

**Project Title: Evaluation of Burn Boss® Air Curtain Burner**

**Project Number C-15612-A**



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## **Section A**

### **Project Background and Objectives**

**Alternatives to open burning of raisin paper trays and vineyard removal materials are currently being investigated by Sun-Maid Growers of California and the Nisei Farmers League. Air Burners, Inc. of Palm City, Florida manufacture Fireboxes or air curtain burners designed primarily as a pollution control device. Their units have effectively reduced particulate matter by controlling the results of the material being burned. A portable prototype unit called the Burn Boss® Air Curtain Burner (ACB) was successfully tested by Sun-Maid in 2010. Modifications were made based off of the initial field tests and a second prototype was delivered to Sun-Maid in March of 2012. The modified prototype ACB unit included the addition of a cage to capture flying ash as well as a Power-Take-Off (PTO) connection in order to control the fan speed by increasing or decreasing the tractor RPM.**

**The main objectives for this project testing are to:**

- Find an alternative to open burning to reduce or possibly eliminate PM 2.5 emissions**
- Reduce or eliminate visible smoke from the burning of trays and vineyard removal materials**
- To test the portability of the unit**
- Find an alternative to open burning that is economically feasible and cost effective for all industry to utilize**

## **Section B**

### **Executive Summary**

**Under the San Joaquin Valley Air Pollution Control Districts Smoke Management System (SMS), agriculture has been required to reduce ambient air emissions from farming practices following the guidelines in Rule 4103, open burning, and reducing PM 2.5 emissions. The reduction or elimination of smoke generated from vineyard removal materials and raisin paper trays has challenged the raisin industry to find alternatives to open burning. Sun-Maid Growers of California and our project partner, the Nisei Farmers League are currently investigating possible alternatives to open burning.**

**One such alternative being investigated is a mobile prototype device called the Burn Boss® Air Curtain Burner (ACB), manufactured by Air Burners LLC of Palm City, Florida. This device is being tested to reduce visible smoke emissions as well as reducing PM 2.5. The basic principle of air curtain burning technology is that the smoke generated from the combustible material is reintroduced back into the burning material, thereby stalling or slowing down the smoke particles as they leave the device. Sun-Maid Growers and the Nisei Farmers League believe that this device will enable industry to significantly reduce visible smoke and PM 2.5 emissions.**

**For calendar year 2012, project testing of the ACB unit was implemented at the following locations along with project personnel:**

- **3/24/12 - Vineyard removal material at Minnewawa and Lincoln Avenues by Sun-Maid personnel Mike Moriyama and Randy Rocca**
- **9/13/12 – Raisin paper trays at Cedar and South Avenues by Sun-Maid personnel Mike Moriyama and Air Burner Inc. personnel Brian O'Connor and Matt O'Connor**

- **9/14/12 – Raisin paper trays at Cherry and Huntsman Avenues with Sun-Maid personnel Mike Moriyama and Air Burner Inc. personnel Brian O'Connor and Matt O'Connor**
- **9/20/12 – Raisin paper trays at Stroud and Golden State with Sun-Maid personnel Mike Moriyama and Rick Stark, Nisei Farmers League President Manuel Cunha and SJV Air Pollution Control District personnel Clay Bishop (Supervising Air Quality Inspector), Kevin M. Wing (Senior Air Quality Specialist) and Chelsea Gonzales (Air Quality Specialist I)**
- **9/24/12 and 9/25/12– Raisin paper trays at Saginaw and Bethel Avenue with Sun-Maid personnel Mike Moriyama and 2 laborers with Rodriguez Ag Enterprises Inc.**
- **10/5/12 – Raisin paper trays at 7<sup>th</sup> and Benecia Avenues with Sun-Maid personnel Mike Moriyama and 2 laborers with Rodriguez Ag Enterprises Inc.**

**The concept of the ACB unit is to have the device stationary, adjacent to the material to be burned. The device was modified to enable portability and enhance functionality by allowing connection to a tractor with power take off to assist with towing and to operate the air curtain fan.**

**Testing by the manufacturer determined the time required and the amount of paper trays that could be burned in the ACB unit. During testing, problems with ash build-up were evident, so suggestions and modifications were made to break-up these layers and accelerate the burning process.**

**Working with a labor contractor, the efficiency of the unit and the costs to operate the unit were determined. Techniques to leave the unit stationary and to have all of the paper transferred to the unit as well as moving the unit to various locations in the vineyard were utilized. Both methods proved to be productive, however having the unit stationary at a central location and moving the paper to the unit is more cost effective.**

**Our overall finding from the testing of the ACB unit is satisfying the requirement to reduce visible smoke emissions from the burning of raisin paper trays and vineyard removal materials. Visible smoke was found to be eliminated in tests with both wood and paper materials and Sun-Maid is confident that this device will also greatly reduce or eliminate PM 2.5 emissions. The unit proves to be a viable alternative to burning paper trays and vineyard removal materials.**

## Section C

### Detailed Description of the Scope of Work

In 2011, modifications were made to the initial prototype to include an attached screen cage over the top of the ACB unit to capture flying ash generated from the paper tray burning. The independent gas motor unit was replaced with connections for a Power-Take-Off (PTO) and hydraulic hose connections to raise and lower the ACB by means of a tractor. This second prototype was delivered to Sun-Maid in March of 2012.

On March 24<sup>th</sup>, 2012, Sun-Maid personnel Mike Moriyama and Randy Rocca tested the ACB unit on vineyard removal material or grape stumps. A vineyard was selected at the corner of Minnewawa and Lincoln Avenues near Fowler, California. Steve Bryant of Bryant Digital Media video and photo logged the testing in order to compare the smoke generated from open burning (Fig. 1) and burning with the ACB unit (Fig. 2). Visual testing showed the effectiveness of the ACB unit on grape stumps to eliminate the generation of visible smoke.



**Fig. 1 Open Stack Burning**





**Fig. 2 Burn Boss® Air Curtain Burner with grape stumps**



**Fan speed was tested on the unit and it was determined that the tractor RPM speed should be no lower than 1,100 RPM after 5 minutes of material ignition, then increased to 1,500 to 2,000 RPM, to maintain the efficiency of the air curtain. The range of the RPM can be increased or decreased to control any flying ash, though this was not normally a problem, unless the paper is loose due to paper not bundled properly.**

**The ACB unit efficiently burns bundles of paper trays very rapidly. The unit can be loaded with 4 to 5 bundles of tray paper every 5 minutes after initial ignition. Care must be taken to not overload the unit, since flames should not be above the air curtain. If this occurs, the air curtains ability to eliminate smoke will not be effective.**

**Further testing of the ACB unit included labor costs to operate the machine and training workers to operate the device safely and the portability of the unit.**

## **Section D**

### **Findings or Results of Each Task**

**The portability of this unit makes it feasible to move to various vineyard sites with a half-ton truck or with a tractor. Pre-testing shows that the ACB unit can also be moved from row to row at the vineyard location, but the flames need to be extinguished prior to moving or the burning ash will smolder and smoke will be generated. Modifications were made to add an opening to the back of the ash containment screen, and making an ash rake to help break-up the “phone book” type layers created by the compressed paper tray bundles. The raking of the ash also helped accelerate the burning process and allowed for more bundles to be added.**

**Paper trays and vineyard removal materials can be burned quickly with the ACB unit. Materials can be added to the fire at a constant rate for a consistent burn. Vineyard removal materials burn down rate is faster than paper trays, but trays can be burned down quickly as well as long as ash is separated by raking. Our testing with the manufacturer approximately 4 to 5 bundles can be burned every 5 minutes, or 48 to 50 tray bundles every hour.**

**Operating the ACB unit with a crew of 2 can be done economically, safely and efficiently. Techniques of moving the unit to various locations to burn paper (Table 1) as well as transporting the paper to the unit stationed at a central location (Table 2) were tested with the crew. Tractor rental and fuel for transportation are not included in the analysis, since normally a grower would be providing his own equipment and fuel. Project leader’s salary and benefits are not included in the project since his costs are calculated based on his involvement in the overall project and not for cost analysis of the actual units testing.**

Location 1 - 69 Acres

ACB Unit Mobile

	Hours	
Acres	Required	Acres/Hour
69	10	6.9

Detailed Costs

				Commission			Cost
Laborers	Rate per Hour	Cost per Hour	Net	at 35%	Total	Acres	per Acre
2	\$10.00	\$20.00	\$200.00	\$70.00	\$270.00	69	\$3.91

**Table 1**

Location 2 - 51 Acres

ACB Unit Stationary

	Hours	
Acres	Required	Acres/Hour
51	6.5	7.8

Detailed Costs

				Commission			Cost
Laborers	Rate per Hour	Cost per Hour	Net	at 35%	Total	Acres	per Acre
2	\$10.00	\$20.00	\$130.00	\$45.50	\$175.50	69	\$2.54

**Table 2**

**The above testing appears that the cost effectiveness of the ACB unit is to have the unit stationed at a central location and have the paper transported to the ACB for burning.**

**Comparative cost for burning paper trays through open burning is unknown, since those costs would be associated with raisin boxing (pick-up) costs which are approximately \$130 to \$140 per acre. The other alternative that Sun-Maid has been evaluating is paper tray recycling, and those costs comparatively average about \$5 to \$8 per acre.**

**Our evaluations have found that the Burn Boss® Air Curtain Burner shows promise in its ability to reduce or eliminate visible smoke emissions from the burning of raisin paper trays and vineyard removal materials. The visible emissions testing by the Air District helped satisfy the requirement to reduce visible emissions, so no further testing of PM 2.5 emissions will be required.**

## **Section E**

### **Summary of Emission Testing and Analyses**

**On September 20<sup>th</sup>, 2012, representatives from the San Joaquin Valley Air Pollution Control District were present to do a Visible Emissions Observation or opacity test on the ACB unit. Clay Bishop, Supervising Air Quality Inspector administered the test (Fig. 3). Also present were Kevin M. Wing and Chelsea Gonzales, Air Quality Specialists, Rick Stark and Mike Moriyama, Sun-Maid Grower personnel and Manuel Cunha, President of the Nisei Farmers League. Several bundles of paper trays were burned in the ACB unit (Fig. 4) in addition to 2 bundles of paper trays to simulate open burning. The Visible Emission Observation satisfied the requirement to show zero opacity readings while the open burning emitted plumes of smoke for several minutes (Fig 5).**

**SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT**  
 Northern Region       Central Region       Southern Region

**Visible Emission Observation Form**

Source Name: <u>Air Burner Sehan</u>		Observation Date: <u>7-20-12</u>				Start Time: <u>10:12</u>				End Time: <u>10:20</u>			
Address: _____ City: _____		Min	0	15	30	45	Min	0	15	30	45		
Contact Person: _____		1	5	0	0	0	16						
Phone: _____ PTO Number: _____		2	0	0	0	0	17						
Process Equipment: <u>Burn Boss</u> Operating Mode: _____		3	0	0	0	0	18						
Control Equipment: _____ Operating Mode: _____		4	0	0	0	0	19						
Describe emission point: _____		5	0	0	0	0	20						
Start _____ Stop _____		6	0	0	0	0	21						
Height above ground level: _____ Height relative to observer: _____		7	0	5	0	0	22						
Start _____ Stop _____		8					23						
Distance from observer: _____ Direction from observer: _____		9					24						
Start _____ Stop _____		10					25						
Describe Emissions: _____		11					26						
Start _____ Stop _____		12					27						
Emission color: _____ Plume Type: <input type="checkbox"/> Continuous <input type="checkbox"/> Intermittent		13					28						
Stop _____ Stop _____		14					29						
Are water droplets present: <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes If water droplet plume: <input checked="" type="checkbox"/> Attached <input type="checkbox"/> Detached		15					30						
Point in plume at which compliance was determined: _____		<p align="center">N</p>											
Start <u>Top of Bed</u> Stop <u>11</u>		<p>Include location of: Stack, Sun, and Observer. Note with arrows: Wind direction and North direction.</p>											
Describe background: _____													
Start <u>Trees</u> Stop <u>Trees</u>													
Background color: _____ Sky conditions: _____													
Start _____ Stop _____													
Wind speed: <u>7 mph</u> Stop _____ Wind direction: _____													
Start _____ Stop _____													
Ambient temp: <u>60</u> Stop <u>65</u> Wet bulb temp: _____ RH percent: _____													
Start _____ Stop _____													
Comments: <u>Some ash at the start</u>		Observer's Name (Print): _____				Observer's Signature: _____				Date: _____			
NOV #: _____		Certified by: _____				Date: _____							

**Fig. 3 Visible Emissions Test Results**





**Fig. 4 Tray Burning in ACB**



**Fig. 5 Open Tray Burning**



**Section F**  
**Costs**

The actual costs listed below shows that we were significantly below budget from the original proposal. This was due to the scope of the field testing, since we were limited on the amount of growers who had trays available for burning and only minimal modifications were made to the ACB unit. Tractor rental cost is included below, but was not included in the economic testing since under most operations, growers would use their own equipment. The material for modifications were ordered by the manufacturer during their evaluation and testing, and used to modify the ash containment screen to allow for ash buildup to be broken up with an ash rake. Other modifications such as a screen floor were considered, but deemed unnecessary at the present time. Future units may be equipped with a low emission motor to operate the air curtain fan, since the unit will most likely be operated in a fixed or stationary location. Details for the economic testing of the ACB unit using labor supplied by Rodrigues Ag Enterprises are mentioned in Section D.

<b>Tractor Rental - Kjar Equipment and Rental Company</b>	
Model MF 2635 – 3 months @ \$1,400 + Delivery @ \$25+Tax.....	\$ 4,340.13
<b>Metal for modifications to ACB Unit – Valley Iron Incorporated</b>	
Expanded metal 2 – 4’x8’ @ \$38 each.....	\$ 76.00
Square tubing 5 - 20’ length 2” x 2” x 1/8” @ \$53 each.....	\$ 265.00
Flat iron 1 – 20’ length 2” x 1/4” @ \$19.95 each.....	\$ 19.95
Sales Tax.....	\$ 28.79
<b>Rodrigues Ag Enterprises, Incorporated</b>	
9/24/12: 2 laborers, 7.0 hours x \$10 per hour.....	\$ 140.00
9/25/12: 2 laborers, 3.0 hours x \$10 per hour.....	\$ 60.00
10/5/12: 2 laborers, 6.5 hours x \$10 per hour.....	\$ 130.00
Commission @ 35%.....	\$ 115.50
<b>Sun-Maid Growers of California</b>	
Mike Moriyama, Project Leader 3 week’s salary plus benefits.....	<u>\$ 4,932.30</u>
<b>Total Project Costs in 2012.....</b>	<b>\$ 10,107.67</b>

## **Section G**

### **Problems**

**Other observations that were noted during our evaluation indicated that due to the compressed nature of a raisin tray bundle, ash buildup in the bottom of the ACB unit needs to be occasionally broken up. To alleviate this “phone book” type ash layer, an opening was cut in the back of the ash containment screen. A 12 foot long pipe was inserted to turn over layers of ash, and this proved to be a positive solution and increased the burn time so that more bundles could be added to the unit. Other possible modifications to the ACB unit were considered, such as the addition of a mechanical auger to break up the ash layers or the addition of rails at the bottom of the open floor so that ash will pass through when the unit is lifted and moved forward. After further discussion with the manufacturer, Air Curtains, Inc., it was decided that these modifications may not work due to the high temperature of the burning material and potential deterioration of the augur or screen floor over time. Due to these findings, no additional modifications will be made on the ACB unit at this time.**

**Sun-Maid has concluded that the ACB unit has proven to be an effective alternative to open burning of vineyard removal materials and paper trays. All evaluations made have been to our satisfaction, so no further evaluations or testing will be done.**

**This service of burning paper trays with the ACB unit will be offered to our growers beginning with the 2013 season.**

## **Section H**

### **Project References and Acknowledgements**

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