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Quality Assurance for Civilian Mine and Munitions Clearance

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Currently civilian mine-clearance operations are carried out according to military principles involving Standard Operating Procedures (SOP). SOPs, however, do not encompass quality assurance concepts, such as the ISO 9000 family, a set of standards developed by the International Standards Organization (ISO). These standards are typically used for civilian works.

At the International Conference on Mine Clearance Technology, held in Denmark, July 2-4, 1996, [1], it was recommended that international standards should be developed and applied to quality assurance (QA) for mine clearance and humanitarian mine clearance operations. The QA standard should be included in overall standards for humanitarian mine clearance operations and established international standards, such as the ISO 9000 family, should be examined for their applicability to mine clearance.

In this article, we address the following subjects:

- The challenge of demining and explosives ordnance disposal (EOD).
- Quality assurance currently in most mine clearance projects.
- Introduction to the ISO 9000 family.
- Applications of the ISO 9000 family to mine clearance.
- Examples from Lebanon and Bosnia.

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[1]This article was presented by Dr. Erik K. Lauritzen and Mr. Soren Gert Larsen at the Global Demilitarization Symposium & Exhibition, May 5-8, 1997, in Reno, Nevada. Both work with DEMEX Consulting Engineers A/S, Copenhagen, Denmark.

The Challenge of Demining and Explosive Ordnance Disposal

Dealing with post-war remains of explosives in former combat areas has always been problematic many years after the end of the war. During the ongoing development of the centre of Berlin, a number of unexploded ordnance (UXO) from World War II were encountered. In Belgium lots of active chemical ammunition from World War I are still found. In France 630 deminers have been killed since 1946, and in 1991, 36 French farmers were killed when their machinery struck unexploded shells. After the Iraq-Iran War, the Persian Gulf was polluted by sea mines produced during the Russian-Japanese war in the beginning of this century. Even in Denmark old minefields still exist in the western coastal areas, these having been established by the German army during the World War II occupation. The Danish fishermen still encounter the risk of catching active mustard gas bombs and shells in their nets.

Explosives do not merely disappear; the typical explosives used in munitions such as TNT, PETN, CompB last, if not forever, then for a long time. Some explosives and their fusing systems become more sensitive during chemical reaction with the casing materials. In other words, time will not solve the problems associated with UXO's and mines.

Today many countries must face the problems of post-war remains, especially unexploded ordnance and landmines. Figures of 110 million landmines all over the world have been mentioned; however, the real number and their location are unknown. That is the problem and the challenge.

Developed countries that have been a theatre of war–for instance western European countries after World War II–have the capacity and the skills to take the necessary steps to clear the post-war remains and protect the people against the threats of UXO and mines. However, developing countries which have been exposed to wars have no chance to either clear the UXO and mines or to protect their people against the risk of mines.

Therefore, a lot of attention and efforts have been concentrated on landmine clearance during the last decade. Many organizations, governments, and non-governmental organizations (NGOs) have placed a significant amount of money and effort into the mine-clearing business. Last year, the Danish government sponsored mine clearing activities totalling more than US $10 million, making the Danish government the third largest mine clearing donor after Japan and the European Union.

The challenge of mine clearance operations or demining is not to find all hidden land mines but to prevent the people against the effects of the mines. The challenge is to minimize the risk of unintended human initiation of mines and UXO, which can be met by three principal different means, or counter-mine actions:

- insulating humans from mines & UXO by removing the people.
- insulating mines & UXO from humans by removing or destroying the mines & UXO.
- separating mines & UXO from humans by warning and fencing.

The success of the counter-mine action and EOD operations is very clearly demonstrated by the number of lost lives or cripples within a certain span of time. The success is closely related to risk and safety, depending on the quality of the work performed. Therefore, quality assurance is one of the most important issues in counter mine actions and EOD operations, especially in demining.

Current Quality Assurance in Most Clearance Operations

Presently, most mine-clearance operations are conducted according to military principles, which deal with other QA concepts than QA in most civilian works. However, we should note that the civilian QA has been derived from the military standards, such as the NATO AQAP (Allied Quality Assurance Publication).

In many demining SOPs, quality assurance is a short section stating that Quality Control (QC) is conducted by re-demining a certain area. However, this does not assure that the demining has been conducted satisfactorily. This method does not take into account the actual demining process. If the demining is not conducted satisfactorily, re-demining a certain area using the same method does not assure that the demining is done in accordance with the quality criteria desired.

The satisfactory level of clearance has been defined by the UN to 99.6 % clearance of munition. The level is also stated in the *International Standards for Humanitarian Mine Clearance Operations* published at the Tokyo Conference in March 1997 [2]. However, it is interesting to note that the demand for achieving satisfactory mine clearance is a figure that the deminer has no specific method or procedure to prove. As the total amount of munition buried at a site is almost never known, complete recovery cannot be documented. These factors must be considered when designing and implementing a QA/QC programme.

Therefore, the only way a contractor can control and measure that the level of quality is in accordance with an employer's demands is to establish a quality management system that controls all procedures and measurable dimensions.

In industry, the quality management and QA models incorporated into the ISO 9000 family have

been used for many years, and these models may perform effectively if made applicable to mine clearance operations.

The ISO 9000 Family

The ISO 9000 family has its origin in the military quality management standards: the US MIL-Q-9858A, the British BS 5750 and NATO's Allied Quality Assurance Publication (AQUAP-1). The ISO 9000 family consists of 6 standards:

ISO 9000-1	Quality management and quality assurance standards - Part 1: Guidelines for selection and use.
ISO 9004-1	Quality management and quality system elements - Part 1: Guidelines.
ISO 9001	Quality systems - Model for quality assurance in design, development, production, installation, and servicing.
ISO 9002	Quality systems - Model for quality assurance in production, installation, and servicing.
ISO 9003	Quality systems - Model for quality assurance in final inspection and test.
ISO 8402	Quality management and quality assurance - Vocabulary.

The ISO 9000 family is independent of any specific industry or sector and provides guidelines for quality management and general requirements for quality assurance. The standards describe what elements quality systems should encompass but not how a specific organization should implement these elements.

In ISO 9000 Part 1: Guidelines for selection and use, the basic philosophy of the Quality Management is described. The fact that all work is accomplished by a process is clearly demonstrated (Figures 1 and 2).

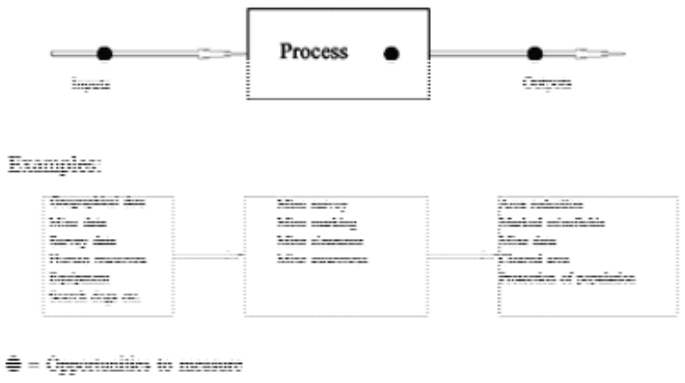

Figure 1. All work is accomplished by a process according to ISO 9000 [4]. Process: A value-adding transformation involving people and other resources.

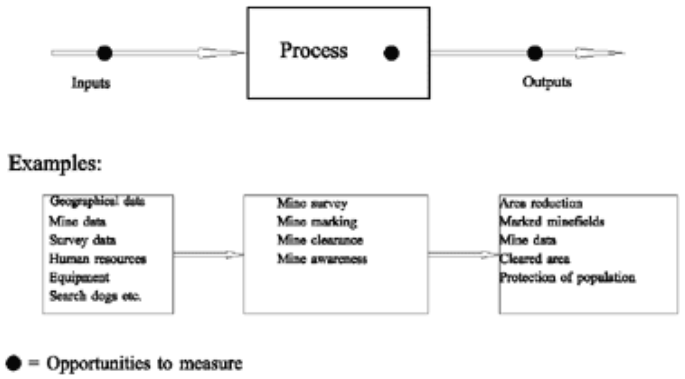

Figure 2. Supply chain relationship of processes, with product-related and information-related flow according to ISO 9004 [4].

Demining should be considered a process. The input factor incorporates different types of resources: deminers, dogs and materials. The output is a demined area according to the agreed level of risk of finding left mines-or, in other words, a certain level of quality.

The standards ISO 9001, 2, and 3 represent quality system requirements suitable for the purpose of a supplier demonstrating its capability, and for the assessment of the capability of a supplier by external parties. ISO 9001 is for use when conformance to specified requirements is to be assured by the supplier during design, development, production, installation and servicing. ISO 9002 is for use when conformance to specified requirements is to be assured by the supplier during production, installation and servicing. ISO 9003 is for use when conformance to specified requirements is to be assured by the supplier solely at final inspection and test. The standard describes a number of clauses which must be accounted for as outlined in Figure 3. ISO 9001 is the most comprehensive of the standards followed by ISO 9002 and finally ISO 9003.

External quality assurance			
Requirements			
ISO 9001	**ISO 9002**	**ISO 9003**	**Clause title in ISO 9001**
4.1 *	*	0	Management responsibility
4.2 *	*	0	Quality system
4.3 *	*	*	Contract review
4.4 *	X	X	Design control
4.5 *	*	*	Document and data control
4.6 *	*	X	Purchasing
4.7 *	*	*	Control of customer-supplied product
4.8 *	*	0	Product identification and traceability
4.9 *	*	X	Process control
4.10 *	*	0	Inspection and testing
4.11 *	*	*	Control of inspection, measuring and test equipment
4.12 *	*	*	Inspection and test status

4.13 *	*	0	Control of nonconforming product
4.14 *	*	0	Corrective and preventive action
4.15 *	*	*	Handling, storage, packaging, preservation and delivery
4.16 *	*	0	Control of quality records
4.17 *	*	0	Internal quality audits
4.18 *	*	0	Training
4.19 *	*	X	Servicing
4.20 *	*	0	Statistical techniques Quality economics Product safety Marketing
Key: * = Comprehensive requirement, 0 = Less-comprehensive requirement than ISO 9001 and ISO 9002, X = Element not present			

Figure 3. Cross-reference list of clause numbers for corresponding topics [ISO 9000-1].

The ISO 9000 Family Applications to Mine Clearance

If the supplier is a demining organization and the end product from a mine-clearance activity is difficult or impossible to measure, then the ISO 9002 standard is particularly applicable to mine clearance and related activities. Since the possibility to measure the end product is limited, the quality assurance and control must be conducted through a thorough documentation of procedures.

Going back to the challenge of demining and EOD, the success of the work is demonstrated by humans. The quality must be related to the use of the land after demining or EOD. In urban areas there must be very high quality levels of the work, whereas the requirement of demining in rural areas or mountain areas might be at a lower level. In farming areas, meadows, etc., we might inform the owner that a quality of less than 99.6% might be satisfactory. In some situations, the UN requirement of 99.6% clearance is not enough. In school and kindergarten areas it will not be sufficient to leave four out of one thousand mines.

In the assessment of the appropriate QA level, it is necessary to consider the time consumption and the available methods of mine survey and clearing. Mine clearing in an urban area with destroyed buildings is very time-consuming because demining machines are not applicable. So, it is important that the quality level is based on

- the goal of the demining operation,
- the available resources, humans, dogs and mechanical means,
- the available time, and
- the cost.

In the article "Minefield Clearance - The Relevance of Quality Management Systems Including ISO 9000," Colonel A.R.R. McAslan [3] makes the interesting comparison between the two types of hazardous waste management: waste mine clearance and contamination clearance. In fact, the basic principles of clearance strategy and concepts are identical.

Clause	Clause title
4.1	Management responsibility for quality policies
4.2	Quality system for humanitarian mine and munition clearance

	operations
4.3	Contract review
4.4	Normally not applicable to the mine and munition clearance process
4.5	Document and data control
4.6	Control of Supplier. Equipment, mine detectors, dogs etc., must meet required demands
4.7	Incorporation and control of information from the employer, mine data, geographical data etc.
4.8	Communication of achievement of clearance
4.9	Control of SOPs and QA/QC activities
4.10	Monitoring and testing critical equipment
4.11	Control and calibration of critical equipment, audit
4.12	Maintenance of records of control and calibration, e.g. mine detectors
4.13	Identification of failure to achieve agreed levels of clearance
4.14	Prevention of recurrence of failure to achieve agreed levels of clearance
4.15	Handling, disposal and security of ordnance. Marking and maintenance of marking of minefields
4.16	Control of quality records
4.17	Internal quality audits
4.18	Training needs, conduct and recording
4.19	In-service support, control of clearance by other organisations
4.20	Statistical methods for the determination of agreed clearance level is achieved and in planning of methods

Figure 4. The 20 clauses in ISO 9001 application to humanitarian mine and munition clearance.

Referring to the list of ISO 9001 clauses listed in Figure 3, and suggestions presented by McAslan [3]we recommend that the 20 clauses should lead to a quality assurance plan applicable for demining and EOD, as shown in Figure 4. If the demining contractor can document his procedures and convince the employer that the procedures are respected, the demining likely meets demanded level of quality.

An advantage of using ISO 9000 standards is that it is the contractor who has to document to the employer that his procedures live up to the necessary demands.

Example No. 1: Sub-sea explosive ordnance survey and clearance, Beirut: In 1996, DEMEX A/S undertook quality control work in connection with the sub-sea clearance of ordnance on the sea-bed in the harbour of Beirut. The client was the company SOLIDERE which is responsible for the reconstruction and development of Beirut Central District. The clearance works consisted of both visual search and search with metal detectors of an area of approximately 100,000 square meters, followed by clearance, removal and EOD of the found explosive items. The work was conducted by the Scottish company Aardvark Clear Mine Ltd. from June 1996 to October 1996 using 6 to 12 EOD divers from the United Kingdom assisted by 6 to 12 local divers.

The explosives items came from the following activities during the 17 years of civil war in Lebanon and earlier war activities during World War II:

- premeditated dumping of ammunition and weapons during periods of cease fire and armistice

followed by demilitarization of the fighting parties.
- emergency dumping of ammunition and weapons or sinking of transport boats due to direct contact between hostile parties.
- firing of shells into the sea area without detonation due to non-functioning of fuses.

Most of the explosives items were small calibre shells, rockets, and artillery shells up to calibre 155 mm. Some of the found items might contain picric acids, which is why they were considered very sensitive.

Due to a layer of silt 0.2 m to more than 1.5 m thick, very poor visibility and huge amounts of rubbish at the sea bed, the survey and clearance work was very difficult. The depth of the sea was approximately 20 to 25 m, which limited the diving time at sea bottom to 20 minutes per diver per day.

The survey and clearance was conducted according to British Navy Standard Operating Procedures (SOP). According to the contract it was the contractor's responsibility to prepare SOPs for the approval of the client. The SOPs contained some important elements of QA/QC, but they did not fulfil the requirements of the ISO 9000 family (British Standard BS 5750). During the work, it was decided to follow some principles laid down in ISO 9003 Quality System Model for Quality Assurance in Final Inspection and tests and the following issues:

- control of procedures in the SOP.
- inspection of Sub-Sea Search and Clearance Work.
- final inspection.

The SOPs were carefully examined and revised according to the actual procedures used by the contractor. The initial inspections showed much lack of coherence between the working procedures and the SOP. After three revisions the working procedures were brought into accordance to the SOPs.

During the QC inspections much effort was laid in the inspection of underwater search procedures, the accuracy of the used GIS-system, and the calibration and range of the used metal detectors.

The final inspection was conducted as a random inspection of grid zones.

Example no. 2: Mine and munition clearance during reconstruction works in Mostar, Bosnia and Herzegovina: From July 1995 until December 1996, DEMEX A/S was project manager for demolition and protection projects in connection with the reconstruction of buildings on the former confrontation line in Mostar, Bosnia and Herzegovina. The client was the European Union Administration of Mostar (EUAM). The city of Mostar, the second largest in Bosnia and Herzegovina and the economic and cultural centre of Herzegovina, became a place of war in 1992. After two years of war, a major part of the city was severely damaged. During the conflict, more than 5,000 buildings were damaged in the inner city. Industry and infrastructure were devastated. The city was divided by ethnic cleansing into two parts (Croats and Muslims) separated by a confrontation line. Search for and clearance of mines and UXO in the ruins were part of the project and were conducted by IFOR Engineers from a Spanish Brigade.

The clearance work was conducted in two turns:

1. Initial surface survey and survey with metal detectors and clearance of mines and munitions.
2. Clearance of mines and munitions found by the contractor during reconstruction works.

A total of 65,000 square meters of building area were surveyed and cleared by the IFOR Engineers.

Most of the munitions were found by the contractor during the reconstruction work. The majority of the munitions found were

- hand and rifle grenades
- rocket-propelled grenades (RPG)
- 82 mm mortars.

The cooperation between the military EOD teams and the contractor was satisfactory. The clearance work was conducted by military forces as humanitarian demining as part of a larger civilian reconstruction project. The work was conducted according to military principles and no documentation was made available for the contractor after the survey and clearance, creating an uncertainty with the contractor as to what was cleared and what was left in the ruins.

An example is that a certain area had been cleared and approved for beginning reconstruction work. The contractor thought that both buildings and gardens belonging to the buildings were cleared; thus, workmen were told to work in both buildings and gardens. Unfortunately, the EOD teams had only cleared the buildings, and people were therefore moving around in uncleared land. The mistake was luckily discovered before any accident occurred. Information later showed that the gardens had been mined during the war.

During the whole project, there was only one incident when a driver of an excavator was injured by a tear gas grenade and hospitalized for one day.

The work clearly proved that an improvement of the clearance work should have been to establish a quality control system in accordance, for instance, with the ISO 9000 family to achieve documentation on which level the search and clearance had been performed.

Closing Remarks

Demining operations are functions of resources, risks, and finances. Though the demining methods are based on military education and technologies, the basic elements are beyond military goals. Humanitarian/civilian mine clearance operations should be considered as projects similar to normal civilian projects (e.g., construction works) and should follow civil procedures and agreements applicable to civil project management. Thereby, QA/QC procedures of demining operations following the ISO 9000 family would be easy to implement, saving much time and money.

References

1. International Conference on Mine Clearance Technology, Copenhagen (Elsinore), Denmark, 2-4 July 1996.

2. Mine Clearance Policy Unit, DHA, United Nations, *International Standard for Humanitarian Mine Clearance Operations*, New York, NY 10017 USA, March 1997.

3. McAslan, Colonel A.R.R., "Minefield Clearance: The relevance of Quality Management Systems Including ISO 9000," Deputy Director Operational Requirements (Land Systems), UK Ministry of Defence. (undated).

4. Danish Standard. "Quality Management and Quality Management Systems. Part 1." Denmark, 1995. (Collection of the ISO 9000 Family). ISBN 87-7310-173-7.