BACKGROUND PAPER ON AIR FORCE USE OF SF_6 IN TRACER GAS APPLICATIONS

1. Implications of a Ban on Air Force Use of SF_6 as a Tracer Gas

Unlike non-military entities, the Air Force faces unique challenges in that we must perform our national defense and security missions while simultaneously satisfying our environmental obligations. California's proposed regulations to restrict the use of sulfur hexafluoride (SF_6) in tracer gas applications after 1 January 2013 would gravely jeopardize planned Air Force field test efforts and render our existing tracer gas analyzer (TGA) measurement array obsolete before its time. Maintaining equivalent mission capability would require an extensive retooling of the existing SF_6-based system to accommodate the use of alternative perfluorocarbon (PFC) tracer gas. Such a retooling would take several years to accomplish and additional field tests would have to be performed in order to revalidate already mature atmospheric dispersion models with the new system. The additional field tests would certainly compromise national security capabilities by negating years of cumulative data already obtained in the tracer gas program. An unqualified prohibition of the use of SF_6 in military tracer gas applications is imprudent not only for its national security implications, but would also result in a time intensive and costly new learning curve.

2. Historical Perspective and Applications of Tracer Gases

a. The electron capture detector (ECD) arguably helped usher in the age of environmentalism with its selective sensitivity to pesticides and chlorofluorocarbons (CFCs). The ECD also opened the door to the use of SF_6 as a conservative gaseous tracer with limits of detectability in the previously unattainable parts-per-trillion by volume (PPTv) range.

b. Short range tracer experiments (such as for odor complaint resolution) are frequently performed to define local source-receptor relationships as well as to characterize building ventilation systems. Additionally, tracers have been used to locate leaks in underground storage tanks and underground cabling. Longer range transport studies have been carried out in urban areas, within geographical regions and across continents.

c. Increasing background concentrations of SF_6 and its classification as a greenhouse gas (GHG) have prompted the recent development of alternative methods that utilize PFCs as atmospheric tracers. PFCs exhibit extremely low global background levels and are detectable at concentrations of parts per quadrillion (PPQv) by volume. While PFCs are themselves recognized as GHGs, as a class of chemicals they exert less of a global warming impact than does SF_6. PFCs have recently become the tracer of choice for most atmospheric dispersion studies where a combination of sensitivity and/or the need to simultaneously tag multiple sources is required, and are also used in vadose zone groundwater contamination partitioning studies.

3. U.S. Air Force Atmospheric Tracer Programs

a. As a result of early above-ground nuclear weapons testing, the ability to detect and analyze the long-ranging effects of atmospheric transport and diffusion of airborne particles became an area of interest to the Federal government as early as the 1940s. In order to meet these needs, the Air Force performs global nuclear treaty monitoring and nuclear event detection, and conducts field test programs to obtain empirical data needed to validate transport and dispersion computer and modeling simulation efforts.

b. Air Force Tracer program investments have focused primarily on a TGA network that facilitates real-time measuring and reporting of SF_6 concentration levels during field tests. Comprised of 36 portable, ultra-sensitive SF_6 gas analyzers and a central control base station, the

TGA network is available to (and has been used by) other U.S. government agencies in support of their individual missions. The expected remaining functional life of the TGA network suggests equipment replacement activities will need to commence by approximately 2018, and will take 2-3 years to complete.

c. The Air Force tracer gas program has evaluated federal test sites nationwide for terrain suitability compatible with our national security-driven Air Force requirements. Because of ideal terrain and meteorological conditions, California was chosen as the optimum location for the conduct of our tracer gas studies. Accordingly, the Air Force has conducted tracer gas studies in California after consultation with local Air Pollution Control District personnel. As indicated in the table below, since 2001 the Air Force has used approximately 2422 kg of SF_6 in field tests in California on a periodic basis. This periodic use is consistent with a mission planning and execution process that, depending on the complexity of the particular mission and the field tests required supporting it, may take from 2-5 years to accomplish. It is important to note that the TGA equipment possesses a real-time monitoring mechanism of SF_6 release. This allows tests to be automatically discontinued after release starts due to uncontrollable changes in atmospheric/meteorological conditions, thus preventing unnecessary amounts of SF_6 to be released.

Air Force SF_6 Tracer Gas Use in California	
Year	**Quantity Used (kg)**
2001	0
2002	0
2003	0
2004	622
2005	1800
2006	0
2007	0

2008	0

d. The Air Force has already begun investigating the use and performance of PFC alternatives to SF_6 in related field test activities. The PFC ECD is 500–1000 times more sensitive than similar SF_6 ECDs, meaning one could perform an equivalent test using 2 kg of a PFC instead of 1000 kg of SF_6. The increased sensitivity of PFC ECDs, and background atmospheric concentrations of PFCs that are lower than those of SF_6, are appealing characteristics for the Air Force atmospheric tracer program.

e. In tests conducted in California in 2007, approximately 60 kg each of three distinct PFCs (perfluoromethylcyclopentane, perfluoromethylcyclo-hexane, and perfluoro-1,3,5-trimethylcyclohexane) were used by the Air Force. The tests were conducted using traditional bag samplers. The use of bag samplers reduces the ability of the Air Force to dynamically alter test activities to meet changing environmental conditions. The consequence of not having real-time data includes having to re-accomplish logistically complex and expensive tests.

4. Request for Waiver

a. In light of the national security function of the Air Force atmospheric tracer program, the periodic use of small quantities of SF_6, and the expected remaining functional life of the existing TGA network, the Air Force requests and recommends the proposed ARB regulation to restrict the use of SF6 in non-electricity and non-semi-conductor applications include a new line item at §95343(b) for "Military Tracer Gas Use", with an effective date of 1 January 2020. Inclusion of such as provision will provide continuity to the tracer program by allowing the Air Force to: execute field test efforts for which planning has already commenced; evaluate alternative technologies; and begin planning for the replacement of the existing TGA network equipment with more sensitive PFC or other ECD technologies.