P11712: Cheesecake Water Dosing Automation

Meeting Purpose:

1) Detailed Review of the Project
2) Present Current State
3) Validate Final Design Proposal

Materials to be reviewed:

1) Customer Needs & Engineering Specifications
2) PLC Logic
3) 3D Model of Design
4) Feasibility Analysis
5) Throughput Analysis
6) Bill of Material
7) Return of Investment
8) Test Plans
9) Risks Assessment

Meeting Date: February 12, 2011

Meeting Location: Wegmans Facility

Meeting time: 10:00 am – 12:00 pm

Timeline:

Meeting Timeline		
Start time	**Topic of Review**	**Required Attendees**
10am	Customer Needs	Mike Least, John Kaemmerlen
10:05	PLC Logic	Mike Least, John Kaemmerlen
10:15	3D Model of Design	Mike Least, John Kaemmerlen
10:35	Feasibility Analysis	Mike Least, John Kaemmerlen
10:45	Throughput Analysis	Mike Least, John Kaemmerlen
10:55	Bill of Material	Mike Least, John Kaemmerlen
11:05	Return of Investment	Mike Least, John Kaemmerlen
11:15	Test Plans	Mike Least, John Kaemmerlen
11:30	Risks Assessment	Mike Least, John Kaemmerlen
10:35	Questions	Mike Least, John Kaemmerlen

Project #	Project Name	Project Track	Project Family
P11712	Cheesecake Water Dosing Automation	Process Innovation	Wegmans Process Innovation
Start Term	**Team Guide**	**Project Sponsor**	**Doc. Revision**
20102	Professor Kaemmerlen	Wegmans	

Project Background

Project Description:

The cheesecake baking process at Wegmans Manufacturing Facility requires a specific water dosing step. Cheesecake batters are filled into the cheesecake pans, and then cheesecake pans are placed on a metal sheet pan. The number of cheesecake pans on the sheet pans is variable depending on the current process. The baking recipe requires water to be added in the sheet pan in order to keep the cheesecake moisture consistent. Current process involves human interaction to fill to sheet pans with 2.5 quarts of water. The project will look into providing an automated user friendly solution to dose water into the metal sheet pans.

Mission Statement:

The mission of this project is to provide Wegmans' Cheesecake Manufacturing Process an automated solution which will be implemented to the current process. The automated solution (Water Dosing Automation) will be capable to dose 2.5 quarts of water to each metal sheet pan prior entering the oven. The Water Dosing Automation will remove the human element of this process step without compromising total throughput. The implementation will not create issues to other processes operating on the same location at the different times of the production schedule.

Deliverables:

1) Automated Water Dose System
2) Implementation Procedures & Costs
3) System Specifications, Bill of Materials, Troubleshoot Procedures

Core Team Members:

- Geoffrey Cresswell
- John Janiszewski
- Noah Mauer
- Joel Sack
- Tuo Shen
- Rodrigo Velarde – Project Manager

P11712 Customer Needs

Revision #: 1

Water Dousing System

Customer Need #	Importance	Description	Comments/Status
Fully Automated System			
1	1	No human interaction	
2	1	Ergonomic setup is ideal for operators	
Functionality			
3	1	System must operate when in position	
4	1	System must keep on pace with current production	
5	1	System set up must be user friendly	
Cost			
6	1	Needs to be within budget	
7	2	Repair components are inexpensive	
8	2	System should consume minimal energy	
Safety and Quality			
9	1	Materials used need to be food safe	
10	1	Will not harm operators	
11	1	Will not spill any water	Wet floors are a large safety concern
12	1	Will consistently dispense the correct amount of water	Water insures uniform baking
Maintenance			
13	1	Easy to maintain/repair	
14	1	Has the ability to be programmable	
15	2	Minimum maintenance/downtime	
Capacity			
16	1	Has the ability to hold enough water in order to perform task at hand	
17	1	Has the ability to be filled with water whenever needed	
18	1	Can be filled quickly in between down time	
Stability			
19	1	Will remain stable while performing task	
20	1	System will not fall apart due to motion of performing task	
Manipulation			
21	1	Easily to clean	
22	2	Can be easily broken down to move and store if needed	
Durability			
23	1	System needs to stand up to physical abuse	
24	1	System must withstand exposure to water/heat	

P11712 Engineering Specifications

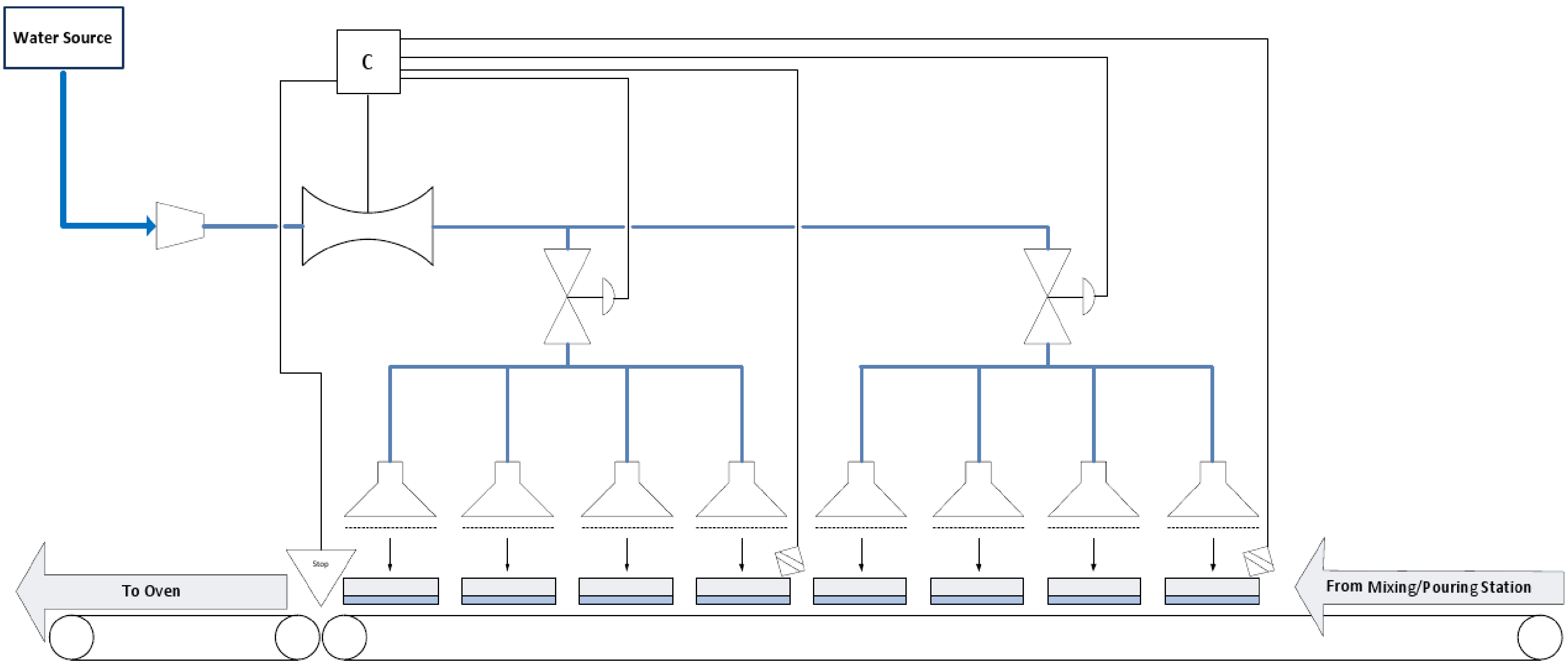
Revision # 1

Water Dousing System

Engr. Spec. #	Importance	Source (CN#)	Specification (description)	Unit of Measure	Marginal Value	Ideal Value	Comments/Status
			Fully Automated System				
1	1	1	Zero human interaction when loading and unloading occurs	person/task	0	zero	1 person for initiation
2	1	2	Zero amount of bending, twisting, lifting, and turning	degrees	15	zero	
			Functionality				
3	1	3	Robust, Reliable and Dependable	downtime: min/week	40	0	
4	1	4,16	Maximum of 40 seconds to fill the 8th pan	seconds	40	35	
5	2	5	System can be set up and torn down quickly	minutes	60	45	
			Cost				
6	1	6	Budget set to $5000	dollars	$10,000	$5,000	
7	2	7	Components are off the shelf components and minimal lead time	day/weeks	2 weeks	1 week	
8	2	8	System requires minimal energy to run	KW	NA	NA	
			Safety and Quality				
9	1	9	Material is "food grade" for production	Material grade	"food grade"	"food grade"	
10	1	10	System functions and locations should not create person/ product safety hazzards	accidents/month	zero	zero	Parts falling in food
11	1	11,12	Will not spill more than 0.1 cup of water per pans	cups	0.1	zero	
12	2	12	System will consistently dose 2.5 quarts of water per pan with minimal variance	Cups variance	1	0.5	
			Maintenance				
13	1	13,15	Downtime	percentage/ weekly	4%	2%	
14	1	13	Insure small components fail before large components to insure low cost for repairs	dollars		$100 or less	
15	2	13	Repairs can be fixed by one person	person / # of repairs	2 people	1 person	
16	2	13	Minimal special training needed for repairs	hours of training	3 hours	1 hour	
17	1	13	No specialty tools needed to fix system	tools		Standard Parts	
18	2	13	Components are readily accessible (aplicable when repairs are needed)	space (inches)	6 inches/part	12 inches/part	
19	1	14	Control systems and its components are adjustable for many setup configurations	NA		NA	
20	2	14	Control system is easily integrated into existing system	NA		NA	
			Capacity				
21	1	16	Minimum of 21 quarts of water deliverable from system	quarts	21	24	
22	1	17	System can hook up to main water line or water source for filling	NA	NA	NA	
23	1	18	System can aquire 21 quarts of water in under 4 minutes	minutes	4	3	
			Stability				
24	1	19	Will not have excessive vibration/translation/rotation while performing job	NA	NA	NA	
25	1	20	Components will remain intact and properly working while performing task	NA	NA	NA	
			Manipulation				
26	1	21	Removal of parts to clean will take minimal ammouts of time	minutes	15	10	
27	2	22	Time required to break down water dispenser in order to remove from line	minutes	20	15	
28	3	22	System is movable and adoptable to different parts of the line	hours	2	1	
			Impact Resistance				
29	1	23	System needs to be able to take abuse from maintenance and operation	hours of operation/repairs		1700 hrs./repair	1 year of operation,
30	2	23	System needs to be able to take an impact from a forklift	pounds of force		500 pounds of force	
31	1	24	System must be built of water and heat resistant materials	Material		Rubber,Stainless, ect.	

P11712: Cheesecake Water Dosing Automation

Proposed Design



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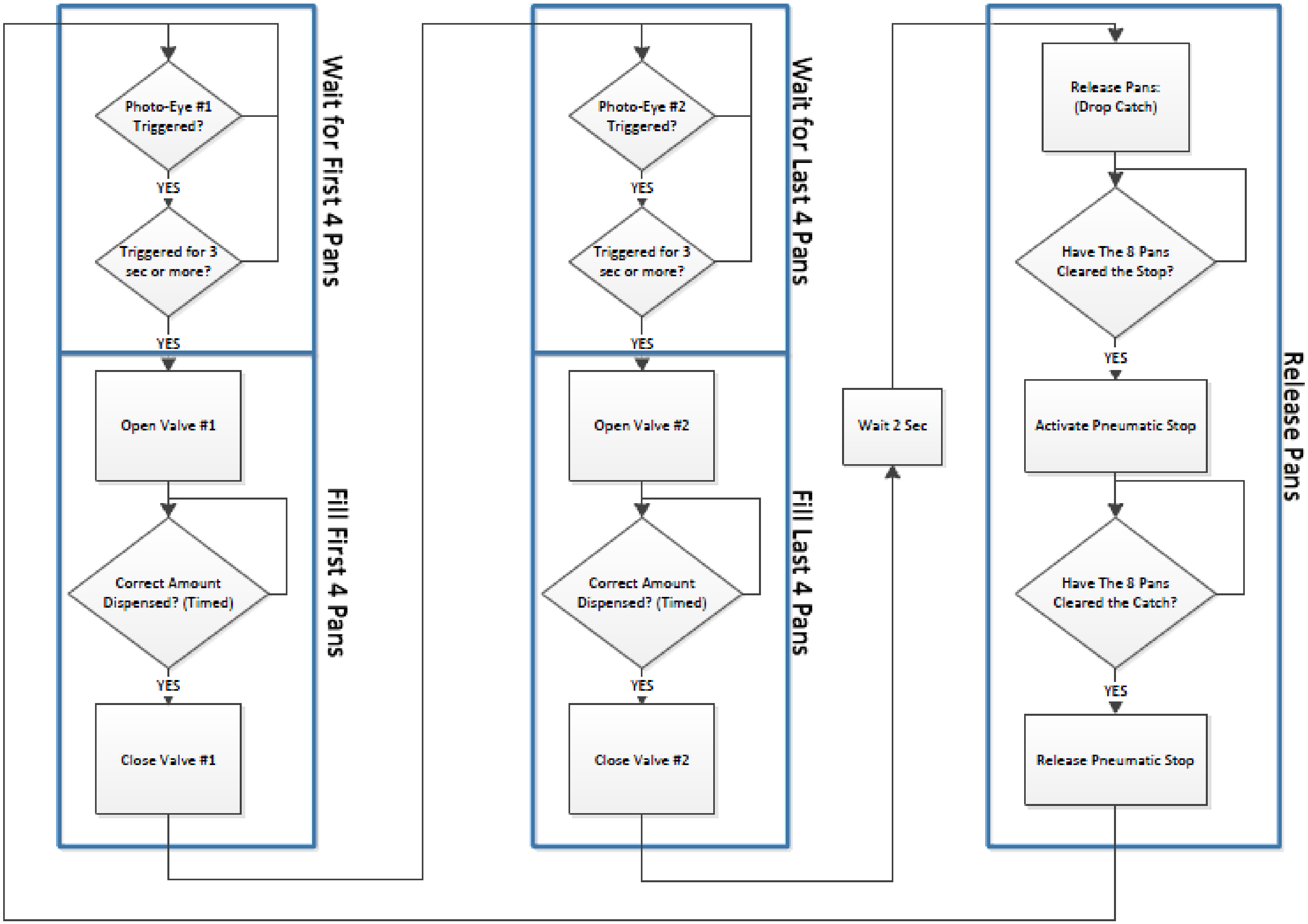
PLC Program Flowchart



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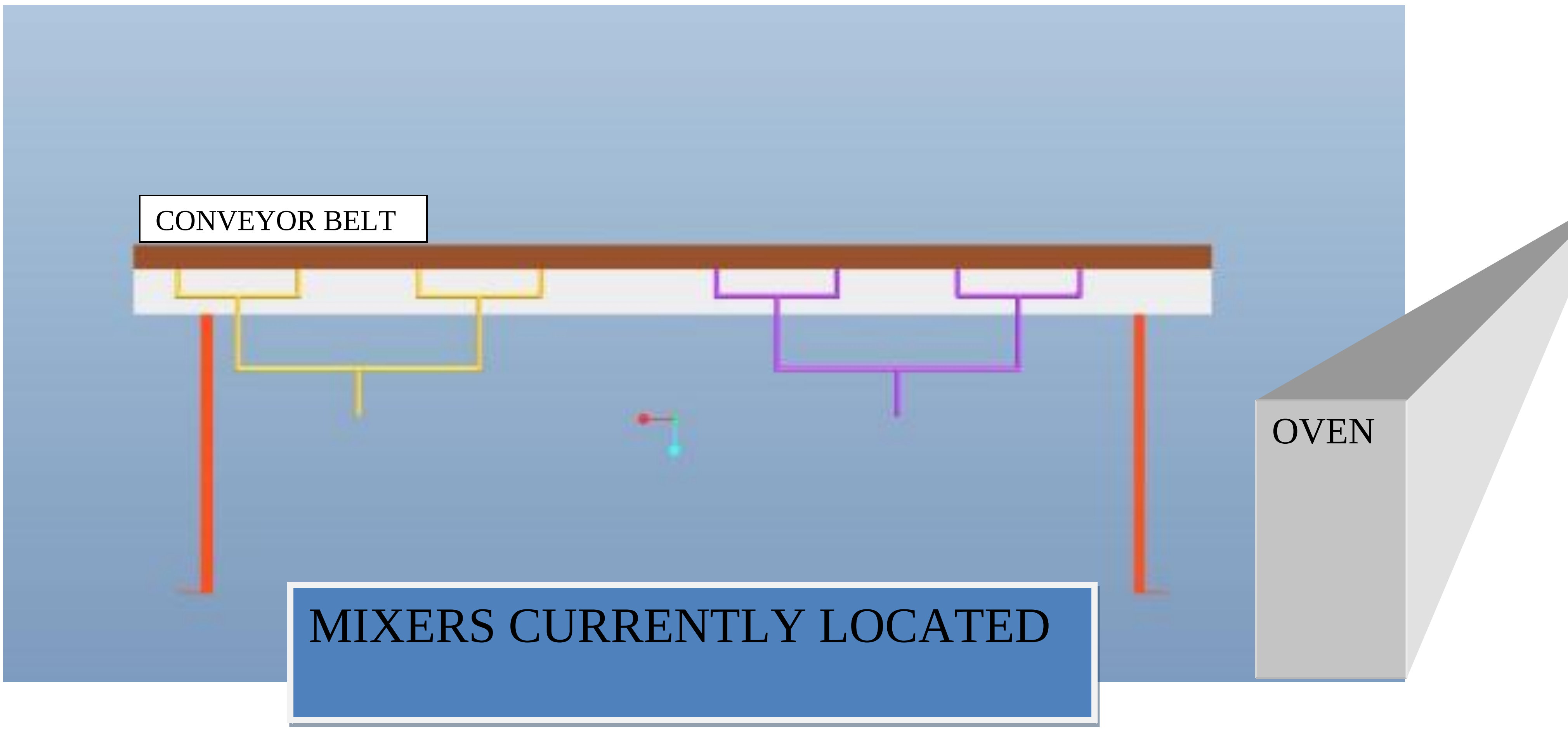
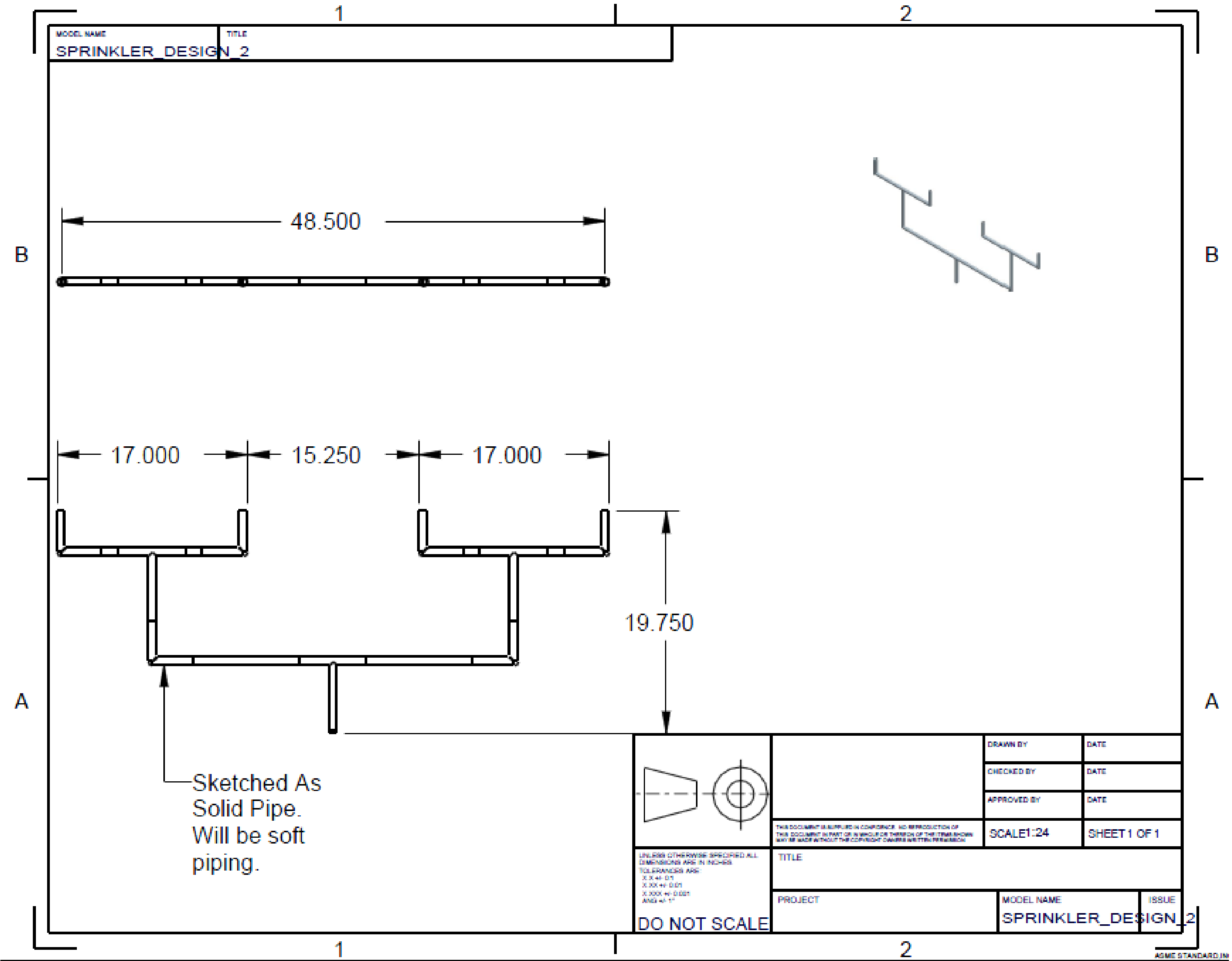
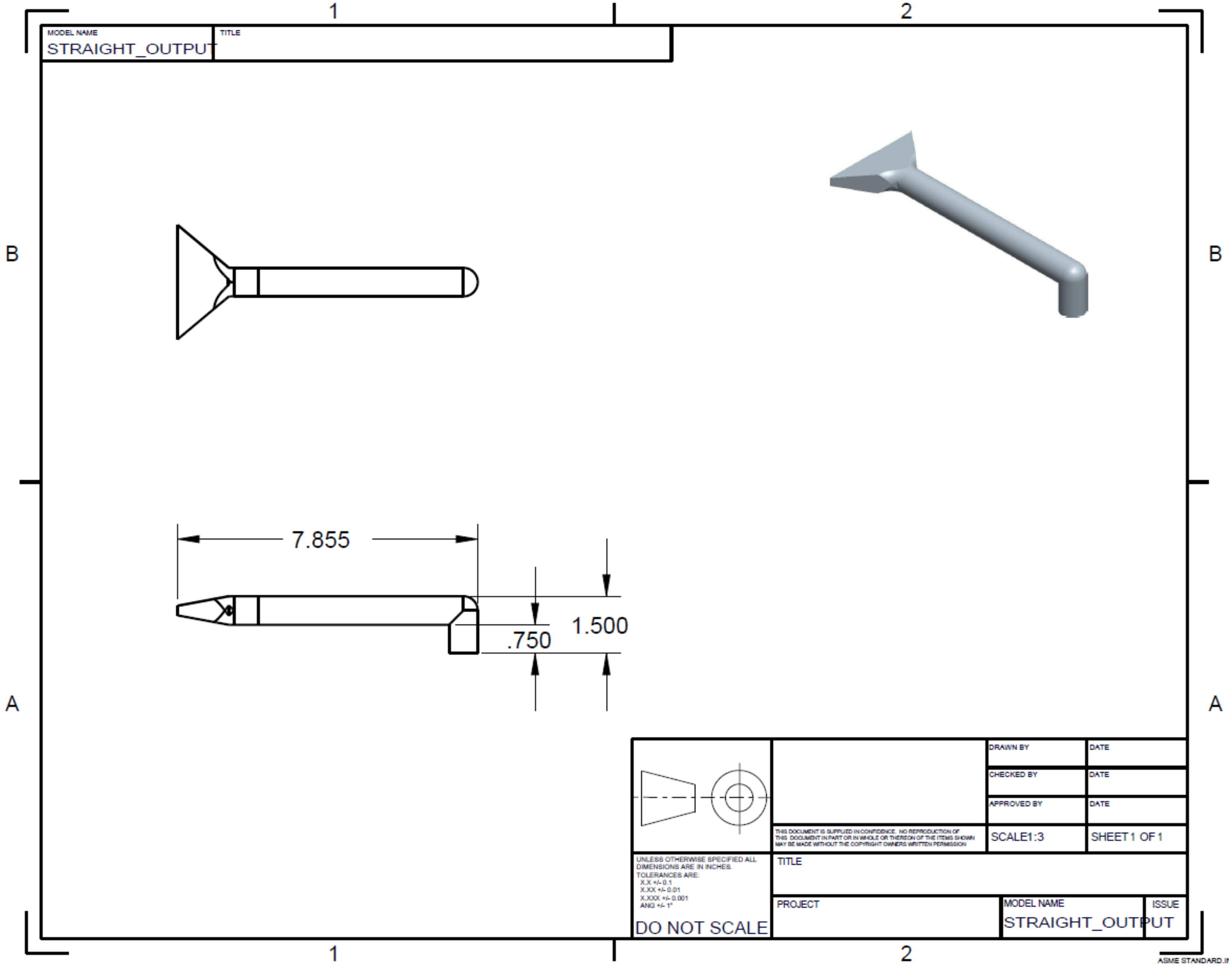
Model Designs – System Location



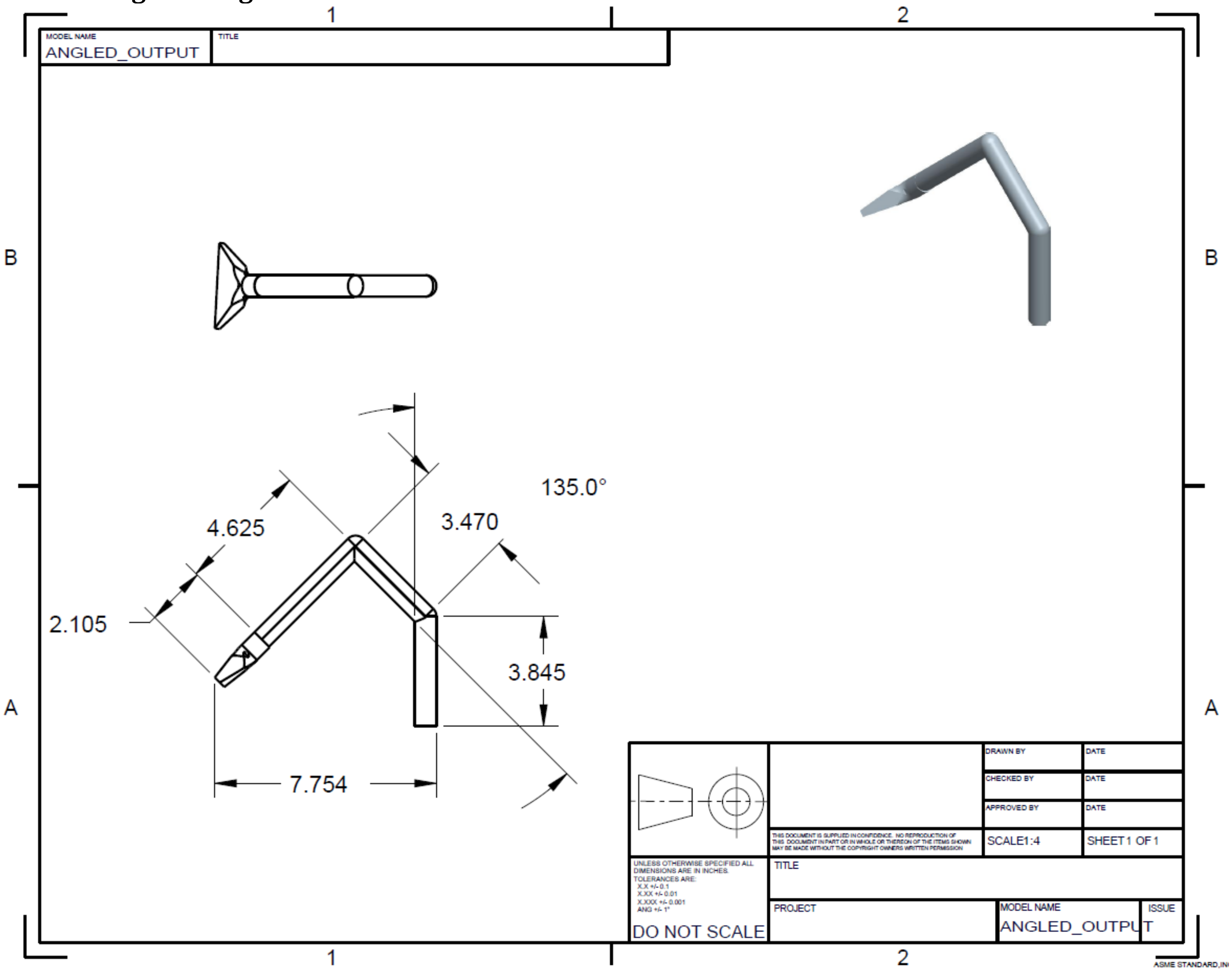
Model Designs – System Measurements



Model Designs – Linear Outlet



Model Designs – Angled Outlet

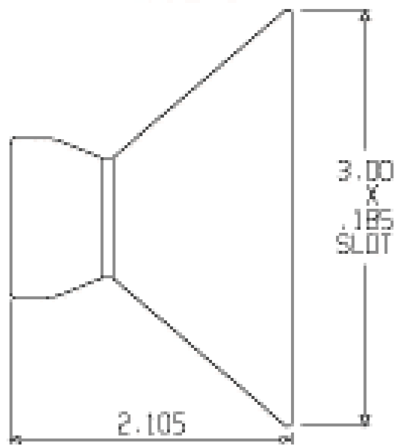


Model Designs – Nozzle

PRODUCTS: 3/4" SYSTEM (INSIDE DIAMETER)

3" Flare Nozzle

Part No.	Description	Price
61507	pack of 2	$9.10
69547	pack of 20	$68.17



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Feasibility Analysis – Head Loss

Pipe Flow/Friction Factor Calculations I:

Calculation of Head Loss, h_L, or Frictional Pressure Drop, ΔP_f, (9 gpm)
for given flow rate, Q, pipe diam., D, pipe length, L,
pipe roughness, ε, and fluid properties, ρ & μ.

1. Determine Friction Factor, f, assuming completely turbulent flow $[f = 1.14 + 2\log_{10}(D/\varepsilon)^{-2}]$

Inputs			Calculations		
Pipe Diameter, D	0.75	in	Pipe Diameter, D	0.0625	ft
Pipe Roughness, ε	0.000017	ft	Friction Factor, f	0.01462	
Pipe Length, L	40	ft	Cross-Sect. Area, A =	0.0031	ft^2
Pipe Flow Rate, Q	0.02228	cfs	Ave. Velocity, V	7.3	ft/sec
Fluid Density, ρ	1.9368278	$slugs/ft^3$	Reynolds number, Re	43,220	
Fluid Viscosity, μ	2.034E-05	$lb\text{-}sec/ft^2$			

2. Check on whether the given flow is "completely turbulent flow"
(Calculate f with the transition region equation and see if differs from the one calculated above.)

$$f = \{-2^*\log_{10}[((\varepsilon/D)/3.7)+(2.51/(Re^*(f^{1/2})))]\}^{-2}$$

Transistion Region Friction Factor, f:	f =	0.0228
Repeat calc of f using new value of f:	f =	0.0215
Repeat again if necessary:	f =	0.0217

3. Calculate h_L and ΔP_f, using the final value for f calculated in step 2

$$(h_L = f(L/D)(V^2/2g) \quad \text{and} \quad \Delta P_f = \rho g h_L)$$

Frictional Head Loss, h_L	11.4	ft
Frictional Pressure Drop, ΔP_f	709	psf
Frictional Pressure Drop, ΔP_f	4.9	psi

Feasibility Analysis – Fittings Loss

Type of Component or Fitting	Minor Loss Coefficient - ξ -
Tee, Flanged, Line Flow	0.2
Tee, Threaded, Line Flow	0.9
Tee, Flanged, Branched Flow	1.0
Tee, Threaded , Branch Flow	2.0
Union, Threaded	0.08
Elbow, Flanged Regular 90°	0.3
Elbow, Threaded Regular 90°	1.5
Elbow, Threaded Regular 45°	0.4
Elbow, Flanged Long Radius 90°	0.2
Elbow, Threaded Long Radius 90°	0.7
Elbow, Flanged Long Radius 45°	0.2
Return Bend, Flanged 180°	0.2
Return Bend, Threaded 180°	1.5
Globe Valve, Fully Open	10
Angle Valve, Fully Open	2
Gate Valve, Fully Open	0.15
Gate Valve, 1/4 Closed	0.26
Gate Valve, 1/2 Closed	2.1
Gate Valve, 3/4 Closed	17
Swing Check Valve, Forward Flow	2
Ball Valve, Fully Open	0.05
Ball Valve, 1/3 Closed	5.5
Ball Valve, 2/3 Closed	200
Diaphragm Valve, Open	2.3
Diaphragm Valve, Half Open	4.3
Diaphragm Valve, 1/4 Open	21
Water meter	7

	Elbows	Tees	2-way S-V	3-way S-V
# of units	18	6	2	1
Loss Coef	1.5	2	5	7.3
Minor loss	3.044691	1.353196	1.127663	0.823194

2 way valves Total Minor Head Loss(psi)	5.52555

3 way valve Total Minor Head Loss(psi)	5.221081

Total Loss - 2 way valves (psi)	10.42555
Total Loss - 3 way valves (psi)	10.12108

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Throughput Analysis – Time Comparison

A_1 = First set of 4 pans
A_2 = Second set of 4 pans
B_1 = Third set of 4 pans
B_2 = Fourth set of 4 pans
C_1 = …

Current Process Time Study

Time Slot	Conveyor	At Stop	Oven	Dose Water	Oven Cycle
4:40/ 0:05	A_1				cycles
2:00	A_2	A_1			
4:00		A_1 & A_2			
4:40/ 0:05	B_1		A_1 & A_2		cycles
1:40				A_1	
2:00	B_2	B_1			
3:20				A_2	
4:00		B_1 & B_2			
4:40/ 0:05			B_1 & B_2		A_1 & A_2

Proposed Process Time Study

Time Slot	Conveyor	At Stop/ Dose	Dose Done	Oven	Oven Cycle
4:40/ 0:05	A_1				cycles
2:00	A_2	A_1			
2:22	A_2		A_1		
4:00					
4:22		A_2	A_1 & A_2		
4:40/ 0:05	B_1			A_1 & A_2	cycles
2:00	B_2	B_1			
2:22	B_2		B_1		
4:00		B_2			
4:22			B_1 & B_2		
4:40/ 0:05				B_1 & B_2	A_1 & A_2

Time to fill a set of 4 pans = 22 seconds

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Bill of Materials

Industrial Hose (ask Wegmans what they have/use)

Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Dunham		3/4 ID, 1 and 3/16 OD	NYALL			

Fittings

Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Grainger	6JM80	3/4 (ID) Tee	Stainless Steel (316)	$14.05	1	$14.05
Grainger	6JM62	3/4 (ID) Elbow	Stainless Steel (316)	$10.67	18	$192.06

Hard Stainless Piping

Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Grainger	4TNN8	120 Long, 3/4 (ID)	Stainless Steel (316)	$182.00	1	$182.00

Nozzels

Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Loc Line	69547	3 x .185" slot, 2.105" L	Acetal Copolymer	$68.17	1	$68.17

Valves/Solenoids

Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Pfening		3/4 (ID) Threaded	Bronze		2	
Parker	12F22C2148AAF4	3/4 Normally Closed	Brass		2	

Material for Clamping System (If Movable Design Need Clamping System)

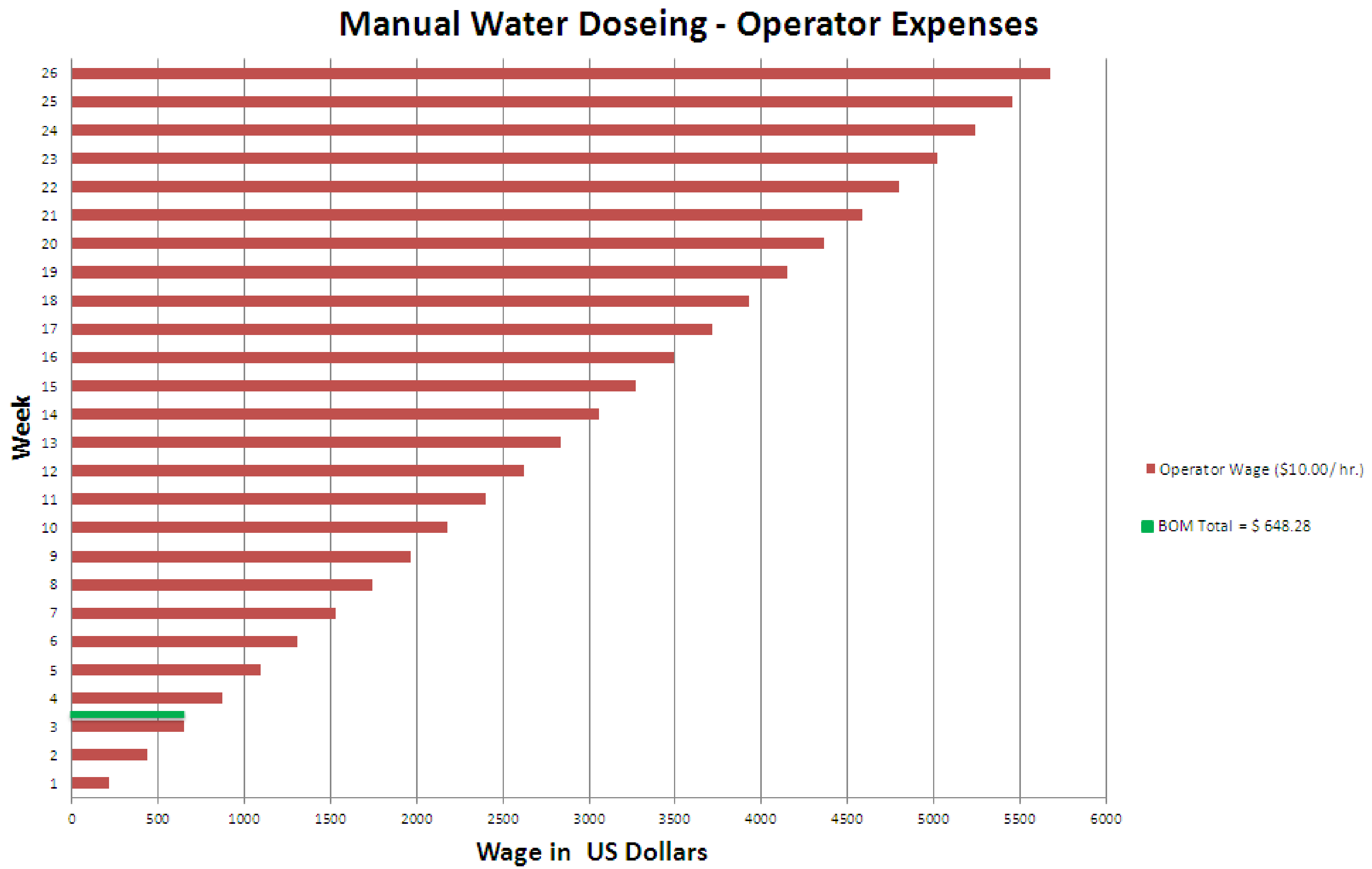
Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Grainger	3XTJ8	3/4 Piping, 2 L	Stainless Steel (316)	$52.00	1	$52.00

Electrical Stuff

Dist.	Part #	Dimensions (inches)	Material	Cost	Qty.	Sum
Durant	5882-1400	5.8 W, 3.04 H, 0.17 D	Cadon FRX plastic case w/ Lexan overlay	$100.00	1	$100.00
Banner	Q45BB6	1.75 W, 3.45 H, 2.13 L	Polyester acrylic lenses stainless steel	$40.00	1	$40.00

Sum	$648.28

Return of Investment



Test Plan

Water Spilling Test

The test intends to verify the customer's specification that no more than .1 cup of water is spilled per pan cheesecake baking. The test focuses on the step when water is poured in the sheet pan. The test system will include a pressure meter to make sure the flow of water is at the proper operating pressure. The system will also be tested to see if water dosing is completed in the proper time. The water trapping device will collect any spilled water from the water dosing system. Any water spilled will be measured to see if it meets the customer's specifications. Failure occurs when system leaks, spills or provides an incorrect amount of water to the cheesecake pans. Upon failure an investigation will be conducted to determine the cause of failure and a new solution will be pursued. The water dosing system will be powered from a standard wall outlet (110 V AC) and a main water line (10 gal/ min) during the duration of the test. The test shall be inspected for failures and operating conditions will be recorded below. The control will be a main shut off valve for the power supply and water supply to insure safety of all workers and employees.

Equipment Needed:

1. **Water Measuring Device**
2. **Pressure meter**
3. **Calibrated Timing Device**
4. **Water Trapping Devices**
5. **Power Supply**

Resources Needed:

1. **Electric Power**
2. **Water Supply**
3. **Trapping Device Space**
4. **Pressure Meter Unit**

Start Date: __TBD_______ **Finish Date: _TBD_______**

Engineer set-up experiment: Joel Sack___________________________________
Assistant: Geoffrey Cresswell and John Janiszewski_________________

Are there any visual defects before testing: ☐ **Yes** ☐ **No**
If yes then Explain: ____
____

Electrical System Test

The following test is subject to determine the proper operating control for the Automated Water Dose System. The test will verify that the sensor has been set up correctly. Initial set up will connect the sensor to a voltage meter. The sensor will be blocked to test for sensor functionality and sensor output. Once the output of the sensor is verified the control system of the sensor can then be calibrated and modified.
The timing of the sensor and the threshold of the sensor will be calibrated initially to a rough estimation of the proper amount of water to be dispensed. Further calibration might be required for accurate result.
The sensor will then be connected to the PLC for recognition. If the output value for the sensor can be observed in the logic for the PLC through RSlogix then further testing can be implemented.
The next step would be to test if the PLC programmed via RSlogix would be able to communicate with the solenoid valve to ensure proper operation for shut off. Even during an event of power failure (Ensure that valve is closed when power is off)
PLC will be tested to obtain proper preset results regarding preset parameters that only apply to cheesecake production. The switching of setting will be tested to see if design interferes with other manufacturing process. (I.e. the dosing system will not function when other settings are chosen and only function when the cheesecake preset is chosen
Control for the solenoid shutoff valves are first tested separately from the mechanical components. The operation of the valve (open and closing) is verified before actually connecting the valves to other mechanical components and piping.

Equipment Needed:

1. **Sensor**
2. **Voltage Meter**
3. **PLC**
4. **Timer**

Resources Needed:

1. **Electric Power**
2. **RSLogix**

Start Date: __TBD_______ **Finish Date: _TBD_______**

Engineer set-up experiment: Tony Shen___________________________________
Assistant: Noah Mauer and Rodrigo Velarde Gonzalez __________________

Are there any visual defects before testing: ☐ **Yes** ☐ **No**
If yes then Explain: ____
____

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Risk Assessment

ID	Risk Item	Effect	Cause	Likelihood	Severity	Importance	Action to Minimize Risk
1	Parts arrive late	Building Schedule is delayed	Delivery Method is deficient	3	5	15	Identify Wegmans Receiving department and create continuous contact
2	Team runs out of time	Customer's requirements are not met	Members are not commited	3	5	15	Project Chart is developed considering 2 days delay on each delivery
3	Team runs out of time	Customer's requirements are not met	Lack of proper planning	3	4	12	Project Chart is detailed to assure all requirements are considered.
4	Team member does not deliver	Delay in production and schedule	Not enough time	3	4	12	Spread the workload among team members/ assign helpers
5	Team norms are not respected	Team unity suffers	Arguments within team members	3	4	12	All team issues must be discussed together as a team
6	Control Box Malfunction	No comunications within the system	Programming error	2	5	10	Develop state diagram logic. Create testing opportunities by week 6 at the latest.
7	Sensor Failure	Does not detect sheet pans	Incompatable detection method	2	5	10	Test sensors prior week 6
8	Design is not user friendly	Customer will not use it	Poor design	2	5	10	Design for no human compenent. If necessary test user interface by week 6
9	Water dosed in cake pan/ floor	Failure of production line	Misalignment of dispenser	2	5	10	Design system in order to control location of cheesecake pan.
10	Design slows down baking process	Production line is less efficient	Low device performance	2	5	10	Redundent testing for timing and proper flow rate analysis
11	Design slows down baking process	Production line is not functionable	Low device performance	2	5	10	Redundent testing for timing and proper flow rate analysis
12	Parts arrive late	Schedule is delayed	Unreliable vendor	2	5	10	Constant Communcation with vendor (Call within 24hr to confirm correct order)