Robert M. Kerr Food & Agricultural Products Center

FOOD TECHNOLOGY FACT SHEET

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Planning the Engineering Design of a Food Processing Facility

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Engineering design and construction of a food processing facility requires a great deal of planning. Information must be collected from many sources and combined into documents that are simple to read and share with others. Planning sessions should involve persons that represent all aspects of facility activity. Examples are production, maintenance, supervision, sales, accounting, receiving, warehousing, distribution, human resources, management, engineering, research and development, key suppliers (products and services), government agencies, and consultants. Consultants include engineers, lawyers, insurance providers, and other specialists that may not be regularly employed by the company. For large projects, it is recommended to hold scheduled planning sessions at a convenient location that is free from distractions. It is often desirable to obtain an unrelated, third party to lead and moderate planning sessions in order to retain objectivity and purpose. An agenda should be drafted for each planning session.

This fact sheet lists many of the elements to consider when designing food-processing plants. Since each situation is unique, some elements will not apply and some important elements may need to be added. Relevant elements can form the basis for a planning session agenda. Elements listed are not in any particular order of importance and emphasize engineering design (not economics, marketing, logistics, and other necessary inputs). Lists of design considerations are given under four headings.

- Facility
- Process
- Product
- Other

The "Other" list contains miscellaneous elements and items that can be classified in multiple categories. Where useful examples and a brief explanation of the desired input are given. For a more detailed explanation of an engineering approach to facility design for food processing, please call the author for a copy of the Oklahoma State University circular *E-959, Process Engineering Method for Food and Agricultural Products*.

Facility

1. Site selection: Identify the best location(s) for the facility, considering the following factors.
   - Economic development assistance –grants or other support offered to new businesses
   - Flexibility
   - Expansion
   - Utilities availability
   - Maintenance
   - Sanitation
   - Access
   - Environmental impact
   - Zoning laws
   - Permit requirements
   - Parking for employees and delivery vehicles
2. Existing or proposed facility size (square feet)
   - Designate size of dedicated areas (storage, cooler, processing, packaging, etc.)
   - Provide a plan view of the proposed facilities layout (a scaled drawing is not necessary if dimensions are included)
   - Estimate expansion requirements (show on drawing)
3. Provide a budget estimate for the cost of the facility
4. Utilities: Identify source(s) and cost to provide utility service as shown in table 1. Review the impact of variable demand charges (if any) and limitations on quantity (e.g. BOD of discharge to treatment system). Consider including meters that can record utility usage to provide data for improving operating efficiency.
5. List code and permit requirements (local, state, federal, and international)
6. Type of construction (steel frame, concrete, panel, prepackaged, etc.)
7. Overhead clearance available or required in designated areas (especially processing)
8. Description of access requirements to facility and dimensions of openings
9. Flooring, walls, and ceiling in wash down and special use areas
10. Floor drains in wash-down and process areas
11. Type (drop-down, floor, or wall) and number of utilities connections (electric, steam, water, air, etc.) in process areas
12. Refrigerated storage requirement (square feet or amount of products/materials/pallets) for proper handling, rotation, and placement of goods
    - Temperatures
    - Raw materials (ingredients)
    - Finished product
    - Rework
    - Long term storage requirements for seasonal goods

Table 1. Utility source, availability, capacity, fee, and rate

UTILITY	*SOURCE (provide contact name and phone number)*	*HOOK-UP FEE (maximum)*	*CAPACITY*	*RATE*
Electric			kW	$/kW
Natural Gas			therm	$/therm
Water			gal.	$/1,000 gal.
Sewage			gal.	$/1,000 gal.
Solid waste		N/A		$/cubic yard
Other				

- Stack height

13. Strategy for grouping separate refrigerated areas to maximize energy efficiency, materials handling requirements, and expansion needs
14. Ambient temperature storage requirement (square feet or amount of products/materials/pallets)
    - Raw materials (ingredients)
    - Finished product
    - Packaging materials
    - Rework
    - Long-term storage for seasonal products (estimate)
    - Incoming materials inspection and storage
    - Wall clearance and inspection lane requirements
    - Stack height
    - Develop a strategy for grouping separate storage areas to maximize materials handling requirements and expansion needs
15. Employee service facilities requirements
    - Drinking water fountains
    - Toilet and lavatory facilities
    - Change rooms
    - Training or class room
    - Retiring room
    - First aid
    - Food service
16. All warehousing and storage areas
    - Incoming materials inspection and storage
    - Truck and railcar parking and sanitation facilities
    - Wall clearance and inspection lane requirements
    - Protective guard posts for walls, doors, and equipment
17. Cleaning and Sanitation
    - Layout
    - Materials handling
    - Grease trap location
    - Building exterior
    - Floors and drains
    - Walls and ceilings
    - Ventilation
    - Lighting
    - Pest proofing
    - Surface treatments and coatings
    - Truck and railcar sanitation
    - Wastewater pretreatment
    - Secondary and tertiary wastewater treatment systems
18. Process electrical equipment rating (wash-down, dust proof, explosion proof, etc.)
19. Electrical switch gear and motor control room location
20. Emergency Power: Indicate the amount (square feet or percentage of area) and temperature of refrigerated warehouse or facility area to be protected by an emergency power source, if any.
21. Parking and access
    - Delivery trucks
    - Truck drivers lounge
    - Railcar
    - Employee
    - Special designation (inspector, visitor, customer, etc.)

Process

1. Describe value-added products to be processed. An example is provided in table 2. Include future requirements.
2. Process organization and flow
    - Materials flow (product, waste, rework, packaging, ingredients, and intermediates) and storage
    - Personnel flow
    - Data collection and manipulation
3. Provide recipes and examples of product/packaging materials if available.
4. Regulatory requirements for products (local, state, federal, and international)
5. Describe the level of process automation desired for the facility (e.g. manual, semi-automated, or fully automated)
6. Describe the level of packaging automation desired for the facility (e.g. manual, semi-automated, or fully automated)
7. Describe the carton or case requirements for products
8. Describe the image desired for the facility (e.g. state-of-the-art, modern, or utility)
9. Provide a budget estimate for capital equipment expense
10. Is used equipment acceptable/desired? If so, state any specific areas in the process where used equipment is unacceptable
11. How will ingredients or raw materials be delivered to the facility (delivery size, pallet or container size, stacking specifications, temperature, frequency, supply capability, and plans for handling)?
12. How will packaging materials be delivered to the facility (delivery size, frequency, pallet dimensions, stacking specifications, case size, and plans for handling)?

13. How will finished goods leave the facility (frequency, pallet requirement, wrapping, coding, and handling requirement)?
14. Technology
    - Process equipment
    - Materials handling (pneumatic conveying, bucket elevators, augers, conveyors, gravity slide, etc.)
    - Control systems for process and environment (degree of automation)
    - Quality assurance (in house systems)
    - Research and development
15. Expansion capability and space availability
16. Flexibility (changeovers, seasonal packs or products, and future upgrades)
17. Reliability of equipment (lifetime requirement)
18. Waste treatment, handling, disposal, and recovery
19. Sanitation standards
    - Housekeeping
    - Raw materials handling and storage
    - Processed and finished product handling and storage
    - Waste handling procedures
    - Current Good Manufacturing Practices (cGMPs)
20. Sanitary facilities
    - Cleaning and Sanitizing
    - Methods required
    - Systems needed
21. Personnel safety
22. Environmental safety
23. Product and process safety
    - Metal detection
    - Line magnets and strainers
    - cGMPs

Product

Describe the value-added products to be processed as shown in table 2. Describe the physical properties of ingredients, intermediate and final product(s) (include or forecast ingredients in future plans). Intermediate products may be important in cases where physical properties of the intermediates are unique when compared to the ingredients and final product. Examples of descriptive terms follow:

1. Common name of ingredient, source, or specification
2. Density (weight per volume)
3. Corrosive nature
4. Viscosity (indicate temperature or range of temperatures)
5. Sensitivity to air
6. Sensitivity to temperature
7. Sensitivity to moisture
8. Sensitivity to materials (contact)
9. Requirement for agitation or mixing
10. Dustiness
11. Flammability
12. Volatility
13. Reactivity
14. Bridging
15. Abrasive nature
16. Toxicity
17. Freezing point
18. Boiling point
19. Rheology
20. Particle size
21. Stiffness
22. Thermal conductivity
23. Electrical conductivity
24. Specific heat

Other design considerations

Food and Drug Administration, United States Department of Agriculture, or applicable regulations
Local, state, and federal permits (construction, business, and environmental)
Local labor groups and labor statistics
Local cropping practices and soil types
Local weather patterns
Hazard Analysis and Critical Control Point (HACCP) program
Test kitchen (product development) requirement
Research and development laboratory and/or pilot plant
Seasonal processing requirements
Softened water requirement
HVAC system pressure and balance for sanitation, and process and odor control
Lighting requirements
Energy and process materials recovery
Return on investment
Environmental safety (chemical handling, storage, and disposal)

Table 2. Description of product, production rate and package

PRODUCT	*PRODUCTION RATE*		*PACKAGE*
	MIN	*MAX*	
Example I: 1 cc capsule of pure emu oil (red or green)	250 caps/min	500 caps/min	250, 500, and 1,000 caps. Plastic bottle with cotton insert and shrink band
Example II: 1cc capsule of pure emu oil (red or green)	500 caps/min phase II	1,000 caps/min phase III	Same as example I
Example III: 5cc capsule of emu oil and aloe (blue and brown)	250 caps/min	500 caps/min	Mini 50 count and Jumbo 5,000 plastic bottle with heat-activated foil seal

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 74 cents per copy. Revised 0717 MG

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The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; home economics; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and based on factual information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.