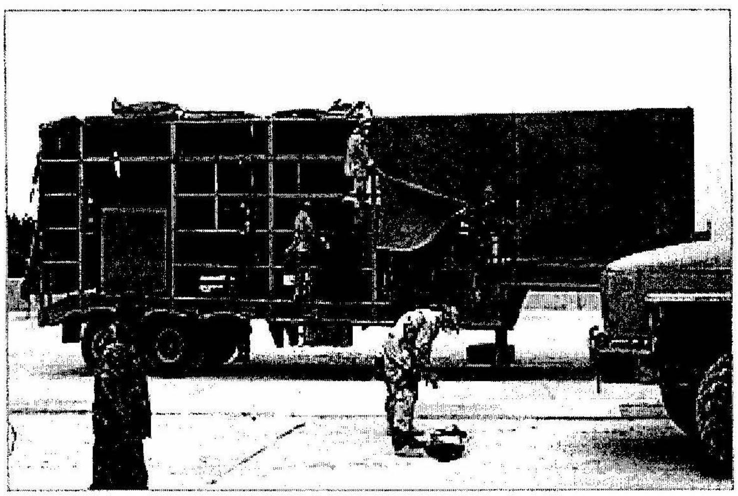

Technical Engineering Exploitation Report of Iraqi Suspect BW-Associated Trailers (U)

The Jefferson Project

June 2003

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(b)(3):10 USC 424,(b)(3):50 USC 403-1(i)

PREFACE

(b)(3):50 USC 403-1(i) ~~(S~~ [redacted] This report forwards an engineering assessment of two Iraqi BW-associated trailers—Trailer #1 from Irbil and Trailer #2 from Mosul that are currently located in Baghdad. The interagency and coalition exploitation team consisted of biological and chemical process experts and a utilities engineer. [redacted] (b)(1),1.4 (c)

(b)(3):50 USC 403-1(i) ~~(S~~ [redacted] This report is NOT an intelligence assessment nor does it reflect the findings, conclusions, or position of an agency, company or community that was represented on the team. However, it DOES forward an objective, independent, and unbiased scientific and technical engineering assessment of the Iraqi trailer and identifies functions and processes that the trailer and its associated equipment are capable of performing. Iraqi intent and purpose for the trailer, as well as possible denial and deception practices, will be investigated by another team. This follow-on team will integrate the findings of this technical report with intelligence data in order to reach a more informed and complete conclusion.

(b)(3):50 USC 403-1(i) ~~(S~~ [redacted] This team evaluated the trailers as configured and addressed the technical capabilities of the equipment and not the intent. The team was instructed to not have a Western scientific bias and although the team had been exposed to intelligence reporting on Iraqi mobile BW-trailers, it was tasked to investigate all possible trailer capabilities. The trailer inspections were performed systematically for the existing utilities and trailer components.

(b)(3):50 USC 403-1(i) ~~(S~~ [redacted] The physical inspection of the trailers was performed on 25 and 26 May 2003 (b)(1),1.4 (c) [redacted] to perform intrusive and non-destructive sampling according to the plan by the Inspection team. A preliminary executive summary of the team's findings was electronically disseminated on 27 May 2003. This report reflects the team's further study of the data collected in Baghdad and documents and diagrams the physical characteristics of the trailer to include the electrical system and all the process equipment such as the cooling water and compressed air system. The team obtained data sufficient to replicate the equipment.

(b)(3):10 USC 424 [redacted]

EXECUTIVE SUMMARY

Introduction. A group of nine technical experts performed a physical inspection of the Irbil and Mosul trailers found in Iraq from 25 to 26 May 2003. The inspection team was responsible for evaluating the trailers' intended use as presently configured. The inspection was performed systematically for the existing utilities and trailer components. The Mosul trailer was found to be incomplete in construction and looted significantly. Although the Irbil trailer was also apparently looted, the essential differences between what remains on the Mosul and Irbil trailers have been previously documented. Thus, most findings are attributed directly to the Irbil trailer where most inspection time was spent.

(b)(1),1.4 (c) [redacted]

Electrical System, Large Water Chilling System, and Large Compressor. The electrical system was traced wire-by-wire throughout the Irbil trailer. The system was designed for operation from the central control panel on the side of the trailer. All electrical cables are sized properly for existing equipment. (*i.e.*, The electrical system would require modification for more equipment to be operational.) Each equipment item was found "hard-wired" to the central control panel, and the original switches on the equipment were found removed. The "pigtail" wire remnant at the front of the trailer could potentially have been plugged to a generator mounted at the rear of the truck pulling the system or to a "house supply" when parked.

The large water chilling system is a two-staged design permitting operation at half or full capacity. None of the pipes connecting the equipment on the trailer were insulated leading to overall reduced chilling by 20% or more which helps to explain why such a large chilling system was employed.

The low pressure air compressor is a two-staged unit for operation at two different output levels. The compressor is unremarkable and is typical for an industrial process.

Reactor Vessel. The stainless steel, dome-shaped reactor vessel was inspected thoroughly, and the inspection team concluded that this vessel with modifications could support an inefficient aerobic fermentation or plausibly an anaerobic process within the existing vessel. Several features lead to the conclusion that the vessel, as it exists presently, is not practical or suitable for efficient fermentation.

Because the vessel lacks a form of mechanical agitation, methods for mixing essential to fermentation would be limited to "air lift" or "bubble column" fermentation. Physical limitations of the construction of the reactor vessel and very low potential yields of microbial growth with these physical limits make these forms of mixing impractical. Additionally, the reactor vessel lacks sight glass, process controls, a gas mixer, and ports for probes to monitor dissolved oxygen and pH or for sterile sampling typical of normal fermentors and bioreactors. In its current configuration, an anaerobic fermentation would require 400 to 500 liters of an inert gas (*i.e.*, nitrogen) to fill the head space. No evidence of separate tanks was available, but an access port that could be isolated from the air supply was present.

No effective sterilization system for the reactor to support uncontaminated microbial growth is present. Although an external steam supply could be provided, this would require several runs, and existing "dead spaces" (*i.e.*, valves, gauges, elbows, tees) would likely prevent effective sterilization of the entire system. The filtration system for the intake of air and water is not adequate to sustain a sterile system.

The reactor vessel is completely jacketed, including the top, which is a configuration not found in fermentors as headspace gas is added to aid in temperature control of the fermentation process.

Based on the structure characteristics of the attachments to the reactor vessel and the structure of the vessel itself, it is concluded that the vessel is better suited for a chemical process. The type of chemical reaction that can be supported has the following characteristics:

- exothermic reaction
- swift reaction rate and high yield
- involves water or reactants in aqueous solution
- generates a gas to be collected in compressed gas cylinders
- batch reaction as opposed to continuous mode
- requires only moderate metering or flow control of one liquid component
- does not require mixing.

The potential to use the trailers for chemical weapons production revealed that processes that could be performed were limited to simple binary reactions well known to be compatible with performance within munitions, or neutralization reactions that convert an agent from its salt. Although these reactions certainly could be performed in the trailer system, no process was identified that utilized all of the components and features of the trailer, and the identified processes that could be performed safely were better suited to a simpler arrangement of equipment.

It is possible to produce hydrogen gas on the trailer system with a process that incurs a substantial explosion hazard because there is no way to remove oxygen from the reaction vessel prior to the start of a liquid feed. Thus, the explosive mixture of hydrogen and oxygen would be present in the vessel during liquid feed, and, also, without an oxygen-free purge gas for the system, the same explosion hazard would exist during shut down.

Gas Collection System. The gas handling and processing system downstream from the reactor vessel is equipped to fill a bank of five compressed gas cylinders. To perform a 24-hour production run of an aerobic culture, approximately 160 type K compressed gas cylinders must be filled. This requires that the compressed exhaust gas must be diverted to permit a replacement of the bank of five receiving cylinders after every 45 minutes of operation. Such a procedure would require another truck to transport the collection of gas cylinders.

The performance of a simple batch chemical process, as opposed to fermentation, in the reactor, generating a gaseous product of interest, is more consistent with the system design. Chemical reactants sufficient to generate 900 moles of gas are readily accommodated with the working volume of the reactor. At the maximum flow rate of the compressor, the five cylinders would be filled in an estimated period from two to seven hours because modifications made to the compressor make it difficult provide an exact time period.

Conclusion. Although modifications that result in an inefficient fermentation process for the existing system are possible, the overall purpose of the trailer system appears to be production of a gas from a chemical reaction in the reactor vessel. Although a substantial explosion hazard does exist based on the configuration of the system, it is possible to produce hydrogen gas with the system. The overall design of the reactor vessel coupled with major discrepancies related to the structural design of the vessel, the monitoring requirements for a fermentation process, and the operational deficiencies and difficulties related to inconsistencies in volumes of gas exiting the reactor vessel lead to the conclusion that the trailer system could not be used as a transportable biological production system as the system is presently configured. (*n.b.*, The ability to achieve fermentation in a given vessel does not qualify the vessel as a biological production system. Fermentation could take place in virtually any empty vessel.) The system configuration does not appear to support other processes, although not specifically investigated, such as sewage treatment, water purification, food testing, biopesticide production, or mobile medical facility.

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INTRODUCTION

A group of nine technical experts performed a physical inspection of the Irbil and Mosul trailers found in Iraq from 25 to 26 May 2003. The inspection team was responsible for evaluating the trailers' intended use as presently configured. The Mosul trailer was found to be incomplete in construction and looted significantly. Although the Irbil trailer was also apparently looted, the essential differences between what remains on the Mosul and Irbil trailers have been previously documented. Thus, most findings are attributed directly to the Irbil trailer where most inspection time was spent.

(b)(1),1.4 (c)

TRAILER SYSTEM OVERVIEW

The major components in the trailer system are the following:

- medium-duty, low pressure, air compressor connected to five high pressure gas storage cylinders,
- two liquid storage tanks,
- water reservoir,
- domed jacketed reactor vessel, and
- high pressure gas compression system fitted to a rack for high pressure gas cylinder filling.

The air compressor, two liquid storage tanks, and water reservoir all feed into the reactor vessel. The reactor vessel, in turn, feeds into the high pressure compressor system. A chilled water supply services the reactor vessel *via* a cooling jacket, cools the oil in the high pressure compressor by means of a heat exchanger, and cools gas exiting the reactor vessel using a countercurrent pipe-in-pipe heat exchange. The water reservoir supply is used to feed water to the lower supply tank and water to the chilled water supply system. (see Equipment Schedule in Appendix 5 for equipment specifications.)

The reactor vessel is essentially identical on both the Irbil and Mosul trailers. The reactor vessel possesses two pressure gauges with ranges from 0 to 25 bar (0 to 360 psi) and from 0 to 16 kg/cm^2 (0 to 230 psi) to measure interior pressures. A safety pressure relief valve (150 psig) is also connected to the domed vessel.

A pressure gauge from 0 to 10,000 psi measures output from the high pressure compressor. Downstream pressure gauges both from 0 to 6,000 psi and a regulator valve indicated that it required an input resistance of 4,500 psi and regulated output from 1,430 to 3,330 psi. The high pressure compressor, for the capture of exhaust gases, appeared to be of sufficient size to fill gas bottles that could be accommodated downstream from the reactor vessel. The compressor was housed in what appears to be an explosion proof box which supports the collection of gases of a flammable or explosive nature. (*n.b.*, The explosion proof box would not be required for the capture for gases from fermentation.) In addition, this compressor has a heat exchanger for cooling not intrinsic to a fermentation process. The mounting for the five gas bottles downstream of the reactor vessel was designed to be tipped out and away so the bottles could be easily removed and transported.

The valves throughout the system were of a consistent material, manufacture, and type. (*i.e.*, All valves connected to the one inch diameter pipe were identical.)

Based on the existing equipment and piping comprising the trailer system, limitations to the types of operations or processes are as follows:

(1) There is no method for heating any of the various tanks, pipes, reactor vessels or other components. Only cooling can be performed for certain components.

(2) No apparent method for effectively mixing components in the domed reactor vessel is present. A one inch diameter pipe ends approximately mid-way down the working volume of the vessel, and there is no evidence of distribution piping.

(3) Only the lower storage tank has sufficient instrumentation, a flow meter and a manual pressure control, to maintain or meter the rate of material flow.

(4) The only method for putting solids into the reactor vessel is through a heavily bolted hatch (*i.e.*, man-way).

(5) The only effective gas/liquid separation available is condensed cooling of the exit gas from the reactor vessel and passage through a pair of filters.

(6) The physical location and mechanical support system for the five gas cylinders downstream of the low pressure compressor indicates the cylinders were not periodically removed and replaced, but serve as additional storage or possibly as a metering for gas into the reactor. These cylinders may also have been used in the event of a very short-term failure of the compressor. Thus, it is most unlikely that the cylinders were used to inject a material other than air into the system. (*n.b.*, A stubbed line at the end of the manifold, to which the five gas cylinders were attached, could have been used to supply gases for special purposes. A valve installed on this line and another on the manifold would allow isolation from the five gas cylinders.)

(7) The lower storage tank is plumbed directly to the water reservoir, and there is no method for purging the vessel of any water without directing all liquid into the reactor vessel. Thus, the lower storage vessel was likely used for only aqueous based liquids.

ELECTRICAL SUPPLY

Introduction. The existing electrical system, a patch-work of materials, on the Irbil trailer is accurately sized to operate all support equipment on the unit. The location of the shore-power connection point could potentially allow the unit to be provided with power while being mobile. The chiller system is most likely not-oversized for its intended operation, when considering the expected ambient operating conditions of the unit coupled with the lack of pipe insulation.

The installation of the electrical system indicates either materials were in short supply or various levels of skilled labor and experience were used. It is plausible to theorize that the better installed materials were completed by competent persons in the assembly plant, and the less presentable connections were made by technicians in the field with limited tools and supplies.