NIOSH

OCCUPATIONAL HAZARD ASSESSMENT

Criteria for Controlling Occupational Hazards in Animal Rendering Processes

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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PREFACE

In 1977, the national injury rate for workers in rendering plants was reported to be almost twice that reported for the manufacturing industries sector. The need to assess and identify the underlying causes of this high rate and provide recommendations to reduce the incidence of these injuries prompted the National Institute for Occupational Safety and Health (NIOSH) to survey rendering plants and assess the occupational hazards of the rendering process. This document critically reviews the scientific and technical information concerning mechanical injury, physical agents (eg, noise, heat), and biological and chemical agents in the rendering workplace. Chapter III of this document, entitled Health and Safety Guidelines, is provided so individuals immediately responsible for hazard control in their specific workplace will have a basis on which to formulate their own occupational safety and health program. Employer knowledge of and adherence to these guidelines will reduce adverse effects on worker safety and health. This document is also intended for use by unions, industrial trade associations, and scientific and technical investigators to further their own objectives in providing for a safer workplace. Furthermore, it is intended to assist the Occupational Safety and Health Administration, US Department of Labor, in its standards development and compliance activities.

Contributions to this document by NIOSH staff, other Federal agencies or departments, the review consultants, the National Renderers Association, and The United Food and Commercial Workers are gratefully acknowledged.

The views and conclusions expressed in this document, together with the recommendations, are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or other Federal agencies. However, all comments, whether or not incorporated, have been carefully considered.

Ronald F. Coene, P.E.
Acting Director
National Institute for Occupational Safety and Health

SYNOPSIS

This document reviews information on occupational hazards associated with the rendering of animal material and recommends guidelines for preventing injury and illness in rendering plant workers. The major hazards in rendering plants result in mechanical injury; they include wet and slippery surfaces, lifting, pushing, and pulling large and heavy containers and carcasses, skinning, hide trimming, gutting and boning dead stock, and the moving parts of process equipment to which workers may be exposed. Burns may result from contact with boilers, cooking vats, and steam and hot water lines. Heat stress may result from excessive exposure to heat generated by process equipment. Exposure to nuisance dust, excessive noise, and electrical shock also occurs.

When processes do not effectively confine fat mist, rendering operations are especially vulnerable to fire, which may result from electrical short circuits and from maintenance operations such as welding and cutting. Materials in percolation (perc) pans may also spontaneously ignite and cause fires if they are not processed promptly.

Infections resulting from organisms associated with animal material occur occasionally. Workers may also be exposed to chemicals generally associated with cleanup or maintenance activities. Under certain conditions, hazardous gases can be generated by anaerobic reactions during the holding of accumulated organic raw materials.

Rendering facilities are of two types, those directly associated with meatpacking and poultry slaughtering and dressing operations (onsite) and those that are independent of these operations. There are approximately 3,000 workers associated with onsite rendering facilities and about 9,000 workers associated with independent rendering facilities in the United States. Rendering processes are classified according to whether inedible or edible products are produced. The major inedible fat products are grease and inedible tallow; major inedible protein meal products are meat meal and meat-and-bone meal. Edible products include lard, edible tallow, and certain proteinaceous tissues.

Based on information from the available literature, reviewer comments, and plant site visits, NIOSH recommends guidelines for engineering controls and work practices to reduce the number of injuries and illnesses in rendering plants. Recommendations for training, posting, personal protective equipment programs, medical surveillance, and maintenance of relevant records are also included.

ACKNOWLEDGEMENTS

The Division of Criteria Documentation and Standards Development, NIOSH, had primary responsibility for the development of this document and guidelines for the rendering of animal material. Martin N. Erlichman and Michael C.R. Alavanja, Dr. P.H., of this Division served as criteria managers.

CONTENTS

CONTENTS (CONTINUED)

I. PLANT AND PROCESS DESCRIPTIONS FOR THE RENDERING OF ANIMAL MATERIALS

Background and Scope of Document

The rendering of animal materials was one of the first recycling industries. It began about 150 years ago, and grew as the meat products industry grew. Many new uses were found for products derived from materials such as grease, hair, blood, feathers, hides, and bones [1]. Products from rendering operations are either inedible or edible; inedible products include inedible tallow and grease and various protein meals such as blood meal, feather meal, meat meal, bone meal, and meat-and-bone meal. Edible products include lard, edible tallow, and protein tissue [1].

Rendering performed at meatpacking or poultry dressing plants is referred to as onsite, or captive, rendering. Onsite renderers produce almost all of the edible lard and edible tallows made. Rendering not performed at meatpacking or poultry dressing plants is referred to as offsite, or independent, rendering. According to the Census of Manufactures, the independent rendering industry accounted for 69% of the inedible tallow and grease in 1977 [2]. This Census reported that 500 establishments were classified under Animal and Marine Fats and Oils (SIC code 2077); about 450 of these rendered animal materials. The number of workers at onsite rendering facilities (SIC codes 2011 and 2016) was estimated to be about 3,000 (A Phifer, written communication, June 1978). The National Renderers Association has estimated that half of the 9,000 workers employed by independent rendering plants are involved in plant operations and maintenance (WH Prokup, written communication, February 1981). Table I-1 summarizes production figures for the rendering industry [3].

This document concerns occupational exposure in the manufacture of rendered animal products, particularly the handling and processing of raw materials at the rendering plant as well as maintenance, cleanup, and repair work. The collection of raw materials from butcher shops, supermarkets, restaurants, farms, and meatpacking plants is not a part of the rendering production process, and is not discussed here. The guidelines in Chapter III apply to both onsite and independent rendering.

Inedible Rendering

Raw materials for independent inedible rendering come from a variety of sources, including butcher shops, restaurants, grocery stores, feedlots, and meatpacking plants [4]. The raw materials are usually bones and bone fragments, offal, blood, feathers, other cut-up materials, and barrels of restaurant grease. This material, usually delivered in barrels or by a dump truck, is weighed, evaluated for potential endproducts, and dumped into receiving pits or bins. The trucks and barrels are hosed out and the washings are emptied into an adjacent pit and drained into an onsite waste-treatment system. Separated solids are recycled into the receiving pits. Some independent rendering plants also process dead stock. Plants without mechanized pre-breakers and crushers that can process whole dead animals must have the carcasses cut up with axes or knives by plant personnel. This is done either with the animal lying on the floor or hanging from an overhead rail.

TABLE I-1

RENDERING INDUSTRY PRODUCTION DATA FOR 1979

Products	Million Pounds	Metric Tons
Inedible Tallow and Grease	5,900	(2,681,550)
Edible Tallow	1,550	(704,475)
Lard	1,280	(581,760)
Meat and Bone Meal and Tankage	4,680	(2,127,060)
Feather Meal	790	(359,055)

Adapted from reference 3

The raw material in the receiving pit is then crushed or ground to the size necessary for cooking or moisture evaporation [4]. To limit the production of odor and to maintain product quality of the tallow or grease and protein meal, raw material is usually processed promptly. Size reduction operations use equipment such as pre-breakers, shredders, grinders, and hashers. Following the size reduction step the raw material is sent on to cookers which can either be a batch or continuous type [4]. Figure I-1 is a generalized flow diagram of this process. Figure I-1 also shows ancillary processes which are discussed later.

Onsite rendering operations in meatpacking and poultry dressing plants usually receive raw materials directly from the kill floor. If the rendering operation is in a separate building on the same premises, the raw material is moved by pump or truck to the cookers. At this point the onsite and offsite rendering processes are similar [1].

(a) Batch Cooker Processing

Moisture is evaporated and fats are released from the raw material by heating it under controlled conditions [1,4]. A quantity of material is cooked in batch cookers to a specified moisture or temperature, and then the load is discharged. Figure I-2 is a generalized diagram of a batch cooking system [4].

Dry-batch rendering is the method most commonly used for inedible products. In this method, moisture is separated from the raw material by evaporation. Heat for evaporation is provided by steam in a jacket around the cooker, reaching process temperatures of 116-138 C (241-280 F). The areas around the process equipment are often hot; insulating process equipment and steam and condensate piping will result in a cooler environment. The water removed from the raw material in the cooking or evaporation step must be condensed and discharged into a sewer according to guidelines of local sewer ordinances for a city sewer or the Clean Water Act Amendments of 1977 for a navigable stream [5]. Vapor is condensed primarily by contact or by surface condensers located just outside the plant or on the roof. Noncondensable vapor from the condenser, which gives off highly intense odors, can be controlled by venting to a scrubber or directly to the boiler that generates the plant's steam.

After the moisture is removed, the liquid fat must be separated from the protein solids. In batch cooking, the initial separation is accomplished with a rectangular percolation pan that contains a perforated screen 6-inches above a sloped bottom. This configuration allows the fluid tallow to drain and be separated from the protein solids. The protein solids still containing about 25% tallow are conveyed to the screw press, which completes the separation. Solid protein material discharged from the screw press is known as cracklings. The cracklings are normally screened and ground with a hammer mill to produce meat-and-bone meal. These products are usually stored outside the plant in silos. Workers occasionally enter these silos for maintenance and repair work.

The liquid fat from the percolation pan and screw press can be processed by screening, settling, centrifuging, or filtering to remove fine solids. Liquid tallow or grease that remains may then be clarified or bleached with various clays or diatomaceous earth. The grease and tallow are usually stored in steam-heated tanks and held for shipping. Workers occasionally enter these tanks when empty to perform maintenance or repair work.

Each rendering plant has a facility for loading trucks, railroad cars, or barges to move the rendered materials to the user. Solids can be top-loaded or end-loaded with flingers (conveyors that throw material horizontally) into covered trailers or boxcars. Stored grease and tallow are liquefied and then pumped into tank trailers or rail tankcars.

(b) Continuous Cooker Processing

Continuous cooking systems for inedible rendering are increasingly common [1]. The receiving, grinding, pressing, and storing operations are similar to those discussed for batch cooking. Continuous systems evaporate water and separate fats by steadily moving the material through the cookers. Advantages of the continuous system over the batch process include improved quality control of the product, better confinement of odor and fat-particle aerosols within the equipment, and a smaller space requirement. Although use of batch cookers has steadily decreased, they may never be entirely replaced by continuous systems; small rendering plants often cannot afford continuous systems. Continuous systems are highly automated and can be operated with fewer workers, but also require a greater maintenance effort because failure of any part can shut down an entire system. The instrumentation and controls for a continuous system are usually centralized at a panel that may be enclosed in a booth.

Currently, the two most widely used continuous systems in inedible rendering are the Anderson C-G (Carver-Greenfield) system and the Duke system, shown in Figures I-3 and I-4, respectively [4]. The Anderson C-G system first uses a fluidizing tank in which recycled fat is used to heat and slurry the raw material. Then the slurry is pumped to a disintegrator for further grinding and for breakdown of cellular structure to release fats. The resulting charge is then pumped to the evaporator, where moisture is removed under vacuum. In the Duke system, the cooker resembles a batch cooker, but differs in that material is continuously charged at one end, driven slowly through the horizontal cooker, and steadily discharged at the other end. Other systems, in limited use, are the Strataflow, the Pfaudler Low Temperature Centrifuge, and the Norwegian Stord-Bartz Rotadisc.

Rendering operations that process a large volume of material are mechanically aided by screw conveyors, pumps, front-end loaders, and other equipment [4]. Pressure vessels and systems, such as feather hydrolyzers, cooker steam jackets, filter presses, and condensate returns, are also used. Other operations use boilers to generate steam or hot water and usually have some sort of system to recover the water vapor produced in the cooking process. For odor control, scrubbers or incinerators are used for cookers, dryers, and other process equipment.

Edible Rendering

Edible rendering usually takes place as an adjunct to slaughtering and dressing processes, where edible raw material is readily available. It has been estimated that less than 2% of independent processers render edible material [6].

A typical edible rendering process consists of a multistage centrifuge system that mechanically separates water from fat, in contrast to a cooking process in inedible rendering. In the edible processes, production volume and temperatures are usually much lower and sanitation requirements more stringent than in the inedible processes.

Batch processes, which are becoming obsolete, are either "wet-batch" or "dry-batch" [1]. In dry-batch low-temperature rendering, the charge is

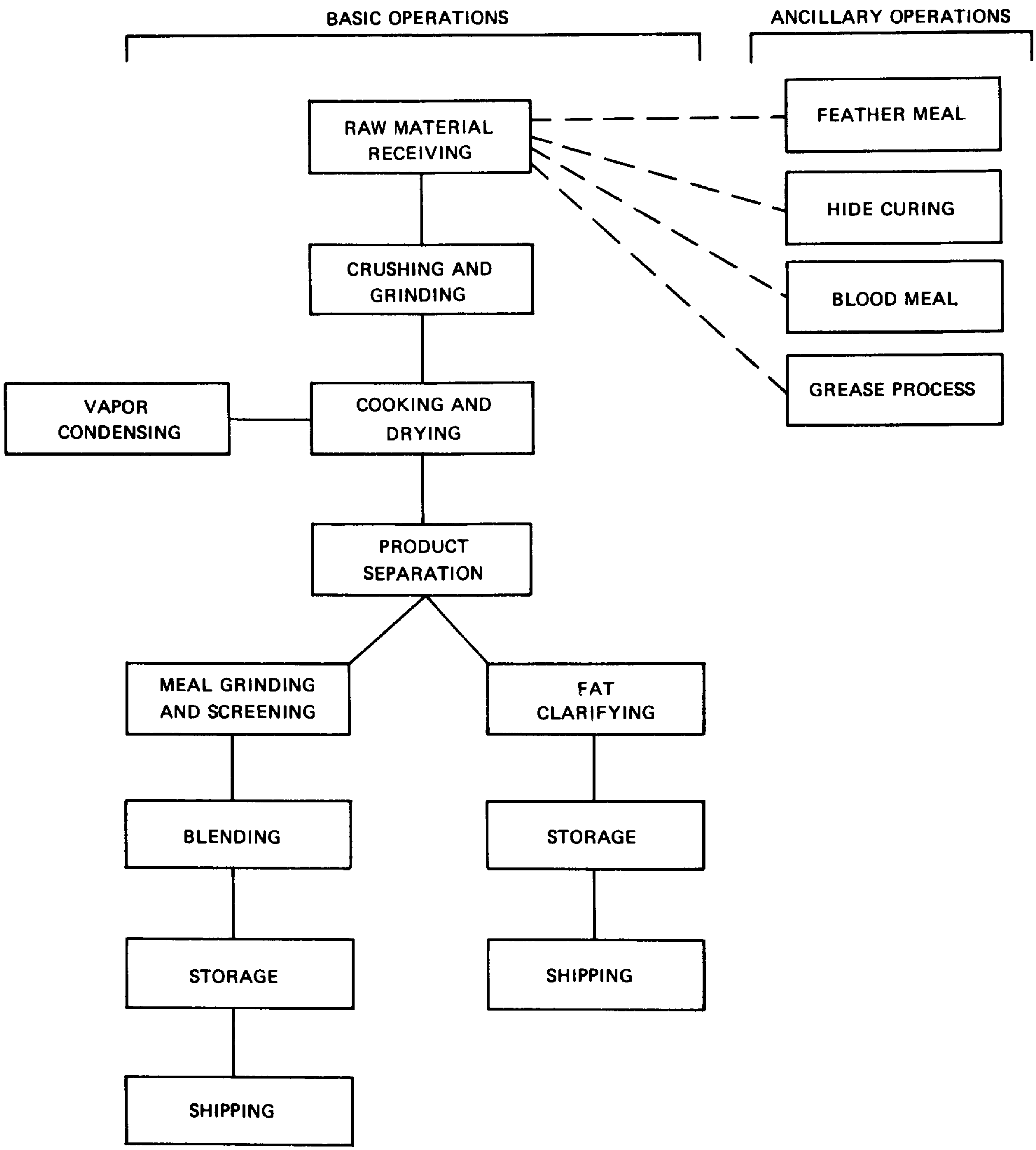

FIGURE I-1. FLOW SCHEME FOR BASIC RENDERING OPERATIONS

Adapted from reference 4

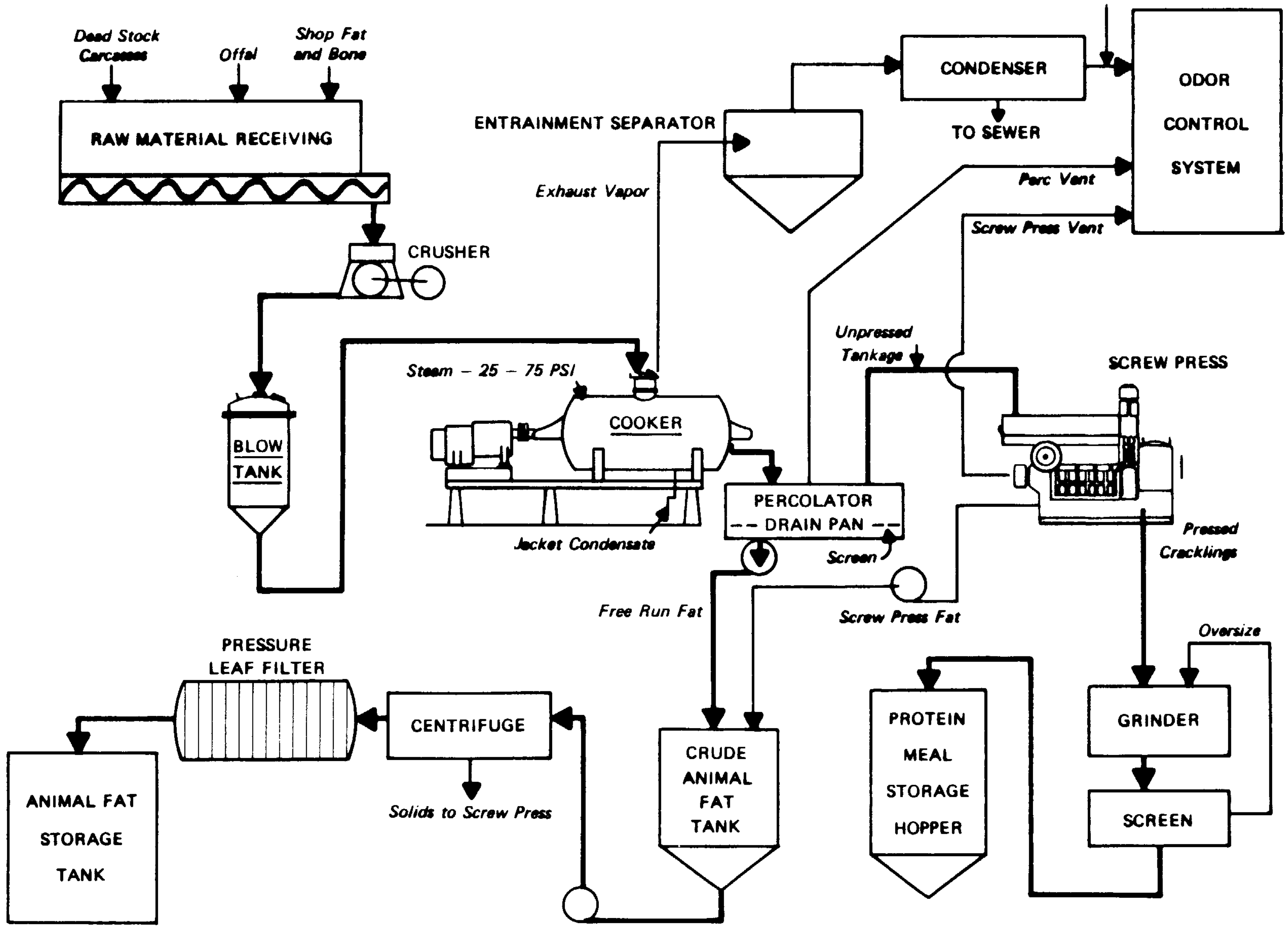

FIGURE I-2. A BATCH COOKER RENDERING SYSTEM

Adapted from reference 4

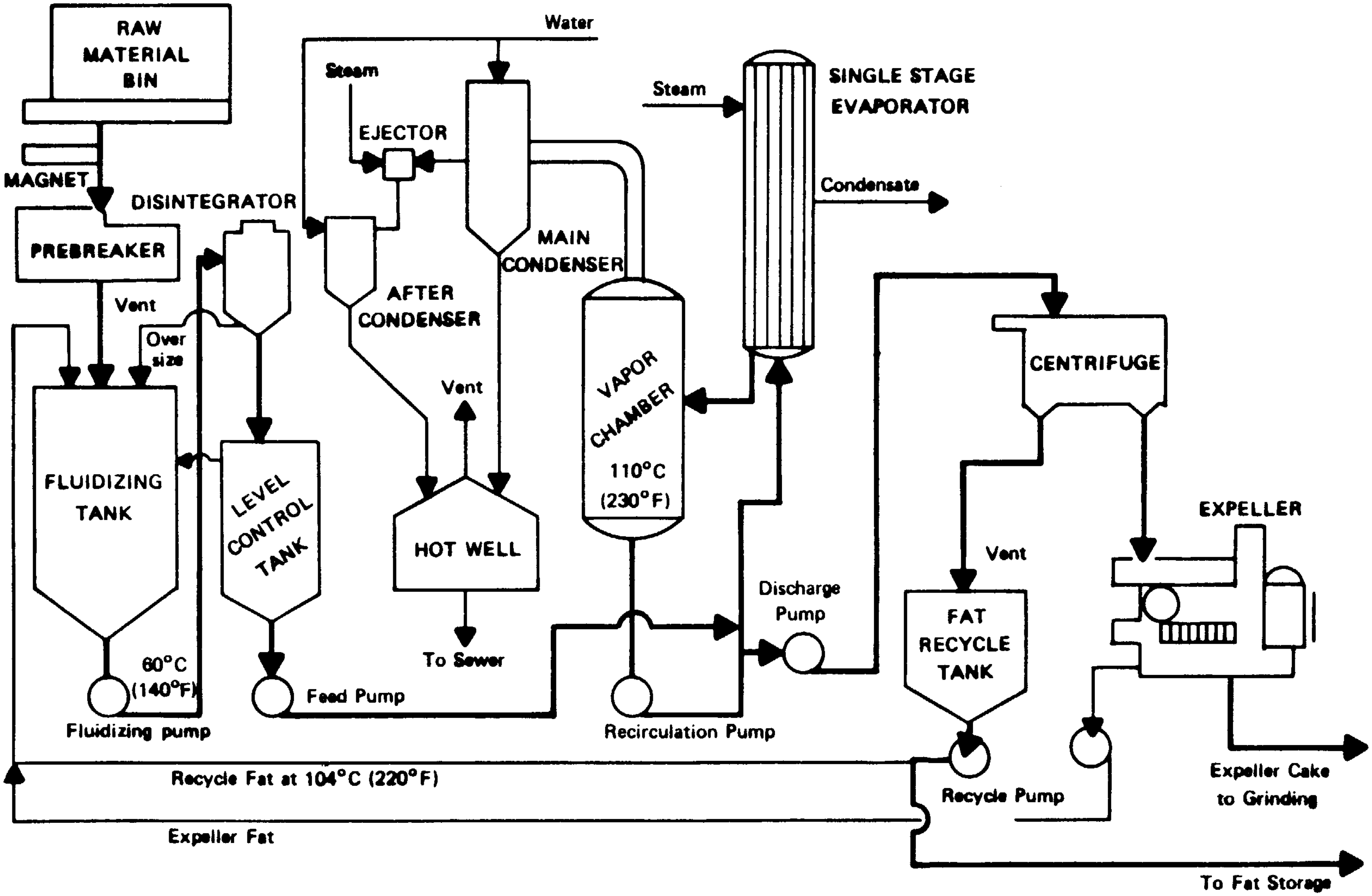

FIGURE I-3. THE ANDERSON C-G (CARVER-GREENFIELD) CONTINUOUS RENDERING SYSTEM

Adapted from reference 4

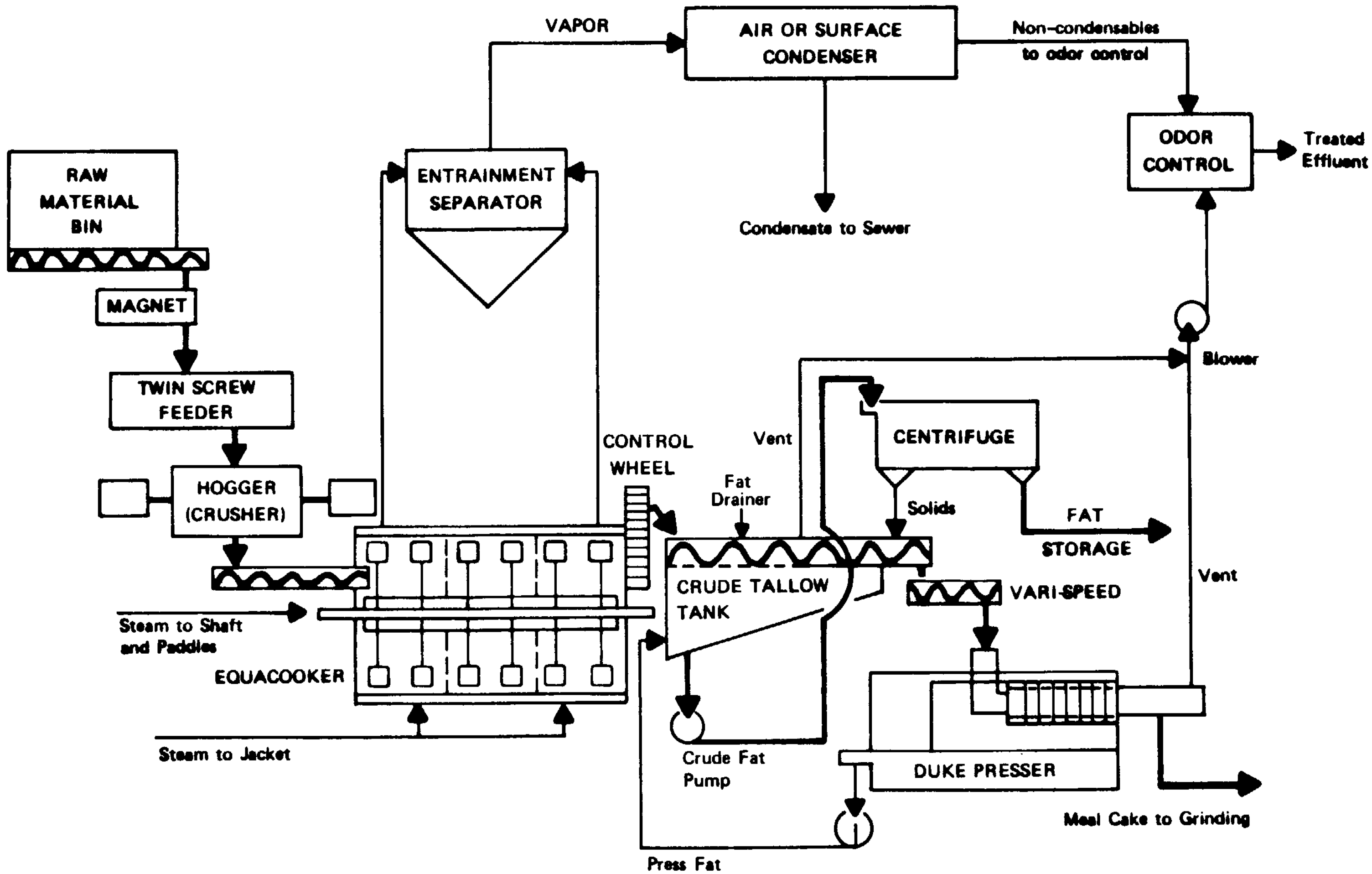

FIGURE I-4. THE DUKE CONTINUOUS RENDERING SYSTEM

Adapted from reference 4

melted in a conventional cooker at a temperature that does not evaporate the moisture in the raw material. The fats are separated from the solids and water by screening or centrifuging. Remaining water entrained in the hot fat is then removed in a second centrifuge. The separated water, called tank water, can be further evaporated to a thick material known as stick, which can be used as tankage for inedible rendering. The solids can be sent to inedible rendering or used in edible meat meals. In wet-batch rendering, now essentially outdated, the material is heated by direct injection of steam. Three materials result: water, fat, and suspended solids (protein tissue). The fat is decanted and the water and solids are separated by filtration or centrifugation.

Currently, edible material is most commonly rendered in continuous, wet systems in which low temperature and centrifugation are used to separate fats from water and solids (protein tissue) [1]. Raw materials are cut finely and heated, which fluidizes them. The fluid mass passes into a centrifuge to separate the fat (and water) from the solids. The resulting solids can be used as food fillers or as pet food. The fat and water mixture goes to a second centrifuge for further separation. The final fat is low in acid and faintly colored. Water goes to the water treatment system, and sludge goes to inedible rendering. Process temperatures are about 49 C (120 F) for edible lard and 68 C (155 F) for edible tallow.

Ancillary Operations

Ancillary operations performed in some rendering plants include the producing of blood meal and feather meal, the reclaiming of grease, the boning of dead stock for pet food, and the processing of hides.

Blood from the kill floor is coagulated and centrifuged, dried, and sold as a protein source for use in animal feed. Figure I-5 is a flow scheme for the process. Blood received from the sticking area of a slaughtering plant is preheated and coagulated by steam injection in the continuous process. Solids are separated from liquids by centrifuge, and then dried and ground. In continuous systems, a gas-fired direct-heat dryer (ring dryer) or a rotary steam tube can be used to dry the blood. In batch processes, coagulation and moisture removal are performed in the batch cooker by drying. Blood meal is valued as animal feed because of its high lysine content. A batch process is less desirable than a continuous one because it results in a lower lysine content of the blood meal.

Poultry feathers and hog hair are also processed in many plants (Figure I-6) [4]. The hair and feathers are hydrolyzed by cooking under pressure, dried in a steam tube or a ring dryer commonly at temperatures of 100 C (212 F), and then blended for use in animal feeds; feather or hair material may also be ground. Feather and hair meals are used as protein sources in animal feed.

The growth of the restaurant business has made the reclaiming of restaurant grease an important part of the rendering industry (F Ward, written communication, December 1978). This reclaimed grease is used as stabilized animal fat for animal feed. A brief outline of this process is shown in Figure I-7. Restaurant grease is delivered to rendering plants in large drums by bucket trucks or other types of barrel trucks. Drums weighing as much as 204 kg (450 lbs) are unloaded by hand or with mechanical aids, such as hand trucks or hoists. These drums are not only heavy, but many times have rough, sharp edges. The distance these drums are lifted, pushed, and pulled from the unloading dock to the hot room varies considerably from plant to plant. Steam, infrared radiation, or electric heaters are used to melt the grease while still in the barrels, which are drained through metal screens and cleaned. The grease is then filtered or screened to remove coarse solids, heated to remove water (water may also be removed by settling), and further filtered or centrifuged to remove the fine solids. The resulting yellow grease is blended with antioxidants and stabilizers, and stored or shipped out for animal feed as stabilized animal fat.

Some rendering plants supply pet food establishments with red meat. Good quality carcasses are placed on a rail where they are skinned and gutted. The meat is kept in a cooler and inspected until it is boned and sold the next day. At some rendering plants this accounts for about 10% of their total tonnage.

Many rendering plants that handle a large number of dead stock find it economically favorable to remove the hides from dead carcasses for curing. These carcasses are skinned while hanging from a rail or lying on the floor. The carcass is usually taken by conveyor or cable to the pre-breaker, and the hide is trimmed, cleaned, and then cured in brine raceway vats.

Chemicals Used During Rendering Plant Operations

Rendering plants use chemicals in several operations: cleaning, grease or fat processing, treating waste water, controlling odors, water cooling, and boiler operation [1,4]. A partial list of the more common chemicals is given in Table I-2.

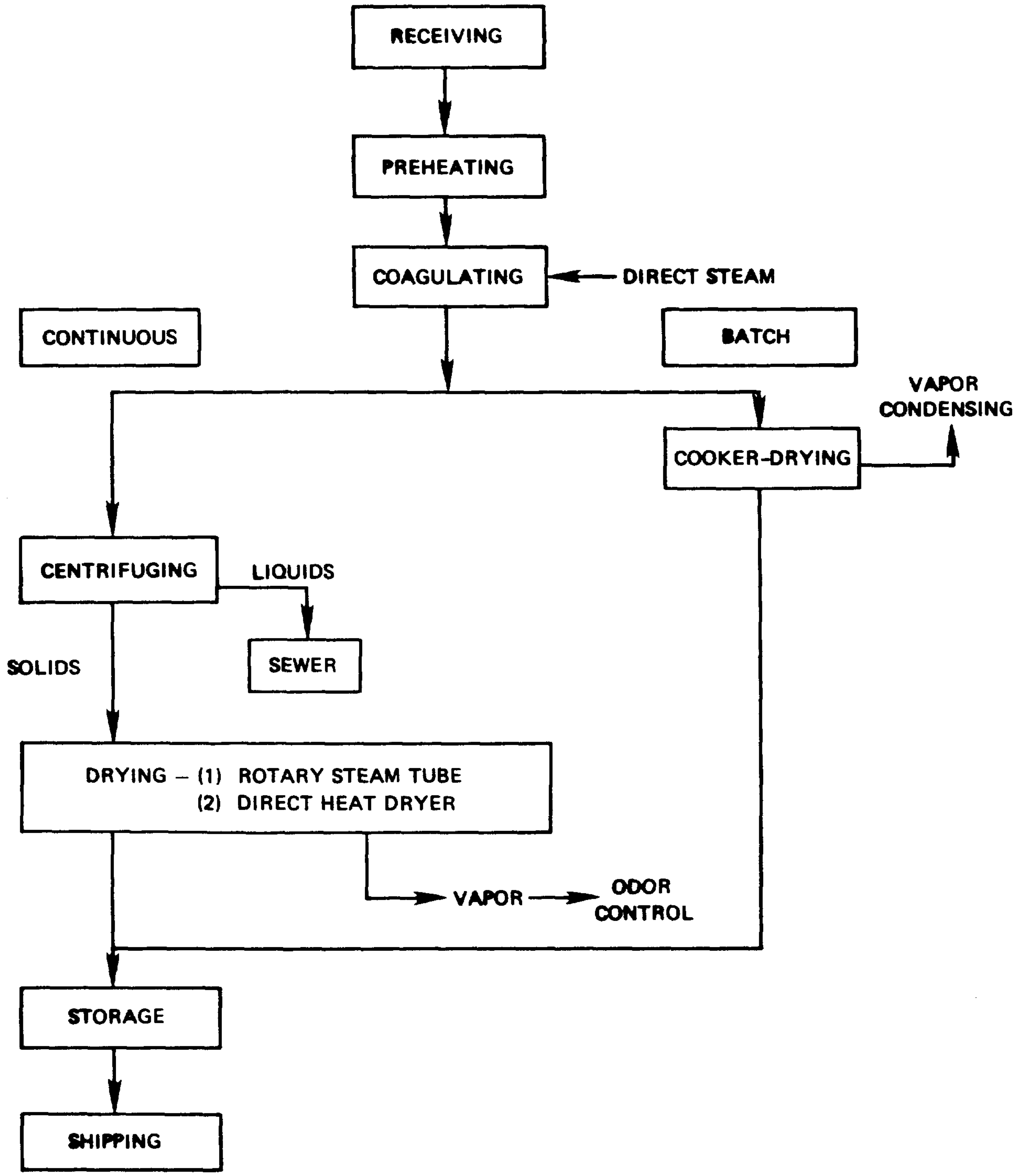

FIGURE I-5. FLOW SCHEME FOR A BLOOD MEAL OPERATION

Adapted from F Ward, written communication, December 1978

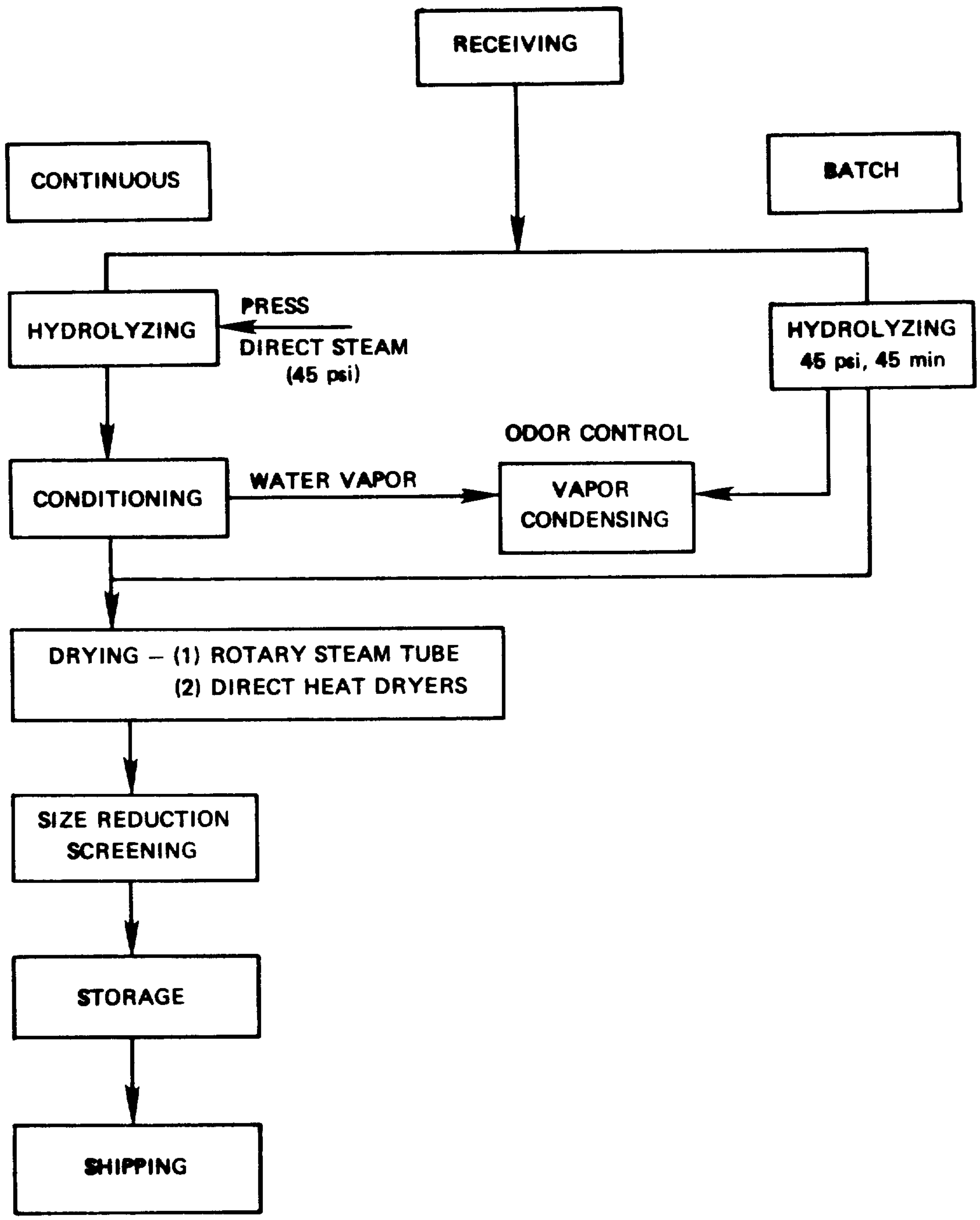

FIGURE I-6. FLOW SCHEME FOR A FEATHER MEAL OPERATION

Adapted from F Ward, written communication, December 1978

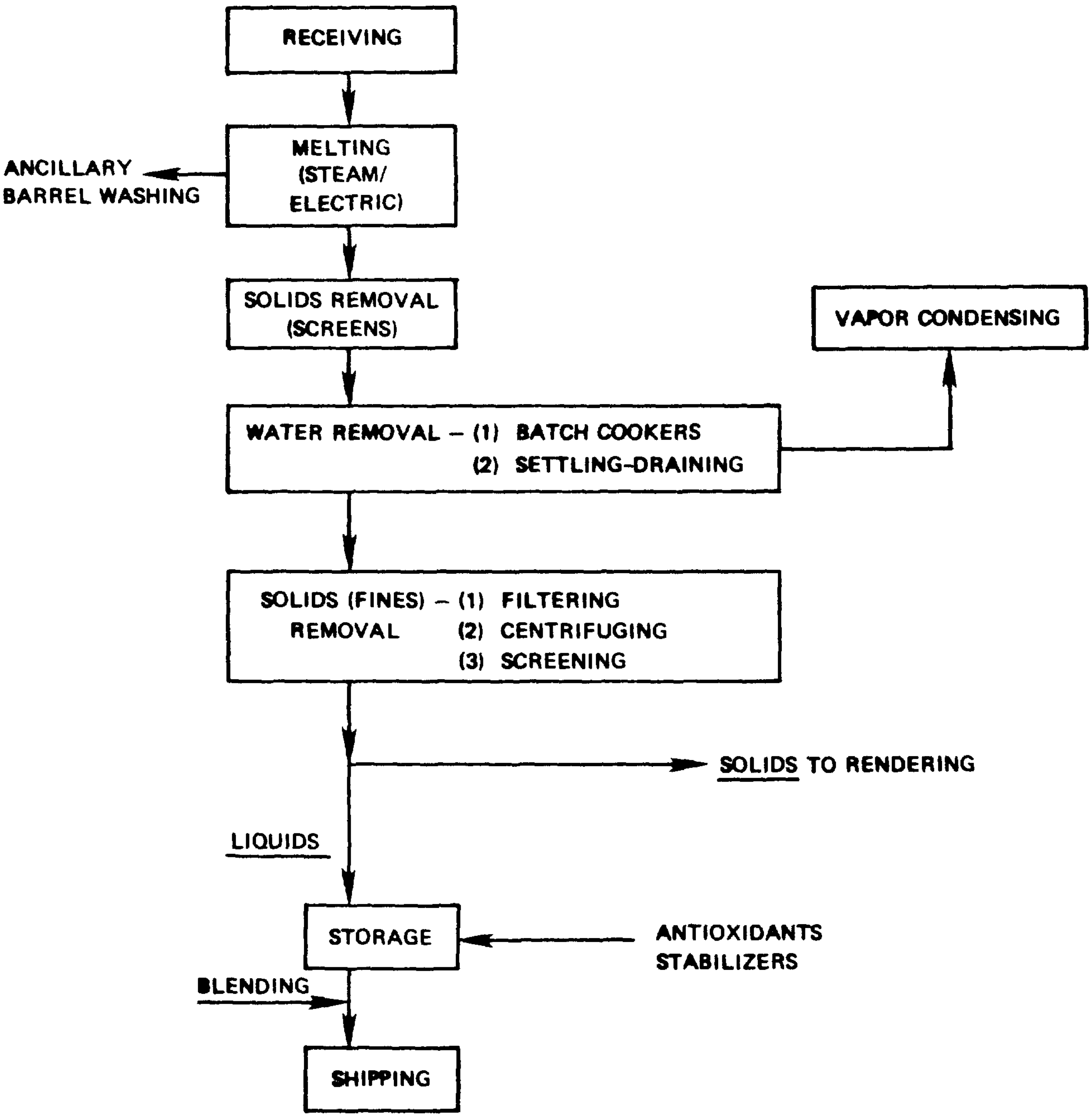

FIGURE I-7. FLOW SCHEME FOR A RESTAURANT GREASE OPERATION

Adapted from F Ward, written communication, December 1978

TABLE I-2

CHEMICALS, COMPOUNDS, OR AGENTS USED IN RENDERING PROCESSES

I. Cleaning, Sanitizing, and Disinfecting

- Sodium Carbonate
- Caustic Soda (Sodium Hydroxide*)
- Sodium Metasilicate
- Sodium Polyphosphates
- Sodium & Potassium Soaps

II. Processing System

- Antifoams - Silicones
- Sodium Sulfite
- Filter Aids - Diatomaceous Earths
- Bleaching Agents - Clays
- Trisodium Phosphate
- Salt (NaCl) and Lime (CaO)
- Stabilizing Agents - Antioxidants
  - Citric Acid
  - BHA and BHT - Phosphoric Acid
  - Propyl Gallate
  - Orthophosphoric Acid
  - MHA (Methionine Hydroxy Analog)
  - n-Propyl Alcohol
  - Silicate Mixtures

III. Waste-Water Treatment System

- Alum
- Ferric Chloride and Ferric Sulfate
- Lime
- Sulfuric Acid*
- Chlorine*
- Sodium Hydroxide*
- Polyelectrolytes - Anionic - Cationic
- Lignosulfonic Acid

IV. Odor Control System

- Sodium Hydroxide* and Sodium Hypochlorite
- Chlorine*
- Sodium Carbonate
- Sulfuric* and Sulfamic Acid
- Potassium Permanganate

V. Water-Cooling System

- Algacides, Chlorine*, Biocides, and Chlorinated Phenols
- Sulfuric Acid*
- Polyphosphates
- Low Molecular Weight Polymers - Polyacrylates
- Chromates* and Silicates
- Zinc Salts
- Sodium Nitrite
- Quaternary Ammonium Compounds

VI. Boiler System

- Salt (NaCl)
- Acid Cleaners
- Sodium Hydroxide*
- Sodium Carbonate, Phosphates, and Aluminate
- Chelants (EDTA, NTA)
- Polymers, Polyacrylates
- Tannins
- Sodium Sulfite and Nitrate
- Hydrazine**
- Filming and Neutralizing Amines
- Antifoams - Polyglycols, Silicones, Polyamides

VII. Hide Processing

- Sodium Hypochlorite
- Pentachlorophenol
- Curing Salt

*See NIOSH's criteria document on this compound for recommended standards and control procedures.
**Not very common

Adapted from F Ward, written communication, December 1978