REVIEW OF AIRBUS WATER MIST FIRE SUPPRESSION PROJECT

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Objective:

This paper provides an overview of the planned Airbus Water Mist Fire Suppression Project incorporating the fire suppression system of Life Mist Technologies, Inc. as the primary water mist/nitrogen test platform.

Overview:

Life Mist Technologies, Inc. (LMT) has been chosen to participate in an Airbus funded Water Mist Fire Suppression Project, the NERO Project, with an objective to prove the effectiveness of the LMT low pressure mist technology as a suitable, weight efficient replacement for halon in commercial aircraft cargo holds. Airbus has contracted with Life Mist Technologies, Inc. to conduct an extensive test campaign of Life Mist's water mist/nitrogen fire suppression system using the protocols outlined in the Federal Aviation Administration Minimum Performance Standard for Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems (FAA MPS). This test campaign is a confirmation of the proactive approach Airbus is taking to finding and implementing a safe, effective, environmentally friendly fire suppression system that also has the unique attributes required for aircraft implementation. Likewise, the choice of the Life Mist system is an affirmation of its unique attributes that qualify it as a "viable" replacement for halon in aircraft applications.

Background:

The FAA MPS:

The US Federal Aviation Administration has devised a test regime to the highest airline industry and fire suppressing standards to evaluate halon replacement agents and systems for aircraft cargo holds. Under the leadership of FAA's Gus Sarkos and Dick Hill, and devised and refined by Dave Blake and John Reinhardt, the MPS has come to represent the accepted litmus test for "viable" halon replacement. This includes effectiveness equal to or better than halon; suitability requirements of non-toxicity, non-damaging to the environment, and non-corrosive or otherwise harmful to the aircraft. The system also must come in at a system weight comparable to halon. The FAA has exhaustively tested every promising fire suppressing agent available over the past 13 years or more with only water mist / nitrogen achieving success. The Halon Options Technical Working Group has played a key role in the development and refinement of the subject tests.

Briefly, the MPS consists of the following:

> Test Environment
> A test chamber dimensioned to replicate the cargo compartment of a modern wide bodied aircraft, roughly 2,000 cubic feet, and outfitted with thermocouples and oxygen sensors as well as a means to replicate a leakage rate of about 50 cubic

feet/minute (agreed to be representative of actual leakage rates during flight conditions).

Test Protocols

A series of four fire tests consisting of (A) a Bulk Load test with a fire load of 178 cardboard boxes each filled with 2 ½ pounds of shredded paper; (B) a Containerized Test with 33 cardboard boxes inside a replicated LD3 bracketed with two other LD3s; (C) a Surface Burn test with simulated ½ gallon of Jet A fuel mixed with 13 ounces of gasoline; and (D) an Aerosol Can Explosion Test. The first two tests are essentially "deep seated" fires while the Aerosol Can test combines elements of the Bulk Load, "deep seated" fire scenario with the explosive potential.

The Life Mist System:

Most high pressure water mist nozzles create mist by forcing water through tiny holes. Experts state that by increasing the pressure, often to over 1,000 psi, a small droplet profile may be obtained. In contrast, the enabling technology behind the Life Mist system is a dual-fluid nozzle that atomizes water into sub 100 micron sized droplets utilizing water and gas at very low pressures. Invented by Professor Yulian Borisov of the Andreyev Acoustics Institute of Moscow, Russia, the Yulian Nozzle creates high volumes of water mist in a narrow, small-droplet profile through an acoustic shock-wave phenomenon. This proprietary nozzle is a rugged device with no moving parts. Gas enters the nozzle at a nominal 60 to 80 psi and is accelerated to supersonic speeds. Upon its exit from the nozzle, the gas impinges on a resonator plate creating extremely efficient shock waves. Water enters the nozzle at a very low 4-10 psi, and it is then atomized at the resonator plate producing an ultra fine mist. By adjusting the gas and water pressures, the mist droplet volume and size profile can be scaled appropriately for the application.

Life Mist passes the MPS tests in September, 2002:

To date, the only fire suppressing agent to meet all the stringent MPS criteria has been water mist/nitrogen. Further, the Life Mist system is the only "flyable" water mist/nitrogen system to have passed the tests; these tests were completed during the summer of 2002 at a burn facility built to FAA specifications in Moscow. LMT was proceeding with these tests at roughly the same time that the FAA's John Reinhardt was testing a hybrid water mist/nitrogen system he had assembled at the FAA test facilities in Pomona, New Jersey. John also passed the MPS with this hybrid water mist system. However, it was high pressure (1150 psi) and thus required 32 nozzles and thick steel piping. Consequently, it was very weighty. To our knowledge, these are the only two systems to have passed these rigorous protocols.

During the Life Mist tests, two US engineers were employed by Life Mist to ensure exact replication of the US standards. All specifications and test protocols were reviewed with John Reinhardt and the tests were directly observed by two engineers from a major aircraft manufacturing company as well as scientists and engineers of the Andreyev Acoustics Institute. The resultant test report document has been shared with the FAA officials as well as the engineering staffs of the major aircraft manufacturing companies.

The only deviation Life Mist made from the strict MPS protocol was in the Aerosol Can Explosion Test. Due to the location and construction of the burn chamber, it was considered too dangerous to risk an actual explosion should there be any missteps. In its place, a

substitute means was discussed, and agreed to in principle with John Reinhardt, to use a continually dispersing propane source with a continuous electrical arc that would indicate the potential for any ignition.

It should be noted that during the 2002 Life Mist MPS testing, the LMT system employed 9 nozzles, each with a discharge capacity of 2 Kgs of Nitrogen and 2 liters of water. During 2005, LMT developed a refined nozzle capable of using significantly less nitrogen to produce the same amount of water mist. During the upcoming testing, it is envisioned that no more than 4 nozzles will be needed.

Another development with potential impact upon the use of water mist/nitrogen aboard aircraft is the current movement towards using Onboard Inert Gas Generating Systems (OBIGGS). These are nitrogen generating systems designed to pump inerting gas into the center-wing fuel tanks to prevent combustion. It is envisioned that this nitrogen could be diverted to the cargo hold in the event of a cargo fire. Although still requiring another fire suppressant system to provide initial fire knock-down, such as LMT's water mist/nitrogen system, this nitrogen inflow would provide long-term inertion for the remainder of the flight.

What makes the MPS test conditions somewhat more difficult than actual flight conditions is that it takes place at ground level with a resultant high ambient oxygen level. Yet, the Life Mist system had no difficulty in extinguishing the fires and bringing the temperatures down below FAA specified levels within the acceptable time frames.

Based upon the successful MPS results and personal observations of the Life Mist system in Moscow by Konstantine Kallergis and Rainer Beuermann, Airbus administrative engineers responsible for fire safety, the Life Mist system was chosen for the Airbus "NERO" project.

The NERO Project:

The Airbus "NERO" Project has been developed and will be managed by Rainer Beuermann, of Airbus, who has full time responsibility for fire suppression and detection at Airbus facilities in Bremen, Germany. The project is intended to provide extensive development and testing to prove the concept of water mist/nitrogen fire suppression in aircraft cargo holds and to determine actual installation parameters to replace halon systems aboard Airbus manufactured planes. The primary goals of the "NERO" project include:

- Development and design of a water mist/nitrogen cargo compartment fire suppression system with major considerations being effectiveness, weight, simplicity, and robustness while being non-damaging to life and the environment.
- Design a system that meets the FAA's MPS[1] test criteria with additional Airbus requirements. With proven ability to pass the MPS, the Life Mist Aircraft Fire Suppression System was chosen to be the primary test platform for this project.

Project Description:

Initial NERO testing shall be held at Life Mist's partner facilities at the Andreyev Acoustics Institute, Moscow, Russia. The following tests will be conducted:

- Water Mist commissioning tests to determine all system components and specifications to be used in the NERO MPS project.
- Full-scale water mist tests according to MPS test criteria. This initial testing will rely solely on the LMT water mist system without benefit of supplemental nitrogen from

an OBIGGS/NEA system. (Subsequent NERO testing will include use of an OBIGGS.

The above testing campaign is scheduled to be conducted during June and July of 2006.

Summary:

The Airbus "NERO" Project represents an opportunity to prove water mist/nitrogen as a viable halon alternative. This initiative by Airbus indicates their commitment to evaluate environmentally friendly technologies. It also allows Life Mist Technologies to work in partnership with a major airframe manufacturer to demonstrate the effectiveness of its low pressure, acoustic method of mist production with nitrogen. In addition to showing fire suppression efficacy by testing according to the FAA's MPS protocol, Airbus and Life Mist are working collaboratively to demonstrate that a water mist/nitrogen system can also meet the stringent weight expectations for aircraft fire suppression systems.

Subsequent phases of the NERO Project will include further testing incorporating an integral OBIGGS and then further MPS testing in a burn chamber scaled for a smaller "single aisle" aircraft cargo compartment.

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References:

1. DOT/FAA/AR-TN05/20: Minimum Performance Standard for Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems (2^{nd} Update).
2. DOT/FAA/AR-01/121: The Evaluation of Water Mist With and Without Nitrogen as an Aircraft Cargo Compartment Fire Suppression System, John W. Reinhardt, February, 2002.
3. Performance Testing of the Life Mist Fire Suppression System: Results of testing conducted at the Andreyev Acoustics Institute, Moscow, Russia, during September 2002. Performance was measured against Minimum Performance Standards of the U.S. Federal Aviation Administration.