US Army TARDEC
Fuels and Lubricants Research Facility

# Low-Volatile and Ozone-Depleting Compound Free Solid Film Lubricant

**by Timothy L. Marbach, Bernie R. Wright, and Cynthia F. Palacios**

**Interim Report TFLRF No. 340, DTIC No. AD A394121**

**Problems and Objectives:** Air-cured formulations of solid film lubricants (SFLs) for Military Specification MIL-L-46147 currently contain solvents such as methyl alcohol, methyl ethyl ketone, and toluene, which are volatile organic compounds (VOC) that are on the Environmental Protection Agency's (EPA) toxic chemical list. These formulations also contain lead and antimony, which are hazardous and potentially carcinogenic. In order to comply with environmental regulations, and to protect the health of personnel, it is necessary to reduce VOC content and eliminate lead and antimony from SFL formulations.

**Importance of Project:** SFLs are widely used throughout the Department of Defense (DoD) to meet lubrication requirements in critical weapon system applications. This type of lubricant is often used in applications where a liquid lubricant would be difficult to apply, or where contamination from dirt and other particles would be detrimental.

**Technical Approach:** Candidate formulations were identified and brought to the TARDEC Fuels and Lubricants Research Facility (TARDEC) at Southwest Research Institute (SwRI) in San Antonio, Tx. The main component of this project consisted of laboratory testing and analysis of possible MIL-L-46147B, Type II lubricants. All of the tests required by MIL-L-46147 were performed, with the exception of storage stability. Lead and antimony content was also tested.

**Accomplishments:** This project resulted in a set of data about commercial products that could be used as MIL-L-46147B, Type II lubricants. While none of the products tested at TFLRF are acceptable for use under MIL-L-46147B, a SFL formulation containing no lead, antimony or VOCs, which meets the military specification, appears feasible. The advancement of pigments and binders is necessary to meet this objective.

**Military Impact:** The results of this project show the possibility of limiting VOC content and eliminating lead and antimony from SFL formulations.

**Potential Solution:** Carbon dioxide exists as a liquid at high pressure, 5 to 1000 atm, and a wide temperature range, from –57°C to 30°C (Figure 1). Supercritical liquid exists at higher pressure and temperature, but state boundries are not clearly defined in this region above the critical state. If liquid $CO_2$ could be used to dissolve the product's binder, this fluid could be used as both a solvent and spraying medium. That is, the pressurized liquid lubricant could be released through a spraying nozzle. The $CO_2$ would quickly vaporize, and the bonded lubricant would be cured in seconds. This process holds substantial advantages over the current SFL application process. First, a $CO_2$ based lubricant would emit no VOCs. Second, the time needed to lubricate a part would decrease dramatically. The part could be lubricated and used just seconds later, rather than 24 hours. Also, more-portable, all-in-one spraying containers could be developed for field use.

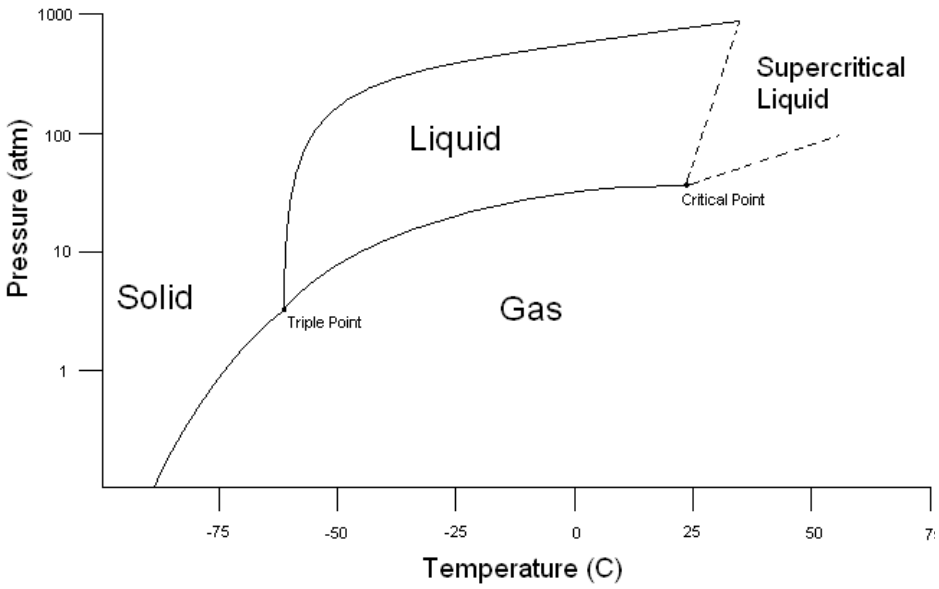


**Figure 1: Carbon Dioxide Pressure vs. Temperature Diagram**