# IN-DEPTH SURVEY REPORT:

# CONTROL TECHNOLOGY ASSESSMENT OF ENZYME FERMENTATION PROCESSES

AT

Gist-Brocades USA, Inc.
Kingstree, South Carolina

REPORT WRITTEN BY:
Kenneth F. Martinez
John W. Sheehy

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Division of Physical Sciences and Engineering
Engineering Control Technology Branch
4676 Columbia Parkway
Cincinnati, Ohio 45226

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| PLANT SURVEYED: | Gist-Brocades USA, Inc.<br>P.O. Box 5000<br>Kingstree, South Carolina 29556 |
| SIC CODE: | 2869 |
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| SURVEY CONDUCTED BY: | Kenneth F. Martinez, NIOSH, DPSE, ECTB<br>John W. Sheehy<br>Dennis M. O'Brien<br>Gary L. Swinehart<br>James H. Jones<br>Alfred A. Amendola |
| EMPLOYER REPRESENTATIVES CONTACTED: | Jerry L. Norman, Director of Government and Industry Affairs<br>Robert Hanson, Production Manager<br>James R. Hettenhaus, Vice President Production and Engineering<br>Wendell Voiselle, Manager MLT Laboratory<br>Barney Easterling, Laboratories Director<br>Ricky Harris, Fermentation Supervisor<br>James Miles, Recovery Supervisor |
| EMPLOYEE REPRESENTATIVES CONTACTED: | No Union |
| ANALYTICAL WORK PERFORMED BY: | Lucy B. Cusick, CDC, CID, HIP<br>Barbara A. MacKenzie, NIOSH, DBBS, ISB<br>Charles E. Neumeister, NIOSH, DPSE, MRSB |

# I. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal agency engaged in occupational safety and health research. Located in the Department of Health and Human Services (formerly DHEW), it was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct a number of research and education programs separate from the standard setting and enforcement functions carried out by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards. The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects of health hazard prevention and control.

Since 1976, ECTB has conducted a number of assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques. Examples of these completed studies include; abrasive blasting,[1] the plastics and resins industry,[2] foundry operations,[3] spray painting and coating,[4] and coke oven emissions.[5] The objective of each of these studies has been to document and evaluate effective control techniques for potential health hazards in the industry or process of interest, and to create a more general awareness of the need for or availability of an effective system of hazard control measures.

These studies involve a number of steps or phases. Initially, a series of walk-through surveys is conducted to select plants or processes with effective and potentially transferable control concepts or techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities builds the data base of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

## BACKGROUND FOR THIS STUDY

NIOSH's research responsibility extends to both existing and emerging technologies which may affect worker health and safety. The attempt to examine new technologies for potential occupational hazards specifically focuses on those technologies which have high growth potentials or for which exposures to particular agents have not been fully characterized. In past research activities, NIOSH has been instrumental in the development of recommendations for safeguarding the workers health from exposure to occupational hazards. Implementation of safeguards and protective engineering controls early in the growth of an industry will minimize occupational health problems and avoid expensive retrofitting of production systems.

NIOSH is currently interested in evaluating the potential hazards and their control for applications of biotechnology and recombinant DNA (rDNA). ECTB's involvement in this NIOSH evaluation is to assess the control technology being

employed to minimize the potential for occupational health hazards in the enzyme fermentation industry. The results of this control technology assessment will be used to develop an informational database that could be extrapolated to other fermentation product technologies. Previous NIOSH research into biotechnology includes a study of six companies employing rDNA techniques in their research activities or their process operations. This earlier study, conducted by the Division of Surveillance, Hazard Evaluation, and Field Studies, was published in a NIOSH report and a journal article.[6,7]

The ECTB study focused on conventional enzyme fermentation process operations. Several factors contributed to the final decision to focus this research project. First, the products manufactured in the overall fermentation industry, although dissimilar entities, are produced with a somewhat standardized process technology. Product recovery operations may vary with the product properties, source microorganisms, and base solvents used, but the basic fermentation technology remains essentially the same. Second, the diversity of the fermentation industry would require different environmental air sampling and analytical methodologies for each product and source microorganism studied. Narrowing the field of investigation satisfied the need to limit the "products" studied in order to minimize sampling and analytical methods development requirements. Third, there was a good probability of finding well controlled processes in the enzyme industry. Last, there existed limited resources (including manpower and finances) with which to conduct this study and time constraints on its completion. Initial studies of various enzyme production plants identified several well controlled processes. Additional studies may evaluate other areas of the fermentation industry including antibiotic, hormone, and steroid production.

This control technology assessment of enzyme fermentation processes attempted to identify effective controls applicable to processes involving microorganisms, processing chemicals, and biologically active products or intermediates. The documentation of effective controls and recommendations to minimize exposure in the enzyme fermentation industry are among the primary objectives of this assessment. Recognizing that the enzyme industry only represents a small segment of the biotechnology industry, the collected data and subsequent evaluation will help to establish a baseline of information on the equipment (and related safety and health programs and practices) currently used in enzyme fermentation operations. This baseline of information will be available for transfer to other fermentation technologies, either those involved with rDNA technology or those utilizing conventional technology.

## BACKGROUND FOR THIS SURVEY

Selection of plants for inclusion in this study of enzyme fermentation processes as in-depth surveys was based on a number of criteria. First, the plant (or parent company) should be a major manufacturer of industrial enzymes or have extensive experience related to fermentation technology. Second, the process operations should be technically current to insure the transferability of the survey results to other fermentation industries -- including those recombinant DNA companies scaling up operations to commercial production capacity. Third, the plants should exhibit an expressed concern for the safety and health of the workers. This would involve adherence to any or all

of the aspects of control technology to protect the worker including engineering controls, personal protective equipment, work practices, and industrial hygiene monitoring.

Gist-Brocades USA, Inc. (GB) met all three of the in-depth survey selection criteria requirements. GB's parent corporation, Gist-Brocades, nv, based in the Netherlands, is a major manufacturer of enzymes, yeast, and antibiotic products. As such, GB has available a broad base of experience, from the parent company, related to fermentation technology concerning enzymes, in addition to yeast and antibiotic production. Although the fermentation equipment has remained relatively unchanged since its construction in 1957, a new semi-automatic recovery operation was constructed in 1983. GB is currently in the process of developing a Health Assurance Committee to oversee all health related issues that will establish programs for occupational health hazards in the plant.

The in-depth survey of GB was conducted on June 24 - July 3, 1985 to evaluate the controls and containment capabilities of their proteolytic enzyme manufacturing process. This report documents the information pertinent to that evaluation.

## II. PLANT AND PROCESS DESCRIPTION

Plant Description:
GB, formerly known as GB Fermentation Industries, Inc., is located in Kingstree, South Carolina, and has produced industrial grade enzymes at this plant for the last eight years. The Kingstree fermentation plant was originally constructed in 1957 by the Wallerstein Company, a wholly-owned subsidiary of Baxter-Travenol, Inc. The plant was purchased by Gist-Brocades, nv in 1977 — Baxter-Travenol continues to operate a large manufacturing plant adjacent to the GB complex. GB is headquartered in Charlotte, North Carolina.

GB employs a total of approximately 160 workers at the Kingstree plant facility. The plant is separated into six Departments; Personnel, Engineering, Maintenance, Quality Assurance, Laboratory, and Fermentation and Recovery. The plant operates continuously using three (3) workshifts weekdays and two (2) workshifts on weekends (12 hours each), 24 hours per day, seven (7) days per week. Enzyme production is maintained with five work crews — two crews are off duty on any given weekday, three on weekends.

Process Description:
The process surveyed at GB involves the production of the industrial enzyme protease using a microbial strain of Bacillus subtilis. This Bacillus strain is a non-pathogen and believed to be weakened or debilitated. The manufacture of the industrial enzyme is accomplished in three process steps; laboratory, fermentation, and recovery. The laboratory is located in a separate building (with offices) away from the building housing the fermentation and recovery equipment.

The laboratory process step includes the selection and maintenance of microorganism cultures. The selection or screening process for microorganisms

determines each culture to be used for a specific enzyme production operation based on their tested ability to produce a commercial quantity of the desired enzyme. Selected cultures must be identified and tested for pathogenicity and their desired inability to co-produce harmful products or toxins. Maintenance of the selected culture must ensure that this isolated microbial culture is pure and uncontaminated before being inoculated into the inoculum tanks. This requires that the culture be regrown at intervals. Single colonies are selected for regrowth usually on the basis of culture morphology. The selected culture is grown (from stock cultures and propagated in shaker flasks), harvested, sub-divided, and stored at the appropriate conditions to maintain its viability and purity. Microbial cultures are transferred manually and aseptically inoculated, maintaining pure cultures, into the inoculum tank for the first segment of the fermentation process.

The fermentation process step is segmented into two parts. In the first part, the seed fermentor containing a sterile nutrient medium is inoculated with the selected microbial culture prepared in the laboratory. The seed fermentor is designed to promote the growth of the microbial population to the level necessary for proper fermentation in the deep-tank reactor vessel. The batch mixture is aerated and mechanically agitated until the optimum level of biomass is achieved. The final contents of the seed fermentor is aseptically transferred through a pipe network to the large fermentor (deep-tank reactor vessel). In the second part, where "fermentation" essentially occurs and the product of interest is biologically synthesized, a submerged, batch fermentation process is employed using a deep-tank reactor vessel with a top-mounted mechanical agitator and a bottom air sparger ( air is sterilized with a 0.22 um pore size filter). Proper temperature conditions are maintained with cooling coils inside the reactor vessel. Some of the reactor vessels are cooled with a jacket located on the outside. Prior to inoculation, the fermentor tank is cleaned with a caustic solution and then sterilized empty with steam for 45 minutes. The fermentor tank, containing a pre-sterilized nutrient medium, is then inoculated with the biomass broth from the seed fermentor. This new broth mixture is aerated, mechanically agitated, and allowed to ferment for continued biomass growth and final production of the desired enzyme. The composition of the medium used in each phase is carefully controlled to promote maximum growth of the organism and/or enzyme production. The nutrient medium used in the inoculum and fermentor tanks is prepared in mix mash tanks using raw materials which are of a suitable purity, free of harmful substances. The ingredients used are tightly controlled to prevent contaminants that would inhibit microorganism growth or enzyme production, and produce a finished product which, in the case of a food grade enzyme product, meets the Food and Drug Administration's specification for enzymes contained in the Food Chemicals Codex (FCC III).

Measurements are performed continuously during the fermentation process step to check specific parameters of the biomass broth. These measurements include control of process parameters such as temperature, pH, and dissolved oxygen. Manual samples are also extracted periodically from a sampling port on the fermentor tank for analysis in the laboratory.

In the recovery process step, the enzyme slurry, from the fermentor tank, is purified, concentrated, and stabilized. Acetone, filter aids, pH adjusters,

stabilizers, etc. are added to the slurry as a pretreatment to processing in the mash treatment tank. The enzyme slurry is pumped to a plate and frame filter press where a major portion of the suspended solids (mycellium and other solids) are separated from the enzyme liquid. An operator "knocks" the cake off of the filter cloth when the press is open. The filter cake is discharged to a dumpster via a belt conveyor where it will be subsequently picked up and later transported to a landfill. The enzyme liquid is then pumped to a vacuum evaporator for removal of the acetone. The acetone is transferred to a recycling process. Further concentration and purification of the enzyme will be accomplished utilizing a candle filter, ultrafiltrator, and bacterial filter (plate and frame press). Liquid wastes from these processes are treated in the plant sewage treatment system.

The final process is to standardize the activity of the purified protease enzyme concentrate with propylene glycol. The finished product is pumped into shipment tanks and sold as bulk liquid.

Potential Hazards:
The potential for exposure to hazards in the occupational environment within the fermentation industry in general is a three-fold problem. Exposure may involve potentially hazardous microorganisms (innate as-well-as genetically modified) toxic processing chemicals, and biologically active products or intermediates.

Presently, the microorganisms used by the enzyme industry for fermentation operations are non-pathogenic in nature. But future involvement with rDNA technology may produce microorganisms in need of more stringent containment requirements and equally stringent programs in occupational safety and health due to the increased health risks that they may pose to the exposed worker. As indicated, the microorganism utilized in the process surveyed at GB (Bacillus subtilis) is a non-pathogen. However, increasing attention is being focused upon the potential for immunologic response, after repeated inhalation, to a variety of organic materials including microorganisms. There are currently no reports of these effects in the enzyme industry. Cases of hypersensitivity pneumonitis have been documented in individuals exposed, in the occupational environment, to fungi, thermophilic actinomycetes, as-well-as animal proteins.

Filter aids, such as diatomaceous earth (amorphous silica), are used in the concentration and purification processing step. Amorphous silica can affect the body if it is inhaled or if it comes in contact with the eyes. Prolonged inhalation of amorphous silica including uncalcined diatomaceous earth may produce x-ray changes in the lungs without disability. Prolonged inhalation of calcined diatomaceous earth may cause silicosis with scarring of the lungs, cough, and shortness of breath. The current OSHA standard for amorphous silica is the quotient of 30 $mg/m^3$ divided by the percent of silica present. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a maximum exposure of 1.5 $mg/m^3$ of respirable amorphous silica over an eight hour work shift.

Acids and bases are used to adjust pH levels of biomass broth mixtures or concentrated enzyme liquids throughout the enzyme production process; both

will cause burns. Depending on the compound being used and its degree of hazard potential, protective clothing should be worn and the appropriate control techniques implemented to prevent potential contact or exposure to these agents.

Acetone is added to the enzyme rich broth prior to the recovery process. Repeated contact exposure (percutaneous absorption) to acetone may produce dry, scaly, and fissured dermatitis. Inhalation of high concentrations of acetone vapors may irritate the conjunctiva and mucous membranes of the nose and throat. Systemic reactions to high concentrations include headaches, nausea, light headedness, vomiting, dizziness, incoordination, and unconsciousness. The current OSHA standard for acetone is 1000 ppm averaged over an eight hour workshift.

The enzyme molecule consists of a chain of amino acids arranged in a specific geometric configuration. This protein structure, as is with the case of many proteinaceous materials, will cause immunologic responses in susceptible persons due to the inhalation of these antigens. Repeated inhalation of enzyme dust may provoke respiratory allergies (hay fever, asthma) or illnesses (rhinitis) in individuals who have become sensitized to a specific enzyme protein structure. Sensitization reactions may vary from mild to severe dependent upon the particular individual exposed. Some enzymes, proteolytic enzymes as an example, have been shown to be primary irritants of exposed areas of moist skin, eyes, and mucous membranes. The majority of documented case studies of persons exposed to enzymes has focused upon the immunologic responses due to the inhalation of or skin irritation due to the contact to enzymatic dusts. ACGIH recommends a maximum exposure of 0.8 Delft Units (DU) per $m^3$ of air of subtilisin proteolytic enzyme over an eight hour work shift. A DU is calculated from the amount of proteolytic enzyme that is required to act on a protein substrate in a specified amount of time.

## III. METHODOLOGY

To effectively evaluate the controls and equipment in place at GB, environmental air samples were taken at strategic locations believed to duplicate workplace exposures and indicate emission sources. The major pieces of equipment used in this evaluation are listed in Table I. of the Appendix.

### MEASUREMENT OF CONTROL PARAMETERS

#### Viable Sampling

To determine concentrations of airborne microorganisms around unit processes, the Andersen 2-stage viable sampler was used at a flow rate of 1 cubic foot per minute (CFM). Locations for viable samples include the laboratory, inoculum tank, fermentor tank, filter press, and in areas outdoors and in the office building -- the latter two samples sites were selected to give approximations of normal background levels. Some area samples were taken as side-by-side (two Andersens) samples to monitor variability of the microbial air samplers. The samples were collected over a five day period to detect day-to-day variability, if any. Sample times varied from 20 minutes down to

$2\text{-}1/2$ minutes depending on the sample location. For example, a sampling time of 20 minutes was used in areas where microbial concentrations (in the laboratory) were expected to be low and a $2\text{-}1/2$ minute sampling time was used in areas of high microbial concentration (around filtering operations). Standard Methods Agar was used as the sampling media in each stage of the viable sampler. The 50% effective cutoff diameter for the top stage of the Andersen viable sampler is 8.0 um -- larger, non-respirable particles are collected on the top stage, smaller, respirable particles are collected on the bottom stage.

Analysis of the viable samples was conducted on-site by a Center for Disease Control (CDC) microbiologist and a NIOSH biologist. The primary goal of the microbiological analysis was to determine the numbers of the production microorganism in the air at different locations in the plant. All air sampling plates were counted at 24 hours using standard colony counters. Colonial morphology was compared with that of the production strain of the same age and on the same medium. Where possible, colonies resembling the production strain were included as a separate count. A percentage of these typical colonies were streaked to Standard Methods Agar (with Manganese) for isolation and identification. Colonies were identified by gram stain and/or the Rapid CH kit manufactured by API System, S.A. This identification scheme consists of 49 biochemical tests read at 24 and 48 hours.[8] Results were compared to the Rapid CH profile of the index strain. Each step of the microbial identification process by itself is not an absolute indicator of the production strain. However, combining the results of these identification tests will give the microbiologist the ability to produce reliable conclusions concerning the production strain.

Sample results are in terms of Colony-Forming Units per cubic meter of air ($CFU/m^3$) with percentages of the production strain, where available. Sample concentrations around process operations are compared to control samples to help ascertain the degree of microorganism release from manufacturing processes.

Enzyme Sampling

Environmental monitoring of the airborne enzyme concentrations were conducted using General Metalworks high-volume samplers and high efficiency (pre-weighed) 8" by 10" glass fiber filters at a flow rate of approximately 40 CFM. The samplers were strategically positioned at fixed locations in the plant best suited to estimate exposure conditions and isolate points of enzyme aerosol release. Locations for the high-volume samplers include the fermentor, ultrafilter, candle filter, blending tank, and one outdoor background location. Samples were collected for eight hour workshifts over a four day period. Analysis of the enzyme samples was conducted on-site by a NIOSH chemist.

The 8" x 10" glass fiber filters were weighed before sampling on a Mettler AE 163 balance. The instrumental precision for one sitting is 0.01 mg. After sampling, the filters were equilibrated in the laboratory environment (cooled and dehumidified) and reweighed on the same balance. The difference in filter weights were recorded as total weight per filter. After gravimetric analysis,

each filter was agitated with a sonic bath in 100 ml of sodium tripolyphosphate/Brig 35 solution to elute the proteolytic enzyme from the filter. The remaining liquid was passed through a 0.45 um PTFE filter.

Samples and standards in duplicate were reacted with the substrate and incubated under stringent temperature, pH, and time controls as described in the GB protease enzyme activity method.[9] Standards were prepared from a GB manufactured protease of a known Delft Unit (DU) per gram. After an incubation period, the reaction was stopped, excess protein precipitated, and the absorbance of the supernatant measured on a spectrophotometer at a wave length of 275 nm. A calibration curve was prepared daily for each set of samples using a polynomial regression program on all of the calculations. The lower limit of detection and the lower limit of quantitation were determined from plots of the media blanks and the three lowest standards on one curve. The lower limit of detection is defined as the amount of material that can be distinguished from the blanks -- determined to be 50 DU per filter. The lower limit of quantitation is defined as the concentration that has a precision greater than 10% and is routinely three times the limit of detection or 150 DU per filter.

Total Dust Sampling

Total dust samples were collected on 37 mm, 5 um pore size PVC filters at an approximate flow rate 2.5 liters per minute (lpm) with Dupont 2500 pumps according to the NIOSH method No. 0500.[10] Samples were collected for eight hour workshifts over a four day period. The pumps were calibrated prior to the field survey. Sample locations included material dump stations, most areas where viable and/or enzyme samples were located, and those areas believed to approximate background dust levels for the plant.

The PVC filters were pre-weighed in the GB laboratory (on a Mettler AE 163 balance) and re-weighed under the same conditions after sampling. The difference between the initial weight and the weight after sampling is given as total weight per filter.

Acetone Sampling

Acetone samples were collected according to NIOSH method 1300.[10] Samples were collected with Dupont P-200 pumps at a flow rate of 50 milliliters per minute (ml/m) through standard 150 milligram charcoal tubes. The pumps were calibrated prior to the field survey. After sampling, the charcoal tubes were desorbed for 30 minutes in 1.0 milliliter of carbon disulfide containing 1 microliter/milliliter of hexane an an internal standard. A Hewlett-Packard gas chromatograph (model 5711A) equipped with a flame ionization detector was used for sample analysis. The Column was a 12' x 1/8" stainless steel, 10% TCEP on 80/100 Chromosorb P (AW). Oven conditions were set at 80°C, isothermal. Sample locations were focused around the filter press, for one hour intervals during times when the filter press was inoperation and airborne levels would be expected to be at their highest. Samples were also collected at other locations within the recovery area (eg. acetone recovery).

## IV. RESULTS

The results of the viable air sampling analysis is reported in the appendix in Table II and summarized in Table III. Background samples located outside were grouped into a single classification. This classification of outside background level was based on the assumption that uncontrollable environmental factors (eg. climatic conditions, surrounding traffic, etc.) had the only significant effect upon sample location variability. Effects on outside background samples due to plant unit processes, if any, were assumed to be uniform from sample location to sample location. The results were also assumed to be log normally distributed. The geometric mean of the outside background samples was 123.2 CFU/$m^3$ with a standard deviation of 7.7. Viable samples collected around selected unit processes ranged from geometric averages of 4.4 CFU/$m^3$ (clean room) to 10599.4 CFU/$m^3$ (open filter press). The highest microbial levels occurred around the filter press, dumpster, sample port (in use), and the agitator shafts. These levels were all significantly different from the outside background concentration. Viable samples were not collected around certain areas of the recovery process (mash treatment tank) due to the explosive nature of the acetone and the non-intrisically safe label on the sampling pumps. All samples were blank corrected.

Results of the samples collected with the high-volume air sampler are reported in Table IV. Average enzyme levels ranged from 0.317 DU/$m^3$ at the candle filter to 0.45 DU/$m^3$ at the ultrafilter and the blending tank. There appears to be no statistically significant differences between sampling locations. All samples were blank corrected.

Acetone sample results (from the filter press and the mash treatment tank) are reported in Table V. The average concentration of all samples was less than 3.6 mg/$m^3$. All samples are blank corrected.

Total dust sample results (from samples collected with the 37 um pore size PVC filters) are reported in Table VI. Average concentrations ranged from 0.02 mg/$m^3$ in the incubation room to 1.21 mg/$m^3$ at the dump station in the recovery area. Concentrations were comparable with the total dust results from the high-volume samplers. All samples are blank corrected.

## V. CONTROL EVALUATION

### PRINCIPLES OF CONTROL

Occupational exposures can be controlled by the application of a number of well-known principles, including engineering measures, work practices, personal protection, and monitoring. These principles may be applied at or near the hazard source, to the general workplace environment, or at the point of occupational exposure to individuals. Controls applied at the source of the hazard, including engineering measures (material substitution, process/equipment modification, isolation or automation, local ventilation) and work practices, are generally the preferred and most effective means of control both in terms of occupational and environmental concerns. Controls which may

be applied to hazards that have escaped into the workplace environment include dilution ventilation, dust suppression, and housekeeping. Control measures may also be applied near individual workers, including the use of remote control rooms, isolation booths, supplied-air cabs, work practices, and personal protective equipment. In the fermentation industry, a debilitated production strain can also be an effective means of reducing the microbial level around unit process operations.

In general, a system comprised of the above control measures is required to provide worker protection under normal operating conditions as well as under conditions of process upset, failure, and/or maintenance. Process and workplace monitoring devices, personal exposure monitoring, and medical monitoring are important mechanisms for providing feedback concerning effectiveness of the controls in use. Ongoing monitoring and maintenance of controls to insure proper use and operating conditions, and the education and commitment of both workers and management to occupational health are also important ingredients of a complete, effective, and durable control system. These principles of control apply to all situations, but their optimum application varies from case to case.

ENGINEERING CONTROLS

GB's enzyme production process is a predominately closed system (with few exceptions) once the process has graduated from the laboratory to the fermentation and recovery process steps. The process equipment is designed to keep microbial contaminants in the ambient environment from getting into the production culture. All growth and holding tanks are closed during process operations. The culture broth is transferred between separate unit operations in the fermentation process step by a steam sterilizable pipe network. Employee contact with the production process, once the raw materials have been added to the mix mash tanks, is minimal other than for equipment maintenance or manual broth sample extraction.

Laboratory Process Step:
There are emission sources of the production microorganism, Bacillus subtilis (BS), during the laboratory process step but these sources are at very low levels due to the small quantity of the microorganism being used. Emissions in the main laboratory room were only possible during biochemical analysis of broth samples from the seed and fermentor tanks. General work practices of the lab workers constituted the greatest determinant of exposure to viable emissions. For example, mechanical devices were used for pipetting wet solutions and microbial cultures but oral pipetting was also observed during the microbial transfer process in the clean room. The laboratory air quality was controlled with the building ventilation (heating and cooling) system. Two fume hoods were accessible, and adjacent to one another, in the wet chemistry area of the main laboratory for chemistry work. Viable samples in the main laboratory room indicated a microbial level of 147.3 CFU/$m^3$ with a standard deviation of 1.1. The percentage of counted colonies identified as the production strain was an average of 34.

Quality control analysis was conducted in a separate laboratory (MLT laboratory) and building (east building) from the main laboratory. The

geometric average of the microbial level in the MLT laboratory was 159.1 CFU/$m^3$ with a geometric standard deviation of 1.6 (an average of 35% of the counted colonies were determined to be the production strain). The survey microbiologic analytical team conducted their microbial analysis in this room and may have affected levels.

Possible emissions sites were also observed in the clean room -- during transfer of the BS cultures from vial to test tube, test tube to flask, and flask to inoculating devices. The clean room contains a horizontal laminar flow hood which purifies recirculated air with a High Efficiency Particulate Air (HEPA) filter. The hood is designed to pass purified air over the work zone, towards the lab technician, to protect the microbial cultures. As a consequence of the airflow directed away from the hood, possible microbial emissions are introduced into the technicians breathing zone. However, the large volume of air recirculated by the hood effectively reduces the concentration of any microbial emissions by diluting the air. The geometric average of the microbial level in the clean room was 4.4 CFU/$m^3$ with a geometric standard deviation of 5.1. The percentage of counted colonies identified as the production strain was an average of 76.

Flasks inoculated with the BS culture are transferred to an incubation room adjacent to the clean room. The incubation room is kept at a constant temperature and humidity for proper propagation of the microbial culture. The flasks (sealed with a cotton gauze stopper) are agitated on a shaker assembly for a required amount of time. The geometric average of the microbial level in the incubation room was 346.4 CFU/$m^3$ with a geometric standard deviation of 29.2. The percentage of counted colonies identified as the production strain was an average of 30.

The microbial culture is manually moved from the laboratory to the seed tank in a sterile, stainless steel inoculating device which serves as containment device during the transfer. The inoculating device is then connected to a steam sealed line on the seed tank and the microbial culture is released into the seed tank. The inoculating device is returned to the laboratory and autoclaved.

Fermentation Process Step:
Minor potential for release of aerosolized viables and/or enzymes exists at certain sites around the seed and fermentor tanks. These sites include the broth sampling ports, agitator shafts, and scrubber for the tank exhaust gases. Broth sampling at the seed and fermentor tanks was an intermittent operation. The sample port valve is closed and continuously steam sealed when not in use to prevent contamination of the culture broth. The steam seal also appeared to be effective in preventing the escape of viables from the sample port. During sampling, the steam seal is turned off and a shake flask and/or beaker is filled with broth. After sampling the valve is shut off, the steam is increased to clear the valve of remaining contaminants. The steam release observed was a completely opened valve which aerosolized any microoganisms remaining in the valve. This resulted in a visible brown haze released from the sample port. Proper company procedure is to open the steam valve only enough to gently wash any remaining microorganisms into a catch basin. No engineering controls or protective equipment was used during sampling; a

concrete curb surrounds the area below the fermentor tank to help contain spills. The sampling procedure was the same for the seed tank and the fermentor tank. The geometric average of the microbial level around the sampling port during manual broth sampling was 1668.3 CFU/$m^3$ with a geometric standard deviation of 1.6 and the percentage of the colonies identified as the production strain was an average of 77. The geometric average of the microbial level around the sampling port when there was no external activities was 195.5 CFU/$m^3$ with a geometric standard deviation of 2.3 and the percentage of the colonies identified as the production strain an average of 19. The former was statistically different from the average outside background levels for the sampling week whereas the latter microbial level was not indicating the release and viability of production strain BS during the sampling procedure.

The agitator shaft of the seed and fermentor tank is steam sealed with an additional bearing at the bottom of the tank to steady the shaft. Sampling results around the fermentor tank agitator shaft indicated a geometric average microbial level of 339 CFU/$m^3$ with a geometric standard deviation of 3.1. The percentage of counted colonies identified as the production strain was an average of 48. Sampling results around the seed tank agitator shaft indicated a geometric average microbial level of 1633.9 CFU/$m^3$ with a geometric standard deviation of 1.5. The percentage of counted colonies identified as the production strain was an average of 23. Both locations had levels that were statistically different from the average outside background level indicating the possibility of minor leaks around the agitator shafts.

The water scrubber (located on a platform 30 feet from fermentor tank agitator shaft) theoretically cleans the exhaust gases from the seed and fermentor tanks. Worker activity around the water scrubber was minimal other than for maintenance. Samples collected next to the scrubber showed a geometric average microbial level of 345.1 CFU/$m^3$ with a geometric standard deviation of 4.2. The percentage of counted colonies identified as the production strain was an average of 38. This level of microbials was statistically different from the outside background concentration indicating the ability of the water scrubber to only minimize the release of entrained production microorganisms. In situations requiring more stringent controls this may not be adequate.

A high-volume air sampler was placed in the vicinity (within 15 feet) of the fermentor tank agitator shaft and the water scrubber. Enzyme levels at this location were 0.325 DU/$m^3$ with a standard deviation of 0.248.

Broth samples from the mash treatment tank are manually collected from a port in the top of the tank. The tank is opened by the worker and the sample is taken with a dipper cup. Emission sources of the BS culture, proteolytic enzyme, and acetone could occur during this procedure. The total exposure time of the worker is small. Viable and enzyme air samples could not be taken at this location due to the explosive nature of the acetone and the sampling pumps were not intrinsically safe. Acetone samples were less than 0.01 mg/$m^3$.

Recovery Process Step:
After acetone addition in the treatment tank, the microbial/enzyme broth is transferred through pipe to the automated filter press for an approximate two hour cycle. This cycle will occur many times during one enzyme fermentation batch. Automation of the filter press does not preclude worker interaction with the process; the worker must intervene at the end of a cycle to manually remove (with a wood oar) the filter cake. Levels during removal of the filter cake ranged as high as 28990 CFU/$m^3$ on a single sample. Geometric average microbial levels when the filter press was closed were 3906.1 CFU/$m^3$ with a standard deviation of 2.5. Geometric average microbial levels when the filter press was open were 10599.4 CFU/$m^3$ with a standard deviation of 1.8. Average levels would decrease by an approximate factor of 2 when the filter press was closed. Geometric average microbial levels when the filter press was closing after the filter cake had been removed were 8757.5 CFU/$m^3$ with a standard deviation of 1.4. Counts of the production strain on these samples were not made due to time constraints and other analytical factors but the production strain was noted as being the predominant strain at this location by the microbiologist. Geometric average microbial levels at the dumpster were 2400 CFU/$m^3$ with a standard deviation of 1.5 -- like the filter press, counts of the production strain were not available but were noted as being the predominant organism. Acetone samples collected around the filter press showed one sample at 3.64 mg/$m^3$ and two other samples less than 0.01 mg/$m^3$. Acetone samples collected around the conveyor belt and at the mash treatment tank were all less than 0.01 mg/$m^3$. Enzyme air samples could not be taken at this location due to the explosive nature of the acetone and the sampling pumps were not intrinsically safe. Only general dilution ventilation was observed including: two ceiling fans, two louvered windows, and one air supply duct on the top floor; and three wall fans, three louvered windows, and one air supply duct on the ground floor.

A local exhaust ventilation hood (with a pulse jet dust collector) was in operation at a dump station in the recovery area for various material additions to the enzyme liquid (diatomaceous earth, calcium carbonate, carbon black, etc.). The hood has a lid with a cylindrical opening into which specially designed bags fit when the lid is down -- effectively enclosing the dumping operation. Unfortunately, the hood was not used by the operator as designed. The operator, as observed, would normally leave the lid open and pour the raw material directly into the hopper negating the purpose of the "enclosed" system design. The total dust level at this location was 1.21 mg/$m^3$. The total dust level in the recovery room at a location away from the dump station and filter press was 0.09 mg/$m^3$.

During cleaning and polishing, the acetone-free enzyme liquid is processed through a candle filter. Immediately prior to this operation, filter aids (diatomaceous earth) are manually added to the liquid in a collection tank through a hatch at the top of the tank. Some of the dust generated from this dumping action was observed passing through the workers breathing zone on its way to a ceiling fan. Worker interaction after this point is limited to equipment maintenance and enzyme sample extraction. General area levels of enzyme were 0.317 DU/$m^3$ with a standard deviation of 0.126 around the candle filter and 0.45 DU/$m^3$ with a standard deviation of 0.232 around the blender tank. High-volume samples were also extracted around the ultrafilters with

levels of enzyme observed at 0.45 DU/$m^3$ with a standard deviation of 0.228. Only dilution ventilation was observed in this area including four ceiling fans and two small louvered windows. One high-volume sample was taken outside between the laboratory and the recovery area with a level of 0.269 DU/$m^3$.

WORK PRACTICES

GB maintains an adequate housekeeping program around unit processes -- generally, to reduce the possibility of contaminating an enzyme broth that is in production. This housekeeping program also helps to minimize any unnecessary exposures to employees from hazardous agents or conditions.

The employees play a major role in the development of safety and health guidelines in the GB plant. Using the concept of "quality circles", employees select safety related projects that they have collectively researched and present them to management for consideration. The employees initiate the engineering studies needed to evaluate the feasibility of these projects but the studies are actually conducted by the Engineering Department. Employees may also submit project studies that are directly related to process operations. As part of their safety program, GB has had two safety committees for a number of years. The first committee is composed of randomly selected employee representatives of each department who meet once a month. The second committee is composed of management personnel and meets one week after the employee committee meeting to discuss the relevant topics of that meeting. This two-committee structure offers an "umbrella" view of plant safety and health issues.

MONITORING

GB does not currently have an environmental health program but is in the process of developing a committee to oversee all health hazard issues (a Health Assurance Committee). Specific health hazard issues of concern include; audiometric studies, pulmonary studies, sensitivity studies (to enzymes), and environmental sampling methods. The committee will be composed of personnel from the corporate level and from the production plant (production workers) in Kingstree. Additionally, an industrial hygienist and an occupational health physician, outside consultants, will sit on this committee.

Pre-employment physical examinations are given to all new employees of GB. Subsequent examinations are administered by a South Carolina mobile health unit on an annual basis and include audiometric tests and pulmonary function tests. The parent company, Gist-Brocades nv, has conducted tests for enzyme sensitivity among its employees overseas (using a radioallergosorbent test -- RAST). A RAST is not used at the Kingstree facility.

PERSONAL PROTECTION

Employees engaging in operations at dumping stations are required to wear disposable dust respirators. Canister type respirators and self-contained breathing apparatuses (SCBA) are available if needed.

## VI. CONCLUSION

Viable sample concentrations around selected unit processes were compared (using the t-statistic for comparing two means) to background concentrations to ascertain the degree of containment of those processes.[11] The results indicate that emissions of the viables are most likely to occur at high-energy operations (where there is probable aerosolization) such as the agitator shafts, belt conveyor, filter press, and sampling ports. Another source of emission are the exhaust gases from the fermentor and seed tanks (345.1 CFU/$m^3$ with 38% production strain) indicating that the water scrubber does not completely control the release of entrained production microorganisms. In situations requiring more stringent controls, a water scrubber may not be adequate.

Work practices of the operators or technicians can be a determining factor in the degree of exposure at the filter press, at the sampling ports, and in the laboratory. Microbial levels at the filter press during removal of the filter cake (the operator knocks the cake off with a wood oar) ranged as high as 28990 CFU/$m^3$ on a single sample with an geometric average concentration of 10599.4 CFU/$m^3$ (the predominant colony was the production strain). Average levels would decrease by an approximate factor of 2 when the filter press was closed (3906.1 CFU/$m^3$) and minimal surrounding activity was observed. Technicians at the sampling ports could possibly lower emissions by exercising proper company procedure by opening the steam valve gently. In the laboratory, pipetting of any solution by mouth is contrary to the safety procedures of any laboratory.

Enzyme levels at all sampling locations were below the ACGIH recommended Threshold Limit Value of 0.8 DU/$m^3$. There appears to be no statistically significant differences between sampling locations.

Acetone levels in the enzyme recovery area were less than 0.01 mg/$m^3$ at all sampling locations with the exception of one.

## VII. REFERENCES


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TABLE I. Equipment Used on Field Survey

| Item | Model | |
|---|---|---|
| Automatic balance | Mettler AE 163 | gravimetric analysis |
| Automatic psychrometer | Vista Scientific Corporation | temperature and humidity measurements |
| Colony Counter | New Brunswick Scientific | colony counts and identification |
| High-volume air sampler | General Metal Works | enzyme and total dust sampling |
| Personal sampling pump | Dupont 2500 | total dust sampling |
| Personal sampling pump | Dupont P-200 | acetone sampling |
| Smoke tubes | Draeger | air flow patterns |
| Viable cascade impactor | Andersen 2-stage | microbial air sampling |

TABLE II. Viable Sampling Results

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Background - RR tracks | 6/24 | 1:30 | 1000 | RESP | 10 | 13 | 39 | 33% | 137.3 | NC |
| Background - RR tracks | 6/24 | 1:30 | 1001 | NON | 10 | 26 | | | | NC |
| Background - RR tracks | 6/24 | 1:45 | 1002 | RESP | 5 | 5 | 5 | 100% | 35.2 | NC |
| Background - RR tracks | 6/24 | 1:45 | 1003 | NON | 5 | 0 | | | | NC |
| Background - RR tracks | 6/24 | 2:15 | 1006 | RESP | 5 | 2 | 3 | 67% | 21.1 | NC |
| Background - RR tracks | 6/24 | 2:15 | 1007 | NON | 5 | 1 | | | | NC |
| Background - RR tracks | 6/24 | 2:25 | 1008 | RESP | 2.5 | 0 | 0 | 0% | 0.0 | NC |
| Background - RR tracks | 6/24 | 2:25 | 1009 | NON | 2.5 | 0 | | | | NC |
| Background - RR tracks | 6/24 | 2:40 | 1010 | RESP | 5 | 0 | 5 | 0% | 35.2 | NC |
| Background - RR tracks | 6/24 | 2:40 | 1011 | NON | 5 | 5 | | | | NC |
| Background - RR tracks | 6/24 | 3:18 | 1012 | RESP | 10 | 0 | 0 | 0% | 0.0 | NC |
| Background - RR tracks | 6/24 | 3:18 | 1013 | NON | 10 | 0 | | | | NC |
| Background - RR tracks | 6/24 | 3:36 | 1014 | RESP | 5 | 0 | 1 | 0% | 7.0 | NC |
| Background - RR tracks | 6/24 | 3:36 | 1015 | NON | 5 | 1 | | | | NC |
| Background - RR tracks | 6/24 | 3:50 | 1016 | RESP | 5 | 0 | 0 | 0% | 0.0 | NC |
| Background - RR tracks | 6/24 | 3:50 | 1017 | NON | 5 | 0 | | | | NC |
| Background - RR tracks | 6/24 | 4:08 | 1018 | RESP | 2.5 | 0 | 0 | 0% | 0.0 | NC |
| Background - RR tracks | 6/24 | 4:08 | 1019 | NON | 2.5 | 0 | | | | NC |
| Background - RR tracks | 6/24 | 4:15 | 1020 | RESP | 2.5 | 2 | 2 | 100% | 28.2 | NC |
| Background - RR tracks | 6/24 | 4:15 | 1021 | NON | 2.5 | 0 | | | | NC |
| Background - RR tracks | 6/24 | 4:26 | 1022 | RESP | 10 | 1 | 11 | 9% | 38.7 | NC |
| Background - RR tracks | 6/24 | 4:26 | 1023 | NON | 10 | 10 | | | | NC |
| Background - RR tracks | 6/27 | 9:39 | 1300 | NON | 10 | 38 | 128 | 70% | 450.7 | 1 |
| Background - RR tracks | 6/27 | 9:39 | 1301 | RESP | 10 | 90 | | | | 0 |
| Background - RR tracks | 6/27 | 9:54 | 1302 | NON | 15 | 120 | 260 | 54% | 610.3 | 1 |
| Background - RR tracks | 6/27 | 9:54 | 1303 | RESP | 15 | 140 | | | | 0 |
| Background - RR tracks | 6/27 | 10:14 | 1304 | NON | 10 | 46 | 91 | 49% | 320.4 | 0 |
| Background - RR tracks | 6/27 | 10:14 | 1305 | RESP | 10 | 45 | | | | 0 |
| Background - RR tracks | 6/27 | 10:29 | 1306 | NON | 10 | 49 | 100 | 51% | 352.1 | 3 |
| Background - RR tracks | 6/27 | 10:29 | 1307 | RESP | 10 | 51 | | | | 0 |
| Background - RR tracks | 6/27 | 10:46 | 1308 | NON | 10 | 97 | 222 | 56% | 781.7 | 0 |
| Background - RR tracks | 6/27 | 10:46 | 1309 | RESP | 10 | 125 | | | | 0 |
| Background - RR tracks | 6/27 | 11:01 | 1310 | NON | 10 | 28 | 91 | 69% | 320.4 | 1 |
| Background - RR tracks | 6/27 | 11:01 | 1311 | RESP | 10 | 63 | | | | 0 |
| Background - RR tracks | 6/27 | 11:17 | 1312 | NON | 10 | 10 | 10 | 0% | 35.2 | 0 |
| Background - RR tracks | 6/27 | 11:17 | 1313 | RESP | 10 | 0 | | | | 0 |
| Background - RR tracks | 6/27 | 11:33 | 1314 | NON | 10 | 66 | 195 | 66% | 686.6 | 9 |
| Background - RR tracks | 6/27 | 11:33 | 1315 | RESP | 10 | 129 | | | | 0 |
| Background - RR tracks | 6/27 | 11:47 | 1316 | NON | 10 | 114 | 243 | 53% | 855.6 | 5 |
| Background - RR tracks | 6/27 | 11:47 | 1317 | RESP | 10 | 129 | | | | 0 |
| Background - RR tracks | 6/26 | 11:58 | 1116 | NON | 10 | 13 | 27 | 52% | 95.1 | NC |
| Background - RR tracks | 6/26 | 11:58 | 1117 | RESP | 10 | 14 | | | | NC |
| Background - RR tracks | 6/26 | 2:05 | 1118 | NON | 5 | 0 | 10 | 100% | 70.4 | 0 |
| Background - RR tracks | 6/26 | 2:05 | 1119 | RESP | 5 | 10 | | | | 0 |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Background - RR tracks | 6/26 | 2:15 | 1120 | NON | 16 | 57 | 126 | 55% | 277.3 | NC |
| Background - RR tracks | 6/26 | 2:15 | 1121 | RESP | 16 | 69 | | | | NC |
| Background - water tower | 6/27 | 1:41 | 1318 | NON | 10 | 74 | 151 | 51% | 531.7 | 5 |
| Background - water tower | 6/27 | 1:41 | 1319 | RESP | 10 | 77 | | | | 1 |
| Background - water tower | 6/27 | 1:56 | 1320 | NON | 10 | 34 | 76 | 55% | 267.6 | 3 |
| Background - water tower | 6/27 | 1:56 | 1321 | RESP | 10 | 42 | | | | 5 |
| Background - water tower | 6/27 | 2:11 | 1322 | NON | 10 | 16 | 30 | 47% | 105.6 | 5 |
| Background - water tower | 6/27 | 2:11 | 1323 | RESP | 10 | 14 | | | | 1 |
| Background - water tower | 6/27 | 2:24 | 1324 | NON | 10 | 107 | 169 | 37% | 595.1 | 71 |
| Background - water tower | 6/27 | 2:24 | 1325 | RESP | 10 | 62 | | | | 34 |
| Background - water tower | 6/27 | 2:39 | 1326 | NON | 10 | 35 | 88 | 60% | 309.9 | 5 |
| Background - water tower | 6/27 | 2:39 | 1327 | RESP | 10 | 53 | | | | 0 |
| Background - water tower | 6/27 | 3:11 | 1328 | NON | 10 | 54 | 137 | 61% | 482.4 | 0 |
| Background - water tower | 6/27 | 3:11 | 1329 | RESP | 10 | 83 | | | | 5 |
| Background - water tower | 6/27 | 3:25 | 1330 | NON | 11 | 51 | 192 | 73% | 614.6 | 6 |
| Background - water tower | 6/27 | 3:25 | 1331 | RESP | 11 | 141 | | | | 0 |
| Background - water tower | 6/27 | 4:19 | 1332 | NON | 10 | 41 | 108 | 62% | 380.3 | 5 |
| Background - water tower | 6/27 | 4:19 | 1333 | RESP | 10 | 67 | | | | 1 |
| Background - water tower | 6/27 | 4:32 | 1334 | NON | 10 | 17 | 26 | 35% | 91.5 | 1 |
| Background - water tower | 6/27 | 4:32 | 1335 | RESP | 10 | 9 | | | | 0 |
| Background - water tower | 6/27 | 4:45 | 1336 | NON | 10 | 12 | 15 | 20% | 52.8 | 0 |
| Background - water tower | 6/27 | 4:45 | 1337 | RESP | 10 | 3 | | | | 0 |
| Background - water tower | 6/27 | 4:58 | 1338 | NON | 10 | 281 | 424 | 34% | 1493.0 | NC |
| Background - water tower | 6/27 | 4:58 | 1339 | RESP | 10 | 143 | | | | NC |
| Background - water tower | 6/27 | 5:13 | 1340 | NON | 10 | 216 | 306 | 29% | 1077.5 | NC |
| Background - water tower | 6/27 | 5:13 | 1341 | RESP | 10 | 90 | | | | NC |
| Background - behind offices | 6/25 | 10:45 | 1050 | NON | 10 | 40 | 71 | 44% | 250.0 | NC |
| Background - behind offices | 6/25 | 10:45 | 1051 | RESP | 10 | 31 | | | | NC |
| Background - behind offices | 6/25 | 11:03 | 1052 | NON | 5 | 1 | 1 | 0% | 7.0 | NC |
| Background - behind offices | 6/25 | 11:03 | 1053 | RESP | 5 | 0 | | | | NC |
| Background - behind offices | 6/25 | 11:16 | 1054 | NON | 2.5 | 0 | 2 | 100% | 28.2 | NC |
| Background - behind offices | 6/25 | 11:16 | 1055 | RESP | 2.5 | 2 | | | | NC |
| Background - behind offices | 6/25 | 12:33 | 1056 | NON | 5 | 0 | 4 | 100% | 28.2 | NC |
| Background - behind offices | 6/25 | 12:33 | 1057 | RESP | 5 | 4 | | | | NC |
| Background - behind offices | 6/25 | 12:45 | 1058 | NON | 5 | 11 | 12 | 8% | 84.5 | NC |
| Background - behind offices | 6/25 | 12:45 | 1059 | RESP | 5 | 1 | | | | NC |
| Background - behind offices | 6/25 | 1:09 | 1062 | NON | 10 | 28 | 47 | 40% | 165.5 | NC |
| Background - behind offices | 6/25 | 1:09 | 1063 | RESP | 10 | 19 | | | | NC |
| Background - behind offices | 6/25 | 1:30 | 1064 | NON | 5 | 0 | 1 | 100% | 7.0 | NC |
| Background - behind offices | 6/25 | 1:30 | 1065 | RESP | 5 | 1 | | | | NC |
| Background - behind offices | 6/25 | 1:40 | 1066 | NON | 5 | 0 | 0 | 0% | 0.0 | NC |
| Background - behind offices | 6/25 | 1:40 | 1067 | RESP | 5 | 0 | | | | NC |
| Background - behind offices | 6/25 | 2:10 | 1068 | NON | 2.5 | 14 | 25 | 44% | 352.1 | NC |
| Background - behind offices | 6/25 | 2:10 | 1069 | RESP | 2.5 | 11 | | | | NC |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Background - behind offices | 6/25 | 2:20 | 1070 | NON | 5 | 9 | 14 | 36% | 98.6 | NC |
| Background - behind offices | 6/25 | 2:20 | 1071 | RESP | 5 | 5 | | | | NC |
| Background - behind offices | 6/28 | 10:02 | 1410 | NON | 10 | 50 | 118 | 58% | 415.5 | NC |
| Background - behind offices | 6/28 | 10:02 | 1411 | RESP | 10 | 68 | | | | NC |
| Background - behind offices | 6/28 | 10:16 | 1412 | NON | 11 | 43 | 76 | 43% | 243.3 | NC |
| Background - behind offices | 6/28 | 10:16 | 1413 | RESP | 11 | 33 | | | | NC |
| Background - behind offices | 6/28 | 10:31 | 1414 | NON | 10 | 82 | 202 | 59% | 711.3 | NC |
| Background - behind offices | 6/28 | 10:31 | 1415 | RESP | 10 | 120 | | | | NC |
| Background - behind offices | 6/28 | 10:46 | 1416 | NON | 10 | 47 | 125 | 62% | 440.1 | NC |
| Background - behind offices | 6/28 | 10:46 | 1417 | RESP | 10 | 78 | | | | NC |
| Background - behind offices | 6/28 | 11:02 | 1418 | NON | 10 | 113 | 264 | 57% | 929.6 | NC |
| Background - behind offices | 6/28 | 11:02 | 1419 | RESP | 10 | 151 | | | | NC |
| Background - behind offices | 6/28 | 11:17 | 1420 | NON | 10 | 76 | 201 | 62% | 707.7 | NC |
| Background - behind offices | 6/28 | 11:17 | 1421 | RESP | 10 | 125 | | | | NC |
| Background - behind offices | 6/28 | 11:46 | 1424 | NON | 10 | 114 | 310 | 63% | 1091.5 | NC |
| Background - behind offices | 6/28 | 11:46 | 1425 | RESP | 10 | 196 | | | | NC |
| Background - field | 6/28 | 8:17 | 1400 | NON | 10 | 22 | 222 | 90% | 781.7 | NC |
| Background - field | 6/28 | 8:17 | 1401 | RESP | 10 | 200 | | | | NC |
| Background - field | 6/28 | 8:31 | 1402 | NON | 11 | 44 | 245 | 82% | 784.3 | NC |
| Background - field | 6/28 | 8:31 | 1403 | RESP | 11 | 201 | | | | NC |
| Background - field | 6/28 | 8:46 | 1404 | NON | 10 | 58 | 194 | 70% | 683.1 | NC |
| Background - field | 6/28 | 8:46 | 1405 | RESP | 10 | 136 | | | | NC |
| Background - field | 6/28 | 9:14 | 1408 | NON | 8 | 97 | 130 | 25% | 572.2 | NC |
| Background - field | 6/28 | 9:14 | 1409 | RESP | 8 | 33 | | | | NC |
| Background - cafeteria | 6/26 | 8:25 | 1100 | NON | 10 | 27 | 59 | 54% | 207.7 | 19 |
| Background - cafeteria | 6/26 | 8:25 | 1101 | RESP | 10 | 32 | | | | 14 |
| Background - cafeteria | 6/26 | 8:43 | 1102 | NON | 5 | 23 | 43 | 47% | 302.8 | 16 |
| Background - cafeteria | 6/26 | 8:43 | 1103 | RESP | 5 | 20 | | | | 6 |
| Background - cafeteria | 6/26 | 8:56 | 1104 | NON | 10 | 44 | 89 | 51% | 313.4 | 10 |
| Background - cafeteria | 6/26 | 8:56 | 1105 | RESP | 10 | 45 | | | | 6 |
| Background - conference room | 6/26 | 9:27 | 1106 | NON | 10 | 53 | 171 | 69% | 602.1 | 35 |
| Background - conference room | 6/26 | 9:27 | 1107 | RESP | 10 | 118 | | | | 48 |
| Background - conference room | 6/26 | 9:43 | 1108 | NON | 5 | 40 | 88 | 55% | 619.7 | 28 |
| Background - conference room | 6/26 | 9:43 | 1109 | RESP | 5 | 48 | | | | 24 |
| Background - conference room | 6/26 | 9:54 | 1110 | NON | 5 | 59 | 111 | 47% | 781.7 | 34 |
| Background - conference room | 6/26 | 9:54 | 1111 | RESP | 5 | 52 | | | | 26 |
| Background - conference room | 6/26 | 10:05 | 1112 | NON | 10 | 109 | 218 | 50% | 767.6 | 30 |
| Background - conference room | 6/26 | 10:05 | 1113 | RESP | 10 | 109 | | | | 39 |
| Background - conference room | 6/26 | 10:22 | 1114 | NON | 5 | 58 | 107 | 46% | 753.5 | 43 |
| Background - conference room | 6/26 | 10:22 | 1115 | RESP | 5 | 49 | | | | 22 |
| Background - locker room | 6/26 | 2:51 | 1124 | NON | 10 | 0 | 2 | 100% | 7.0 | NC |
| Background - locker room | 6/26 | 2:51 | 1125 | RESP | 10 | 2 | | | | 0 |
| Background - locker room | 6/26 | 3:16 | 1126 | NON | 5 | 13 | 19 | 32% | 133.8 | NC |
| Background - locker room | 6/26 | 3:16 | 1127 | RESP | 5 | 6 | | | | NC |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Background - office | 6/26 | 3:32 | 1130 | NON | 20 | 111 | 211 | 47% | 371.5 | 0 |
| Background - office | 6/26 | 3:32 | 1131 | RESP | 20 | 100 | | | | NC |
| Background - office | 6/26 | 4:01 | 1132 | NON | 10 | 115 | 213 | 46% | 750.0 | NC |
| Background - office | 6/26 | 4:01 | 1133 | RESP | 10 | 98 | | | | NC |
| Filter Press | 6/24 | 1:24 | 2003 | RESP | 4 | 244 | 959 | 26% | 9439 | NC |
| Filter Press | 6/24 | 1:24 | 2004 | NON | 4 | 715 | | | | NC |
| Filter Press | 6/24 | 1:42 | 2008 | RESP | 5 | 227 | 1118 | 21% | 8803 | NC |
| Filter Press | 6/24 | 1:42 | 2007 | NON | 5 | 891 | | | | NC |
| Filter Press | 6/24 | 2:57 | 2011 | RESP | 4 | 223 | 597 | 38% | 5876 | 0 |
| Filter Press | 6/24 | 2:57 | 2012 | NON | 4 | 374 | | | | NC |
| Filter Press | 6/24 | 3:19 | 2015 | RESP | 3 | 406 | 2209 | 19% | 28990 | NC |
| Filter Press | 6/24 | 3:19 | 2016 | NON | 3 | 1803 | | | | NC |
| Filter Press | 6/24 | 3:42 | 2019 | RESP | 4 | 170 | 384 | 45% | 3780 | NC |
| Filter Press | 6/24 | 3:42 | 2020 | NON | 4 | 214 | | | | NC |
| Filter Press | 6/24 | 3:55 | 2023 | RESP | 4 | 87 | 237 | 38% | 2333 | NC |
| Filter Press | 6/24 | 3:55 | 2024 | NON | 4 | 150 | | | | NC |
| Filter Press | 6/24 | 1:24 | 2001 | RESP | 4 | 276 | 1871 | 15% | 18343 | NC |
| Filter Press | 6/24 | 1:24 | 2002 | NON | 4 | 1595 | | | | 0 |
| Filter Press | 6/24 | 1:42 | 2006 | RESP | 5 | 264 | 1379 | 19% | 10816 | NC |
| Filter Press | 6/24 | 1:42 | 2005 | NON | 5 | 1115 | | | | NC |
| Filter Press | 6/24 | 2:57 | 2009 | RESP | 4 | 231 | 1394 | 17% | 13667 | NC |
| Filter Press | 6/24 | 2:57 | 2010 | NON | 4 | 1163 | | | | NC |
| Filter Press | 6/24 | 3:42 | 2017 | RESP | 4 | 2221 | 2406 | 92% | 23588 | NC |
| Filter Press | 6/24 | 3:42 | 2018 | NON | 4 | 185 | | | | 0 |
| Filter Press | 6/24 | 3:55 | 2021 | RESP | 4 | 64 | 170 | 39% | 1667 | NC |
| Filter Press | 6/24 | 3:55 | 2022 | NON | 4 | 106 | | | | NC |
| Filter Press | 6/25 | 8:10 | 2024 | NON | 4 | 36 | 155 | 80% | 1520 | 10 |
| Filter Press | 6/25 | 8:10 | 2025 | RESP | 4 | 119 | | | | 10 |
| Filter Press | 6/25 | 8:22 | 2028 | NON | 4 | 36 | 112 | 72% | 1098 | 28 |
| Filter Press | 6/25 | 8:22 | 2029 | RESP | 4 | 76 | | | | 13 |
| Filter Press | 6/25 | 8:53 | 2032 | NON | 3 | 195 | 343 | 45% | 4484 | 165 |
| Filter Press | 6/25 | 8:53 | 2033 | RESP | 3 | 148 | | | | 101 |
| Filter Press | 6/25 | 9:01 | 2036 | NON | 3 | 236 | 407 | 43% | 5320 | 197 |
| Filter Press | 6/25 | 9:01 | 2037 | RESP | 3 | 171 | | | | NC |
| Filter Press | 6/25 | 9:18 | 2040 | NON | 2.5 | 253 | 447 | 45% | 7012 | NC |
| Filter Press | 6/25 | 9:18 | 2041 | RESP | 2.5 | 194 | | | | NC |
| Filter Press | 6/25 | 10:20 | 2044 | NON | 2.5 | 224 | 597 | 63% | 9365 | NC |
| Filter Press | 6/25 | 10:20 | 2045 | RESP | 2.5 | 373 | | | | NC |
| Filter Press | 6/25 | 11:11 | 2048 | NON | 5 | 39 | 126 | 73% | 988 | NC |
| Filter Press | 6/25 | 11:11 | 2049 | RESP | 5 | 87 | | | | NC |
| Filter Press | 6/25 | 12:41 | 2056 | NON | 4 | 701 | 985 | 29% | 9657 | NC |
| Filter Press | 6/25 | 12:41 | 2053 | RESP | 4 | 284 | | | | NC |
| Filter Press | 6/25 | 1:01 | 2058 | NON | 4 | 150 | 265 | 45% | 2598 | NC |
| Filter Press | 6/25 | 1:01 | 2059 | RESP | 4 | 115 | | | | NC |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Filter Press | 6/25 | 8:10 | 2026 | NON | 4 | 69 | 183 | 65% | 1801 | 26 |
| Filter Press | 6/25 | 8:10 | 2027 | RESP | 4 | 114 | | | | 16 |
| Filter Press | 6/25 | 8:22 | 2030 | NON | 4 | 83 | 178 | 56% | 1752 | 60 |
| Filter Press | 6/25 | 8:22 | 2031 | RESP | 4 | 95 | | | | 19 |
| Filter Press | 6/25 | 8:53 | 2034 | NON | 3 | 369 | 570 | 36% | 7480 | 10 |
| Filter Press | 6/25 | 8:53 | 2035 | RESP | 3 | 201 | | | | 162 |
| Filter Press | 6/25 | 9:01 | 2038 | NON | 3 | 669 | 884 | 25% | 11601 | NC |
| Filter Press | 6/25 | 9:01 | 2039 | RESP | 3 | 215 | | | | NC |
| Filter Press | 6/25 | 9:18 | 2042 | NON | 2.5 | 273 | 462 | 42% | 7276 | NC |
| Filter Press | 6/25 | 9:18 | 2043 | RESP | 2.5 | 189 | | | | NC |
| Filter Press | 6/25 | 10:20 | 2046 | NON | 2.5 | 183 | 339 | 47% | 5339 | NC |
| Filter Press | 6/25 | 10:20 | 2047 | RESP | 2.5 | 156 | | | | NC |
| Filter Press | 6/25 | 11:11 | 2050 | NON | 5 | 1069 | 1136 | 6% | 8945 | NC |
| Filter Press | 6/25 | 11:11 | 2051 | RESP | 5 | 67 | | | | NC |
| Filter Press | 6/25 | 12:41 | 2054 | NON | 4 | 653 | 938 | 31% | 9232 | NC |
| Filter Press | 6/25 | 12:41 | 2055 | RESP | 4 | 285 | | | | NC |
| Filter Press | 6/25 | 1:01 | 2060 | NON | 4 | 245 | 349 | 31% | 3435 | NC |
| Filter Press | 6/25 | 1:01 | 2061 | RESP | 4 | 104 | | | | NC |
| Fermentor Sample Port - open | 6/24 | 2:10 | 3000 | NON | 4 | 100 | 148 | 32% | 1312.1 | 89 |
| Fermentor Sample Port - open | 6/24 | 2:10 | 3001 | RESP | 4 | 48 | | | | 42 |
| Fermentor Sample Port - open | 6/24 | 2:10 | 3003 | NON | 4 | 114 | 139 | 18% | 1215.0 | 74 |
| Fermentor Sample Port - open | 6/24 | 2:10 | 3002 | RESP | 4 | 25 | | | | 18 |
| Fermentor Sample Port - open | 6/25 | 1:45 | 3034 | NON | 6 | 190 | 444 | 57% | 2902.0 | NC |
| Fermentor Sample Port - closed | 6/25 | 1:45 | 3035 | RESP | 6 | 254 | | | | NC |
| Fermentor Sample Port - closed | 6/24 | 2:27 | 3004 | RESP | 4 | 20 | 40 | 50% | 354.6 | 4 |
| Fermentor Sample Port - closed | 6/24 | 2:27 | 3005 | NON | 4 | 20 | | | | 0 |
| Fermentor Sample Port - closed | 6/24 | 2:27 | 3006 | RESP | 4 | 27 | 33 | 82% | 288.5 | 0 |
| Fermentor Sample Port - closed | 6/24 | 2:27 | 3007 | NON | 4 | 6 | | | | 0 |
| Fermentor Sample Port - closed | 6/24 | 2:48 | 3008 | RESP | 4 | 4 | 21 | 19% | 186.2 | 1 |
| Fermentor Sample Port - closed | 6/24 | 2:48 | 3009 | NON | 4 | 17 | | | | 3 |
| Fermentor Sample Port - closed | 6/24 | 2:48 | 3010 | RESP | 4 | 5 | 11 | 45% | 96.2 | 3 |
| Fermentor Sample Port - closed | 6/24 | 2:48 | 3011 | NON | 4 | 6 | | | | 5 |
| Fermentor Sample Port - closed | 6/24 | 3:05 | 3012 | RESP | 4 | 5 | 7 | 71% | 62.1 | 0 |
| Fermentor Sample Port - closed | 6/24 | 3:05 | 3013 | NON | 4 | 2 | | | | 1 |
| Fermentor Sample Port - closed | 6/24 | 3:05 | 3014 | RESP | 4 | 9 | 9 | 100% | 78.7 | 0 |
| Fermentor Sample Port - closed | 6/24 | 3:05 | 3015 | NON | 4 | 0 | | | | 0 |
| Fermentor Sample Port - closed | 6/25 | 2:01 | 3036 | NON | 11 | 78 | 124 | 37% | 442.1 | NC |
| Fermentor Sample Port - closed | 6/25 | 2:01 | 3037 | RESP | 11 | 46 | | | | NC |
| Fermentor Sample Port - closed | 6/25 | 2:21 | 3038 | NON | 10 | 50 | 125 | 60% | 490.2 | NC |
| Fermentor Sample Port - closed | 6/25 | 2:21 | 3039 | RESP | 10 | 75 | | | | NC |
| Incubation Room | 6/25 | 8:47 | 3016 | NON | 17 | 76 | 160 | 53% | 333.8 | NC |
| Incubation Room | 6/25 | 8:47 | 3017 | RESP | 17 | 84 | | | | NC |
| Incubation Room | 6/25 | 9:08 | 3020 | NON | 20 | 60 | 168 | 64% | 297.9 | NC |
| Incubation Room | 6/25 | 9:08 | 3021 | RESP | 20 | 108 | | | | NC |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Incubation Room | 6/25 | 9:39 | 3026 | NON | 22 | 122 | 237 | 49% | 382.0 | NC |
| Incubation Room | 6/25 | 9:39 | 3027 | RESP | 22 | 115 | | | | NC |
| Incubation Room | 6/25 | 10:10 | 3028 | NON | 20 | 118 | 178 | 34% | 315.6 | NC |
| Incubation Room | 6/25 | 10:10 | 3029 | RESP | 20 | 60 | | | | NC |
| Incubation Room | 6/26 | 2:38 | 3078 | NON | 20 | | | | | ND |
| Incubation Room | 6/26 | 2:38 | 3079 | RESP | 20 | 52 | | | | 29 |
| Incubation Room | 6/26 | 3:59 | 3084 | NON | 20 | 143 | | | | 42 |
| Incubation Room | 6/26 | 3:59 | 3085 | RESP | 20 | | | | | 31 |
| Incubation Room | 6/26 | 2:11 | 3076 | NON | 20 | 102 | 160 | 36% | 315.0 | 20 |
| Incubation Room | 6/26 | 2:11 | 3077 | RESP | 20 | 58 | | | | 20 |
| Incubation Room | 6/26 | 3:32 | 3082 | NON | 20 | 107 | 175 | 39% | 344.5 | 30 |
| Incubation Room | 6/26 | 3:32 | 3083 | RESP | 20 | 68 | | | | 35 |
| Clean Room | 6/25 | 8:56 | 3018 | NON | 20 | 2 | 6 | 67% | 10.5 | NC |
| Clean Room | 6/25 | 8:56 | 3019 | RESP | 20 | 4 | | | | NC |
| Clean Room | 6/25 | 9:54 | 3022 | NON | 9 | 0 | 1 | 100% | 3.9 | NC |
| Clean Room | 6/25 | 9:54 | 3023 | RESP | 9 | 1 | | | | NC |
| Clean Room | 6/25 | 10:15 | 3030 | NON | 10 | 0 | 0 | 0% | 0.0 | NC |
| Clean Room | 6/25 | 10:15 | 3031 | RESP | 10 | 0 | | | | 0 |
| Clean Room | 6/25 | 10:30 | 3032 | NON | 10 | 0 | 4 | 100% | 14.0 | 0 |
| Clean Room | 6/25 | 10:30 | 3033 | RESP | 10 | 4 | | | | NC |
| Clean Room | 6/26 | 8:19 | 3052 | NON | 21 | 32 | 39 | 18% | 72.8 | 27 |
| Clean Room | 6/26 | 8:19 | 3053 | RESP | 21 | 7 | | | | 9 |
| Clean Room | 6/26 | 8:49 | 3054 | NON | 16 | 0 | 0 | 0% | 0.0 | 1 |
| Clean Room | 6/26 | 8:49 | 3055 | RESP | 16 | 0 | | | | 1 |
| Clean Room | 6/26 | 9:11 | 3056 | NON | 20 | 0 | 0 | 0% | 0.0 | 0 |
| Clean Room | 6/26 | 9:11 | 3057 | RESP | 20 | 0 | | | | 0 |
| Clean Room | 6/26 | 11:05 | 3062 | NON | 20 | 0 | 0 | 0% | 0.0 | 1 |
| Clean Room | 6/26 | 11:05 | 3063 | RESP | 20 | 0 | | | | 1 |
| Clean Room | 6/26 | 1:56 | 3064 | NON | 20 | 0 | 0 | 0% | 0.0 | 1 |
| Clean Room | 6/26 | 1:56 | 3065 | RESP | 20 | 0 | | | | 1 |
| Clean Room | 6/26 | 2:25 | 3066 | NON | 20 | 0 | 0 | 0% | 0.0 | 1 |
| Clean Room | 6/26 | 2:25 | 3067 | RESP | 20 | 0 | | | | 1 |
| Clean Room | 6/26 | 2:53 | 3068 | NON | 21 | 16 | 19 | 16% | 35.5 | 2 |
| Clean Room | 6/26 | 2:53 | 3069 | RESP | 21 | 3 | | | | 1 |
| Clean Room | 6/26 | 3:46 | 3072 | NON | 20 | 0 | 0 | 0% | 0.0 | 1 |
| Clean Room | 6/26 | 3:46 | 3073 | RESP | 20 | 0 | | | | 1 |
| Main Laboratory | 6/26 | 9:53 | 3058 | NON | 25 | 21 | 98 | 79% | 153.7 | 12 |
| Main Laboratory | 6/26 | 9:53 | 3059 | RESP | 25 | 77 | | | | 4 |
| Main Laboratory | 6/26 | 10:32 | 3060 | NON | 20 | 29 | 70 | 59% | 137.3 | 15 |
| Main Laboratory | 6/26 | 10:32 | 3061 | RESP | 20 | 41 | | | | 21 |
| Quality Control Laboratory | 6/27 | 2:48 | 1 | RESP | 10 | 26 | 70 | 37% | 275.6 | 10 |
| Quality Control Laboratory | 6/27 | 2:48 | 2 | NON | 10 | 44 | | | | 9 |
| Quality Control Laboratory | 6/27 | 3:04 | 3 | RESP | 15 | 27 | 69 | 39% | 181.1 | 6 |
| Quality Control Laboratory | 6/27 | 3:04 | 4 | NON | 15 | 42 | | | | 10 |
| Quality Control Laboratory | 6/27 | 3:23 | 5 | RESP | 10 | 15 | 34 | 44% | 133.9 | 0 |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Quality Control Laboratory | 6/27 | 3:23 | 6 | NON | 10 | 19 | | | | 9 |
| Quality Control Laboratory | 6/27 | 3:39 | 7 | RESP | 10 | 15 | 75 | 20% | 295.3 | 9 |
| Quality Control Laboratory | 6/27 | 3:39 | 8 | NON | 10 | 60 | | | | 19 |
| Quality Control Laboratory | 6/27 | 4:15 | 9 | RESP | 10 | 11 | 25 | 44% | 98.4 | 5 |
| Quality Control Laboratory | 6/27 | 4:15 | 10 | NON | 10 | 14 | | | | 8 |
| Quality Control Laboratory | 6/27 | 4:31 | 11 | RESP | 10 | 10 | 23 | 43% | 90.6 | 4 |
| Quality Control Laboratory | 6/27 | 4:31 | 12 | NON | 10 | 13 | | | | 6 |
| Quality Control Laboratory | 6/27 | 4:44 | 13 | RESP | 15 | 14 | 35 | 40% | 91.9 | 2 |
| Quality Control Laboratory | 6/27 | 4:44 | 14 | NON | 15 | 46 | | | | NC |
| Quality Control Laboratory | 6/27 | 5:02 | 15 | RESP | 10 | 5 | 59 | 8% | 232.3 | 3 |
| Quality Control Laboratory | 6/27 | 5:02 | 16 | NON | 10 | 20 | | | | NC |
| Dumpster | 6/28 | 9:05 | 3612 | NON | 6 | 281 | 434 | 35% | 2565.0 | NC |
| Dumpster | 6/28 | 9:05 | 3613 | RESP | 6 | 153 | | | | NC |
| Dumpster | 6/28 | 9:05 | 3614 | NON | 6 | 339 | 501 | 32% | 2919.6 | NC |
| Dumpster | 6/28 | 9:05 | 3615 | RESP | 6 | 162 | | | | NC |
| Dumpster | 6/28 | 9:05 | 3616 | NON | 6 | 111 | 177 | 37% | 1161.4 | NC |
| Dumpster | 6/28 | 9:05 | 3617 | RESP | 6 | 66 | | | | NC |
| Dumpster | 6/28 | 10:16 | 3618 | NON | 5 | 234 | 352 | 34% | 2496.5 | NC |
| Dumpster | 6/28 | 10:16 | 3619 | RESP | 5 | 118 | | | | NC |
| Dumpster | 6/28 | 10:16 | 3620 | NON | 5 | 309 | 508 | 39% | 3552.4 | NC |
| Dumpster | 6/28 | 10:16 | 3621 | RESP | 5 | 199 | | | | NC |
| Dumpster | 6/28 | 10:16 | 3622 | NON | 5 | 163 | 262 | 38% | 2063.0 | NC |
| Dumpster | 6/28 | 10:16 | 3623 | RESP | 5 | 99 | | | | NC |
| Dumpster | 6/28 | 12:07 | 3630 | NON | 5 | 243 | 364 | 33% | 2581.6 | NC |
| Dumpster | 6/28 | 12:07 | 3631 | RESP | 5 | 121 | | | | NC |
| Dumpster | 6/28 | 12:07 | 3632 | NON | 5 | 469 | 666 | 30% | 4657.3 | NC |
| Dumpster | 6/28 | 12:07 | 3633 | RESP | 5 | 197 | | | | NC |
| Dumpster | 6/28 | 12:07 | 3634 | NON | 5 | 106 | 174 | 39% | 1370.1 | NC |
| Dumpster | 6/28 | 12:07 | 3635 | RESP | 5 | 68 | | | | NC |
| Fermentor Tank - agitator shaft | 6/25 | 1:56 | 3040 | NON | 2.5 | 19 | 95 | 80% | 1328.7 | NC |
| Fermentor Tank - agitator shaft | 6/25 | 1:56 | 3041 | RESP | 2.5 | 76 | | | | NC |
| Fermentor Tank - agitator shaft | 6/25 | 1:56 | 3042 | NON | 2.5 | 22 | 64 | 66% | 907.8 | NC |
| Fermentor Tank - agitator shaft | 6/25 | 1:56 | 3043 | RESP | 2.5 | 42 | | | | 45 |
| Fermentor Tank - agitator shaft | 6/25 | 2:08 | 3044 | NON | 2.5 | 5 | 11 | 55% | 153.8 | 9 |
| Fermentor Tank - agitator shaft | 6/25 | 2:08 | 3045 | RESP | 2.5 | 6 | | | | 9 |
| Fermentor Tank - agitator shaft | 6/25 | 2:08 | 3046 | NON | 2.5 | 0 | 14 | 100% | 198.6 | 1 |
| Fermentor Tank - agitator shaft | 6/25 | 2:08 | 3047 | RESP | 2.5 | 14 | | | | 13 |
| Fermentor Tank - agitator shaft | 6/25 | 2:24 | 3048 | NON | 2.5 | 3 | 82 | 96% | 1146.9 | 4 |
| Fermentor Tank - agitator shaft | 6/25 | 2:24 | 3049 | RESP | 2.5 | 79 | | | | 82 |
| Fermentor Tank - agitator shaft | 6/25 | 2:24 | 3050 | NON | 2.5 | 4 | 162 | 98% | 2297.9 | 4 |
| Fermentor Tank - agitator shaft | 6/25 | 2:24 | 3051 | RESP | 2.5 | 158 | | | | 161 |
| Fermentor Tank - agitator shaft | 6/26 | 11:25 | 3129 | RESP | 5 | 5 | 12 | 42% | 83.9 | 0 |
| Fermentor Tank - agitator shaft | 6/26 | 11:25 | 3130 | NON | 5 | 7 | | | | 0 |
| Fermentor Tank - agitator shaft | 6/26 | 11:25 | 3131 | RESP | 5 | 0 | 13 | 0% | 92.2 | 1 |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Seed Tank - agitator shaft | 6/27 | 10:45 | 3422 | NON | 5 | 73 | | | | 5 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3423 | RESP | 5 | 194 | 242 | 80% | 1716.3 | 3 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3424 | NON | 5 | 48 | | | | 5 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3425 | RESP | 5 | 119 | 190 | 63% | 1328.7 | 4 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3426 | NON | 5 | 71 | | | | 5 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3427 | RESP | 5 | 78 | 149 | 52% | 1056.7 | 10 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3428 | NON | 5 | 71 | | | | 25 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3429 | RESP | 5 | 105 | 155 | 68% | 1083.9 | 13 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3430 | NON | 5 | 50 | | | | 19 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3435 | RESP | 10 | 126 | 467 | 27% | 1656.0 | 85 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3436 | NON | 10 | 341 | | | | 128 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3437 | RESP | 10 | 102 | 331 | 31% | 1157.3 | 66 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3438 | NON | 10 | 229 | | | | 114 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3439 | RESP | 5 | 102 | 179 | 57% | 1269.5 | 18 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3440 | NON | 5 | 77 | | | | 34 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3441 | RESP | 5 | 182 | 264 | 69% | 1846.2 | 9 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3442 | NON | 5 | 82 | | | | 20 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3443 | RESP | 5 | 115 | 270 | 43% | 1914.9 | 9 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3444 | NON | 5 | 155 | | | | 55 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3445 | RESP | 5 | 133 | 252 | 53% | 1762.2 | 22 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3446 | NON | 5 | 119 | | | | 37 |
| Scrubber exhaust | 6/26 | 8:32 | 3101 | RESP | 5 | 43 | 51 | 84% | 356.6 | 35 |
| Scrubber exhaust | 6/26 | 8:32 | 3102 | NON | 5 | 8 | | | | 0 |
| Scrubber exhaust | 6/26 | 8:32 | 3103 | RESP | 5 | 72 | 77 | 94% | 546.1 | 45 |
| Scrubber exhaust | 6/26 | 8.32 | 3104 | NON | 5 | 5 | | | | 1 |
| Scrubber exhaust | 6/26 | 8:50 | 3105 | RESP | 5 | 24 | 27 | 89% | 188.8 | 15 |
| Scrubber exhaust | 6/26 | 8:50 | 3106 | NON | 5 | 3 | | | | 3 |
| Scrubber exhaust | 6/26 | 8:50 | 3107 | NON | 5 | 8 | 54 | 15% | 383.0 | 5 |
| Scrubber exhaust | 6/26 | 8:50 | 3108 | RESP | 5 | 46 | | | | 31 |
| Scrubber exhaust | 6/26 | 9:06 | 3109 | RESP | 5 | 60 | 63 | 95% | 446.8 | 46 |
| Scrubber exhaust | 6/26 | 9:06 | 3110 | NON | 5 | 3 | | | | 0 |
| Scrubber exhaust | 6/26 | 9:06 | 3111 | RESP | 5 | 43 | 45 | 96% | 314.7 | 34 |
| Scrubber exhaust | 6/26 | 9:06 | 3112 | NON | 5 | 2 | | | | 2 |
| Scrubber exhaust | 6/26 | 9:20 | 3113 | RESP | 2.5 | 12 | 12 | 100% | 170.2 | 2 |
| Scrubber exhaust | 6/26 | 9:20 | 3114 | NON | 2.5 | 0 | | | | 0 |
| Scrubber exhaust | 6/26 | 9:20 | 3115 | RESP | 2.5 | 23 | 23 | 100% | 321.7 | 22 |
| Scrubber exhaust | 6/26 | 9:20 | 3116 | NON | 2.5 | 0 | | | | 0 |
| Scrubber exhaust | 6/26 | 9:44 | 3117 | RESP | 2.5 | 103 | 120 | 86% | 1702.1 | 61 |
| Scrubber exhaust | 6/26 | 9:44 | 3118 | NON | 2.5 | 17 | | | | 5 |
| Scrubber exhaust | 6/26 | 9:44 | 3119 | RESP | 2.5 | 75 | 91 | 82% | 1272.7 | 29 |
| Scrubber exhaust | 6/26 | 9:44 | 3120 | NON | 2.5 | 16 | | | | 1 |
| Scrubber exhaust | 6/26 | 9:55 | 3121 | RESP | 5 | 37 | 70 | 53% | 496.5 | NC |
| Scrubber exhaust | 6/26 | 9:55 | 3122 | NON | 5 | 33 | | | | 1 |
| Scrubber exhaust | 6/26 | 9:55 | 3123 | RESP | 5 | 31 | 47 | 66% | 328.7 | NC |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFI | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Fermentor Tank - agitator shaft | 6/26 | 11:25 | 3132 | NON | 5 | 13 | | | | 4 |
| Fermentor Tank - agitator shaft | 6/26 | 11:37 | 3133 | RESP | 5 | 2 | 17 | 12% | 118.9 | 0 |
| Fermentor Tank - agitator shaft | 6/26 | 11:37 | 3134 | NON | 5 | 15 | | | | 7 |
| Fermentor Tank - agitator shaft | 6/26 | 11:37 | 3135 | RESP | 5 | 17 | 42 | 40% | 297.9 | 2 |
| Fermentor Tank - agitator shaft | 6/26 | 11:37 | 3136 | NON | 5 | 25 | | | | 9 |
| Fermentor Tank - agitator shaft | 6/26 | 11:48 | 3137 | RESP | 2.5 | 0 | 6 | 0% | 83.9 | 0 |
| Fermentor Tank - agitator shaft | 6/26 | 11:48 | 3138 | NON | 2.5 | 6 | | | | 2 |
| Fermentor Tank - agitator shaft | 6/26 | 11:48 | 3139 | RESP | 2.5 | 0 | 8 | 0% | 113.5 | 0 |
| Fermentor Tank - agitator shaft | 6/26 | 11:48 | 3140 | NON | 2.5 | 8 | | | | 4 |
| Fermentor Tank - agitator shaft | 6/26 | 11:57 | 3141 | RESP | 2.5 | 26 | 70 | 37% | 979.0 | 7 |
| Fermentor Tank - agitator shaft | 6/26 | 11:57 | 3142 | NON | 2.5 | 44 | | | | 22 |
| Fermentor Tank - agitator shaft | 6/26 | 11:57 | 3143 | RESP | 2.5 | 19 | 55 | 35% | 780.1 | 22 |
| Fermentor Tank - agitator shaft | 6/26 | 11:57 | 3144 | NON | 2.5 | 36 | | | | 19 |
| Fermentor Tank - agitator shaft | 6/27 | 2:03 | 3500 | NON | 5 | 26 | 35 | 26% | 248.2 | 1 |
| Fermentor Tank - agitator shaft | 6/27 | 2:03 | 3501 | RESP | 5 | 9 | | | | 0 |
| Fermentor Tank - agitator shaft | 6/27 | 2:03 | 3502 | NON | 5 | 23 | 43 | 47% | 300.7 | 5 |
| Fermentor Tank - agitator shaft | 6/27 | 2:03 | 3503 | RESP | 5 | 20 | | | | 0 |
| Fermentor Tank - agitator shaft | 6/27 | 2:20 | 3504 | NON | 5 | 8 | 22 | 64% | 156.0 | 0 |
| Fermentor Tank - agitator shaft | 6/27 | 2:20 | 3505 | RESP | 5 | 14 | | | | 0 |
| Fermentor Tank - agitator shaft | 6/27 | 2:20 | 3506 | NON | 5 | 11 | 15 | 27% | 104.9 | 2 |
| Fermentor Tank - agitator shaft | 6/27 | 2:20 | 3507 | RESP | 5 | 4 | | | | 0 |
| Fermentor Tank - agitator shaft | 6/27 | 2:53 | 3508 | NON | 5 | 99 | 222 | 55% | 1574.5 | 38 |
| Fermentor Tank - agitator shaft | 6/27 | 2:53 | 3509 | RESP | 5 | 123 | | | | 35 |
| Fermentor Tank - agitator shaft | 6/27 | 2:53 | 3510 | NON | 5 | 41 | 132 | 69% | 923.1 | 7 |
| Fermentor Tank - agitator shaft | 6/27 | 2:53 | 3511 | RESP | 5 | 91 | | | | 24 |
| Seed Tank - agitator shaft | 6/27 | 9:51 | 3400 | NON | 3 | 146 | 265 | 45% | 3132.4 | 51 |
| Seed Tank - agitator shaft | 6/27 | 9:51 | 3401 | RESP | 3 | 119 | | | | OG |
| Seed Tank - agitator shaft | 6/27 | 9:51 | 3402 | NON | 3 | 164 | 363 | 55% | 4230.8 | OG |
| Seed Tank - agitator shaft | 6/27 | 9:51 | 3403 | RESP | 3 | 199 | | | | 62 |
| Seed Tank - agitator shaft | 6/27 | 10:07 | 3404 | NON | 2.5 | 74 | 162 | 54% | 2265.7 | 28 |
| Seed Tank - agitator shaft | 6/27 | 10:07 | 3405 | RESP | 2.5 | 88 | | | | 19 |
| Seed Tank - agitator shaft | 6/27 | 10:07 | 3406 | NON | 2.5 | 161 | 231 | 30% | 3276.6 | 44 |
| Seed Tank - agitator shaft | 6/27 | 10:07 | 3407 | RESP | 2.5 | 70 | | | | 9 |
| Seed Tank - agitator shaft | 6/27 | 10:21 | 3408 | NON | 5 | 128 | 219 | 42% | 1553.2 | 77 |
| Seed Tank - agitator shaft | 6/27 | 10:21 | 3409 | RESP | 5 | 91 | | | | OG |
| Seed Tank - agitator shaft | 6/27 | 10:21 | 3412 | NON | 5 | 139 | 234 | 41% | 1636.4 | NC |
| Seed Tank - agitator shaft | 6/27 | 10:21 | 3413 | RESP | 5 | 95 | | | | 65 |
| Seed Tank - agitator shaft | 6/27 | 10:36 | 3414 | NON | 6 | 101 | 195 | 48% | 1152.5 | 38 |
| Seed Tank - agitator shaft | 6/27 | 10:36 | 3415 | RESP | 6 | 94 | | | | 24 |
| Seed Tank - agitator shaft | 6/27 | 10:36 | 3416 | NON | 6 | 131 | 211 | 38% | 1229.6 | 59 |
| Seed Tank - agitator shaft | 6/27 | 10:36 | 3417 | RESP | 6 | 80 | | | | 29 |
| Seed Tank - agitator shaft | 6/27 | 10:45 | 3419 | RESP | 5 | 101 | 149 | 68% | 1056.7 | 1 |
| Seed Tank - agitator shaft | 6/27 | 10:45 | 3420 | NON | 5 | 48 | | | | 6 |
| Seed Tank - agitator shaft | 6/27 | 10:45 | 3421 | RESP | 5 | 100 | 173 | 58% | 1209.8 | 2 |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Seed Tank - agitator shaft | 6/27 | 10:45 | 3422 | NON | 5 | 73 | | | | 5 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3423 | RESP | 5 | 194 | 242 | 80% | 1716.3 | 3 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3424 | NON | 5 | 48 | | | | 5 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3425 | RESP | 5 | 119 | 190 | 63% | 1328.7 | 4 |
| Seed Tank - agitator shaft | 6/27 | 10:53 | 3426 | NON | 5 | 71 | | | | 5 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3427 | RESP | 5 | 78 | 149 | 52% | 1056.7 | 10 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3428 | NON | 5 | 71 | | | | 25 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3429 | RESP | 5 | 105 | 155 | 68% | 1083.9 | 13 |
| Seed Tank - agitator shaft | 6/27 | 11:11 | 3430 | NON | 5 | 50 | | | | 19 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3435 | RESP | 10 | 126 | 467 | 27% | 1656.0 | 85 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3436 | NON | 10 | 341 | | | | 128 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3437 | RESP | 10 | 102 | 331 | 31% | 1157.3 | 66 |
| Seed Tank - agitator shaft | 6/27 | 11:25 | 3438 | NON | 10 | 229 | | | | 114 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3439 | RESP | 5 | 102 | 179 | 57% | 1269.5 | 18 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3440 | NON | 5 | 77 | | | | 34 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3441 | RESP | 5 | 182 | 264 | 69% | 1846.2 | 9 |
| Seed Tank - agitator shaft | 6/27 | 11:42 | 3442 | NON | 5 | 82 | | | | 20 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3443 | RESP | 5 | 115 | 270 | 43% | 1914.9 | 9 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3444 | NON | 5 | 155 | | | | 55 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3445 | RESP | 5 | 133 | 252 | 53% | 1762.2 | 22 |
| Seed Tank - agitator shaft | 6/27 | 11:52 | 3446 | NON | 5 | 119 | | | | 37 |
| Scrubber exhaust | 6/26 | 8:32 | 3101 | RESP | 5 | 43 | 51 | 84% | 356.6 | 35 |
| Scrubber exhaust | 6/26 | 8:32 | 3102 | NON | 5 | 8 | | | | 0 |
| Scrubber exhaust | 6/26 | 8:32 | 3103 | RESP | 5 | 72 | 77 | 94% | 546.1 | 45 |
| Scrubber exhaust | 6/26 | 8:32 | 3104 | NON | 5 | 5 | | | | 1 |
| Scrubber exhaust | 6/26 | 8:50 | 3105 | RESP | 5 | 24 | 27 | 89% | 188.8 | 15 |
| Scrubber exhaust | 6/26 | 8:50 | 3106 | NON | 5 | 3 | | | | 3 |
| Scrubber exhaust | 6/26 | 8:50 | 3107 | NON | 5 | 8 | 54 | 15% | 383.0 | 5 |
| Scrubber exhaust | 6/26 | 8:50 | 3108 | RESP | 5 | 46 | | | | 31 |
| Scrubber exhaust | 6/26 | 9:06 | 3109 | RESP | 5 | 60 | 63 | 95% | 446.8 | 46 |
| Scrubber exhaust | 6/26 | 9:06 | 3110 | NON | 5 | 3 | | | | 0 |
| Scrubber exhaust | 6/26 | 9:06 | 3111 | RESP | 5 | 43 | 45 | 96% | 314.7 | 34 |
| Scrubber exhaust | 6/26 | 9:06 | 3112 | NON | 5 | 2 | | | | 2 |
| Scrubber exhaust | 6/26 | 9:20 | 3113 | RESP | 2.5 | 12 | 12 | 100% | 170.2 | 2 |
| Scrubber exhaust | 6/26 | 9:20 | 3114 | NON | 2.5 | 0 | | | | 0 |
| Scrubber exhaust | 6/26 | 9:20 | 3115 | RESP | 2.5 | 23 | 23 | 100% | 321.7 | 22 |
| Scrubber exhaust | 6/26 | 9:20 | 3116 | NON | 2.5 | 0 | | | | 0 |
| Scrubber exhaust | 6/26 | 9:44 | 3117 | RESP | 2.5 | 103 | 120 | 86% | 1702.1 | 61 |
| Scrubber exhaust | 6/26 | 9:44 | 3118 | NON | 2.5 | 17 | | | | 5 |
| Scrubber exhaust | 6/26 | 9:44 | 3119 | RESP | 2.5 | 75 | 91 | 82% | 1272.7 | 29 |
| Scrubber exhaust | 6/26 | 9:44 | 3120 | NON | 2.5 | 16 | | | | 1 |
| Scrubber exhaust | 6/26 | 9:55 | 3121 | RESP | 5 | 37 | 70 | 53% | 496.5 | NC |
| Scrubber exhaust | 6/26 | 9:55 | 3122 | NON | 5 | 33 | | | | 1 |
| Scrubber exhaust | 6/26 | 9:55 | 3123 | RESP | 5 | 31 | 47 | 66% | 328.7 | NC |

TABLE II. Viable Sampling Results (Continued)

| SAMPLE LOCATION | DATE | TIME | PLATE | FRAC | MIN | CORRECTED COUNT | TOTAL CFU | % RESP | CFU/m3 | BS |
|---|---|---|---|---|---|---|---|---|---|---|
| Scrubber exhaust | 6/26 | 9:55 | 3124 | NON | 5 | 16 | | | | NC |
| Scrubber exhaust | 6/26 | 10:08 | 3125 | RESP | 5 | 156 | 182 | 86% | 1290.8 | 143 |
| Scrubber exhaust | 6/26 | 10:08 | 3126 | NON | 5 | 26 | | | | 1 |
| Scrubber exhaust | 6/26 | 10:08 | 3127 | RESP | 5 | 143 | 168 | 85% | 1174.8 | 131 |
| Scrubber exhaust | 6/26 | 10:08 | 3128 | NON | 5 | 25 | | | | 8 |
| Scrubber exhaust | 6/27 | 3:13 | 3512 | NON | 5 | 24 | 110 | 78% | 780.1 | 0 |
| Scrubber exhaust | 6/27 | 3:13 | 3513 | RESP | 5 | 86 | | | | 5 |
| Scrubber exhaust | 6/27 | 3:13 | 3514 | NON | 5 | 25 | 97 | 74% | 678.3 | 4 |
| Scrubber exhaust | 6/27 | 3:13 | 3515 | RESP | 5 | 72 | | | | 4 |
| Scrubber exhaust | 6/27 | 3:26 | 3516 | NON | 5 | 9 | 22 | 59% | 156.0 | 2 |
| Scrubber exhaust | 6/27 | 3:26 | 3517 | RESP | 5 | 13 | | | | 1 |
| Scrubber exhaust | 6/27 | 3:26 | 3518 | NON | 5 | 0 | 0 | 0% | 0.0 | 1 |
| Scrubber exhaust | 6/27 | 3:26 | 3519 | RESP | 5 | 0 | | | | 0 |
| Scrubber exhaust | 6/27 | 4:25 | 3520 | NON | 5 | 4 | 27 | 85% | 191.5 | 0 |
| Scrubber exhaust | 6/27 | 4:25 | 3521 | RESP | 5 | 23 | | | | 0 |
| Scrubber exhaust | 6/27 | 4:25 | 3522 | NON | 5 | 12 | 32 | 63% | 223.8 | 0 |
| Scrubber exhaust | 6/27 | 4:25 | 3523 | RESP | 5 | 20 | | | | 0 |
| Scrubber exhaust | 6/27 | 4:35 | 3524 | NON | 5 | 9 | 18 | 50% | 127.7 | 1 |
| Scrubber exhaust | 6/27 | 4:35 | 3525 | RESP | 5 | 9 | | | | 0 |
| Scrubber exhaust | 6/27 | 4:35 | 3526 | NON | 5 | 8 | 16 | 50% | 111.9 | 0 |
| Scrubber exhaust | 6/27 | 4:35 | 3527 | RESP | 5 | 8 | | | | 0 |
| Scrubber exhaust | 6/27 | 4:46 | 3528 | NON | 5 | 31 | 50 | 38% | 354.6 | 4 |
| Scrubber exhaust | 6/27 | 4:46 | 3529 | RESP | 5 | 19 | | | | 6 |
| Scrubber exhaust | 6/27 | 4:46 | 3530 | NON | 5 | 18 | 33 | 45% | 230.8 | 2 |
| Scrubber exhaust | 6/27 | 4:46 | 3531 | RESP | 5 | 15 | | | | 1 |
| Scrubber exhaust | 6/27 | 5:02 | 3532 | NON | 5 | 7 | 8 | 13% | 56.7 | 1 |
| Scrubber exhaust | 6/27 | 5:02 | 3533 | RESP | 5 | 1 | | | | 1 |
| Scrubber exhaust | 6/27 | 5:02 | 3534 | NON | 5 | 14 | 25 | 44% | 174.8 | 4 |
| Scrubber exhaust | 6/27 | 5:02 | 3535 | RESP | 5 | 11 | | | | 0 |
| Scrubber exhaust | 6/28 | 8:08 | 3600 | NON | 5 | 8 | 211 | 96% | 1496.5 | NC |
| Scrubber exhaust | 6/28 | 8:08 | 3601 | RESP | 5 | 203 | | | | NC |
| Scrubber exhaust | 6/28 | 8:08 | 3602 | NON | 5 | 8 | 205 | 96% | 1433.6 | NC |
| Scrubber exhaust | 6/28 | 8:08 | 3603 | RESP | 5 | 197 | | | | NC |
| Scrubber exhaust | 6/28 | 8:22 | 3608 | NON | 5 | 18 | 215 | 92% | 1524.8 | NC |
| Scrubber exhaust | 6/28 | 8:22 | 3609 | RESP | 5 | 197 | | | | NC |
| Scrubber exhaust | 6/28 | 8:22 | 3610 | NON | 5 | 12 | 209 | 94% | 1461.5 | NC |
| Scrubber exhaust | 6/28 | 8:22 | 3611 | RESP | 5 | 197 | | | | NC |

TABLE III. Viable Sampling Summary

| Sample Location | Geometric Mean | St Dev | % Bl | Minimum Value | Maximum Value |
|---|---|---|---|---|---|
| Fermentor Tank - agitator shaft | 339.0 | 3.1 | NA | 83.9 | 2297.9 |
| Seed Tank - agitator shaft | 1633.9 | 1.5 | 23 | 1056.7 | 4230.8 |
| Scrubber | 345.1 | 4.2 | 38 | 0 | 1702.1 |
| Sample Port - open | 1668.3 | 1.6 | 77 | 1312.1 | 2902.0 |
| Sample Port - closed | 195.5 | 2.3 | 19 | 62.1 | 490.2 |
| Incubation Room | 332.4 | 1.1 | 31 | 297.9 | 382.0 |
| Clean Room | 4.4 | 5.1 | NA | 0 | 72.8 |
| Main Laboratory | 147.3 | 1.1 | 34 | 137.3 | 153.7 |
| Quality Control Laboratory | 159.1 | 1.6 | 35 | 90.6 | 295.3 |
| Dumpster | 2400 | 1.5 | NA | 1161.4 | 4657.3 |
| Filter Press - open | 10599.4 | 1.8 | NA | 4484.0 | 28990.0 |
| Filter Press - closing | 8757.5 | 1.4 | NA | 5320.0 | 11601.0 |
| Filter Press - closed | 3906.1 | 2.5 | NA | 988.0 | 23588.0 |
| Background - outside | 123.2 | 7.7 | 7 | 0 | 1493.0 |
| Cafeteria | 270.2 | 1.3 | 42 | 207.7 | 313.4 |
| Conference Room | 701.5 | 1.1 | 51 | 602.1 | 781.7 |
| Locker Room | 32.9 | 7.3 | NA | 7.0 | 133.8 |
| Office | 528.9 | 1.6 | NA | 371.5 | 750.0 |

TABLE IV. Enzyme Sampling Results

| SAMPLE LOCATION | DATE | FILTER NO. | FLOW RATE (ft3/min) | SAMPLE TIME(hr) | DUST (ug) | TOTAL DUST (ug/m3) | ENZYME DU/m3 |
|---|---|---|---|---|---|---|---|
| Ultrafilter | 6/25 | 25-6 | 45 | 5.42 | 70.68 | 0.171 | 0.657 |
| Ultrafilter | 6/26 | 25-3 | 45 | 6.79 | 66.99 | 0.129 | 0.276 |
| Ultrafilter | 6/27 | 27-3 | 45 | 7.57 | 53.52 | 0.093 | 0.230 |
| Ultrafilter | 6/28 | 28-6 | 45 | 8.72 | 136.67 | 0.205 | 0.637 |
| Candle Filter | 6/25 | 25-5 | 46 | 5.05 | 144.44 | 0.366 | 0.316 |
| Candle Filter | 6/26 | 26-6 | 46 | 6.68 | 45.82 | 0.088 | 0.255 |
| Candle Filter | 6/27 | 27-2 | 46 | 7.57 | 35.09 | 0.060 | 0.205 |
| Candle Filter | 6/28 | 28-2 | 46 | 8.65 | 92.11 | 0.137 | 0.494 |
| Blender Tank | 6/25 | 25-7 | 42 | 5.07 | 49.57 | 0.137 | 0.339 |
| Blender Tank | 6/26 | 26-5 | 42 | 6.6 | 45.71 | 0.097 | 0.522 |
| Blender Tank | 6/27 | 26-2 | 42 | 7.5 | 35.21 | 0.066 | 0.204 |
| Blender Tank | 6/28 | 28-4 | 42 | 8.65 | 79.82 | 0.130 | 0.738 |
| Fermentor | 6/26 | 25-4 | 42 | 7.44 | 33.02 | 0.062 | 0.209 |
| Fermentor | 6/27 | 27-4 | 42 | 7.81 | 27.48 | 0.050 | 0.156 |
| Fermentor | 6/28 | 27-5 | 42 | 8.3 | 39.58 | 0.067 | 0.609 |
| Outside-Background | 6/28 | 28-1 | 44 | 7.68 | 99.12 | 0.173 | 0.269 |
| Blank | | 25-1 | | | -0.34 | | |
| Blank | | 25-2 | | | -0.30 | | |
| Blank | | 25-8 | | | -0.01 | | |
| Blank | | 26-1 | | | 0.50 | | |
| Blank | | 26-3 | | | 0.06 | | |
| Blank | | 26-4 | | | -1.63 | | |
| Blank | | 26-7 | | | -0.58 | | |
| Blank | | 27-1 | | | -0.42 | | |
| Blank | | 27-6 | | | 0.23 | | |
| Blank | | 28-3 | | | 0.23 | | |
| Blank | | 28-5 | | | 0.95 | | |

TABLE V. Acetone Sampling Results

| SAMPLE LOCATION | DATE | TUBE NO. | FLOW RATE (cc/min) | SAMPLE TIME(hr) | ACETONE (mg) | ACETONE mg/m3 |
|---|---|---|---|---|---|---|
| Filter press | 6/25 | 165 | 49.6 | 0.94 | (0.01) | |
| Filter Press - rail | 6/25 | 162 | 51.9 | 0.95 | (0.01) | |
| Filter Press - rail | 6/28 | 173 | 49.2 | 0.93 | 0.01 | 3.64 |
| Filter Press - rail | 6/28 | 176 | 49.2 | 0.95 | (0.01) | |
| Conveyor | 6/25 | 163 | 52.2 | 0.93 | (0.01) | |
| Conveyor | 6/28 | 179 | 51.2 | 0.95 | (0.01) | |
| Conveyor | 6/28 | 174 | 51.2 | 0.85 | (0.01) | |
| Mash Tank | 6/28 | 181 | 51.9 | 0.95 | (0.01) | |
| Mash Tank | 6/28 | 177 | 51.9 | 0.82 | (0.01) | |
| Mash Tank | 6/28 | 184 | 51.9 | 0.99 | (0.01) | |
| Blank | 6/28 | 164 | | | (0.01) | |
| Blank | 6/28 | 172 | | | (0.01) | |
| Blank | 6/28 | 178 | | | (0.01) | |
| Blank | 6/28 | 180 | | | (0.01) | |
| Blank | 6/28 | 167 | | | (0.01) | |
| Blank | 6/25 | 171 | | | (0.01) | |
| Blank | 6/25 | 166 | | | (0.01) | |
| Blank | 6/27 | 172 | | | (0.01) | |

() = less than

TABLE VI. Total Dust Sampling Results

| SAMPLE LOCATION | DATE | FILTER NO. | FLOW RATE (l/min) | SAMPLE TIME(HR) | TOTAL DUST (ug) | TOTAL DUST mg/m3 |
|---|---|---|---|---|---|---|
| Blending Tank 1 | 6/25 | 102 | 2.21 | 6.36 | -0.03 | 0.02 |
| Blending Tank 1 | 6/26 | 112 | 2.20 | | | |
| Blending Tank 1 | 6/27 | 178 | 2.21 | 8.27 | 0.02 | 0.02 |
| Blending Tank 2 | 6/25 | 145 | 2.20 | 6.35 | 0.04 | 0.05 |
| Blending Tank 2 | 6/26 | 109 | 2.20 | 8.30 | 0.02 | 0.02 |
| Blending Tank 2 | 6/27 | 184 | 2.22 | 8.22 | 0.10 | 0.09 |
| Blending Tank 2 | 6/28 | 189 | 2.21 | 8.80 | 0.14 | 0.12 |
| Candlefilter | 6/25 | 111 | 2.21 | 6.38 | -0.01 | 0.02 |
| Candlefilter | 6/26 | 101 | 2.20 | 8.28 | 0.05 | 0.05 |
| Candlefilter | 6/27 | 154 | 2.21 | 8.26 | 0.05 | 0.05 |
| Candlefilter | 6/28 | 160 | 2.20 | 8.80 | 0.19 | 0.17 |
| Dumpster | 6/25 | 123 | 2.21 | 6.54 | 0.05 | 0.06 |
| Dumpster | 6/26 | 116 | 2.20 | 8.43 | 0.03 | 0.02 |
| Dumpster | 6/27 | 192 | 2.20 | 8.37 | 0.21 | 0.19 |
| Dumpster | 6/28 | 157 | 2.20 | 9.00 | 0.06 | 0.05 |
| Dumpster | 6/25 | 122 | 2.21 | 6.50 | -0.01 | 0.02 |
| Dumpster | 6/26 | 114 | 2.20 | 8.39 | -0.01 | 0.02 |
| Dumpster | 6/27 | 162 | 2.20 | 8.35 | 0.24 | 0.22 |
| Dumpster | 6/28 | 153 | 2.22 | 9.00 | 0.31 | 0.26 |
| Sampling Port | 6/25 | 135 | 2.21 | 6.50 | 0.06 | 0.07 |
| Sampling Port | 6/26 | 104 | 2.20 | 8.44 | -0.07 | 0.02 |
| Sampling Port | 6/27 | 174 | 2.21 | 8.35 | 0.05 | 0.05 |
| Fermentor Tank | 6/25 | 103 | 2.20 | 6.43 | -0.05 | 0.02 |
| Fermentor Tank | 6/26 | 146 | 2.22 | | | |
| Fermentor Tank | 6/27 | 148 | 2.20 | 8.35 | 0.07 | 0.07 |
| Fermentor Tank | 6/25 | 139 | 2.20 | 6.42 | 0.00 | 0.02 |
| Fermentor Tank | 6/26 | 115 | 2.20 | | | |
| Fermentor Tank | 6/27 | 191 | 2.20 | 8.37 | 0.05 | 0.05 |
| Filter Press - belt conveyor | 6/25 | 128 | 2.21 | 6.80 | 0.07 | 0.08 |
| Filter Press - belt conveyor | 6/26 | 126 | 2.20 | 8.39 | 0.00 | 0.02 |
| Filter Press - belt conveyor | 6/27 | 156 | 2.21 | 8.29 | 0.30 | 0.28 |
| Filter Press - belt conveyor | 6/28 | 176 | 2.20 | 8.96 | 0.11 | 0.10 |
| Filter Press - left | 6/25 | 131 | 2.20 | 6.88 | -0.01 | 0.02 |
| Filter Press - left | 6/26 | 106 | 2.21 | 8.38 | -0.03 | 0.02 |
| Filter Press - left | 6/27 | 179 | 2.20 | 8.30 | 0.21 | 0.20 |
| Filter Press - left | 6/28 | 170 | 2.21 | 8.99 | 0.04 | 0.04 |
| Filter Press - right | 6/25 | 138 | 2.20 | 6.89 | 0.01 | 0.02 |
| Filter Press - right | 6/26 | 127 | 2.22 | 8.38 | 0.01 | 0.02 |
| Filter Press - right | 6/27 | 193 | 2.21 | 8.28 | 0.43 | 0.40 |
| Filter Press - right | 6/28 | 168 | 2.21 | 8.93 | 0.14 | 0.12 |
| Incubation Room | 6/25 | 130 | 2.21 | 7.03 | 0.01 | 0.02 |
| Incubation Room | 6/26 | 117 | 2.21 | 8.38 | -0.02 | 0.02 |
| Mash Treatment Tank | 6/26 | 105 | 2.21 | 8.16 | -0.02 | 0.02 |
| Mash Treatment Tank | 6/27 | 173 | 2.20 | 8.37 | 0.05 | 0.05 |

TABLE VI. Total Dust Sampling Results (continued)

| SAMPLE LOCATION | DATE | FILTER NO. | FLOW RATE (l/min) | SAMPLE TIME(HR) | TOTAL DUST (ug) | TOTAL DUST mg/m3 |
|---|---|---|---|---|---|---|
| QC Laboratory | 6/26 | 110 | 2.21 | 8.31 | 0.06 | 0.06 |
| QC Laboratory | 6/27 | 180 | 2.20 | | | |
| Recovery - dump station | 6/25 | 142 | 2.20 | 6.74 | 0.00 | 0.02 |
| Recovery - dump station | 6/26 | 107 | 2.20 | 8.40 | -0.02 | 0.02 |
| Recovery - dump station | 6/27 | 161 | 2.21 | 9.02 | 4.29 | 3.59 |
| Recovery - work table | 6/25 | 129 | 2.20 | 6.76 | 0.05 | 0.06 |
| Recovery - work table | 6/26 | 125 | 2.21 | 8.40 | 0.06 | 0.06 |
| Recovery - work table | 6/27 | 151 | 2.21 | 8.32 | 0.15 | 0.14 |
| Scrubber | 6/25 | 121 | 2.20 | 6.45 | 0.01 | 0.02 |
| Scrubber | 6/26 | 144 | 2.21 | | | |
| Scrubber | 6/27 | 175 | 2.20 | 8.29 | 0.04 | 0.04 |
| Seed Tank | 6/26 | 136 | 2.20 | 8.26 | 0.09 | 0.09 |
| Seed Tank | 6/27 | 183 | 2.21 | 8.18 | 0.06 | 0.06 |
| Ultrafilter | 6/25 | 141 | 2.22 | 6.30 | 0.10 | 0.12 |
| Ultrafilter | 6/26 | 140 | 2.21 | 8.27 | -0.01 | 0.02 |
| Ultrafilter | 6/27 | 147 | 2.20 | 8.28 | 0.05 | 0.05 |
| Blank | 6/28 | 150 | | | 0.01 | |
| Blank | 6/28 | 166 | | | -0.02 | |
| Blank | 6/28 | 164 | | | 0.02 | |
| Blank | 6/26 | 119 | | | -0.10 | |
| Blank | 6/26 | 120 | | | -0.03 | |
| Blank | 6/26 | 132 | | | -0.06 | |
| Blank | 6/26 | 124 | | | -0.08 | |
| Blank | 6/26 | 108 | | | -0.04 | |
| Blank | 6/25 | 143 | | | -0.32 | |
| Blank | 6/25 | 134 | | | -0.05 | |
| Blank | 6/25 | 137 | | | -0.06 | |
| Blank | 6/25 | 113 | | | -0.06 | |
| Blank | 6/25 | 118 | | | -0.07 | |
| Blank | 6/25 | 133 | | | -0.07 | |
| Blank | 6/27 | 152 | | | -0.04 | |
| Blank | 6/27 | 181 | | | 0.02 | |
| Blank | 6/27 | 177 | | | 0.02 | |
| Blank | 6/27 | 182 | | | 0.09 | |
| Blank | 6/27 | 172 | | | 0.01 | |

TABLE VII. Exploratory Viable Sampling Results

| SAMPLE LOCATION | PLATE | MIN | COLONY COUNT | TOTAL CFU | CFU per m3 |
|---|---|---|---|---|---|
| Main Laboratory | 1 | 20 | 91 | 151 | 266.8 |
| Main Laboratory | 2 | 20 | 60 | | |
| Main Laboratory | 3 | 10 | 37 | 65 | 229.6 |
| Main Laboratory | 4 | 10 | 28 | | |
| Main Laboratory | 5 | 2.5 | ---- | --- | --- |
| Main Laboratory | 6 | 2.5 | 9 | | |
| Main Laboratory | 5 | 20 | 40 | 141.3 | |
| Main Laboratory | 8 | 5 | 20 | | |
| Clean Room | 175 | 2.5 | 3 | 4 | 56.5 |
| Clean Room | 176 | 2.5 | 1 | | |
| Clean Room | 177 | 13 | 26 | 88 | 239.2 |
| Clean Room | 178 | 13 | 62 | | |
| Clean Room | 179 | 20 | 50 | 85 | 150.2 |
| Clean Room | 180 | 20 | 35 | | |
| Fermentor - agitator shaft | 81 | 15 | 1316 | 1672 | 3938.8 |
| Fermentor - agitator shaft | 82 | 15 | 356 | | |
| Fermentor - agitator shaft | 83 | 15 | 1208 | 1531 | 3606.6 |
| Fermentor - agitator shaft | 84 | 15 | 323 | | |
| Fermentor - agitator shaft | 86 | 2.5 | 22 | 103 | 1455.8 |
| Fermentor - agitator shaft | 87 | 2.5 | 81 | | |
| Fermentor - agitator shaft | 88 | 2.5 | 279 | 636 | 8989.4 |
| Fermentor - agitator shaft | 89 | 2.5 | 357 | | |
| Scrubber | 91 | 15 | 302 | 1326 | 3123.7 |
| Scrubber | 92 | 15 | 1024 | | |
| Scrubber | 93 | 2.5 | 58 | 110 | 1554.8 |
| Scrubber | 94 | 2.5 | 52 | | |
| Scrubber | 95 | 5 | 187 | 494 | 3491.2 |
| Scrubber | 96 | 5 | 307 | | |
| Scrubber | 97 | 5 | 270 | 592 | 4183.7 |
| Scrubber | 98 | 5 | 322 | | |
| Filter Press | 9 | 10 | 244 | 400 | 1413.4 |
| Filter Press | 10 | 10 | 156 | | |
| Filter Press | 11 | 20 | 142 | 319 | 563.6 |
| Filter Press | 12 | 20 | 177 | | |
| Filter Press | 13 | 2.5 | 120 | 205 | 2897.5 |
| Filter Press | 14 | 2.5 | 85 | | |
| Filter Press | 15 | 10 | 834 | 1060 | 3745.6 |
| Filter Press | 16 | 10 | 226 | | |
| Filter Press | 17 | 2.5 | 41 | 89 | 1258.0 |
| Filter Press | 18 | 2.5 | 48 | | |
| Filter Press | 19 | 20 | 2804 | 3276 | 5788.0 |
| Filter Press | 20 | 20 | 472 | | |
| Conference Room | 30 | 20 | 331 | 618 | 1091.9 |
| Conference Room | 31 | 20 | 287 | | |
| Conference Room | 32 | 20 | 361 | 688 | 1215.5 |

TABLE VII. Exploratory Viable Sampling Results (Continued)

| SAMPLE LOCATION | PLATE | MIN | COLONY COUNT | TOTAL CFU | CFU per m3 |
|---|---|---|---|---|---|
| Conference Room | 33 | 20 | 327 | | |
| Conference Room | 34 | 10 | 197 | 373 | 1318.0 |
| Conference Room | 35 | 10 | 176 | | |
| Conference Room | 36 | 10 | 176 | 369 | 1303.9 |
| Conference Room | 37 | 10 | 193 | | |
| Conference Room | 38 | 6 | 600 | 711 | 4187.3 |
| Conference Room | 39 | 6 | 111 | | |
| Conference Room | 40 | 6 | 191 | 326 | 1919.9 |
| Conference Room | 41 | 6 | 135 | | |
| Background - outside | 60 | 20 | 197 | 410 | 367.5 |
| Background - outside | 61 | 20 | 213 | | |
| Background - outside | 62 | 20 | 241 | 429 | 494.7 |
| Background - outside | 63 | 20 | 188 | | |
| Background - outside | 66 | 20 | 225 | 406 | 353.4 |
| Background - outside | 67 | 20 | 181 | | |
| Background - outside | 68 | 2.5 | 65 | 228 | 3222.6 |
| Background - outside | 69 | 2.5 | 163 | | |
| Background - outside | 70 | 2.5 | 91 | 239 | 3378.1 |
| Background - outside | 71 | 2.5 | 148 | | |
| Background - outside | 72 | 2.5 | 51 | 126 | 1780.9 |
| Background - outside | 73 | 2.5 | 75 | | |
| Background - outside | 74 | 5 | 65 | ---- | ---- |
| Background - outside | 75 | 5 | ---- | | |
| Background - outside | 76 | 5 | 23 | 111 | 784.5 |
| Background - outside | 77 | 5 | 88 | | |
| Background - outside | 78 | 5 | 73 | 121 | 855.1 |
| Background - outside | 79 | 5 | 48 | | |
| Background - outside | 42 | 2.5 | 18 | 26 | 367.5 |
| Background - outside | 43 | 2.5 | 8 | | |
| Background - outside | 44 | 2.5 | 18 | 35 | 494.7 |
| Background - outside | 45 | 2.5 | 17 | | |
| Background - outside | 46 | 2.5 | 14 | 25 | 353.4 |
| Background - outside | 47 | 2.5 | 11 | | |
| Background - outside | 48 | 20 | 251 | 505 | 892.2 |
| Background - outside | 49 | 20 | 254 | | |
| Background - outside | 50 | 20 | 232 | 393 | 694.3 |
| Background - outside | 51 | 20 | 161 | | |
| Background - outside | 52 | 20 | 263 | 569 | 1005.3 |
| Background - outside | 53 | 20 | 306 | | |
| Background - outside | 54 | 5 | 16 | 34 | 240.3 |
| Background - outside | 55 | 5 | 18 | | |
| Background - outside | 56 | 5 | 20 | 48 | 339.2 |
| Background - outside | 57 | 5 | 28 | | |
| Background - outside | 58 | 5 | 8 | 23 | 162.5 |
| Background - outside | 59 | 5 | 15 | | |