Dear Mr. Healy,

Thank you for your inquiry regarding the environmental impact of the use of various formulations for firefighting foams. This issue is one that has received a great deal of attention in the U.S., as it has in Australia.

The Naval Research Laboratory (NRL), located in Washington, D.C., conducts qualification testing of foams against DoD standard, MIL-F-24385F, which governs Aqueous Film Forming Foam (AFFF) performance for DoD use. In addition, NRL has conducted various research projects on AFFF and alternative foam technologies, and has a great deal of experience with the Solberg RF6 fluorine-free foam product, which was originally developed by 3M Australia.

RF6 presently does not conform to the MIL-F-24385F, and cannot be used as an AFFF substitute in U.S. DoD applications which require MILSPEC AFFF. There are three principal reasons for this:

1) MIL-F-24385F explicitly states that AFFF must contain fluorosurfactants. In addition, it requires that all qualified products must be cross-compatible (two or more products mixed in any proportions must maintain the same fire-fighting performance). This would be difficult to achieve for a non-AFFF foam.

2) Although RF6 has good fire suppression performance, it falls short of MIL-F-24385F requirements. Fire extinguishment times for a 6-foot diameter gasoline test fire (as tested by NRL) range between 35-40 seconds, compared to a 30 second maximum in the MIL-F-24385F standard, and a typical performance of 23-25 seconds for DoD qualified AFFFs. An extinguishment time as short as possible is critical for applications such as aircraft carrier flight decks, where fires must be extinguished before ordnance cook-off. Whether a nonfluorinated foam such as RF6 will provide an adequate level of protection for Australian Department of Defence needs will obviously depend on the details of the application (fire threats, application rate, and potential for collateral damage).

3) As presently formulated, the RF6 concentrate is very viscous, and would not be compatible with existing proportioning systems which require a low viscosity concentrate. MIL-F-24385F has a concentrate viscosity specification for this reason.

The issue of the relative environmental effects of different foam products is complicated, as there are several different classes of possible environmental effects which are not directly comparable, which includes:

- All AFFFs (but not fluorine-free foams such as RF6) contain fluorosurfactants, which are environmentally persistent as a class. As a result of legacy AFFF use, a number of present and former DoD sites have soil and groundwater contamination by

fluorosurfactants. The DoD Strategic Environmental R&D Program (SERDP) has funded a number of research projects to characterize the types and occurrence of fluorosurfactant contamination from legacy AFFF use, and to identify technologies for remediation. Research in this area is continuing, but at present there is no straightforward treatment technology once fluorosurfactants are dispersed into the environment.

- Perfluorooctane sulfonate (PFOS) is a specific class of fluorosurfactants which was manufactured by 3M and was used primarily in 3M's AFFF products. We are unaware of the presence of PFOS in any of the current MILSPEC AFFFs, including the Ansul products. The enclosed paper, describing a research project analyzing the surfactant composition of all MILSPEC AFFFs (funded under the SERDP program mentioned above) identifies PFOS only in the 3M products.

- Perfluorooctanoic acid (PFOA) sometimes called "C8" is not present in MILSPEC AFFFs, but in some cases the surfactants in AFFF can degrade into PFOA in the environment. The key factor for this to occur is the presence of an eight carbon fluorinated "tail" on the surfactant molecule. The non-PFOS fluorosurfactants currently used in AFFF have predominantly a six-carbon tail, which cannot form PFOA. However, they typically have an eight-carbon tail impurity. One of the current issues in AFFF is reformulation of the fluorosurfactants to greatly reduce the eight-carbon impurity. This will require reformulation of the AFFFs and their re-qualification under the MIL-F-24385F standard. In short, the current AFFFs do not contain PFOS, will not contain significant materials capable of degrading into PFOA after reformulation, but do contain fluorosurfactants which are environmentally persistent.

- In addition to fluorosurfactants, AFFF can have acute environmental effects. There can be acute toxicity to aquatic life forms, particularly fish. The mechanism of fish toxicity is the adherence of non-fluorinated surfactants to the fishes' gills, causing suffocation. Because RF6 contains no fluorosurfactants but does contain non-fluorinated surfactants, it has greater fish toxicity. The statement quoted in your letter that RF6 is "ten times more toxic to the environment" than Ansulite probably refers to fish toxicity. All of the components of RF6, however, degrade quickly in the environment, so there is no straightforward way to compare a short-term environmental effect with the dispersal of an environmentally-persistent compound.

- Because AFFF and fluorine-free foams contain hydrocarbons which can be biodegraded, their oxidation can cause depletion of oxygen if large amounts are discharged into a small body of water. For this reason, MIL-F-24385F specifies a maximum chemical oxygen demand (COD) as well as a minimum ratio of biological oxygen demand (BOD) to COD.

The Naval Sea Systems Command (NAVSEA) and the Naval Research Laboratory (NRL) under The Technical Cooperation Program (TTCP) will continue to interface and share with our Australian partners any germane information that may pertain to this important on-going environmental review of AFFF and any future alternative fluorine-free firefighting foam products.