United States
Environmental Protection
Agency

Office Of Air Quality
Planning And Standards
Research Triangle Park, NC 27711

EPA 452/R-00-004
January 2001

Air

Economic Impact Analysis for the Final Nutritional Yeast NESHAP

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Acronyms

ADY	Active Dry Yeast
CAAA	Clean Air Act Amendments
EIA	Economic Impact Analysis
EPA	United States Environmental Protection Agency
HAPs	Hazardous Air Pollutants
SIC	Standard Industrial Code
IDY	Instant Dry Yeast
ISEG	Innovative Strategies and Economics Group
MACT	Maximum Achievable Control Technology
NAICS	North American Industrial Classification System
NESHAP	National Emission Standards for Hazardous Air Pollutants
OAQPS	Office of Air Quality, Planning, and Standards
RFA	Regulatory Flexibility Act
SBREFA	Small Business Regulatory Enforcement Fairness Act
SISNOSE	Significant Impact on a Substantial Number of Small Entities
VOC	Volatile Organic Compounds

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1 INTRODUCTION

Under Section 112(d) of the Clean Air Act, the U.S. Environmental Protection Agency (referred to as EPA or the Agency) is developing National Emission Standards for Hazardous Air Pollutants (NESHAP) for the nutritional yeast manufacturing source category. This source category produces emissions of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) through the fermentation process involved in the production and manufacture of nutritional yeast. The proposed NESHAP was published October 19, 1998 (63 FR 55812). The Innovative Strategies and Economics Group (ISEG) has developed this economic impact analysis (EIA) to support the evaluation of impacts associated with regulatory options considered for this NESHAP.

1.1 Scope and Purpose

This report evaluates the economic impacts of pollution control requirements on nutritional yeast manufacturing facilities. These requirements are designed to reduce emissions of HAPs into the atmosphere. Section 112 of the Clean Air Act Amendments of 1990 establishes the authority to set national emission standards for hazardous air pollutants. The emissions of HAPs from nutritional yeast manufacturing originate from the fermentation process. Acetaldehyde is a constituent of VOC emissions and is the only known HAP to be emitted in significant quantity during the manufacture and production of nutritional yeast.

To reduce emissions of HAPs, the Agency establishes maximum achievable control technology (MACT) standards. Under the Clean Air Act Amendments (CAA), major sources under Section 112 that emit 10 or more tons of a HAP are subject to a MACT standard. The fermentation process involved in the production of nutritional yeast produces the HAP acetaldehyde. A major source of HAP emissions is further defined as a stationary source or group of stationary sources located within a contiguous area and under common control that emits, or has the potential to emit considering control, 10 tons or more of any one hazardous air pollutant (HAP) or 25 tons or more of any combination of HAPs. The typical nutritional yeast manufacturing facility is classified as a major stationary source and therefore, subject to a MACT standard.

1.2 Organization of the Report

The remainder of this report is divided into three sections that describe the methodology and present results of this analysis. Section 2 provides a summary profile of the nutritional yeast manufacturing industry. Section 3 presents an overview of the economic impacts associated with this regulatory action. The Agency's analysis of the regulation's impact on small businesses appears in Section 4.

2 INDUSTRY PROFILE

Nutritional yeast is currently manufactured in the United States at 10 plants owned by five parent companies. In 1998, the total gross sales of this industry were estimated to exceed $230 million. There are two main types of nutritional yeast being produced: (1) compressed (cream) yeast and (2) dry yeast. Compressed yeast is sold mainly to wholesale bakeries, while dry yeast is sold primarily to consumers for home baking needs. Compressed and dry yeasts are produced in a similar manner, but dry yeast is developed from a different yeast strain and is dried after processing. The two types of dry yeast produced are active dry yeast (ADY) and instant dry yeast (IDY). IDY is produced from a faster-reacting yeast strain than that used for the ADY. The main difference between IDY and ADY is that the ADY has to be dissolved in warm water before usage while IDY does not.

Other or specialty types of yeast are produced by some of the affected facilities, but production of these yeast products is not subject to the MACT standard since their production is estimated to be small relative to the total annual production of the affected products at these facilities.

2.1 Production Overview

The North American Industrial Classification System (NAICS) code 311999, formerly designated by the Standard Classification Code (SIC) code 2099, covers the production and manufacture of nutritional yeast. In the yeast production process, yeast is grown from a pure yeast culture in a series of fermentation vessels. Except after the earliest fermentation stages, yeast is recovered from the fermentor liquid by using centrifugal action to concentrate the yeast solids. After the last fermentation stage, the yeast solids may be further concentrated by a filter press or a rotary vacuum filter. This filter cake of concentrated yeast is blended in mixers with small amounts of water, emulsifiers, and cutting oils. This mixed pressed cake is extruded and cut, with the resulting yeast either wrapped for shipment or dried to a form of dry yeast.

2.1.1 Raw Materials

The primary raw materials used in producing nutritional yeast are the pure yeast culture and molasses. The type of yeast used in the production of nutritional yeast is *Saccharomyces cerevisiae.* [1] Different strains of *Saccharomyces cerevisiae* are used to order to manufacture the different varieties of yeast including compressed, IDY and ADY forms. Cane molasses and beet molasses are the principal carbon sources to promote yeast growth. Usually, a blend consisting

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[1]Encyclopedia of Chemical Technology, Fourth Edition, Volume 25. Pg. 769. John Wiley & Sons. New York, NY.

of both cane and beet molasses is used in the fermentation process. Once the molasses mixture is blended, the pH level is lowered because an alkaline mixture would promote bacteria growth. Bacteria growth occurs under the same conditions as yeast growth. Monitoring the pH level is very important. The molasses mixture is clarified to remove any sludge and is then sterilized with high-pressure steam. After sterilization, it is diluted with water and held in holding tanks until it is needed for the fermentation process.

2.1.2 Fermentation Process of Nutritional Yeast

Yeast cells are grown in a series of fermentation vessels. Yeast fermentation vessels are operated under aerobic conditions (free oxygen or excess air present). Under anaerobic conditions (limited or no oxygen), the fermentable sugars are consumed in the formation of ethanol and carbon dioxide, which would result in lower yeast yields.

While the number and names of the sequential fermentation stages in yeast production vary among manufacturers, a typical process is described here. Yeast growth begins in the laboratory. In the initial stage, generally called the flask stage, a portion of the pure yeast culture is mixed with molasses malt in a sterilized flask, and the yeast is allowed to grow for two to four days. The entire contents of the sterilized flask are used to inoculate the fermentor in the next stage, commonly called the pure culture stage. Pure culture fermentations are batch fermentations, where the yeast is allowed to grow for 13 to 24 hours. Typically, one or two fementors are used in this stage of the process. The pure culture fermentations are basically a continuation of the flask fermentation.

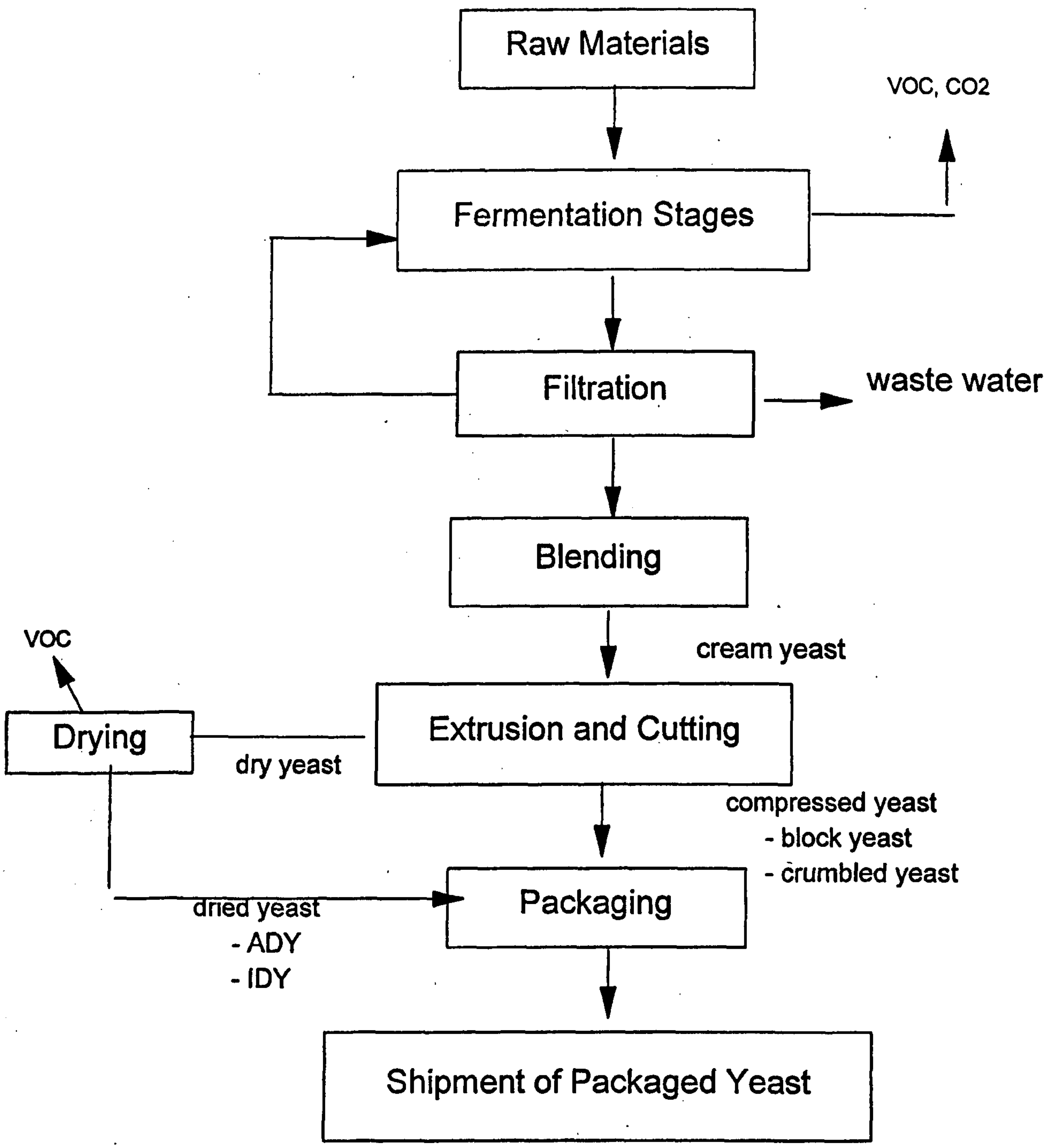
Following the pure culture fermentation, the yeast mixture is transferred to an intermediate fermentor for batch fermentation during the yeasting stage. The contents from the yeasting fermentor are pumped into the stock fermentor, which is equipped for incremental feeding with aeration. After the stock fermentation stage, the yeast is separated from the bulk of the fermentor liquid by centrifuging. This produces a stock, or pitch, of yeast for the next stage. The next stage, first-generation fermentation, also produces a pitch of yeast. Aeration is vigorous, and the molasses and other nutrients are fed incrementally. Again the yeast is separated from the fermentor liquid by centrifuging. The yeast is then usually divided into several parts for pitching the final trade fermentation.

The final fermentation, typically called trade fermentation, has the highest degree of aeration, and the molasses and other nutrients are again fed incrementally. Large air supplies are required during the trade fermentation. Several vessels are often started in a staggered fashion in order to reduce the size requirements for the air compressors. The trade stage of fermentation can range from 10 to 18 hours.

Once the optimum quantity of yeast has been grown, the yeast cells are recovered from the trade fermentor by centrifugal yeast separators. The centrifugal yeast solids are further concentrated by a filter press or rotary vacuum filter. A filter press forms a filter cake. This filter

Figure 2-1

Nutritional Yeast Fermentation Process Flow



cake is then blended in mixers with small amounts of water, emulsifiers, and cutting oils to form the end products.

In compressed yeast production, emulsifiers are added to give the yeast a white, creamy appearance and to inhibit water spotting of the yeast cakes. A small amount of oil, usually soybean or cottonseed oil, is added to help extrude the yeast through nozzles to form continuous ribbons of yeast cake. The ribbons are cut, and the yeast cakes are wrapped, cooled and prepared for shipment in refrigerated trucks.

In dry yeast production, the product is sent to an extruder after filtration, where emulsifiers and oils are added to texturize the yeast and aid its extrusion. After the yeast is extruded into thin ribbons, pellets, or noodles, it is cut and dried in either a batch or continuous drying system. Following drying, the yeast is vacuum packed or packed under nitrogen gas before heat sealing. The shelf life of IDY and ADY at normal room temperatures is 1 to 2 years.

This production process is used to produce both compressed (or cream yeast) and dry yeast. Compressed yeast (including block yeast and crumbled yeast) and cream yeast differ in water content.

2.2 Product Characteristics, Uses and Consumers

Bread is a staple of the American diet. Nutritional yeast is a necessary ingredient in most breads. The demand for food in general and for bread in particular is considered inelastic. According to Marshall's rules, within an industry, the absolute elasticity of demand for a factor (i) varies directly with:

1. The absolute elasticity of demand for the product the factor produces,
2. The share of the factor in the cost of production,
3. The elasticity of supply of the other factor,
4. The elasticity of substitution between the factor in question and the other factor.

Therefore, the demand for nutritional yeast is directly linked to the consumption of bread. The demand for bread is inelastic. Nutritional yeast is an essential component of bread that is not easily substitutable. Consequently, the demand for nutritional yeast is assumed inelastic.

Cream yeast is sold directly to large baking facilities for the production of various breads. The other types of yeast are primarily sold for home baking needs.

2.3 Manufacturing Plants

In 1998, there were 10 nutritional yeast manufacturing facilities within the United States. Data about these facilities are quite limited. These facilities and their products are identified below in Table 2-1.

Table 2-1 Potentially Affected Companies, their Nutritional Yeast Facilities, and Products in 1998

Company Name	Facility Location(s)	Product(s) Produced
Red Star Yeast & Products	Milwaukee, WI	One or more of the following; compressed yeast; ADY; IDY; and specialty yeast (beer, wine & saccharase.
	Oakland, CA	One or more of the following; compressed yeast; ADY; IDY; and specialty yeast (beer, wine & saccharase.
	Baltimore, MD	One or more of the following; compressed yeast; ADY;IDY; and specialty yeast(beer, wine & saccharase.
Fleischmann's Yeast Inc.	Memphis, TN	Various Yeast
	Oakland, CA	Various Yeast
	Gastonia, NC	Various Yeast
SAF Baker's Yeast	Headland, AL	Compressed yeast (including block yeast) and cream yeast
American Yeast Corp.	Bakersfield, CA	Compressed Yeast
	Baltimore, MD	Compressed Yeast
Minn-Dak Yeast Co.	Wahpeton, ND	Compressed Yeast

2.4 Company Ownership

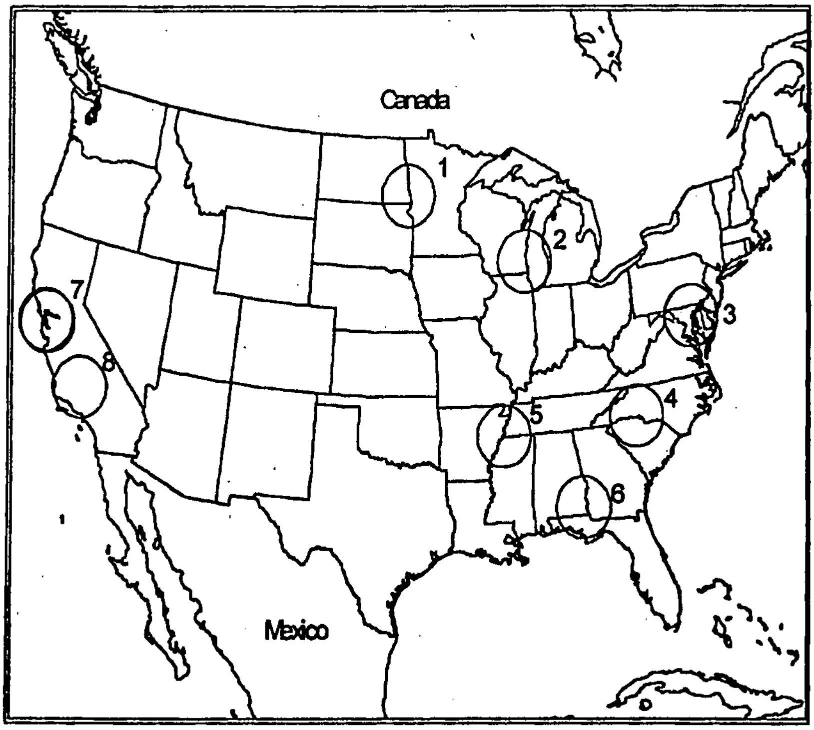
Nutritional yeast is currently manufactured in the United States at 10 plants owned by five parent companies. Firm size is one factor to be considered when analyzing the economic impacts of a regulation. Grouping the firms by size facilitates the analysis of small business impacts, as required by the Regulatory Flexibility Act (RFA) of 1982 as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA). Firms are typically grouped into small and large categories using the Small Business Administration (SBA) general size standard definition for NAICS codes. These size standards are presented either by the number of employees or by the annual receipt levels, depending on the NAICS code. For nutritional yeast, the SBA has designated a firm employing 500 employees or less as a small business for the NAICS code of 311999. Based on the size of the companies shown above or the consolidated entities that own these companies, Minn-Dak is the only firm that might be considered small among the affected facilities. Due to the complex ownership issues involved with this company, an absolute determination is uncertain. A discussion of the small business impacts of this rule is addressed in Section 4 of this document.

2.5 Market Structure

Market structure is of interest because it determines the behavior of producers and consumers in the industry. In perfectly competitive industries, no producer or consumer is able to influence the price of the product sold. In addition, producers are unable to affect the price of inputs purchased for use in production. This condition most likely holds if the industry has a large number of buyers and sellers, the products sold and inputs used in production are homogeneous, and entry and exit of firms is unrestricted. In industries that are not perfectly competitive, producer and/or consumer behavior can have an effect on price. Industries with one seller are considered a monopoly and those with few sellers, oligopolies.

Only five firms produce nutritional yeast domestically. The nutritional yeast facilities are dispersed into different regional markets. Figure 2-2 illustrates the regional nature of the markets. As shown, only a few of the facilities are within 100 miles of each other. The exception being the facilities in Maryland and California. To the extent that yeast producers compete, they do so regionally or on a name brand basis. Thus, the market structure of the nutritional yeast industry is considered to be regionally oligopolistic.

Figure 2-2 Map of Nutritional Yeast Production Facilities



Symbol Legend
American
Fleischmann's
Minn-Dak
Red Star
SAF

100 Mile Radius Market Analysis
1. Minn-Dak
2. Red Star
3. Red Star, American
4. Fleischmann's
5. Fleischmann's
6. SAF
7. Red Star, Fleischmann's
8. American

3 ECONOMIC IMPACTS

The MACT standards for the nutritional yeast manufacturing facilities require major sources to reduce the level of HAPs in their fermentation process to meet the levels specified by the "MACT floor". The costs of meeting MACT will vary across facilities. These regulatory costs will have financial implications for the affected producers, and broader implications as these effects are transmitted through market relationships to other producers and consumers. These potential economic impacts are the subject of this section.

3.1 Market and Facility Impacts

3.1.1 Engineering Compliance Cost Estimates

Based on engineering estimates, the total annualized compliance cost of this regulation for the nutritional yeast industry is less than $700,000. Some facilities will incur no compliance cost due to the regulation. No individual facility will incur more than $200,000 in annualized compliance cost.

3.1.2 Methodology

Data necessary to conduct a detailed economic impact analysis (EIA) for the nutritional yeast industry are largely unavailable. The limited data submitted by companies for use in the EIA are considered Confidential Business Information (CBI). Additionally, the costs of the regulation are small in relative and absolute terms. For these reasons, two simple methodologies were used to analyze the economic impacts of this regulation for nutritional yeast facilities, the markets they serve, and those companies owning nutritional yeast facilities.

3.1.2.1 Cost-to-Sales Analysis

The first approach compares the estimated cost of emission controls for this rule to estimates of annual sales revenues for affected facilities and companies owning these facilities for 1998. This comparison is referred to as cost-to-sales ratio. The cost-to-sales ratio refers to the change in annualized control costs divided by the sale revenues of a particular good or goods being produced in the process for which additional pollution control is required. It can be estimated for facilities, individual firms, or as an average for some set of firms such as affected small firms. While it has different significance for different market situations, it is a good rough gauge of potential impact. If costs for the individual (or group) of firms are completely passed on to the purchasers of the good(s) being produced, it is an estimate of the price change (in percentage form after multiplying the ratio by 100). If costs are completely absorbed by the producer, it is an estimate of changes in pretax profits (in percentage form after multiplying the ratio by 100). The distribution of costs-to-sales ratios across the whole market, the competitiveness of the market, and profit-to-sales ratios are among the obvious factors that may influence the significance of any particular cost-to-sales ratio for an individual facility.

3.1.2.2 Market Analysis

The second approach looks at potential market impacts of this regulation. This approach seeks to evaluate the behavioral response of firms in this industry to this regulation, and to estimate the potential impacts in terms of price and quantity changes that may result. The following scenarios are used to estimate the range of market impacts for the regulation: 1) the first scenario assumes that nutritional yeast producers operate in a perfectly competitive market and 2) the second assumes these producers operate in a pure monopoly market. In reality, firms in this industry are likely to operate behaviorally between the two extreme cases of perfect competition and monopoly. Since there are few firms in this industry and production facilities are relatively dispersed throughout the country, a more reasonable assumption is that firms in this industry have some market power and choice about market price. As previously discussed, a more reasonable market structure assumption may be regional oligopoly for the nutritional yeast market. However, without additional information about the market behavior of firms in this industry it is not possible to more accurately model behavior. This analysis should therefore be considered a bounding exercise of potential market impacts. Both of the scenarios assume that the nutritional yeast industry is a nationwide market. Thus, nationwide average impacts are analyzed, and no attempt has been made to examine potential regional impacts.

3.1.2.3 Perfect Competition

The perfectly competitive paradigm assumes a market with many buyers and sellers. The sellers sell a homogeneous product and have free entry or exit into the industry. For ease of computation, it is assumed that the nutritional yeast industry exhibits constant returns to scale in the long run. This means that the industry may expand or contract in the long run causing no change in factor input prices. Thus, firms may increase or decrease production at the same per unit cost of production. Under these assumptions, the long run supply curve is perfectly elastic. When the regulation is imposed, this implies that the supply curve will shift up by the per unit cost of production (estimated to be 3 percent nationwide for this regulation). As previously discussed in Section 2.3, the price elasticity of demand for yeast is likely inelastic. For this analysis, estimates of -0.5 and -1.0 are used to estimate potential market impacts of the regulation.

3.1.2.4 Monopoly

The second scenario of pure monopoly assumes a market with a single producer. The seller in this market is selling a differentiated product with few substitutes and there are significant barriers to entry and exit in this market. This monopoly firm will choose to produce the market quantity that maximizes profits by choosing to produce the quantity that equates the marginal cost of production to the marginal revenues of the firm. For ease of computation, it is assumed that the monopoly firm has a perfectly elastic marginal cost curve and faces a downward sloping linear demand curve. Since a monopoly firm will never choose to produce in the inelastic portion of the demand curve, it is assumed that the price elasticity of demand for this analysis is -1.0.

3.1.3 Economic Impact Results

As indicated above, this EIA provides results for both the cost-to-sales analysis and the market analysis.

3.1.3.1 Cost-To-Sales

The cost-to-sales ratio analysis indicates that when the estimated cost of compliance of this regulation are compared to the estimated annual revenues for the industry, a cost-to-sales ratio of 0.3 percent results. Individual company and facility cost-to-sales ratios are not presented due to CBI considerations.

3.1.3.2 Market Analysis

The results of the market analysis are summarized in Table 3-1. This table shows a national estimate of potential changes in price, quantity produced and sold, and sales revenues that may occur as a result of this regulation. In the perfect competition scenario, one expects the demand to be inelastic in the region of the equilibrium. Estimates of -0.5 and -1.0 are used to encompass the likely range for price elasticity of demand. Thus, as shown in Table 3.1, in the competitive scenario prices increase by 0.3% and quantity decreases by 0.15% to 0.3%, depending upon the demand elasticity.

The second scenario is that of a pure monopoly market. Since it is not profitable for the monopolist to price a good in the inelastic range of a demand curve, a price elasticity of demand of -1.0 is assumed. For ease of computation, assumptions are also made that the monopolist is faced with a linear demand curve and has cost characteristics that exhibit a perfectly elastic marginal cost curve. Thus, when the marginal cost curve shifts by 0.3%, the price change is only half what it would be in the competitive case. Therefore, the price change is 0.15% as is the quantity change. (See Table 3.1)

While we have used the two simple scenarios of perfect competition and pure monopoly, rather than the more complex model of regional oligopoly, the results for the average national market should fall between predicted price increase of between 0.15% and 0.3%, and a predicted national quantity decrease of between 0.15% and 0.3%. Market results of this magnitude are considered minimal. From the firms' perspective, some portion of the emission control cost will likely be passed on to the consumer. From the consumers' perspective, the predicted price change is a small price increase for an item that has a small cost in the production of the final good (e.g., bread). No changes in industry structure are expected because of the small quantity changes and the regional nature of the markets. This market impact analysis assumes nationwide average cost increases and does not address changes in prices, quantities produced, or revenues that may occur for individual facilities, companies, or regional markets.

The social cost of a regulation represents its opportunity cost, which is the value of goods and services that society foregoes to allocate resources to the pollution control activity. For this analysis, based on applied welfare economics principles, social costs are measured as the sum of the regulation induced changes in consumer and producer welfare (otherwise known as 'surplus'). Consumers experience reductions in their surplus because of increased market prices and reduced levels of consumption. Producers may experience either increases or decreases in their surplus (i.e., profits) as a result of increased market prices and changes in production levels and compliance costs. However, it is important to emphasize that these surplus measures do not include benefits that occur outside the market, that is, the value of reduced levels of air pollution with the regulation.

Table 3-1. Estimated Market Impact of the MACT Floor Level of Regulation on the National Nutritional Yeast Market

	Change In Price (%)	Change In Quantity (%)	Change In Sales (%)
Perfect Competition:			
Assumed Price Elasticity of Demand			
-0.5	0.3	-0.15	0.15
-1.0	0.3	-0.3	0
Pure Monopoly:			
Assumed Price Elasticity of Demand			
-1.0	0.15	-0.15	0

The national estimate of compliance costs is often used as an approximation of the social cost of the rule. Under MACT, the engineering analysis estimated annualized compliance costs to be under $700,000. In this analysis the social cost is expected to be similar to the engineering cost, because the market adjustments are small in magnitude.

4 SMALL BUSINESS IMPACTS

This regulatory action will potentially affect the economic welfare of owners of nutritional yeast manufacturing facilities. The ownership of these facilities ultimately falls on private individuals who may be owner/operators that directly conduct the business of the firm (i.e., "mom and pop shops" or partnerships) or, more commonly, investors or stockholders that employ others to conduct the business of the firm on their behalf (i.e., privately-held or publicly-traded corporations). The individuals or agents that manage these facilities have the capacity to conduct business transactions and make business decisions that affect the facility. The legal and financial responsibility for compliance with a regulatory action ultimately rests with these agents; however, the owners must bear the financial consequences of the decisions. While environmental regulations can affect all businesses, small businesses may have special problems in complying with such regulations.

The Regulatory Flexibility Act of 1980 requires that special consideration be given to small entities affected by federal regulation. The RFA was amended in 1996 by the Small Business Regulatory Enforcement Fairness Act to strengthen the RFA's analytical and procedural requirements. Under SBREFA, the Agency implements the RFA as written with a regulatory flexibility analysis required only for rules that will have a significant impact on a substantial number of small entities. This section summarizes the nutritional yeast manufacturing and provides a screening analysis to determine whether this rule is likely to impose a significant impact on a substantial number of the small entities (SISNOSE) within this industry.

Based on facility responses, the Agency identified the ultimate parent companies of the potentially affected facilities and obtained their sales and employment data from either their survey response or other secondary sources. The SBA defines a small business in terms of the sales or employment of the owning entity. These thresholds vary by industry and are evaluated based on the industry classification NAICS code of the impacted facility. Small business designation for the NAICS code of 311999 is firms employing 500 employees or less.

Although there appears to be one small business in the nutritional yeast manufacturing industry, the complex ownership issues involved with the firm make the absolute determination uncertain. Since potentially only one small business may be affected by this regulation, the estimated national price and quantity changes expected for this rule are small, and the cost-to-sales ratios for all affected companies are less than 3 percent, it is reasonable to assume that this rule will not have a significant impact on a substantial number of small businesses.

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