SMOKE, GREASE AEROSOL AND ODOR CONTROL IN MEAT PROCESSING PLANTS*

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INTRODUCTION

The National Air Pollution Control Administration (NAPCA), a division of the Public Health Service within the Department of Health, Education and Welfare, is responsible for implementing the 1970 Clean Air Act of the Federal government. Its program activities include:

"Establishing ambient air quality standards for air quality control regions--by issuing health criteria and control techniques, establishing performance standards, and approving regional standards and implementation plans for stationary sources."

"(Awarding) Grants to state, local and regional agencies for planning and control."

Following the dictate of NAPCA's first objective, most of the fifty states have moved to enact enabling legislation creating state air pollution control agencies and to develop control regulations. Recent inquiry to these agencies have disclosed that--as of May 1972:

Over forty states have promulgated, publicly heard, and adopted regulations covering controls restricting the more obvious air pollutants (e.g. smoke, particulate matter, incineration or open burning, etc.).

Two states have adopted general regulations, with delegation of authority to enact specific regulations to designated air basin districts within the state itself, so that the rules finally adopted will answer the needs peculiar to the affected area.

The remaining states are either in the process of adopting general and specific regulations, or report that such regulations are being prepared and will be adopted before May 31, 1972, the EPA response deadline.

Every state contacted has indicated that specific regulations aimed at control of toxic and/or particularly offensive emissions from industrial operations will be adopted; in addition, municipalities and counties are enacting similar rules, which in many instances are more stringent than state law.

The survey indicates that both the more highly industrialized states and predominantly agricultural states have enacted regulations directed toward control of combustion emissions, incineration emissions. Regulations defining the control of non-toxic, but "nuisance," odors are less prevalent, but an increasing number of states are enacting odor control limitations. In many instances, these regulations have been adopted from existing codes of highly industrialized states without prior extensive evaluation to establish the real necessity for stringent and restrictive control measures in agricultural or less highly industrialized areas. In a few instances, the technique for control has been written into the regulation, rather than the objective of the control ordinance. The meat packing and related industries face major expenditures in complying with existing and proposed air pollution control regulations.

Existing and proposed regulations affecting meat packers may be classified into three major categories:

1. Smoke, particulates and toxic gases emissions from boiler house and incidental (combustible wastes) incineration operations.

2. Process dusts from operations related to meat packing operations, such as animal feed and bone meal processing.

3. Odors, grease aerosols, smoke particulates from inedible rendering, blood drying and protein concentration operations, smokehouse operation, and from feedlots, holding pens and paunch and ground manure storage areas, or even from the anaerobic digestion basins utilized to control water-borne process wastes from abattoir operations.

Table 1 summarizes sub-processes within the industry which are capable of discharging contaminants in violation of existing, or proposed air pollution control rules and regulations.

This discussion will be confined to air pollution control problems associated with animal matter reduction operations (rendering/blood drying) and sausage and provisions processing (smokehouses).

**ANIMAL MATTER REDUCTION OPERATIONS**

Only a small number of states have adopted regulations specifically directed to rendering and other "animal matter reduction" operations. On the other hand, almost all now have general "nuisance odor" rules which can be applied to control of odors from inedible rendering, blood drying, stick water evaporation and feeds formulation and drying.
TABLE 1. AIR POLLUTION POTENTIALS IN MEAT PACKING AND RELATED OPERATIONS

<table>
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<tr>
<th>Operation</th>
<th>Current (C) and Potential (P) Problems</th>
<th>Pollution Potential</th>
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<tr>
<td></td>
<td>Smoke</td>
<td>Particulate matter (fly ash, process dusts)</td>
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<td>Abattoirs</td>
<td>C*</td>
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<td>Fabricating/processing</td>
<td>C*</td>
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<td>Canning</td>
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<tr>
<td>Smokehouses</td>
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<tr>
<td>Rendering/blood drying</td>
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<td>Holding pens</td>
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<td>Hide curing</td>
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<td>Stick water drying</td>
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<td>Feed/fertilizer production</td>
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<td>Waste water lagoon operation</td>
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* Indicates pollution resulting from coal or oil fuel firing of boilers.
In a few instances, state and local laws have specified the technique by which control of vapors from reduction operations shall be achieved; typically stating that:

No person shall operate any device for the inedible rendering of animal matter unless all gases, vapors and gas-entrained effluents from such processes are thermally incinerated at $1500^\circ F$ for not less than 0.5 second. (1)

The incineration temperature and dwell time varies somewhat with different regulatory agencies, but the intent--thermal incineration--is common to all. The rule was originally enacted by the Los Angeles County Air Pollution Control District to control odors from operations of renderers of aged stock (meat and tallow scrap, dead animals, etc.). However, it does not differentiate between fresh and decaying stock and, therefore, also applies to the meat packer who renders only fresh offal resulting from slaughtering and processing conducted the same day. (2)

In March of 1972, the Techniques Advisory Committee of NAPCA (made up of state air pollution control agents, industry representatives, equipment agents and academicians) met with members of the EPA Performance Standards Branch and selected industry representatives to review recommended performance standards for inedible rendering plants (3). Although earlier recommendations had included the thermal incineration requirement, the final standard recommended acknowledged that only the objective, rather than the technique of achieving the objective, required definition and control parameters. In all probability, the standard--to be published in the Federal Register in June or July of 1972--will follow the recommendations of Report 10:

Standards of performance are being proposed for certain new rendering plant facilities. The standards would limit the emission of odors from several sources.

The standards of performance would apply only to the processing of inedible rendering matter such as packinghouse and poultryhouse offal, blood, butchershop scrap, waste grease, and "dead stock" (animals that die from natural cause or accident). They do not apply to the rendering of edible animal products or to fish reduction systems.

The proposed standards would limit emissions of odorous air pollutants to the atmosphere as follows:

Rendering cookers, processing tanks and tallow presses. Gases and vapors discharged to the atmosphere shall not contain more than 200 odor units* per standard cubic foot. Subject gases and vapors may not be diluted before measurement except:
(1) as required to introduce combustion gases or chemical reactants necessary for odor abatement, or

(2) as required to assure gathering of rendering gases and vapors as with ventilation hoods for tallow presses.

For purposes of the regulation, processing tanks are defined as vessels in which tallow, greases or other animal matter are heated to temperatures greater than 180°F, subjected to reduced pressure, or are aerated with air, steam or other volatile fluids. The term rendering cooker covers both "dry cookers" (steam-jacketed) and "wet cookers" (live steam heated) which are used for the processing of inedible animal matter.

*(An odor unit, OU, is defined as the quantity of any single or combination of odorous substances which, when completely dispersed in one cubic foot of odor-free air, is detectable by a median number of observers in a panel of 6 to 10 persons). (4)

After time lapse for comments by interested persons and consideration thereof, the standards will be published in final form and are expected to be issued by October, 1972.

In addition to omitting thermal incineration requirements, the proposed standards do not include a limitation on total odor emission (odor units per minute). In this respect, the regulation will be less stringent than those of other states; Minnesota, for example, limits not only the odor level (150 OU for defined stacks 50 feet or more above grade, and 25 OU for odor sources at less than 50 feet elevation), but also the emission rate (not in excess of 1,000,000 OU per minute). (5)

The term "new rendering plant facilities" designates both new plants and modification of existing plants which results in increased odor emission. Inevitably, these standards, when adopted by the states, will also be applied to existing, non-modified plants as well.

Elimination of the thermal incineration requirement and omission of a limit on the odor emission rate from federal standards will permit the use of other equally efficient procedures which operate at significantly lower costs. Odors discharged from animal matter reduction operations may be successfully controlled by:

1. Condensation of the odor-bearing steam vapors in heat exchangers, or (waste-water operated) scrubbers or counter-current heaters, or by air cooled exchangers.

2. Chemical oxidation or neutralization of odor bodies by vapor condensation in wet scrubbers using oxidants or neutralizing agents, e.g., permanganate, hypochlorite, acid, or alkali solutions.

3. Condensation of steam vapor and incineration of the odorous non-condensibles remaining in (gas fueled) direct thermal incinerators
or catalytic combustion incinerators, or as primary air to boiler operation.

4. Chemical oxidation of odor bodies in the steam vapor with ozone, or other gaseous oxidants.

**MEAT PROCESSING OVEN OPERATIONS (SMOKEHOUSES)**

Meat processing ovens discharge moisture, excess smoke (particulates), grease aerosols, and a wide range of tars and other organic substances (acids, ketones, aldehydes, phenols) during the "smoking" portion of the processing cycle. The odors from the operation are generally not unpleasant, and most existing state and local control requirements have been directed to visible smoke limits (Riengelmann opacity values), and/or particulate matter levels (process weight rate limits). Typically, these regulations read as follows: (6)

All meat smokehouses or groups of meat smokehouses which consume in excess of ten pounds of wood or sawdust per hour shall be equipped with gas cleaning devices or shall be controlled in such manner that the particulate matter in the gas discharged to the atmosphere shall not exceed 0.10 grain per standard cubic foot of exhaust gas (adjusted to 12% CO2).

At the present time there is no indication that EPA is proposing performance standards for this industry. However, some local agencies have enacted regulations which are intended to control not only smoke and particulates emissions, but the (sometimes irritating) emissions of grease aerosols and other organic derivatives (photoreactive substances, such as aldehydes and ketones) as well; for example, the Allegheny County Health Department in Pennsylvania has probably enacted the following regulation (proposed in May, 1972, with an effective date of July 1, 1972) in an effort to control both visible and irritating or toxic substances: (7)

**Odor Emissions.** No person shall cause...the emission into open air of odorous material, from any source or process whatsoever, in such a manner as to have the effect of being perceptible beyond such person's property.

Odorous material from the following processes must be treated prior to release by incineration:...rendering of animal matter,... smokehouses,...meat processing other than from single family houses.

General adoption of this regulation, or its equivalent, by other agencies would impose a severe economic burden on the meat processor without complete abatement of air pollution. **Supplies of natural gas**, the fuel generally utilized in thermal incinerators, are currently being severely curtailed in industrial uses in most northern cities, and—in many instances—will not be made available for any new uses, even on an interruptible basis.
The alternate fuel is oil, which is more costly and is a source of sulfur and nitrogen oxides emissions. In the instance cited, the requirement for (oil fueled) thermal incineration of emissions from a bank of smokehouses discharging smoke in excess of Ringlemann standard number 1, at a maximum of 24 pounds of particulates per day, would have resulted in the discharge of 73 pounds of sulfur and nitrogen oxides, plus approximately 10 pounds of particulates and organic derivatives. When the real probability of exchanging one pollutant for another with recognized toxic effect was disclosed, permission to investigate alternate control resolutions was obtained.

At the present time, the technology for control of emissions from smokehouses includes:

1. Direct flame incineration, or catalytic incineration. ("Trade-off" of one pollutant for another, coupled with high first cost and operating cost makes this resolution impractical. To maintain the refractory lining of the incinerator at or near the specified incineration temperature, the direct flame unit must be fueled throughout the working day against its intermittent need during the smoke emitting portion of the total processing cycle, a wasteful requirement. Catalytic incinerators, which depend on a catalytic mat of precious metal to lower the effective burning temperature, are frequently fouled by the grease aerosols and particulates present in exhaust gases. Reactivation of catalyst mats is costly. Significant amount of trade-off pollutants also result).

2. Wet scrubbers, with or without oxidant chemicals. (Low energy scrubbers have the ability to remove the water soluble and oxidizable contaminant fractions, but have not been totally effective in removal of sub-micron smoke particulates. Investigations are being conducted on the application of high energy scrubbers to determine their ability to remove such particulate matter. If these devices prove effective, they promise to provide the degree of control required at reasonable installation and operation costs).

3. Electrostatic Precipitators. (Electrostatic precipitators involve a high first cost, but are operated most economically. The electrode grid is readily fouled with accumulations of grease aerosols and particulates, and require excessive maintenance. When the control ordinance limits emissions of odorous substances as well as particulates and smoke, this device cannot be utilized, for the electrostatic unit has no appreciable effect on odors and volatilized organics (aldehydes, etc.).

Wet electrostatic precipitation, in which the modified grids are periodically bathed in a flow of water to purge the electrodes of accumulations, may eliminate present operational problems with conventional dry-operated units. In some instances, it may be necessary to employ a wet scrubber and electrostatic precipitator in series to effectively remove particulates, odors, and volatile substances. Wet precipitators and scrubber-precipitators are currently being evaluated).
4. **Boiler Incineration.** (Incineration of emissions from smokehouses as the primary air, or as a portion of the primary air, to boilers has the advantage of extremely low first cost and operating cost. Some problems with burner fouling are encountered, but may be overcome by regular maintenance.

Successful application of this technique is dependent on assurance that boiler operation will be required throughout the smoking operation; if the two operations do not coincide at all times, there will be periods when no control will be in effect. If the processing operation is not physically located in near proximity to the boilers, extensive ducting, with subsequent problems of duct clean-up and danger of duct fires, will be required.

Despite the generally non-toxic nature of the odorous emissions from these sub-processes, process smoke and odor control promises to be one of the more difficult and costly resolutions facing meat packers in the next two years. The regulations which have been issued, or are in the process of issuing, vary widely in intent and technique. One regulation may place limits only on smoke particulates and be silent on odor limits. Another may place limits primarily on odor, while a third may flatly specify the technique of control, without reference to limits on odor or smoke.

The problem is compounded by the absence of any precise method for measurement of odor; all present techniques are eventually dependent on the sense of smell of individuals in a panel of from three to ten members, each with varying odor perception, and with perception sensitivity which can vary from day to day, or even hour to hour. Odor determinations are, therefore, highly subjective. Agreement among the current methods utilized is not consistent. (4) (8).
BIBLIOGRAPHY

(1) Minnesota Pollution Control Agency, APC-102 (July 7, 1969).

(2) Air Pollution Control District, County of Los Angeles, Rules and Regulations, Rule 64 (December 21, 1971).


(5) Minnesota Pollution Control Agency, APC-9 (September 14, 1971).

(6) State of Illinois Air Pollution Control Board, Rules and Regulations Governing Control of Air Pollution, Section 3-3.260 (August 19, 1969).

(7) (Proposed) Article XVIII, Air Pollution Control, Bureau of Air Pollution Control, Allegheny County Health Department, Pittsburgh, Pennsylvania, Section J-VIII (April 24, 1972).

J. D. FOX: Thank you, Dr. Hesler. We have a few minutes for discussion. So, do we have some questions for these gentlemen?

UNIDENTIFIED: Mr. Franke, in distributing the paunch manure, is there a charge to the farmer or do you have to pay them to take it?

J. FRANKE: We do give them, depending upon the location and areas where we have a real rough terrain, from 2 to 3 cents per head. They furnish the equipment and maintain it. We do help them in purchasing the equipment by increasing our rate and withholding enough to amortize it; but in most cases it will run from 2 to 3 1/2 cents per head.

UNIDENTIFIED: I would like to ask Mr. Franke a question. In one of the slides you showed what appeared to be fertilization with paunch manure on a growing crop. Is this possible, or do you encounter problems with burning of the growing materials?

J. FRANKE: This is spread fine enough so that if you can get through the crop with a truck without running it down, we don't have any burning problem at all. So it can be done. It is not done very largely other than on alfalfa grounds and where alfalfa is taken off you can put a real good coat on at that time without hurting the next crop.

UNIDENTIFIED: Question regarding problems with paunch disposal.

J. FRANKE: No, in fact where we had this problem arise near Sioux City, and we did have a problem, there was a lot of flies and a lot of odor from this windrowed material. These people have been very cooperative and we have gotten along real well. So, we don't have a fly problem and the odor problem has really been almost nil.

G. H. WELLINGTON: You mentioned that there was a good possibility you might feed back this material, but that you had some problems. I wonder if these problems are such that it would eliminate the possibility of using paunch for feeding in areas around larger cities, say New York State, etc., not speaking of New York and the metropolitan area but cities such as Rochester and Buffalo.

J. FRANKE: I wouldn't say so. I do think that we do need to consider the value of the product. We kill primarily choice cattle that are on a high concentrate ration. The food value is much greater than it would be if we were of a cow type operation, but there are some distinct natures and qualities of the digestive juices, acids and one thing or another that we did have some problems with. The reason a lot of cattle don't accept it is not because it's not palatable, it's because they can't eat it. We have overcome these and down the line a ways, we do anticipate using this as a feed.

J. D. FOX: You said that you were spreading grain feed paunch. Do you anticipate any problems with the grass fed animals? I know that the consistency is altogether different from the paunch of the grass fed or silage animals. Do you anticipate any problems with spreading if someone was killing primarily grass fed animals?
J. FRANKE: No, this spreading operational works equally as well with grass fed animals or hay fed animals or with grain.

R. H. REA: In feeding this back to your animals, were you pelletizing it in any way or was it just fed in a meal form to them or bunk fed.

J. FRANKE: No, I did mix the paunch with other ingredients, I put it down into a silo. I had the pH about right and allowed it to ferment for not less than three weeks in order to get the pH down where it was good feed. We had good conversion and good acceptance.

V. R. CAHILL: Mention was made of prekill cleaning of cattle. Would any of you speakers care to comment on that, how it might be done or the effectiveness of it?

W. MIEDANER: I tossed that in as a possibility for a research. Down in South America I have seen precleaning of cattle, but it was done for another reason and that is to control the hoof and mouth disease. It was very effective and it did have quite an effect on the hide curing operations. It is expensive; it is not cheap; it is not a good way.

UNIDENTIFIED: Do they use water to clean the animals in South America?

W. MIEDANER: Yes, actually the animal walked through a foot of water before it was slaughtered and sprays come up on the under side where most of the manure hangs and it just took the manure off and mixed it with the water. You really haven't eliminated your problem completely, you just inserted it at another point.

UNIDENTIFIED: Does South America have a pollution problem?

W. MIEDANER: No, South America doesn't have a pollution problem, at least not like we have. They are aware of it, but certainly some research can be done on how to preclean the animals. Maybe it has to start in the feedlots. If they kept the feedlots cleaner and don't let the cattle wallow around in a foot of mud and manure. This puts a terrific problem in the beef slaughtering operations.

Z. L. CARPENTER: I was wondering, Dr. Hesler, if there is a problem under occupational safety or if you considered the pollution problems from the health standpoint. I understand that some of the workers are considering this as a hazard and that there has been some investigation with regard to smoking plants, with regard to air pollution and with regard to rendering facilities and the affect on the actual workers in plants.

J. C. HESLER: Well, if I understand your question properly, yes. For example, in Minnesota the regulations do not require, but the agency personnel very strongly recommend or twist your arm to change the air within the building, for workers comfort and safety, at least once every
five minutes or twelve times an hour. They further insist that any such ventilation exhausts be controlled by scrubbing. They are not adamant on incineration for these exhausts, but they do consider scrubbing an acceptable substitute on these low odor intensity discharges. I hope I have answered your question.

L. E. ORME: Dr. Hesler, in the foreseeable future do you see the discontinuation of smoking meat, and the process for cured meats and sausages, especially around these cities that have a large population?

J. D. HESLER: If I understood your question, you asked, "did we see the possibility of cessation of smoking." Is that right?

L. E. ORME: No, do you foresee the possibility of ceasing from smoking meat in the foreseeable future?

J. D. HESLER: Yes, at the present time there are liquid smoke processing operations which in effect, produce the same effect as natural smoking through the spray application of liquid smoke on the materials being processed. The liquid smoke is essentially an extract of real wood smoke normally picked up in an acid such as acetic acid. We have found in a few instances where we are utilizing liquid smoking that the odor intensity of the acetic acid which vaporizes in the spray application is pretty tough on the workers. We have gone to a ventilation hood so that even the alternate process is susceptible to odor or vapor controls and we are using in these instances water scrubbers in which the acetic acid is relatively soluble and is essentially completely removed before the air is exhausted into the atmosphere.

UNIDENTIFIED: Mr. Franke talked very briefly about the corps of engineer permits along with all the multitude of permits that were all required to complete for waste water treatment facilities. I would like to point out that under the 1899 refuge act, which requires permits for all discharges to surface courses or navigable rivers in the United States, the Federal government is currently bringing to a close its study of the requirements and the EPA, which is the big brother to the corps of engineers and is administering the program, is establishing a set of performance standards known as a B level and an A level. The B level may be defined, for example, in terms of 0.4 pounds of BOD per 1000 pounds of liveweight killed and 0.3 pounds of suspended solids per 1000 pounds of liveweight killed. The B level would permit you to get a conditional permit which requires you by 1976 to reach an A level which is essentially half of the B level values. Further, there is the warning that by 1981 there will be further requirements on discharges and by 1986 the objectives of the federal congress is to close the loop completely and to prohibit any waste water discharges regardless of the degree of treatment into navigable waters. This is an extremely difficult task to accomplish and I think that the industry is going to have to look pretty carefully at some of the newer techniques such as reverse osmosis, electrolytic membrane operations and so on, in an effort to meet this objective if indeed it does become a fact by 1986.
J. D. FOX: I certainly want to thank our speakers for the excellent program this afternoon and would also like to thank the committee that worked on the program with me, Dr. Brissey, Dr. Bryant, Dr. Epley, Dr. Price, Dr. Sleeth, and Dr. Wilson. They did a lot of work in helping us pull this program together today.

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R. L. HENRICKSON: Good afternoon, ladies and gentlemen. We trust that you all enjoyed the lunch and are now ready for another skull session. It is nice to see such a large group present. Not only does it indicate great interest in the technical session prepared by the Histological Committee, but it is a fine tribute to the speakers. I feel sure you will not be disappointed. I am privileged to chair this session, but recognize the fine cooperation of Drs. Cassens, Henderson, Hultin, Melton, and Stromer for the ideas, speakers and preparation of this program. They were a wonderful group to work with. Would you men please stand and be recognized?

The three topics which we will present are currently under investigation. Therefore, so much of the information will be exposed for the first time and we are grateful for the willingness of these investigators to share their knowledge. Without taking more of their time, we will present all three topics and then devote the remaining time for questions. Our first speaker is Dr. Larry Anderson, who will share with you his knowledge on muscle histochemistry in relation to tenderness in post-mortem muscle. Let's give Dr. Larry Anderson, John Morrell & Co., a warm welcome.