

Fuelish Errors: Taking the Risk out of Hazardous Petroleum Specialist Training with Interactive Simulations

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ABSTRACT

One of the highest risk activities within the U.S. Army and Marine Corps is the fueling of vehicles and aircraft in the field. Soldiers and Marines are constantly endangered by field operations where complex systems must be set up in combat areas under less-than-ideal conditions. These fuel supply systems are critical for successful field operation and require those manning them to follow strict protocols for the safety of personnel and equipment at all times. The 92F10 Petroleum Supply Specialist program uses interactive 3D modeling, animations, multiple game platforms, and real-world scenarios to provide initial and refresher training for U.S. Army and Marine field specialists in a non-threatening environment. Using interactive 3-D models, participants learn not only where components are located, but how they work with each other. From there, individual system elements are assembled, maintained, and disassembled for storage using a variety of simulations, games, and exercises that include every valve, lever, and switch. This allows the participating fuel specialists to gain full knowledge of the fuel system before they are placed in dangerous situations. Accessible using any current web browser, the package can be tailored to fit individual learning needs, making it ideal for initial or refresher training.

ABOUT THE AUTHORS

Gayla Thompson has a diverse background with over 35 years of experience in project management, training development, and instructional design, covering every facet of training and presentational material. She has a concentrated skill set with transportation, engineering, and management of multiple development teams. Her skills include LMS Administrator for the following: Saba, Blackboard, JKO-Nemesis, Moodle, ALMS and SUM all dealing in SCORM Packaging. Her technical expertise has proven valuable in loading APK, IOS, WebGL packages on Land War Net and Testing on all Mobile and PC platforms. Her variety of skills and technical courses make her a valued asset within many areas; Equipment operation, bituminous pavement, flexible pavement structures, concrete engineering and construction, drainage, materials used to build roadways, to name a few. She has developed computer and classroom-based training with a communication background and is recognized for her ability to work with customers and team members. Her experiences include rapid prototyping using evolving technologies, complete training systems from initial needs analysis to final product delivery, and working with customers ranging from private industry to Top Secret SCI materials for the Pentagon, United States Coast Guard and Marine Corps. She has excellent written and verbal communication skills and independently manages instructional development projects and mentors less senior designers and other team members, while providing hands-on design of learning materials. As a Sr. PM/Sr. ISD Developer, she has transitioned government asset materials to instructional material gaps; planned and implemented enhancements on existing training, which includes the design of case studies, scripts for video vignettes, and exercises, the development of instructor and participant guides, scripting of instructor notes, and developed new training materials according to the ADDIE model. Ms. Thompson has demonstrated theoretical and knowledgeable skills, experiences, and abilities to include: using Blooms Taxonomy; planning and developing Kirkpatrick 4 level evaluations; uses advance organizers, mnemonics and experiential training components; develops Instructor Guides and flow charts; uses screen capture software and animation software and storyboarding. In addition, she has manages conversion of ILT to WBT on several projects. She has used Web Seminar Design; Training Delivery Skills; and MS Project Skills on several projects. Her portfolio averages \$5 to \$20 Million per year. Additionally, she has managed training program contracts for a wide variety of contracts throughout her 27 years of military service with the United States Coast Guard and she has an extensive mechanical/civil engineering background. She is currently extending those skills to Army DLI and CASCOM, AFJROTC, NATO, AVLE, NHI, DINFOS, CDSE, NAVAIR, CAPdL and dLEPT contracts, and over 140 proposals in the last 20 years,

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INTRODUCTION

The problem faced by the Army is conveying the complicated and critical elements of the Petroleum Supply Specialist's job while maintaining personal safety for the Soldiers. As many as 4500 new Soldiers and Marines join the military as Petroleum Specialists each year. This creates an additional concern over availability of the various equipment items used in the fuel storage and delivery systems, as well as locations where large and complex fuel delivery systems can be set up.

Adding work with petroleum products to the list of "familiar" hazards that Petroleum Specialists revisit periodically is one way to solve the issue. Without reminders of the inherent dangers and a review of the steps that can be taken to mitigate the hazards, it's all too easy for Soldiers to become complacent and increase the chances of an incident. Since fueling is one of the most dangerous and resource-heavy activities in the field, the U.S. Army needed to find a solution that would provide the requisite equipment availability and setup experience while also removing the danger inherent in the use of actual systems.

Utilizing multiple 3D training environments, replicating the operational conditions, and providing the opportunity for Soldiers to brush-up on how these systems work became a crucial part of the initial training environment. The goal of this project focused on a safe, controlled environment that addressed high risk environments, lack of experience, and safety procedures. These 3D environments reach many students at all skill levels while providing them with a carefully curated lesson plan in a controlled world. These worlds provide safe and replayable exercises that challenge students and build their confidence while instilling a level of competitiveness.

Identifying the Issues

HIGH RISK ENVIRONMENTS



Figure 1: Petroleum products are inherently dangerous, creating constant fire and fume hazards.

Petroleum storage and delivery systems operate in high-risk environments where flammable and hazardous substances are handled. Exposure to such environments poses significant risks, including potential fires, explosions, leaks, and chemical exposures. Inexperienced Soldiers may not fully comprehend the hazards involved, leading to accidents that can cause injuries, property damage, or even loss of life.

LACK OF EXPERIENCE AND EXPERTISE

Soldiers and Marines just starting out with petroleum storage and delivery systems typically lack the necessary experience and expertise to handle complex equipment and processes. Inadequate knowledge of safety protocols, emergency procedures, and proper handling techniques can increase the probability of accidents and jeopardize the integrity of the system. Without proper guidance and supervision, Soldiers may inadvertently cause equipment failures or operational errors, resulting in catastrophic consequences.

INADEQUATE SAFETY

Effective safety is paramount in mitigating the risks associated with petroleum storage and delivery systems. Unfortunately, Army units may not always provide comprehensive safety knowledge for Soldiers in this field. Insufficient emphasis on safety protocols, emergency response strategies, and risk management can leave Soldiers ill-prepared to handle potential hazards. Without a solid foundation in safety practices, Soldiers may inadvertently engage in unsafe behaviors, leading to accidents or compromising the integrity of the system.

ENVIRONMENTAL IMPACTS



Figure 2: Petroleum product spills are a major environmental hazard that digital models eliminate.

Petroleum storage and delivery systems have the potential to cause significant environmental harm if mishandled or improperly maintained. Soldiers who do not have adequate focus on environmental considerations can increase the likelihood of spills, leaks, or contamination incidents. Lack of awareness regarding environmental regulations and best practices may result in accidental releases of petroleum products, endangering ecosystems, wildlife, and water sources.

SOLVING THE PROBLEM

In the realm of petroleum storage and distribution systems, the importance of equipment and systems familiarity cannot be overstated. Using actual equipment and sites can be costly, time-consuming, and potentially hazardous. However, with the advent of immersive digital technologies, a paradigm shift is underway. The Potawtomi immersive digital models and gaming solutions for petroleum storage and distribution systems have multiple advantages over traditional hands-on practice and have demonstrated enhanced safety outcomes.

REALISTIC AND SAFE SIMULATIONS

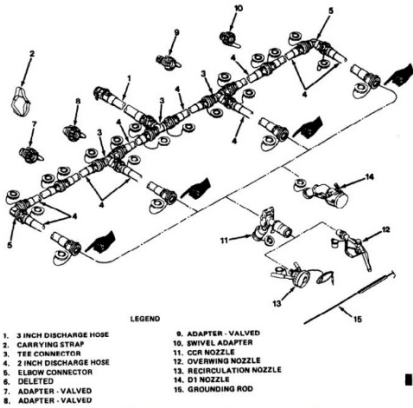


Figure 1-1. HEMTT Tanker Aviation Refueling System (HTARS)



Technical Manual Illustration and Courseware Interactive 3-D Models for HTARS

The Potawatomi digital models and gaming platforms leverage advanced computer graphics, animations, and interactive 3-D technologies to create realistic simulations of petroleum storage and distribution systems. These simulations accurately mimic the actual equipment and site conditions, providing Soldiers with an authentic experience. By using simulated environments and interactive models with the same controls and indicators, Soldiers can safely explore and interact with complex systems without the associated risks of working with flammable substances, hazardous materials, or high-pressure environments. This effectively eliminates potential accidents, injuries, and damage to equipment.

REPEATABLE AND SCALABLE PRACTICE

In a physical environment, the repetition of scenarios can be challenging and time-consuming. The Potawatomi digital gaming package overcomes this limitation by offering repeatable and scalable experiences. Soldiers can repeatedly practice specific procedures, emergency response protocols, or equipment operations in a controlled virtual environment, enabling them to refine their skills and build muscle memory.

ENHANCED ENGAGEMENT

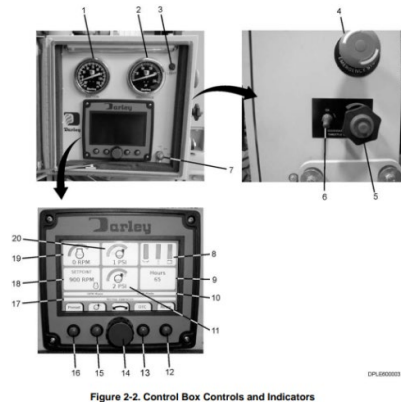


Figure 2-2. Control Box Controls and Indicators



600 GPM Pump Control Panel TM Illustration and Digital Interactive Model

The Potawatomi digital models and gaming promote active engagement and interactivity. Soldiers can actively participate in simulations, manipulate virtual equipment, and respond to realistic scenarios, fostering a deeper understanding of the concepts and procedures involved in petroleum storage and distribution systems. The visual and interactive nature of digital models stimulate cognitive engagement, leading to improved retention and transfer of knowledge. Additionally, immersive experiences evoke a sense of presence and emotional connection, making the experience more engaging and memorable for Soldiers.

COST-EFFECTIVENESS

One of the biggest benefits of the Potawatomi digital models and gaming packages are cost-effectiveness. Constructing and maintaining physical facilities, as well as procuring and maintaining real equipment, can be

prohibitively expensive. In contrast, immersive digital gaming utilizes virtual environments and simulations, eliminating the need for costly infrastructure and equipment. How does this impact safety? By making the systems accessible to more Soldiers and expanding its application cost-effectively as on-demand refresher practice. This technology offers a more accessible and affordable option, enabling organizations to provide experience to a larger number of Soldiers.

Complete Operation and Maintenance Practice on Petroleum Storage and Distribution Systems

Previous Petroleum Supply Specialist experience has been adapted and expanded into an interactive blended web-based environment that allows Soldiers to apply what they have learned in an immersive environment utilizing real world scenarios. Extensive interactive 3D modeling and a wide variety of gaming environments with real-world situations provide a much more complete experience that retains the safety of computer-based gaming while providing a form of ‘hands-on’ experience. Instead of flat drawings, the Soldiers interact with switches, knobs, valves, and other components as they go through the steps to set up, operate, and then disassemble equipment. Gaming environments are used to apply knowledge in a logical process, just as if the learner were performing with actual equipment and live supervision.

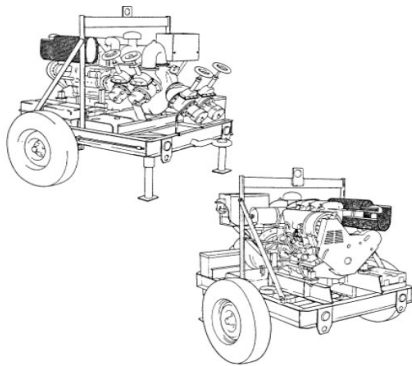


Figure 20-6. The 350-GPM pumping assembly



The 350 GPM Pumping Assembly as seen in the TM and the rotatable interactive 3-D Model

Developed for WebGL, APK, and IOS platforms, the Potawatomi 3-D models can be accessed by current generation web browsers on both PCs and mobile devices, allowing field or other independent location usage. The Unity portion provides Soldiers with the ability to interact with models and places Soldiers in the real-world environment, creates a realistic 3D environment, and simulates these activities during operational activities. These simulations encompass all types of real-world conditions and world physics to replicate each aspect a Soldier would encounter.

FLAMMABILITY AND HEALTH HAZARDS

The fire and explosion potential of petroleum products is their primary hazards. Vapors are heavier than air and tend to “pool” in excavations and pits common to field petroleum installations. Although most field installations will have enough natural ventilation to remove these vapors, they can collect around pumps and other equipment. Strict safety protocols are required to prevent the risk of accidental injury or death, often explained using actual products and equipment. These creates a serious risk factor for Soldiers.

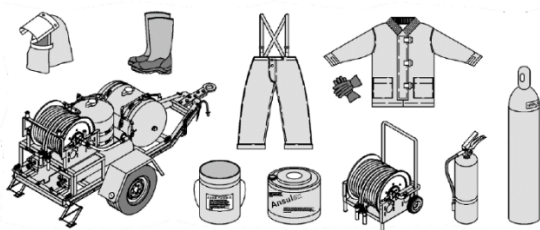


Figure 2-11. Fire suppression equipment



TM illustrations and the interactive 3-D Models and Images

The fumes from petroleum products can also damage lungs, skin, and eyes, with dangers often magnified by additives in the special fuel products distributed to aircraft and other equipment. Short-and long-term exposures can result in health problems. Issues such as skin chapping and drying are common immediate problems caused by the loss of skin's protective oils. More serious long-term effects include burns and infections, as well as a risk of lead poisoning when using petroleum products with lead additives.



Manifold Virtual Environment with highlighted pipes to show fuel flow

Petroleum products play a vital role in various industries, including energy production, transportation, and manufacturing. While these products offer numerous benefits, it is crucial to understand the inherent flammability and health hazards associated with their handling and use.

REMOVING THE DANGER

Potawatomi digital modeling eliminates the need for actual fuels, thus removing the inherent dangers of previous petroleum specialist practice. Soldiers and Marines new to fuel delivery systems, component, and methods do not handle fuels until after they have practiced the required safety precautions and protocols.



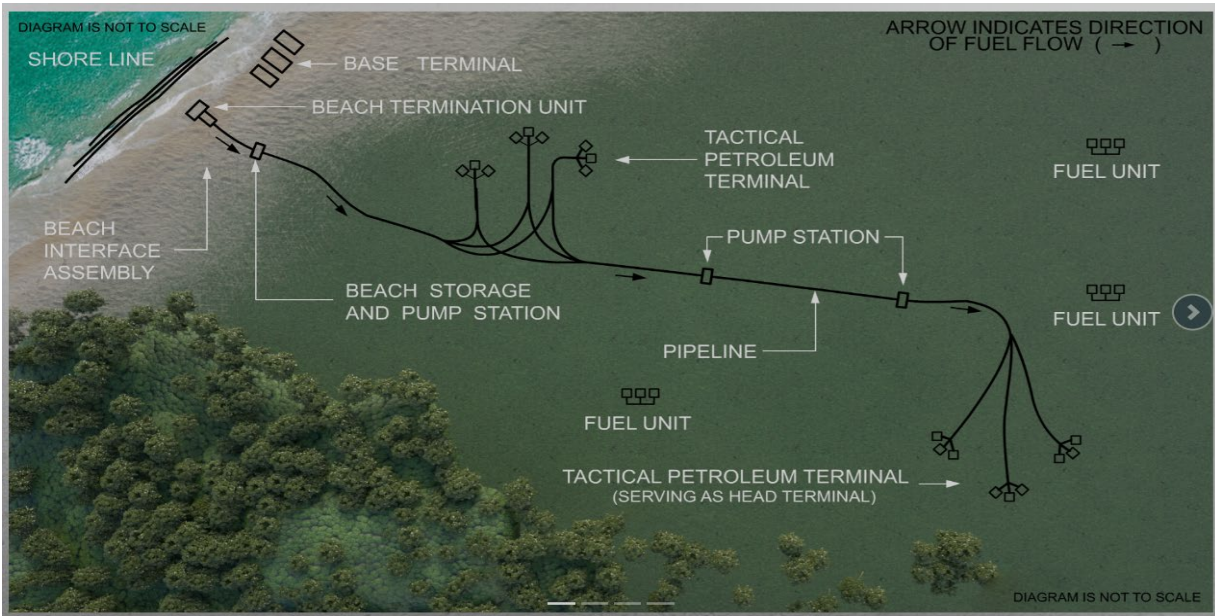
Interactive fire apparatus 3-D model

Through the use of interactive 3-D models and system simulations, Soldiers can do fuel testing; leak repairs; and full system setup, operation, and teardown without the hazards and expense of petroleum products or scarce equipment. These models and simulations require Soldiers to perform the same actions as they would using the actual equipment. As with the removal of health and safety hazards for personnel, the use of digital modeling eliminates the need for actual petroleum product use, as well as the harm caused to the ecology from assembling fuel dispersal equipment on site.

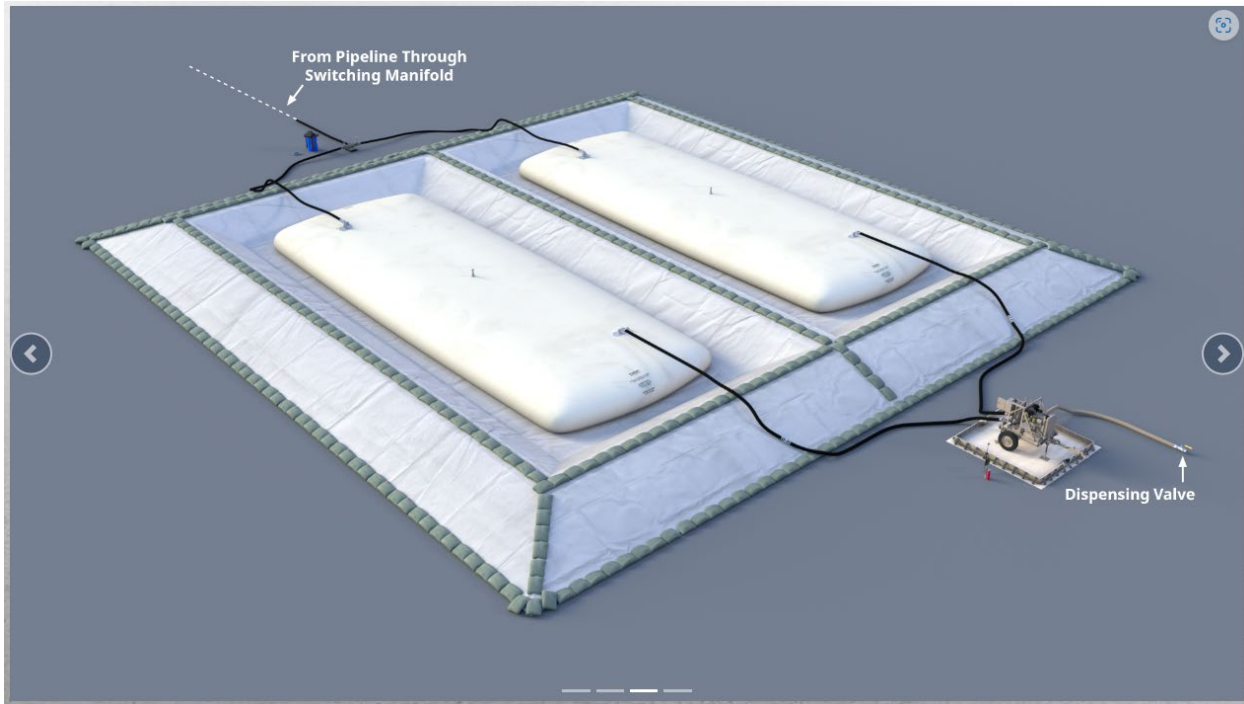
PRACTICING SYSTEM SET UP WITH ECOLOGICAL AND ENVIRONMENTAL SAFETY

One of the biggest issues with petroleum specialist practice is where system setup can be performed. Besides the environmental concerns, a typical U.S. Army petroleum distribution system can extend for miles. Trying to build a pump site and the connected pipelines to and from fuel supplies to receiving aircraft, vehicles, and equipment is difficult, and requires extensive resources and available land areas.

The Petroleum Specialist digital gaming package allows the learner complete setup capability on a desktop, laptop, or handheld device. Sample terrains with real-world issues provide both basic practice and specialized problem-solving for Soldiers and Marines.



Virtual Site Selection



Virtual equipment setup and data gathering



Interactive Setup Activity

By eliminating the need for actual setup, Petroleum Specialists can practice anywhere regardless of outside weather conditions or availability of work sites. Soldiers will get more complete experience without endangering themselves, others, or the environment.

CONCLUSION

The Potawatomi Systems Petroleum Specialist digital 3D models and gaming packages have removed the danger of high-risk situations while accomplishing a much more complete and realistic experience for Soldiers that can be used regardless of location. Immersive digital gaming has revolutionized the way petroleum storage and distribution systems are practiced. With its cost-effectiveness, realistic simulations, scalability, and enhanced hands-on experiences, this technology offers numerous benefits over traditional methods. Although the benefits of not needing actual equipment and locations are huge in themselves, the bigger benefit is safety for our Soldiers, Marines, and the environment. By embracing the Potawatomi Petroleum Specialist digital gaming and 3D models. The U.S. Army and Marines can create safer, more accessible, and highly effective experience to provide the necessary skills and expertise to excel in the petroleum industry.

ACKNOWLEDGEMENTS



The Quartermaster (QM) School of the United States Army Combined Arms Support Command (CASCOM) G3/5/7 Training Development Directorate (TDDF) Fort Gregg-Adams, VA is responsible for the development and maintenance of Programs of Instruction (POI), courses and lesson plans that support the Military Occupational Specialty (MOS) of the 92F10 Petroleum Supply Specialist. The Quartermaster School has embarked on a change to the current training methodology, the Blended Learning Environment. This blended learning update promises to have a dramatic impact on the way Quartermaster Soldiers learn, which falls directly in line with the requirements of the Army Learning Concept (ALC) for Training and Education. Special thanks to all Petroleum Staff and Subject Matter Experts that played a huge role in the successes of these products.



Potawatomi Training, LLC (PT) is a Small Business Administration (SBA)-certified 8(a) and HUBZone Small Disadvantaged Business (SDB) and American Indian Tribal (AIT)-owned company headquartered in Milwaukee, WI. PT is a premier provider of training and training support services to the Federal Government. We specialize in instructional delivery, courseware and doctrine development, technical analysis, information technology (IT), and training and evaluation services. Part of the Team special thanks to Rachael Murray, Project Manager and Phil DeAlmedia Lead Software Architect for the overall framework and serious game, both members were a key contributors to the success of this project.

REFERENCES

N/A