yd) depth and 452 m (494.3 yd) frontage, it was cleared by a

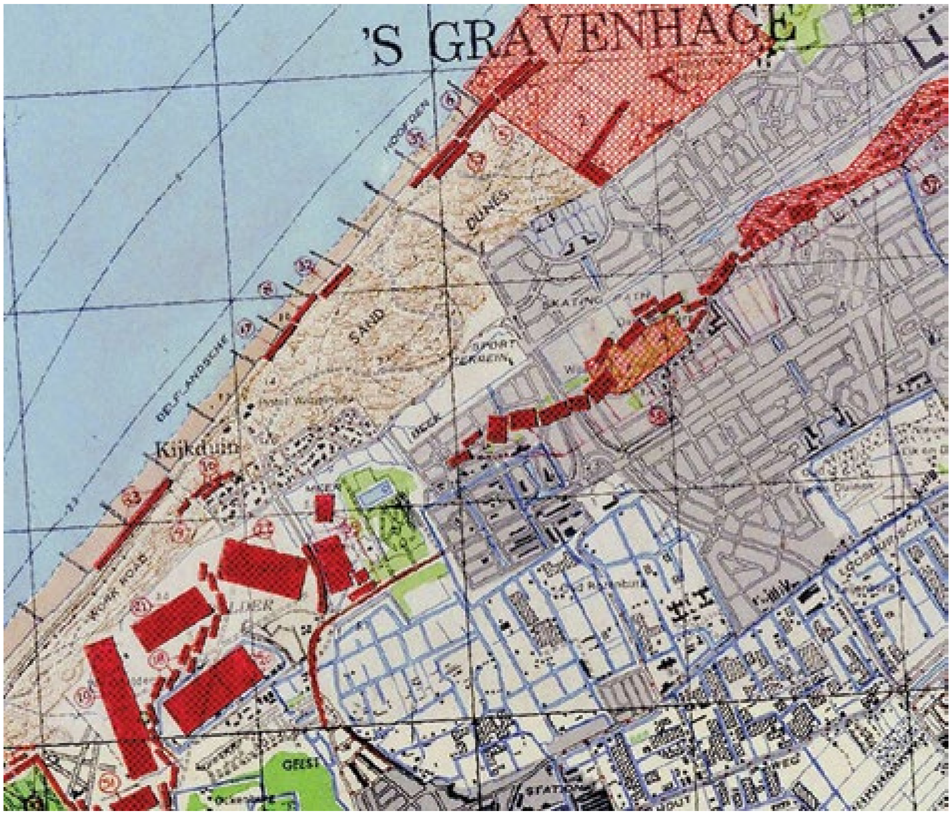

Image 5. Mine Map Book record of minefields in the Hague. Minenplan 235 Goldfisch is numbered Minefield 20 and can be seen among the large rectangular minefields in the southwest corner of the image. The minefield site is now the playing fields of the International School of The Hague.
Image courtesy of Defense Expertise Center, Explosive Ordnance Disposal, the Netherlands.

Fallschirmjäger pioneer platoon in just two days, 26–27 July 1945.[7] Clearance of nearly 9 ha (22 ac) and nine-hundred mines in two days would rightly not be repeated in modern mine action, where such a task would take many months. Such speed underlines the urgency of the task and the risks that members of the Draeger Brigade were expected to undertake. The location of this minefield today now forms the playing fields of the International School in The Hague.

Collection and Quality Control of Data

One particular aspect of the demining operations in Holland was the great emphasis placed on recording and checking data. Both the official 6th Army Confidential Report and the Military Operational Research Unit Report No.7 detail at length the procedures followed. First, all minefield records were checked, assigned serial numbers, and drawn onto linen map traces by a Royal Engineers Intelligence Section attached to 66 Field Company Royal Engineers prior to clearance.[8] A color-coding system to denote German or Allied minefields was adopted: green for Allied, blue for German. Copies of all maps were then bound in book form. An accompanying "Schedule of Minefields" was developed, recording all known details to complement the maps. Records were duplicated into a field copy and a master copy. Minefield maps were issued to clearance teams from June 1945 onwards. By 9 October 1945, 4,522 minefields had been registered in this way. Eventually 5,400 minefields and 900 areas contaminated with explosive remnants of war (ERW) would be registered in Holland by 1947.[9] Ten book sets covered the whole of the Netherlands.

Further to this overview, individual minefield maps and the remaining German records made up minefield files that were completed when the clearance certificate was added. All documents moved under careful control with the dispatch and receipt recorded in an index book. Importantly, field and master copies were carefully compared at the end of the process for discrepancies or irregularities as they were termed; essentially a form of data quality control not always present in modern mine action.[10] For the period July–November 1945, time spent clearing in minefields was also carefully recorded in other forms with comparisons between units and sites made to check for irregularities.[11]

6th Army HQ itself also recorded all casualty data using a simple standardized pro-forma split into a section detailing the circumstances of an accident and a section detailing injuries. Staff officers sought casualty data wherever it could be found, whether from unit medical officers, civilian doctors, or hospital records. Corroboration of forms was made by interviewing witnesses and by examination of the returned forms against unit daily records.[12] This careful and detailed approach to operational data, very briefly outlined here, while unglamorous, was essential to the subsequent operational analysis.

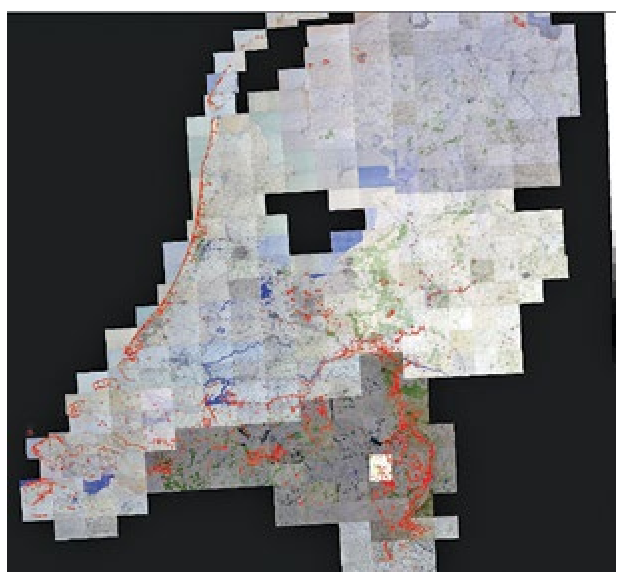

Image 6. By 1947, 5,400 minefields and 900 areas were registered by the authorities in Holland. The red dots in this image indicate where minefields were found. Broadly the minefields can be divided into two categories; those on the coast forming part of the Atlantic Wall, and those in the areas of the September 1944 until May 1945 front lines. The latter tend to be near the Rivers Maas and Waal, from eastern Holland to the coast.
Image courtesy of Defense Expertise Center, Explosive Ordnance Disposal, the Netherlands.

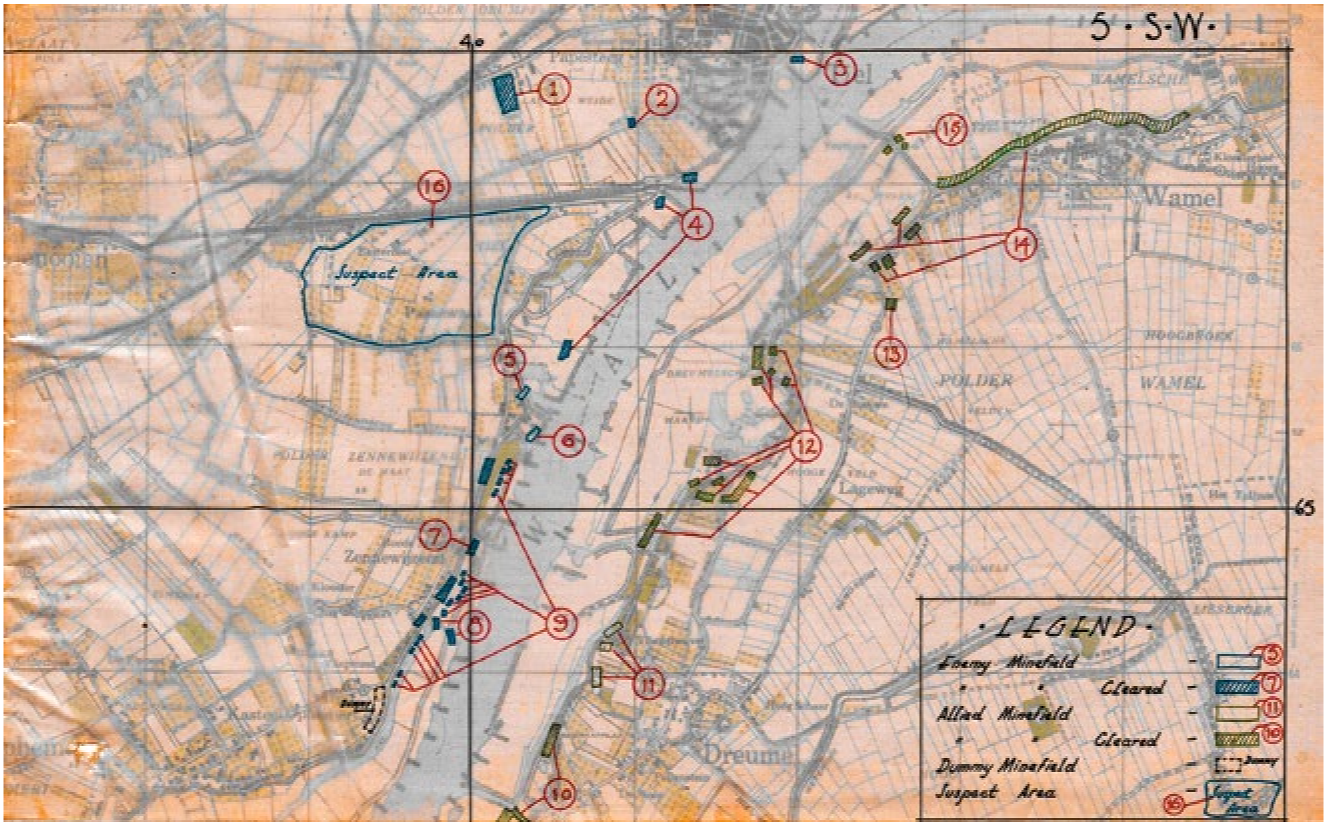

Image 7. 6th Army HQ Minefield Map trace between the villages of Dreumel and Wamel on the Waal river, west of Nijmegen. German minefields are represented in blue, Allied minefields in green. As minefields were cleared, the polygons would be colored in. A field and HQ copy of this and associated documents existed, one being used to check the other for discrepancies. This was a small part of what was in effect a larger data quality management system that enabled the subsequent operational research contained in Military Operational Research Unit Report No.7. (The information on this map does not relate to any current clearance of minefields in this area). The National Archives (TNA) PRO: CAB 106/1023. Military Operational Research Unit Report No.7 Battle Study. Minefield clearance and casualties. p.42.

Time Study

No study in mine action has ever recorded the man hours expended versus the mines removed on the scale of Military Operational Research Unit Report No.7. Trials were conducted of manual mine clearance methods in Moamba, Mozambique, from October to November 2004, and while the record of this is more detailed in some respects, it was a severely limited trial, not an analysis of a work sample as large as in Holland in 1945.

The study of "time and labor factors" in 1945 allowed an analysis for each battalion of the man hours expended per 100 mines lifted. This ranged from 57 to 78 hours—a difference of up to 27 percent between units, usually explained by the different concentration of mines between minefields rather than differences in operational efficiency. The more concentrated minefields required fewer man hours to remove an equivalent number of mines.[13]

The time spent removing different mine types was also calculated. Metal anti-tank Tellerminen required on average 56 man hours to remove 100 mines. Wooden, anti-personnel Schuminen, almost

APPENDIX "F"

PERCENTAGES OF BOOBY TRAPPED AND DEFECTIVE MINES.

Extracted from Records of all mines lifted during period 11 July, 1945 to 1 October, 1945.

Type of Mine	Total Number lifted	Booby Trapped		No of mines which would NOT have detonated.		No of mines damaged by weather and site condition	
		No	%	No	%	No	%
Tellermines	99,811	868	0.87	Nil	0.00	6,576	6.59
Holtzmines	33,668	320	0.95	3,614	10.73	6,906	20.51
Riegelmines	22,401	666	2.97	120	0.53	120	0.53
Glasmines	2,588	Nil	0.00	Nil	0.00	60	2.31
L P Z (A/Tk) Mines	6,373	Nil	0.00	Nil	0.00	Nil	0.00
Box mines V D	823	Nil	0.00	Nil	0.00	Nil	0.00
Brit A/Tk Mk IV - V	9,774	4	0.04	Nil	0.00	Nil	0.00
Brit 75 Gren Hawkins	1,526	Nil	0.00	Nil	0.00	Nil	0.00
American A/Tk Mines	7,775	493	6.34	380	4.88	380	4.88
French A/Tk Mines	31,922	197	0.62	332	1.04	332	1.04
Dutch A/Tk Mines	875	Nil	0.00	Nil	0.00	Nil	0.00
"S" 35 A/P Mine	86,129	2,011	2.33	376	0.44	3,444	4.00
Schu A/P Mine	120,042	232	0.19	17,302	14.41	24,834	20.66
Stock A/P Mine	445	181	40.67	Nil	0.00	Nil	0.00
A 200 A/P Mine	20,825	Nil	0.00	Nil	0.00	430	2.06
Shrapnel Mine	1,173	Nil	0.00	Nil	0.00	Nil	0.00
W 1 A/P Mine	9,170	Nil	0.00	290	3.16	Nil	0.00
Handgrenades	4,613	Nil	0.00	Nil	0.00	Nil	0.00
Shells	583	Nil	0.00	Nil	0.00	Nil	0.00
Booby traps (Proper)	126	-	100.00	Nil	0.00	Nil	0.00

Image 8. This table and similar ones in the Report No.7 (Table 5, p.17) underline the benefits of accurate reporting supported by appropriate data quality control systems. Those overseeing clearance in the Netherlands in the post-war years often had much better information about what was found and in what condition than we do in many cases today. Which national authority or even clearance organization could produce such statistics now? WO 205/1186: Confidential Report on Mine Clearance in the Netherlands. Appendix F.

Image 9. Draeger Brigade personnel count disarmed Tellermine-43s beside a road in the Hook of Holland, August 1945. 200,456 Tellermines of all types were eventually removed by the Draeger Brigade in 1945, a total representing 18.6 percent of all mines found. The Tellermine-43 would be copied by the Yugoslav Army as the TMM-1 and would later be found during the 1990s conflicts in the Balkans.
Image courtesy of Nationaal Archief.

impossible to find with the detectors of the day, required on average 70 hours. The Riegelminen 43, required on average 97 man hours to remove 100 mines, most likely because deminers were extremely wary since wiring within the fuze mechanism could function easily on handling due to the effects of corrosion. In Holland in 1945, the Draeger Brigade removed, on average, a Tellerminen every 34 working minutes, and a Schuminen every 42 working minutes. The fastest time recorded in a given week for a minimum sample of 1,000 mines was 15 working minutes for a Tellerminen and 20 minutes for a Schuminen.[14] Whether using the averages or the fastest times recorded, this speed of demining is well outside of modern norms, even in circumstances such as the dense minefield patterns in Sri Lanka.

Analysis of Mines Found

The Draeger Brigade's conscientious reporting also allowed a good overview of explosive devices found. For example, careful records were kept of what mines were booby-trapped, what mines were assessed as being in a condition that made them unable to detonate and which mines had been damaged by the weather or corrosion. Less than 1 percent

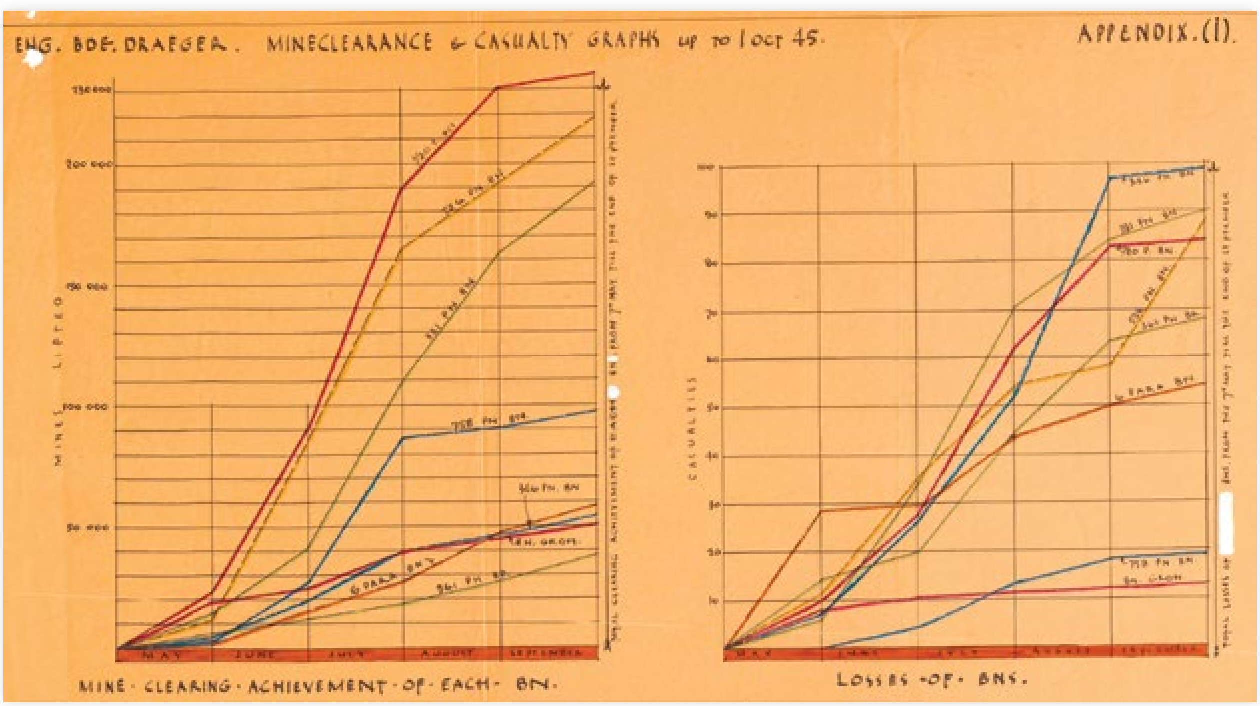

Image 10. 6th Army HQ were able to use the casualty and mines found returns to plot the respective figures in two comparative graphs. The graph underlines the significant casualties sustained by each sub unit of the Draeger Brigade and how casualties were broadly proportional to the number of mines removed, albeit with the notable exception of the 346th Pioneer Battalion, which lifted approximately 55,000 mines but had the highest casualty figures, greater than units that lifted up to four times more mines. The 346th Pioneer Battalion was employed for a considerable time in the area of Arnhem clearing "unrecorded or scattered" Schumine minefields. WO 205/1186: Confidential Report on Mine Clearance in the Netherlands. Appendix I.

Image 11. A Dutch sailor guards two members of the Kriegsmarine as they remove Tellerminen-42s from an Atlantic Wall beach minefield. Dependent on which time period is used, between 0.87 and 1.7 percent Tellerminen were recorded as booby-trapped with anti-lift devices in Holland. The image underlines the lack of basic safety precautions taken by most units at the time, be it PPE or working/safety distances. Units that reduced the number of individuals working in close proximity tended to have lower casualty rates.
Image courtesy of Beeldbank WO2 – NIOD.

Image 12. No.2 Dogs Platoon checking the railway line between Eindhoven and Venlo, 25 November 1944. The report surmised the belief that dogs were "not 100% effective" and that it was decided to use them to search long stretches of railway line and under high tension cables. Dogs were not used as a search asset in areas known to be mined.
Image courtesy of the Imperial War Museum.

of the main anti-tank mines, Tellerminen and Holzminen, were booby-trapped, 2.33 percent of S-Minen, and 2.97 percent of Riegelminen. This was less than the military authorities were expecting, having become used to German booby-trapping during the later years of the conflict.

Seven decades before the current studies of landmine aging, a relatively detailed analysis was made in Holland in 1945. Ground conditions were characterized into three categories: sandy/dry earth, low-lying meadows, and polderland flooded since the mines were laid. The respective aging characteristics of casings, igniters, or fuzes and detonators for metal and wooden mines were noted in each of these conditions. The report found that wooden mines were unsurprisingly the most vulnerable to weathering, with 20 percent deemed damaged. Anti-handling devices, especially cocked striker pull fuzes, were particularly prone due to "damp penetrating the firing cap and rusting the spring." Indeed, aside from what casing was used for the mine (metal being more resilient than wood), the chief cause of probable failure of a device was "the high percentage of ineffective igniters."[15] This is consistent with recent studies of mine functionality in the Falkland Islands, where of a sample of 100 P4B mine fuzes, only one was found to be functional.[16]

Analysis of Accidents and Casualties

The Draeger Brigade sustained 563 casualties from 290 accidents in 1945, an average casualty rate of 17.5 percent of its final strength. There were 165 fatalities, 29 percent of all casualties. Casualty rates for its sub-units ranged from 6.1 to 29.6 percent.[17] The landmines or other explosive hazards involved in accidents were strictly recorded allowing an analysis of the respective risk of different mine types. Of the 563 casualties from 290 accidents, 391 casualties came from 201 anti-personnel mine accidents, 69 percent of each respective total. In terms of accidents proportional to mines lifted, bounding fragmentation S-Mines proved to have the highest fatality rate amongst anti-personnel mines. This corresponded to anecdotal experience of combat where soldiers routinely feared the S-Mine for the number of casualties it could cause over a relatively wide area. Even today bounding fragmentation mines tend to require enhanced safety distances during clearance operations. While there were significantly fewer anti-tank mine accidents (31 percent), when they did happen fatality rates were high as would be expected given the higher net explosive quantities involved.[18] The mean number of casualties per accident ranged between 1.62 for the Schuminen to 2.32 for the S-mine, with an average for all types being 1.94.[19] Safety or working distances were not introduced during these clearance operations, and it is difficult to understand why such a simple safety measure was not employed.

Units were given a high degree of discretion in how they went about clearing the minefields and considerable differences in procedure existed amongst them. The Battalion GROH, made up of former "fortress troops" manning the Atlantic Wall, stated that there were "never more than four men in any one mine-lifting party." Whereas in Battalion 526, twenty men could be "prodding and lifting in the same row of mines." The average size of mine clearance party working in close proximity to each other in the Draeger Brigade was seven other ranks and one NCO.[20] Battalion 526 had the third highest casualty rate, Battalion GROH the lowest.[21] Procedure was not the only explanation for casualty rates however, as the graph reproduced at Image 10 makes clear. In general the more mines a unit cleared the more casualties they had. As in modern mine action, explanations for given indicators could often be multi-faceted.

Schuminen were the most common mine of any type found in the Netherlands, with 229,431 cleared in 1945 alone.[22] Despite some metal content, the mine was very difficult to find using the detectors of the day and effectively posed the same hazard to deminers as more modern minimal metal mines. Schuminen were normally detected using a standing prodding drill. This proved to be inappropriate and dangerous. Resulting injuries to the face and eyes from primary and secondary fragmentation were common, with rudimentary eye protection proving only partially effective. This prodding drill often missed Schuminen with casualties caused by stepping on them usually resulting in an amputation of the leg.

What was also significant about the Military Operational Research Unit Report No. 7 was how casualty data could be analyzed in contect of the good quality operational reporting overall. For example, the study could calculate the number of mines lifted for each accident and for each casualty by battalion. The figures for the eight units ranged between the 20th Pioneer Battalion, who lifted 5,500 mines per accident and 2,720 mines per casualty (40 accidents), and the 346th Pioneer Battalion who lifted 1,240 mines per accident and 580 mines per casualty (49 accidents). For all the eight battalions there was a rank correlation of 0.71 between the number of mines lifted per accident and the number of casualties per accident.[23] This could be explained by the differing working procedures in the field between units. However, there were other explanations. The 20th Pioneer Battalion tended to clear well-marked and recorded Atlantic Wall minefields; the 346th Pioneer Battalion was employed for a considerable time in the area of Arnhem clearing "unrecorded or scattered" Schuminen minefields. It is believed context such as this was important in understanding the difference in performance. As with all performance indicators, the key was to use the evidence as the starting point to seek further explanation. In short, the statistics allowed those in charge to ask the right questions. The same principle applies when using statistics and key performance indicators in mine action today.

The study also contained recommendations concerning the use of dogs in demining operations that resonate with experience in modern mine action. The requirements for practice on dummy minefield and the need for rest days in order to maintain the "interest of both dogs and men" were deemed essential. Handlers needed to demonstrate "care and patience." While dogs had uses, they were deemed "not 100% effective." It was decided that the dogs were not reliable enough to be used on known minefields but were better suited to "routine checking of suspect areas and the proving of and delimiting of areas in which mines were rumored to exist." 155 miles of railway line, 73 miles under high tension cables, and 77,000 sq yd (64,382 sq m) were searched by "war dogs" with 29 mines being found in this way. Dogs were "fully justified on large areas of non-metallic anti-personnel mines."[24] Much of this experience is reflected in the modern Animal Detection Systems IMAS, where it is recognized that a concentration of explosive targets can confuse dogs, and the need for strict accreditation of both handler and mine detection dog is mandated.[25]

Conclusion

This brief summary of the Military Operational Research Unit Report No.7 has given only a limited overview. The detail the report was able to marshal is only partially reflected.

A number of German personnel continued clearance in Holland for another two years. The last 19 German Surrendered Enemy Personnel were sent back to the British Army of the Rhine for demobilization on the 3rd of October 1947. The final total of German casualties for both mine and ERW clearance in the Netherlands was 650. Of these 225 (34 percent) were fatal casualties. Eighty-three Dutch clearance personnel were also killed during the clearance effort of their country.[26]

Much was done poorly during the clearance efforts in Holland in 1945. Casualties were very high, unacceptably high by modern standards, and the treatment of German Surrendered Enemy Personnel remains contentious to this day. Clearance techniques were often rudimentary and safety precautions were often casual. Modern mine action has in many ways improved significantly on the technical demining ability of those who went before us in the post-war years, with better on-site procedures and personal protective equipment.

However, the limitations of the 1945 efforts should be seen in the context of what was done well, and even what was done better. The military authorities in Holland were ahead of their time in terms of analyzing their own operations, be it in relation to the use of mine detection dogs, aging of landmines, time studies, recording of devices found or the recording of casualties. Data collection and analysis was in many ways superior in 1945 than during much of modern mine action. Quality management of data in particular is an aspect where arguably we have still not caught up. We can do better. We owe it as a sector to the deminers risking their lives daily in the field to do so.

See endnotes page 71

The author wishes to sincerely thank the following without whom this article would not have been possible. Antoon Meijers, Jan Wijdemans, Commander Eddy Jolink, Lt Col Hans Linschoten, WO Herwin Eric Bührmann, and Kit van den Anker.

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