NEW PRODUCTS **USING** PARTICULATE AEROSOLS TECHNOLOGY (SFE)

by

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ABSTRACT

The new emerging technology of creating finely dispersed aerosols by pyrotechnic means and using them as an efficient extinguishing medium has introduced to the fire protection market new products and applications. The present paper describes a family of such products, their various applications as well as technological problems related to the aerosol generation and the specific solutions.

Test results as well as a video film describe the various fire scenarios, SFE products and their application modes.

1. INTRODUCTION

The accelerated phase-out of Halons and CFC has created an ongoing challenge for the experts that are involved in the protection of life and property, especially in the fire suppression market.

The search for a new fire extinguishing agent with the following qualifications is a must:

a. Powerful and efficient fire extinguishing agent

b. Non toxic.

c. Zero ODP (Ozone Depletion Potential).

d. No GWP (no contribution to Global Warming Potential).

e. Electrically non conductive.

g. Long storage life.

h. Provide low space/weight impact.

i. Competitive in cost .

The key feature of Halon 1301 and the possible reason for its wide use today was its high extinguishing power to weight ratio as compared to the CO_2 which was widely used in the past.

The relatively low toxicity was another important feature that has contributed to its use for total flooding systems in occupied areas.

The proposed SFE family of extinguishing agents and associated technologies provides a new class of fire suppressants which meet all of these qualifications and more. This new class of fire extinguishing agents known as SFE or EMAA (Encapsulated Micron Aerosol Agents) offer an air suspended dry chemical aerosol with micron size particles, that provide total flood capabilities three times more efficient than regular dry powders and five times more efficient than halocarbon extinguishing agents.

2. TECHNOLOGICAL BACKGROUND

The S.F.E. compound in it's various forms, upon activation ignites and creates an aerosol that contains about 40% solid particles (size of particle less than 1μ) of salts like KCl, K_2CO_3, etc. and the rest of 60% gaseous combustion products such as CO_2, N_2, H_2O, O_2 and traces (ppm) of hydrocarbons.

The Aerosol solid particles, as a result of the high temperature of combustion, create a large surface area for capturing active species of the fire chain, such as hydroxils (OH) which are considered to be the fire chain carriers. The smaller particle size provides for better dispersion and more effective Aerosol E. As the particle size decreases the extinguishing surface of the Aerosol on which heterogenous recombination of the chain propagators takes place, increases.

Moreover, as the size of the particles diminishes, rate of sublimation increases and the extinguishing effect is augmented by homogenous gas phase inhibition of the fire/flame through the interference of gaseous products forming from the condensed part of the Aerosol.

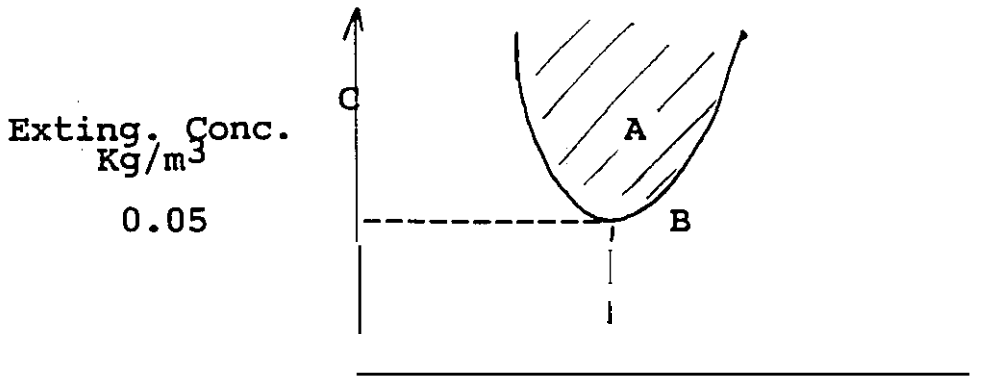
It can be summarized that both heterogenous inhibition (on the surface of the solid particles) as well as homogenous inhibition (in the gaseous phase) take place in the extinguishing process.

Physical characteristics of the solid compound include:

- Specific density	ρ = 1.6-1.8x10^{3}Kg/m^3
- Combustion Temp (°K)	T = 1500-2400°K
- Combustion Velocity (mm/Sec)	U = 0.3-1.5mm/sec
- Shelf Life	15 years
- Texture	Solid uniform or fine gelled paste.

The amount of the extinguishing agent required for effective fast action is described by the following relation:

V	x	0.05	=	Q
Volume to (m^3) be protected				Amount of (Kg) material



Rate of Application
Kg / m3 sec

A - The area of extinguishing effectiveness
B - The optimal application rate and extinguishing concentration

The build-up of this optimal condition depends on the fire scenario configuration, and could be applied from various equipment (apparatus) such as:

1. Hand held extinguishers
2. Local application aerosol generators
3. Total flood aerosol generators
4. Specific destructive (combustible) containers.
5. Solid compound encased in specific coatings (line-charges, shaped charges, etc.)
6. Deployable (throwable) units.

According to the volume to be protected, the specific configuration of the solid compound could be selected, as well as its generation discharge means.

In fact, when compared to existing fire extinguishing agents as well as new gaseous replacements S.F.E shows great promise, as can be seen from the following table.

EXTINGUISHANT COMPARISONS

		HALON 1301	GASEOUS REPLACE	CO_2	SFE/EMAA
1.	ODP	HIGH	LOW/ZERO	ZERO	ZERO
2.	GWP	MODERATE	LOW	LOW	NIL
3.	TOXICITY	LOW	LOW	HIGH	LOW
4.	CONDUCTIVITY	LOW	LOW	LOW	LOW
5.	CORROSIVITY	MODERATE	MOD-LOW	MOD-LOW	UNK
6.	VOL.EFFICIENCY	GOOD	MODERATE	LOW	EXCELLENT
7.	EXT.CONCENTRATION	5%	10-15%	45%	----
a.	EXT.DENSITY	300 g/m^3	600-900 g/m^3	700 g/m^3	50g/m^3
9.	COST [a]	$150/$m^2$	>$250/$m^2$	$150/$m^2$	$50/$m^2$
10.	LIFE CYCLE COST [b]	HIGH	HIGH	HIGH	LOW

a - Includes piping, cylinders, installation; no detection
b - Includes initial cost, maintenance, agent replacement

S.F.E. offers an entire family of novel extinguishing agents, some of which have been tested. The lowest required concentration that was observed during testing was 0.03 kg/m^3 which is approximately 10 times more effective than halon 1301.

S.F.E. needs no pressure cylinders. In fact it could be stored as tablets in the open air, on the shelf, and employed immediately on demand. When activated the tablet extinguishes the fire, depending on the application, between 5 to 30 seconds.

3. Development programs status

Several evaluation programs are in progress, performed by the various armed forces, research institutes and leading industries.

A Cooperative Research and Development Agreement (CRDA) between the U.S. Air Force and Spectrex Inc. has been signed on March 93, starting a two-year term of evaluation and specific product development of the EMAA/SFE technology for the Air Force specific needs. As part of this program, recently the Air Force has been awarded a Strategic Environmental Research and Development (SERDP) grant for the EMAA program that will fund work on the three basic formulations developed by Spectrex Inc. at New Mexico Engineering Research Institute (NMERI), Armstrong Lab (Wright - Patterson AFB), Wright Laboratory (Tyndall AFB) and the University of Florida.

The tasks to be funded include:

a. Thermal output characteristics during solid material combustion.
b. Investigation of various heat absorption strategies for use in devices containing EMAA.
c. Particle size characterization.
d. Materials compatibility/corrosion studies.
e. Extinguishment capability with various Class A, B, C and D fires,
f. Toxicity assessment of aerosols generated by EMAA combustion.

Among these systems, the EMAA/SFE deployable units held much promise for various applications.
The Naval Research Laboratory (NRL)' Navy Technology Center for Safety and Survivability, is studyin? p rotechnic generated aerosol fire suppressants as par? *of* its Halon Replacement Program for NAVSEA Code 03V2.

This program includes two stages. The first one, an SFE/EMAA evaluation process was performed at the NRL 2000 cubic feet test chamber and it's preliminary results were presented by Dr. R.Sheinson in a paper entitled " Fire Extinguishment by Fire Aerosols Generation" at the CFC & Halon Alternative Conference (10-22 October 93, Washington DC.)

The second stage includes evaluation of several SFE/EMAA aerosol generating devices and their application to large engine rooms. The tests will be performed as part of the alternative evaluation study on the U.S. Shadwell.

The Naval Medical Research Institute Toxicology Detachment (NMRI/TD) is examining the physical characteristics of the aerosol created after the combustion of SFE Formulations A,B and C; and the individual chemical components for each formulation.

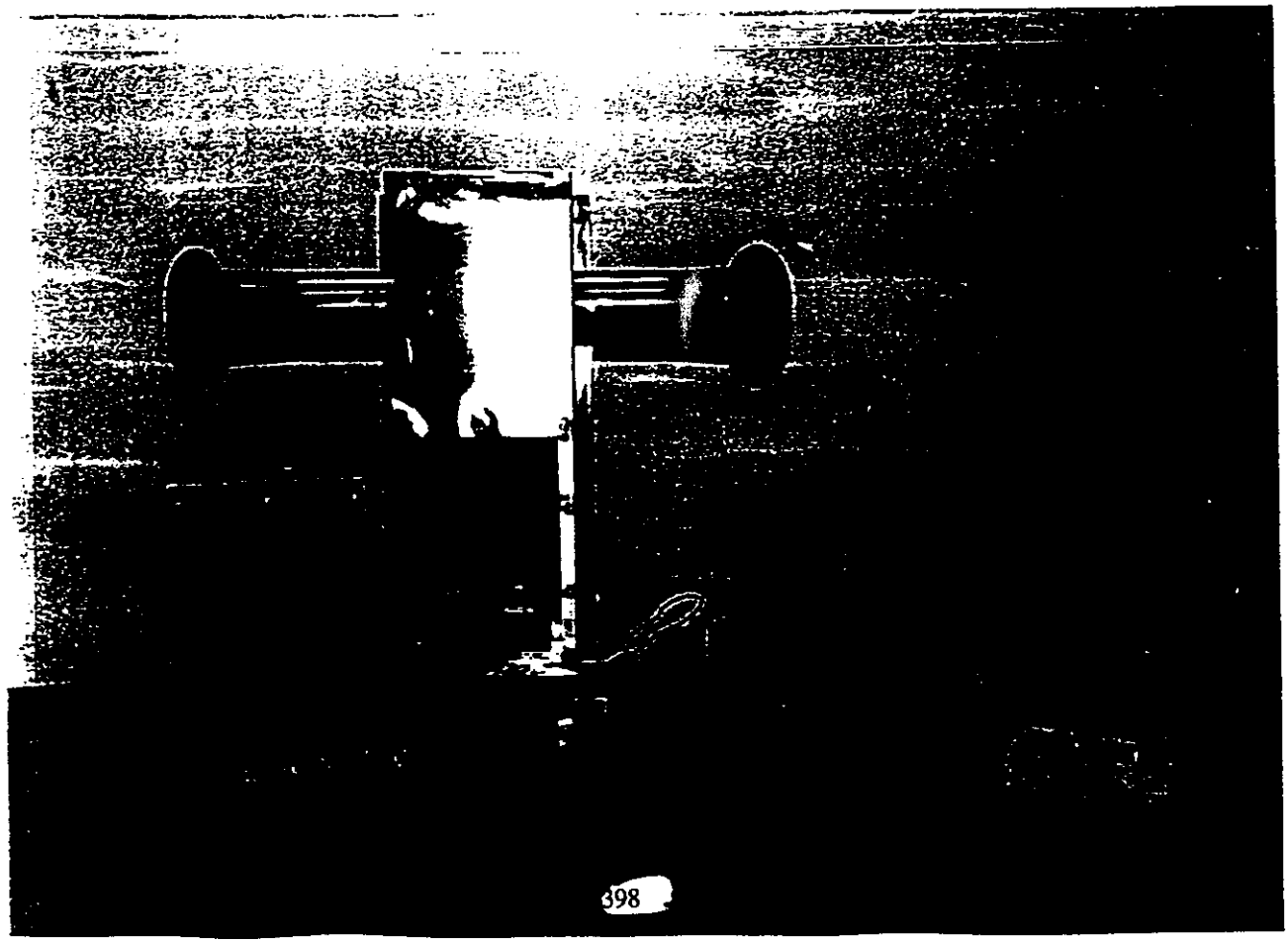
NMRI/TD also has conducted a pilot animal study to examine the mortality produced by SFE/EMAA on Fisher rats, via clinical observations, specific blood chemistry and physiological study. A preliminary report on the toxicity data appears to be very favorable and indicates that there are ho apparent toxicology problems with the material tested. No immediate lethality was observed for as long as 60 minutes after exposure to 50-80gr/m3 SFE agent formulation A. Additional formulations are now being evaluated as well for their toxicity.

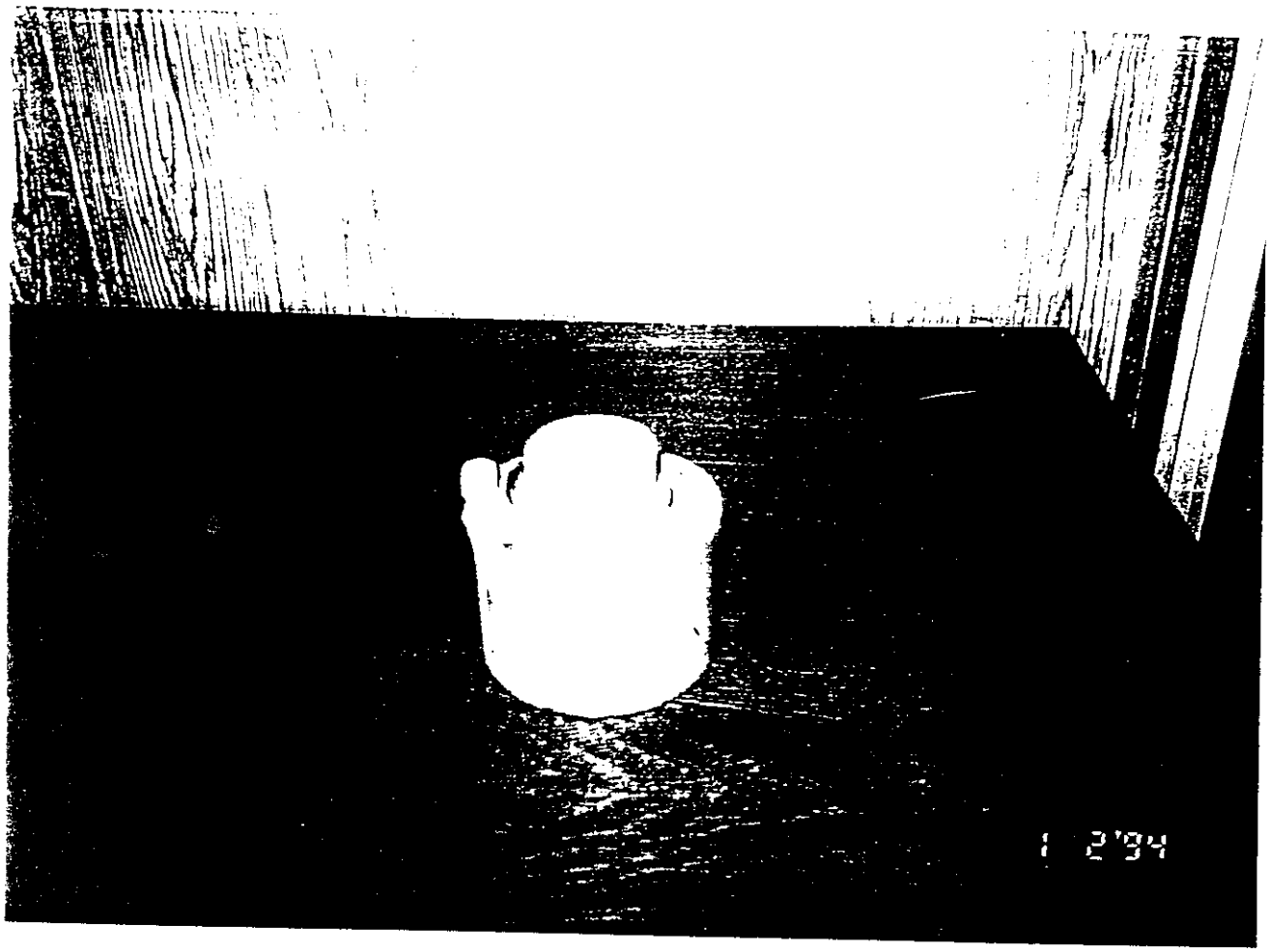
The FAA has conducted a preliminary evaluation of the inertization capabilities of SFE/EMAA on class A deep-seated fires at the FAA Technical Center. The first test program included tests on shredded papers fires (in cardboard boxes). The fires were successfully suppressed and the inertization was continued for a period of 15 minutes.

For this purpose, a novel formulation "D" has been developed and is programmed for inertization tests in the near future. T is new formulation has the unique capability to extinguish deep seated fires, class A, and sustain inertization for 1 hour and more, without lowering the oxygen concentration in the protected volume.

An SFE bulletin issued by the NAVY CFC & Halon Clearing-house will encompass the various evaluation programs, NAVY-NRL, NMRI, TQXLAB, USAF-CRDA progress, development programs, projects in industry and regulations/approval status. The NAVY CFC & Halon Clearing-house will edit and publish SFE bulletin periodically as new developments arise.

Last but not least, the SFE/EMAA technology is included in the EPA-SNAP list published on February - March 94.

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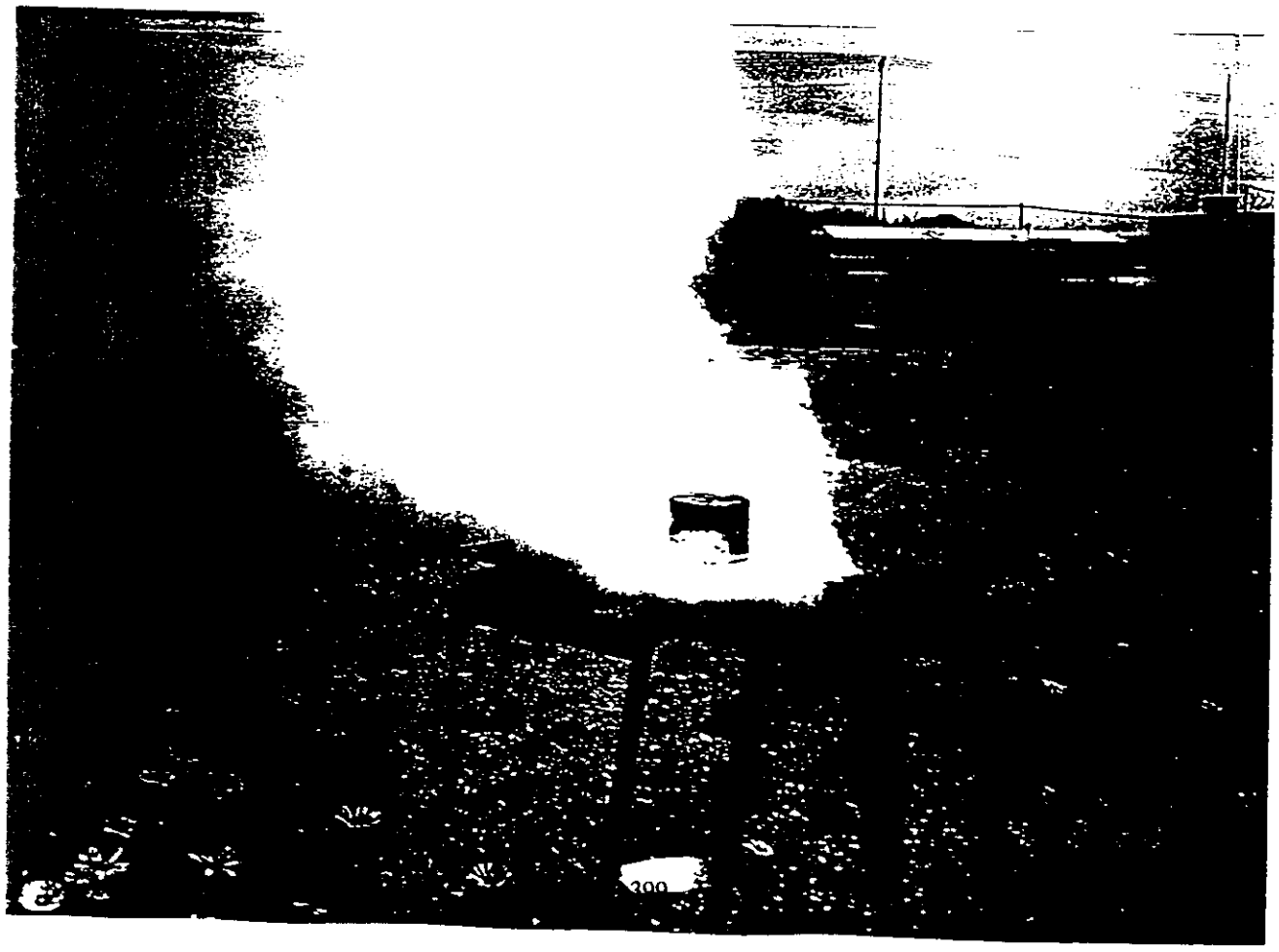
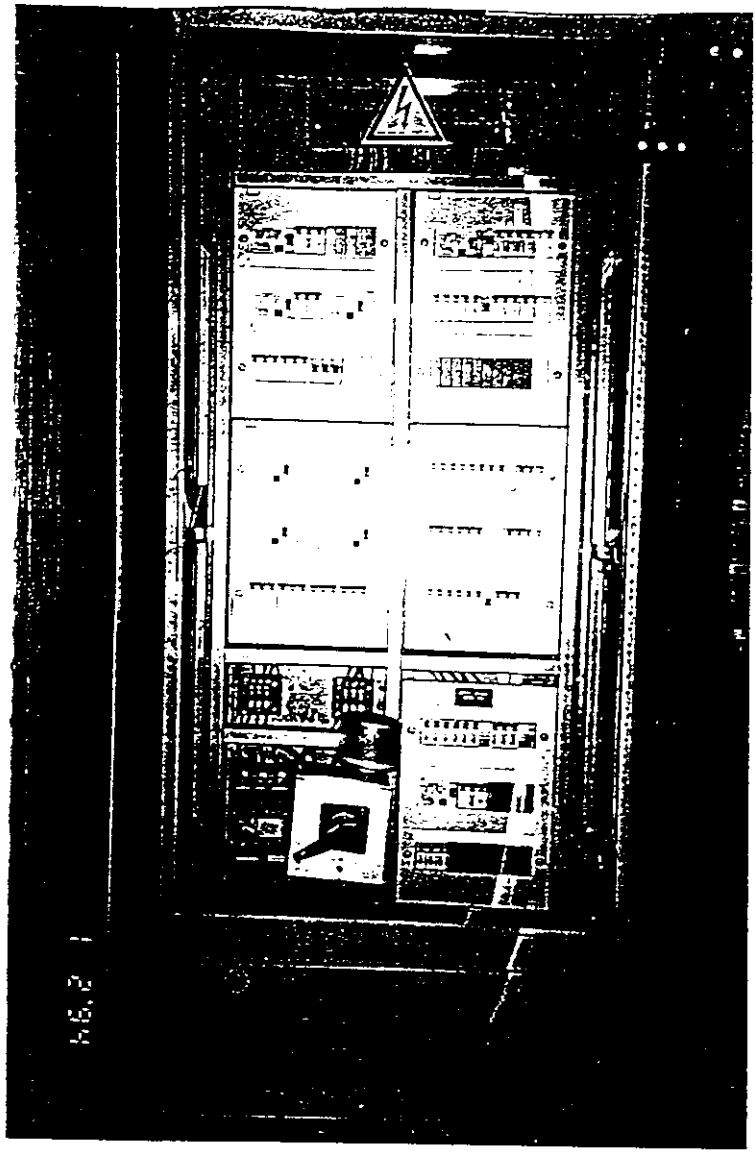
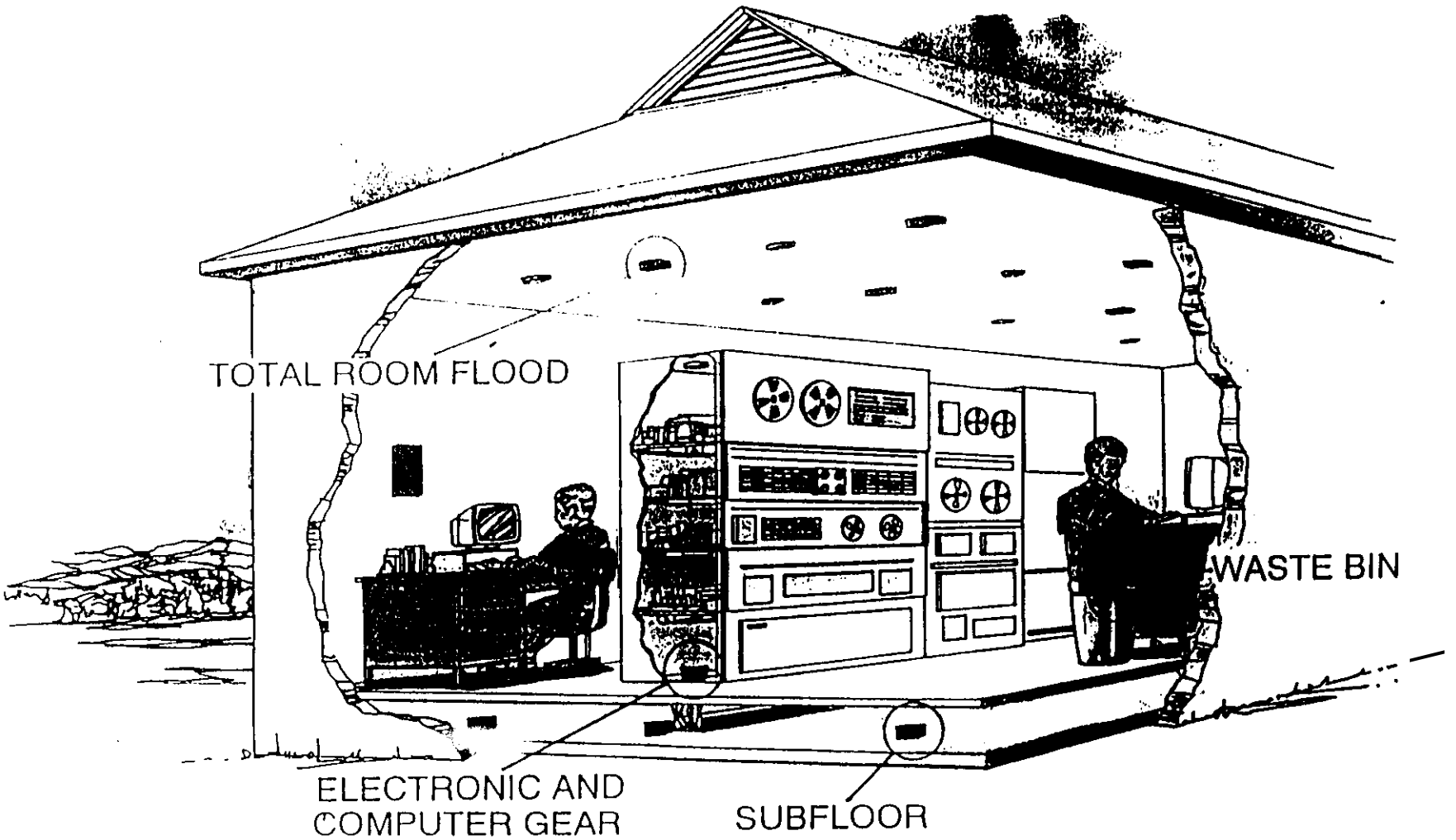




EMAA APPLICATIONS



STAND-OFF EMAA SYSTEM