Technical Memorandum

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Prepared for: Nestlé Purina PetCare Company

Project Title: Odor Assessment and Mitigation Strategy

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Technical Memorandum

Subject: Flagstaff Odor Assessment and Mitigation Strategy Project Summary

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This technical memorandum (TM) summarizes a project completed by Brown and Caldwell (BC) for Nestlé Purina PetCare Company (NPPC) in which odors associated with the NPPC Flagstaff, Arizona pet food plant were assessed and a recommended odor mitigation approach was identified.

Section 1: Background

The NPPC Flagstaff factory has been in operation for 40 years and includes ingredient receiving, pet food production, packaging, finished product warehousing, and distribution operations. The pet food cooking process creates aromas, which are currently collected and exhausted on the roof through a series of stacks. NPPC has identified that odor mitigation options should be reviewed for this factory because of the residential and commercial growth that has taken place nearby in recent years.

The project summarized in this TM identifies the best path forward for significantly reducing offsite impacts.

Section 2: Baseline Testing and Modeling

A current assessment of emissions from the Flagstaff factory was needed so that appropriate options could be identified to lessen offsite impacts. Air sample collection and laboratory analysis was used to quantify current stack emissions; air dispersion modeling was used to provide an estimation of how far these emissions might currently travel away from the factory.

2.1 Stack Testing Elements

A focused air sampling and analysis program was completed in the fall of 2015 at the Flagstaff factory. Samples were collected and analyzed for total odor detectability and certain compounds commonly associated with food production. Following are descriptions of those tests.

Laboratory Analysis

Air samples were collected from key factory stacks using specialized equipment and containers. Sample collection activities followed standard source testing protocols. Collected samples were sent to the St. Croix Sensory odor panel laboratory for analysis and characterization using Method EN13725[1], which is one of the industry-accepted norms for this type of testing. The St. Croix laboratory is certified for this purpose. The trained odor panel reports the total detectability for each air sample in units of dilutions-to-threshold, or D/T, also referred to as “odor units”. This value is defined as the number of volumes of clean air that would be required to be mixed with the odorous air sample to make the total mixed volume non-detectable to the average person. For example, a 1-liter air sample that needed to be diluted with 1,000 liters of clean air would have a measurement of 1,000 odor units (or 1,000 D/T odor concentration).

Targeted samples were also collected and analyzed in a separate laboratory for compounds commonly associated with food production. This knowledge can sometimes help rule out certain types of odor mitigation technologies based on past experience with those technologies.

[1] EN13725 is a European method, which is also used in the United States. ASTM E679 is a US method for this analysis and it generally yields lower results.

2.2 Testing Results

The laboratory results indicate which cooking processes at the Flagstaff factory should be most closely evaluated as part of the mitigation strategy. This section discusses these observations.

Process Area Stack Emissions Quantification

Air samples to be analyzed by the odor panel were collected in Tedlar plastic bags using a vacuum pump apparatus shown in Figure 1. Air samples were collected from stacks emitting air from six different process areas of the factory. Multiple samples from each area were analyzed during times and days when different pet food products were being made.

Figure 1. Air Sample Collection for Odor Panel Analysis

Upon review of the odor panel data, the following two source types were found to have significantly higher D/T values than other cooking process exhausts:

- The five **extruder air-take-aways (ATAs)**, and
- The five **dryers**.

All other tested sources had odor detectability measurements on the lower end of what was observed during the study. Because of these data, BC determined that the extruder ATAs and dryers were the most appropriate sources to be managed at the Flagstaff facility to achieve the goal of significantly reducing current offsite odor impacts.

2.3 Model Results

The offsite impact of an air stream emitted from a stack or combination of stacks is estimated by a mathematical model. Field and laboratory measurements collecting during stack testing are entered into a US EPA-approved computer program called “AERMOD,” which calculates an hourly offsite impact on the surrounding

area under all possible weather conditions, and identifies a "worst-case" condition. Following production of a baseline model, reductions in offsite impact are estimated by modeling specific mitigation measures applied to the baseline run. Such measures may also change the location (horizontal and/or vertical) of the release point of the air and in turn may change the offsite point of maximum impact.

For the baseline Flagstaff run, the odor at the point of maximum impact was approximately 55 D/T. This modeled result is caused by the combination of all cooking exhaust stacks at the factory. The location of this maximum impact is shown on the Flagstaff factory map in Figure 2 near the northwest corner of the NPPC property. BC's experience at other facilities has shown that odor levels in this range are generally noticeable.

Figure 2. Baseline Odor Model Output Result on Area Map

Section 3: Odor Mitigation Approach

Additional dispersion modeling was completed assuming incorporation of various mitigation strategies on the key Flagstaff factory sources. The model results were analyzed to determine how well they met project goals. Next, specific technologies were evaluated to identify the likely best choices for the Flagstaff factory. This section describes the approach.

3.1 Odor Mitigation Program Development

BC completed dispersion model runs that tested the effect of reducing offsite impacts by treating the cooking exhaust air streams and/or dispersing the exhausts using new tall stacks. If an air stream is exhausted through a tall stack it experiences greater mixing with fresh air in the atmosphere such that by the time it reaches ground level it is noticeably less odorous. At the Flagstaff factory the presence of the tall mill building (Figure 3) presents an ideal opportunity to construct tall stacks which will achieve this objective. The modeling was completed using this dispersion approach and a separate air treatment approach for comparison. Specific air treatment technologies were analyzed to determine the most efficient choice.

Figure 3. Flagstaff Factory Mill Building

Table 1 summarizes the odor mitigation program for the Flagstaff factory that NPPC is proposing to begin this year. The table identifies the proposed, phased capital improvements and associated follow-up validation studies.

Table 1. Flagstaff Factory Odor Mitigation Recommended Approach

Year	Projects	Project Description and Projected NPPC Cost
Year 1 (2016)	Extruder ATA Dispersion	• Combine all extruder ATA air into one new tall stack supported by mill building • Anticipated fence line odor reduction of 35% from current value, estimated by dispersion model • Estimated cost is $430,000 with $67,000 additional annual energy usage
	Validation Study	• Fence line odor analysis and report completed following construction of new dispersion stack • Estimated cost is $50,000
Year 2 (2017)	Dryer Dispersion	• Combine all dryer air into four or five new tall stacks supported by mill building • Anticipated fence line odor reduction of 50% from current value, estimated by dispersion model. Includes anticipated Year 1 reduction. • Estimated cost is for Year 2 $670,000 with $205,000 additional annual energy usage
	Validation Study	• Fence line odor analysis and report completed following construction of new dispersion stacks • Estimated cost is $50,000
Year 3 (2018)	Extruder ATA Ionization	• Implement ionization of Extruder ATA exhaust for all 5 existing banks • Anticipated fence line odor reduction of 60% from current value, estimated by dispersion model and an assumed removal efficiency for the ionization technology. Includes prior years. • Estimated cost for Year 3 is $1,380,000 with $41,000 additional annual energy usage

Table 1. Flagstaff Factory Odor Mitigation Recommended Approach

Year	Projects	Project Description and Projected NPPC Cost
Year 3 (2018) [CONTINUED]	Optional Pilot Study	• Ionization is the assumed control technology for the purpose of this plan, but pilot testing is recommended prior to installation. • Estimated cost of pilot study is $60,000
	Validation Study	• Fence line odor analysis and report completed following construction of new ionization units (or alternate control technology) • Estimated cost is $50,000
Year 4 (2019)	Dryer Ionization	• Implement ionization of dryer exhaust for 3 of 5 existing dryers • Anticipated fence line odor reduction of 70% from current value, estimated by dispersion model and an assumed removal efficiency for the ionization technology. Includes prior years. • Estimated cost for Year 4 is $1,520,000 with $169,000 additional annual energy usage
	Optional Validation Study	• Fence line odor analysis and report completed following construction of new ionization units • Estimated cost is $50,000 • Follow-up odor study may be unwarranted, as all viable mitigation options will have been implemented by this time.

3.2 Odor Control Technology Evaluation

Odor control technologies that were considered potentially most effective included the following:

- **Biofilters** are environmentally friendly and use a bed of porous and moist media that support microorganisms that absorb and oxidize odorous constituents. Biofilters have a good track-record of success, but have the drawback of requiring a large footprint and can be considerably more expensive than other options. Additionally the weight of the biofilter would likely be an issue in construction of such a system on the Flagstaff factory roof.
- **Ionization** involves the electrically induced formation of air ions that attach to oxygen molecules to form reactive oxygen species. When a large concentration of these ions is produced, they can attach to and react with various odorous molecules and particles in the vicinity of the electrical field, thereby enabling considerable odor reduction. Ex situ (direct injection of ionized air into a duct) and in situ (conveyance of an entire air stream into an ionization reactor) are the two major forms of odor control with this technology.
- **Dry media adsorption** is used to reduce the concentration of odorous compounds in an odorous air stream by passing the air through a packed bed of media, often activated carbon, where the compounds are adsorbed into the media pores. Many dry media are sensitive to humidity, which presents an issue for their use at the Flagstaff factory. Additionally, activated carbon does not have a good history of successful reduction or removal of some of the compounds that could be present in the factory emissions.

The dry media adsorption technology was downgraded because of poor ability to remove the types of compounds commonly found in pet food cooking exhausts. The biofiltration technology was also downgraded because of size requirements. The ionization technology was determined to be a potentially feasible, efficient, and cost-effective odor control solution to be used in conjunction with dispersion at the Flagstaff factory, if warranted.

3.3 Testing and Modeling Procedures

The four-phased approach presented in Table 1 is being proposed at the Flagstaff factory to achieve reduction in offsite odor impacts. Based on the dispersion modeling and assumed removal efficiencies attributed to the ionization units, the point of maximum impact odor offsite could be reduced from 55 D/T to approximately 17 D/T following completion of all four phases of the proposed program. Additional sampling, laboratory analysis, and modeling will be conducted between the phases to confirm sufficient progress toward the goal of significantly reducing offsite impacts. Additional modeling will incorporate five consecutive years of meteorological data to enhance the results.

Prior to proceeding with the Year 3 project (installation of new ionization odor control systems), it is recommended that NPPC conduct pilot testing at the Flagstaff factory to: (1) confirm the removal efficiency of the systems under consideration, and (2) test various vendor ionization systems, including both ex situ and in situ systems. The ex situ systems are viewed as more desirable at this time because they only require modifications to the existing fan and ducting system and would occupy the least amount of space of all viable odor reduction technologies considered.

Following completion of the pilot testing, the extruder ATAs and dryer exhausts would be modified, as needed, to incorporate the selected ionization system. Should ionization systems not provide adequate odor removal based on the pilot testing results, other technologies will be considered if the dispersion technology (new tall stacks supported by the mill building) is deemed to be insufficient. These technologies might include biofiltration and dry media, in addition to other promising odor control technologies that are available and have had a sufficient track-record of success.