Deodorization as Applied to Disaster Restoration

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Introduction

Trips to the library, extra hours at the plant, and study do not come easily to one who has fallen into the habit of full time management of a business; however, this is what happened when I decided to write a paper on deodorization. There must be a reason if one departs from his normal life style. The reasons are complicated but there are two basic incentives, the first was a curiosity about ozonization and deodorization, the second was the fact that I would like to have the title "Certified Restorer" after my name.

I shall begin with basic terms used in this field, some of the theory, then move into the different ways of achieving deodorization and finally my summary. Since this area has not been covered completely by any individual I am forced to make observations as they have touched me in the past 25 years.

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SECTION ONE

Terms Used in Deodorization

as applied to fire and water restoration

Absorb - dictionary meaning: to suck up or to hold as in a sponge. In deodorization terms the meaning is similar, spraying water into the air in tiny globules will absorb the odor from the air.

Adsorb - dictionary meaning: to take up and hold on the surface/an example of adsorbing in deodorizing is when we pass the air (with odor molecules suspended) over charcoal and cause them to be collected on the surface of the charcoal.

Airborne Odors - odors that are suspended in the air and have not been absorbed or adsorbed onto surfaces.

Angstrom - a unit used in measuring the length of light waves, one hundred-millionth of a centimeter.

Anosmatic - lack of ability to smell.

Deadening Effect - a rather poor approach to deodorizing by using a chemical which disables the olfactory gland. Formaldehyde is one of the typical chemicals used to deaden the olfactory gland.

Fatigue - long periods of subjection to strong odors will cause physical and mental fatigue by the olfactory glands and the subject becomes unable to discern these odors.

Fogging - a term used to describe breaking up a water based deodorant into small globules and spraying the mixture into the air.

Germicidal Chemical - some odors are living organism, which must be destroyed thus eliminating the odor.

Heat Line - a term used in fire damage to denote the amount of heat generated in an enclosed area and best determined by observing how far the heat continues down from the ceiling.

Odor Cancellation - using one chemical to nullify the effects of another.

Odor Modification - using a series of chemicals to modify the odor of another chemical.

Odor Sensitivity - biological, aesthetic, or psychological.

Olfactory Gland - the gland that causes us to be sensitive to odors.

Olfaction - a distance sense, unlike touch, one can smell an odor at a distance.

Osmogenes - producer or generator of smell.

Ozone - O3 is an element of oxygen that is somewhat heavier. O3 is very unstable and will quickly combine with other materials. The new combination formed by O3 may modify the odor or eliminate it.

Persistance - the time which a substance in free air remains noticable to the sense of smell. Persistance is a function of vapor pressure, molecular weight and velocity of evaporation.

Photo Chemical - a process used to generate ozone from ultra violet rays.

Rinsing - a method to rid odors from absorbent type materials.

Silent Discharge - using high voltage (corona effect) to generate ozone.

Surface Borne Odors - odors that are no longer in the air but have been transferred to surfaces.

Surface Cleaning - a technique for ridding surface odors from different materials.

Thermal Smoke - a technique of deodorizing where an oil base deodorizer is heated until it volatilizes and becomes smoke.

SECTION TWO

Basic principles of Odors and Deodorization

To achieve deodorization one must only produce, as an end result carbon dioxide and water. Chemically we know this as oxidization. Masking an odor is never a good answer although it is used quite extensively. We consider masking subjective as it works on the negative principle of affecting the nervous system in such a way that the senses are dulled to the extent that they cannot perceive an odor.

A popular method long used in the fire restoration field is called odor cancellation and is based on a discovery by a Flemish chemist Zwardemaker (Leipzig Press p. 423). In theory I can best explain by the well known high school chemistry experiment where the odor of a Gardenia is completely cancelled out by the odor of the Lily of the Valley. The tiny hair folicules in ones nose are tuned in length (radio theory) to infra-red frequencies. When we "sniff" the air it causes these hairs to vibrate at a definite frequency which in turn sends a signal to our brain. Odor cancellation occurs when two such osmogenes causes vibrations at frequencies that are similar and thus cancel each other out. These frequencies are in the infra range and can actually be measured. The entire crux of our studies of deodorization are based on the human gland known as the Olfactory. This gland is generally accepted by scientists and doctors as the most variable gland known to man. In all of the history of medicine and physical science no one has been able to establish a definite scale of the threshold or even levels for unacceptable odors. While one can find exact and established levels for the other senses (smoke densities, colors, and musical tones). The odor level meter reins unconquered. To illustrate the levels of tolerance, we all have known individuals who could not stand the odor of garlic, while another person delighted in its fragrance.

Those of us who are fire damage contractors have noted with regularity that some individuals are much more sensitive to odors than others. The psychological effect of having a trumatic experience may sensitize the Olfactory gland. In Laymans terms I would like to point out that an insured will react much more strongly to odors and in somewhat proportional way to the size of the loss; and to how great the personal crisis was at the time of the fire. W. Summer in his book Air Deodorization is quick to admit that the sense of smell can be varied even in the individual by:

1. Surprise
2. Fright
3. Anger
4. Frustration
5. Illness
6. Combination of the other five.

The Olfactory Gland can be stimulated:

1. Biologically
2. Aesthetically

Examples of biological stimulation would be the fact that eating or sexual activity does increase a subjects sense of smell. Example of aesthetic stimulation would be music or initial fright of fire or just viewing a stimulating picture. We humans often identify odors by association as in the case of the odor of Hydrogen Sulphide. If you were a person who spent his childhood on a farm you would associate the odor with that of rotten eggs. On the other hand if you had not ever smelled rotten eggs you might associate it with a high school chemistry experiment. Thus outside stimuli has a great deal to do with reaction to odors. Fire damage contractors have noticed insureds who have complained of certain side effects from strong odors. My research leads me to believe the nausea, headaches, dizzyness, and often nervousness manifests itself when:

1. The person exposed is allergic or the occasion has been one of surprise, anger, or frustration. I have even noticed people that would hyperventilate causing dizzyness after a fire.

2. The air contains a greater amount of positive ions then is normal (Airborne negative ions are healthful).

3. There is a biologic or aesthetic reason that affects their system.

In thinking about the olfactory gland we realize that here is a sense organ that is greater than the sense of touch. It is described by Sherrington as a distance sense. In the case of humans the osmogenic sense must enter the nose to signal an odor. Insects smell with an outside antenna. It is important to understand that humans have a broad band of sensitivity to odors while most animals have a very narrow band (infra red frequencies) of sensitivity. The wild beast can detect an odor up to a mile away. This is why hunters (man and beast) always approach up wind. Birds are very sensitive to smoke odors and should be the first thing removed from an effected area, due to their tiny lung capacity and inability to strain the tiny smoke particles from the air. Fish too are very sensitive but for a different reason. The soot covers the surface of the water and cuts off their fresh oxygen supply. Plants will surely die if not washed after a severe smoke damage and they also require fresh uncontaminated air for survival.

With the advent of modern fibres it becomes much more

important to operate quickly after a fire. This is especially true where there is soot discharge on all cold items. While all clothes are affected by the discharge of soot many of the miracle fibres actually are weakened. They are further damaged by the physical action necessary to remove the odor and discharge. Each fire has a unique chemical make up in its discharge. We note that many experts quote their findings from the result of only a few fires. Burning a few milk cartons in the fireplace with the damper closed will not cause the same effect upon drapes and soft goods that would result from having a plastic can opener burn.

Heat and resulting conditions also change the end results that can be obtained in deodorizing.

The greater the heat the greater the tendency for the odor to penetrate the surfaces and become more difficult to remove. One of the most difficult odors to remove is one that has penetrated the surface of vinyl (poly vinyl carbide). I have observed that it becomes more difficult as the heat in the room at the time of the fire increases. Consultation with a chemical engineer leads us to believe that the warm surface being more pliable can accept the molecules (osmogenes) into the surface irregularities more easily. I have found if we take the situation back and reverse the procedure that we can speed up the deodorizing process. Placing the naugahyde chair in the dry room and achieving over 120 degrees and then hard scrubbing with a hot detergent containing an odor canceling material will sometimes break the odor molecules loose. Finally leaving it in the ozone vault for several days will usually remove lingering odors. Still another technique now being used is that of spraying the surface with (soot set) a material that seals the odors in. This new idea can be used not only to seal small amounts of soot in heat and ventilation pipes but works to some degree on naugahyde, scortched wood and cement.

Usually without knowing the why, fire damage contractors have resorted to sealing pockets of odors using white shellac, aluminum paint, etc. In the study of chemistry it is said that Vander Waals forces are superior to any forces offered by mechanical means. One must think of these forces in terms of infinitely small particles that adher together electrically. Once they adsorb to a surface there expulsion is almost intractable. This, then is the practical reason for sealing a surface rather than attempting to remove the offending odor.

SECTION THREE

Equipment used in Deodorization

The Fogging Machine - has generally been adapted from the insecticide industry. Basic principle is to break the liquid up into very fine fog which will more readily achieve the purpose of absorption. It is interesting to note that spraying water alone is quite effective in deodorizing. The tiny droplets quickly absorb the osmogenic odors out of the air.

Thermal Fog - this technique too is a device used in the insecticide industry. Converting an oil based odor modification chemical to a warm smoke by either an electric element or with butane. The butane device is effective but too dangerous to use indoors. The advantage of the thermal smoke is that one can penetrate attics and crevices that the fogging will not reach. ONe must be sure to use an oil based chemical. The products are usually formulated especially for the chemical odors associated with manufacturing and are not always right for protein absorption. I have found them effective on electrical fires.

Paste/Gel - such as eastonair, bad air sponge. Consisting of polyresins and detergents with aromatics this product works on the adsorbing principle and is enhanced by it's peculiar properties which cause it to expose new surfaces as time elapes. (This is the important part of Adsorption). Coupled with a small amount of aromatic and odor modifaction chemicals it is quite effective where there is air movement. (Such as we find in furnace ducts). They also manufacture this product with activated charcoal which has a great adsorbent quality.

The Dehumidifier - not generally considered in the deodorization field but is valuable in water damage contractors bag of tricks because removing moisture will help sweeten the air and inhibit the growth of musty type odors. At this point one threshold level.

Ozone Producer - Ozone can be manufactured in 3 different ways:

1. Silent Discharge - Most efficient way but does produce nitrous oxides.
2. Photo Chemical - Ultra violet rays in the 1730 angstrom range will generate pure ozone.
3. Electro Chemical

Conclusions

Any chemical or mechanical means that creates oxidization should be considered in pursuing deodorization.

SECTION FOUR

Research Project

I built my first ozone deodorizer in 1962 using 12 stereo lamps and an exhaust fan from an old range hood. I found it moderately effective on lingering odors. Under ideal conditions I believe that I was generating less than 2 grams per day. In 1965 I purchased a germicidal lamp from Westinghouse which generated ultra violet rays in the 2537 angstrom range and produced ozone as a by product. I had a metal shop build a box a little over 4 ft. long and then mounted two of these tubes in parallel, Using a small squirrel cage fan in one and we pushed the ozone out the other end. This model was much more effective and produced about 10 grams per day. During these years we were not a nation concerned with ozone and I was not aware of any danger in these small concentrations. This unit went on literally hundreds of fire jobs. I was careful to tell the insured to not sleep in the same room and never left it in a room with less than a thousand cubic feet.

In 1973 while attending a NIRC meeting in Atlanta, Georgia, we first saw ozone producers for sale to our industry. I observed that they used the silent discharge method and wondered why industry preferred this method over the photo chemical. I feel that ozone generation by the photo chemical, that is using a cold anode tube, which operates in the ultra wiolet ray band and produces pure ozone, is best for deodorization. I also believe, that I know why photo chemical is best. I quote from American Chemical Society issue 21, page 63, "Oxides of nitrogen are produced by some ozone generators. These oxides react with some of the reagents and they have also been shown to be toxic. Ultra violet lamps do not produce oxides of nitrogen". Thus in this method we produce a pure ozone. Pure ozone is effected mostly by humidity and temperature. Best ozone production has been found to be at 70 to 75 degrees farenheit and a humidity at 20 to 30 percent.

Now to report on my final ozone project. I designed this ozone vault to be variable in all respects in order that I could carry out experiments and be able to weigh test results. I selected a room 6 ft. by 9 ft. We completely sealed and painted the room and brought in two ten inch air ducts from outside. The exhaust duct goes to within 4 inches of the floor. The theory being that ozone is heavy and we would get the best exhaustion in this manner. The cold air intake is in the ceiling. I then installed a cold anode tube designed to operate in the 1849 angstrom band. It is located within 10 inches of the ceiling and mounted behind the tube are two squirrel cage blowers (157c.f.p.m.).

The control panel gives many options and consists of

a rather complex circuit with two 24 hour timers, and control relays to cause us to be able to vary the following functions:

1. Ozone generator off and on - predetermined times.

2. Exhaust on and off up to 6 times per night. (Each time exhaust cuts on it disables ozone generator. The idea being to purge the room and start all over).

3. Ability to operate exhaust all of the time and clean air intake all of the time.

4. Ability to operate ozone with out exhaust or intake.

5. Innerlock on the door, making it impossible to walk into the ozone and ultra violet ray saturated room.

6. Test circuit to test operation from outside of the vault.

7. Humidistat to dump moist air when humidity exceeds 30 percent.

After months of experimentation my favorite setting is ozone and ultra violet on for 6 hours with exhaust and new air cutting in each 2 hours for 50 minutes. At this point I am disabling ozone and ultra violet rays for the 50 minutes that we are exhausting. Failure to exhaust causes a build up of osmogentic odors. I believe that insertion of fresh air from outside is also very important.

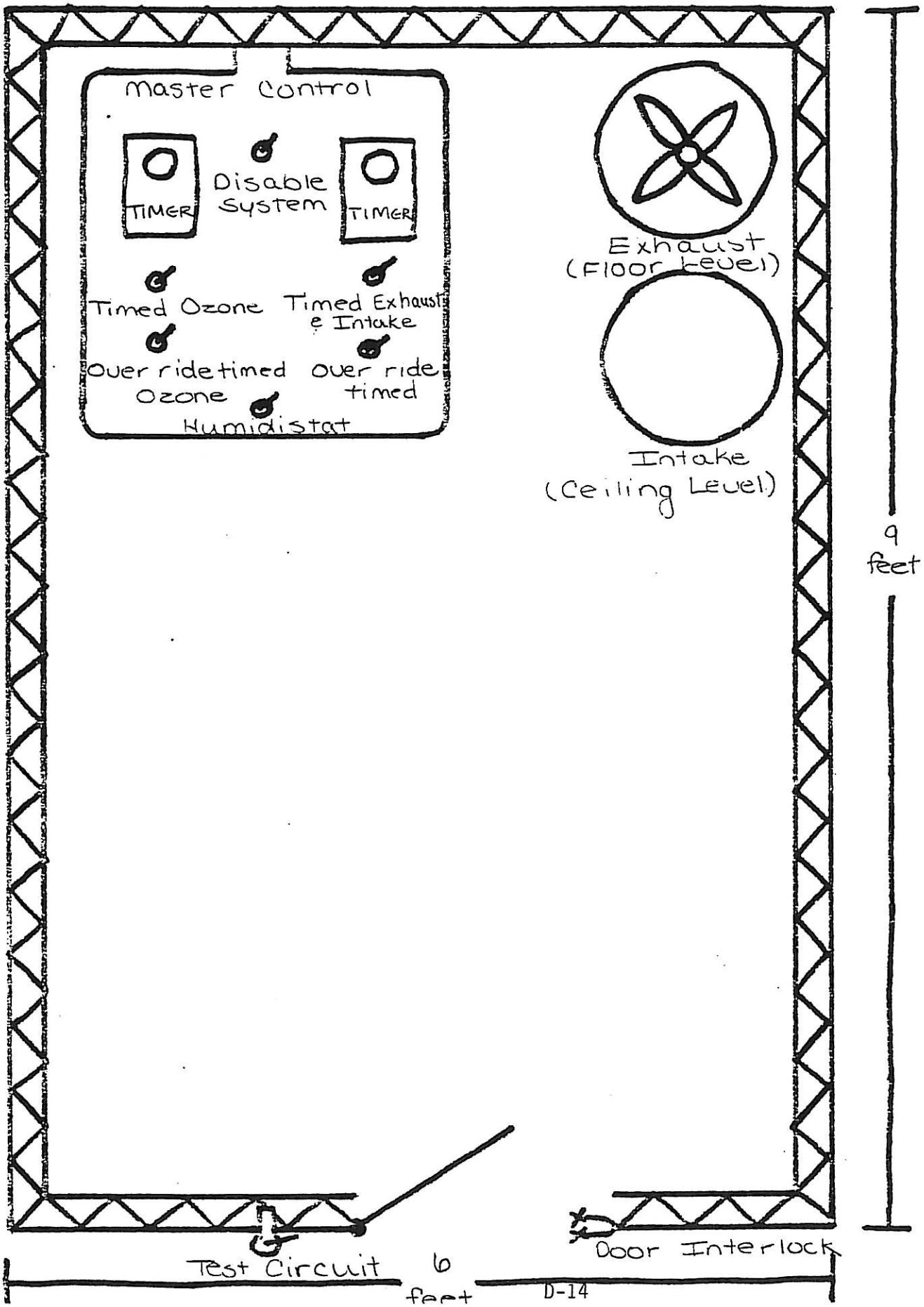
The following tests were performed to study degradation from ozone and or ultra violet rays. Items below were subjected to three nights under three conditions. No deterioration was found in any of the tests.

Ozone and ultra violet only - no exhausting	Ozone - with ultra violet shielded	Ozone and ultra violet with intake and exhaust
polyester	polyester	polyester
cotton	cotton	cotton
acetate	acetate	acetate
nylon	nylon	nylon
rubber bands	rubber bands	rubber bands

We use the ozone vault for all kinds of content materials found in homes. They are usually placed in the vault after cleaning. I feel that my vault is especially

effective because we are using the ultra violet rays as well as ozone. I have not been troubled by deterioration due to ultra violet rays or ozone. I would like to quote from the book "Methods of Air Deodorization", by W. Summer page 117, "Not even the introduction of ozone into the room air will really help as only some of the ozone molecules will contact the osmophores. The only promise of success is in the direct erradication of the tainted materials by ultra violet rays, which produces nascent oxygen in close proximity to the osmogenes". In this section he was speaking of Vander Waals phenomena of how the tiny molecules stick on a surface by their electrical charge and are nearly impossible to remove by mechanical means.

Research Project- Ozone Vault



1. Before using a space deodorant, what must you first do:

(Select one)

a. Determine origin of odor.
b. Eliminate source of odor.
c. Analyze the type of odor.

Answer: b

2. Ozone is a highly reactive form of:

(Select one)

a. Chlorine
b. Oxygen
c. Nitrogen

Answer: b

3. Ozone is generally pumped into an area from the ceiling because Ozone is:

(Select one)

a. Lighter than air.
b. Heavier than air.
c. Equal to weight of air.

Answer: b

4. Ozone becomes dangerous when concentration in air reaches:

(Select one)

a. 0.02 ppm
b. 0.10 ppm
c. 50.0 ppm

Answer: b

5. Ozone can only be used safely in a dwelling in which the dwelling:

(Select one)

a. Is occupied
b. Unoccupied
c. Contains plastic and rubber compounds

Answer: b

6. Ozone can be produced by:

(Select 3 of 4)

a. Man made machines
b. Lightning
c. Rain
d. Sunlight

Answers: a, b, d

7. Odor modification is the process of:

(Select one)

a. Covering odor.
b. Eliminating odor.
c. Altering an unpleasant odor to a more pleasant one.

Answer: c

8. Odor modification is <u>best</u> accomplished with minimum risk by:

(Select one)

a. Ozone
b. Fogging
c. Solid deodorant
d. Passing air over a liquid deodorant.

Answer: d

9. Adsorption is <u>best</u> accomplished by:

(Select one)

a. Fogging
b. Ozone
c. Passing air through activated carbon.

Answer: c

10. Absorption of odor is best accomplished by:

(Select one)

a. Fogging
b. Ozone
c. Odor modification

Answer: a

11. Mildew can be eliminated by using the following:

(Select 3 of 4)

a. Ozone
b. Fogging
c. Bacteriacide
d. Fungicide

Answers: a, c, d

12. Deodorizing smoke damaged clothes utilizes one or all of the following methods:

(Select 3 of 4)

a. Normal dry cleaning
b. Ozone
c. Washing with detergent
d. Odor modifier added to dry cleaning rinse.

Answers: a, b, d

13. Formaldehyde has been used as a space deodorant. It works by:

(Select one)

a. Disinfecting air
b. Covering odor
c. Modifying odor
d. Destroying sensitivity of sense of smell.

Answer: d

14. Deodorizing carpets of animal odors may require treatment with any of the following:

(Select 4 of 6)

a. Contact deodorant
b. Disinfectant
c. Mildewcide
d. Treatment with an oil break.
e. Wet cleaning with extraction.
f. Needle injection with deodorant.

Answers: a, b, c, e, f

15. Wood beams and walls which do not release odors readily can be treated successfully by:

(Select 3 of 4)

a. Washing with detergent.
b. Fogging
c. Brushing with a liquid deodorant.
d. Sealing

Answers: a, c, d

16. Space deodorization is accomplished by:

(Select 4 of 5)

a. Fogging
b. Odor modification
c. Solid deodorant
d. Ozone
e. Sponging surface

Answers: a, b, c, d

17. Select the most correct answer for successfully deodorizing surface odors:

a. Fogging
b. Washing with a solution of liquid deodorizer and detergent.
c. The ozone Gun
d. Fungacide

Answer: B

18. You are called out on a meat fire where the roast was left on the stove on high for 4 hours while the insured went bowling.

(Select the 2 best steps you would take when writing your original work order.)

a. Wash kitchen down complete using detergent and odor modification chemical.
b. Use a fogging device.
c. Clean all affected areas that have a discharge in the entire home, with the proper chemicals.
d. Wash the floor with a germicidal detergent.
e. Leave a space deodorizer on the premises until you can return.

Answer: C and E

19. You have a naugahyde chair with a very strong odor.

(Select the 3 best ways to deodorize)

a. Use a high test solvent to break down film
b. Remove dust cover- clean and spray odor modification chemicals.
c. Wash several times with detergent and liquid deodorant.
d. Place in the ozone room.

Answer: B,C,D,

20 You have 3 dozen shoes and purses from a fire to deodorize overnight, in order that the insured and family can go to work the following day.

(Check the 3 best steps)

a. Wash with detergent and liquid deoderant if possible.
b. Place non washables in a bag with a good dry-cleaning sawdust and shake.
c. Leave all night in the ozone room
d. Place all shoes on table and spray with Lysol.

Answer: A, B, C,