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Preventing Sheet Metal Wrinkling in Coil Lines

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Preventing Sheet Metal Wrinkling in Coil Lines

by

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ABSTRACT

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by

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Coil lines are used in metal packaging facilities to treat the metal before forming the final product. As the sidewalls of cans are becoming thinner and thinner, one can see that the equipment has not been designed properly to feed up lighter plate weight metal. Thinner can walls cause the metal sheet to be fed into the machine crooked and results in a wrinkling of the first few feet of metal, which then needs to be thrown away. Because the current equipment is not working properly, operators have been feeding sheets of metal up a ten-foot ladder into the machine to feed the sheet in straight. This method puts the operator at a safety risk. The feed mechanism that is currently installed does work better with heavier plate weight metal. After talking with the operators and looking at the current equipment, a conceptual design test prototype was built to see if it would fix the problem. When running numerous tests with the prototype it was verified that the conceptual design would fix the problem. After the test prototype proved to be successful, a full design of the roller system was implemented. The design is currently finished and is in the process of being purchased. The expected installation date will be December 3-7th of this year.

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CHAPTER 1: INTRODUCTION

1.1 Coil Lines

1.1.1 Coil Lines

Coil lines have been around for hundreds of years in the metal industry. Although coil lines are primarily used for metal purposes, they can also be used for paper and some plastics [28]. In the metal industry, coil lines are used in many applications predominantly for coating, cutting, and punching. There are a wide variety of metal materials that can be used on coil lines like steel, aluminum, copper, stainless steel, and alloy metals [29].

Coil coating lines are used to coat the metal sheet as it goes through the line. Coating lines vary in size, but are often hundreds of feet long consisting of un-coilers, re-

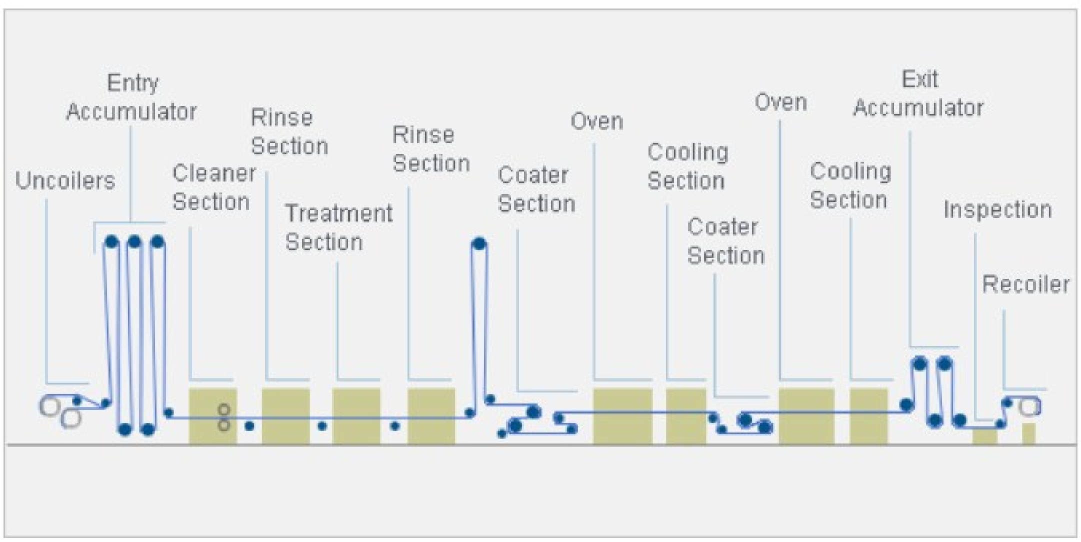

Figure 1-1: Process diagram of a coil coating line

coilers, accumulators, coaters and ovens. As shown in Figure 1-1 above, there are two un-coilers which uncoil the large metal rolls to keep the line running continuously. There are two accumulator sections, one in the front of the line and one in the back. The accumulators are used when the line needs to switch rolls. They accommodate about a

45-second window for the operator to crimp and connect the end of one sheet to the beginning of the other. The accumulators allow for the line to run continuously. Depending on the product you are making, the metal sheet sometimes goes into a pretreatment and rinse section of the line where the metal is cleaned of all dirt and oils to ensure good adhesion of the coating [30]. The coaters come next, where the metal sheet goes through a series of rollers and a set of large applicator rolls apply a controlled thickness coating to both sides. The protective coating is applied to protect the metal from the environment and the product that the metal will be used for. This coating also creates a good-looking finish [30]. After the metal sheet is coated, it travels through a series of different temperature ovens ranging from 400^{o} to 1000^{o} to bake and cure the coating on the metal [30]. Once out of the oven, the metal sheet is wrapped back up into a large roll to be used on a different line.

Coil cutting lines are used in industry to take large rolls of metal and cut them into smaller metal sheets. Figure 1-2 below shows the floor plan for a typical coil cutting line.

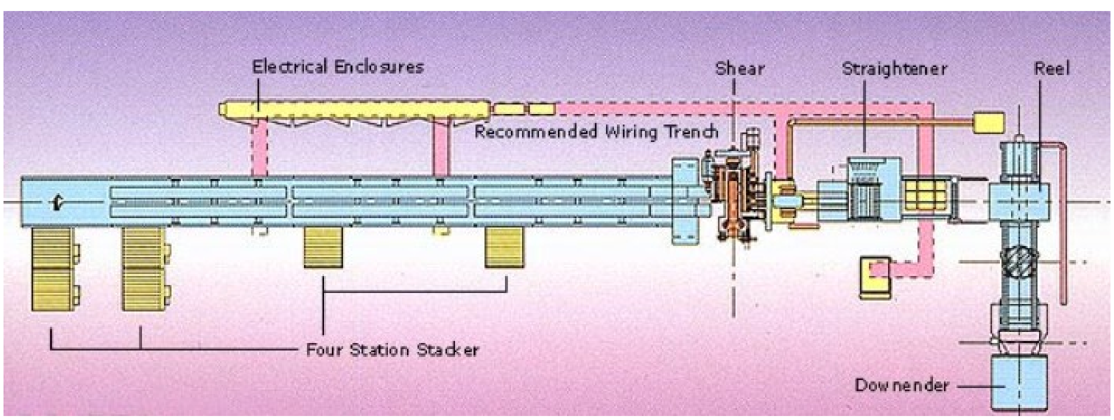

Figure 1-2: Coil cutting line floor plan

The start of the line is on the right, where a large roll of metal is put on the reel. The metal sheet is fed through a straightener that straightens the metal sheet from being coiled on the roll, this ensures that the metal sheet is flat when the sheet gets cut into smaller

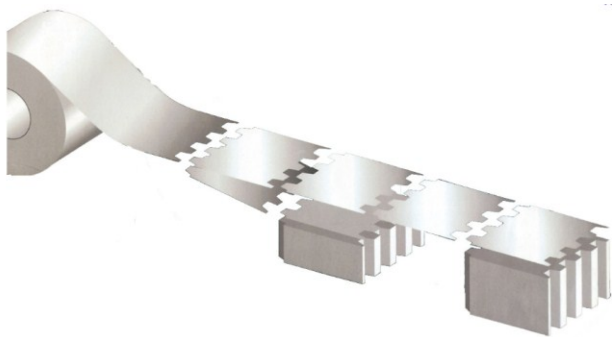

Figure 1-3: Process flow for a coil cutting line

pieces. The metal sheet then advances to the build-up loop, which allows the roll to continuously pay out instead of starting and stopping a 5-10 ton roll [31]. The metal sheet is then aligned by side guide rollers and goes into the shear. The shear cuts the metal sheet into specific sizes and lengths to help minimize the amount of scrap that is left over [31]. From here, the metal sheets are stacked on bundles to be used on a different line.

Coil punching lines are extremely similar to coil cutting lines. The main difference is that instead of having a cutting shear, there are series of punches that punch

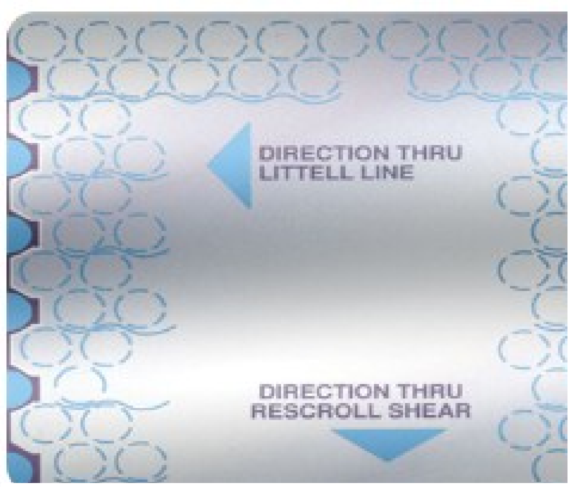

Figure 1-4: Coil punch line sheet layout

out the product. If the product is simple, the process can be completed all in one step by forming the shape in a die and cutting it out from the metal sheet [31]. Other processes simply cut the metal shape out of the sheet and form it in another machine later on.

Figure 1-4 above shows an accurate representation of a pattern of a coil punch layout system for can ends. Once the product is punched out, there are scrap choppers which cut the metal waste into small pieces so it can be recycled [31].

1.1.2 Silgan Containers Coil Lines; Process Description

Silgan Containers began their company back in 1899 under the name Carnation Company, which specialized in metal packaging [1]. Over the course of 113 years in business, Silgan has become the leading supplier of the metal packaging market in the United States with some big brand companies like Campbell's Soup, Spam and Del Monte [1]. Using their 28 manufacturing facilities, on average Silgan produces 28-30 billion cans per year [32]. Worldwide Silgan operates 82 manufacturing facilities in North and South America, Europe, and Asia.

Out of Silgan Containers' 28 manufacturing facilities, they currently run 31 coil lines. Out of the 31 coil lines at Silgan, 13 are coil cutting lines, 17 are coil punch lines, and only one is a coil coating line [32]. Wrinkling is more prominent in coil coating lines because the metal sheet is run through a line that is 100-700 feet long, compared to a three-foot by three-foot cut piece of metal. This is why the majority of Silgan's coil lines are either coil line cutters or coil punch lines.

One of Silgan's manufacturing plants in Hammond, IN is having issues with their coil coater. In Hammond, this manufacturing plant coats five-foot in diameter by three-foot wide rolls of bare metal, with an epoxy coating on either side. The large five-foot diameter rolls are first placed on a large mandrel in the beginning of the 500-foot long coil line [33]. Once on the mandrel, the three-foot wide metal sheet is fed up a conveyor to a set of pinch rolls that are ten feet off the ground. The pinch rolls feed the metal sheet to the shear, where a straight edge is cut and then continues to the crimping machine to connect the sheet to the end of the last roll. The machine is set up to run continuously

Figure 1-5: Mandrel #2 and mandrel #1

where there are two mandrels in the beginning of the machine. For mandrel #2 the roll is fed directly horizontally, but for mandrel #1 the roll is fed up and over the first process. When one roll runs out, the crimper crimps the end of one roll to the beginning of the other to keep it a continuous process. After going through the crimper, the metal goes through a series of two coaters which applies an epoxy coating to either side of the metal. Next, the metal is suspended through a massive oven, where the metal is heat treated at different temperatures to cure the epoxy coating. At the end of the line, there is one mandrel that rolls the metal back up into a five-foot diameter roll so that it can be used in another plant.

1.1.3 Problems

The coating line in Hammond is having problems with the mandrel #1 loading station. The problem exists because mandrel #1 has to go up ten feet in order to go over the mandrel #2 station. A hydraulic conveyor system is the current process that allows the sheet to be fed up ten feet. Once the roll is on the mandrel, the operator sets the angle for the conveyor. After the angle is set, the dead plate moves out to almost touch the metal roll. The operator then turns on the conveyor belt and pinch rolls at the top of the conveyor. The operator then advances the mandrel to feed the metal sheet up to the pinch rolls.

Figure 1-6: Current conveyor system

The key to this entire process is to have the metal sheet fed straight into the pinch rolls. If the metal sheet goes into the pinch rolls crooked, then it wrinkles and destroys the first 10 to 20 feet of metal sheet until it straightens out. Throughout the entire day, the plant runs

Figure 1-7: Metal sheet as it enters the pinch rolls

on average 30 to 36 rolls [33]. When looking at the average day, the approximate cost per foot of a three-foot wide roll is $0.40 and the number of occurrences where the metal sheet wrinkles is about five times per day [33]. Estimating that about ten feet of material is wasted during each occurrence, this calculates to be $20 of wasted material per day. If this is projected though the 235 work days per year, the average estimated material wasted per year adds up to $4,700 per year [33].

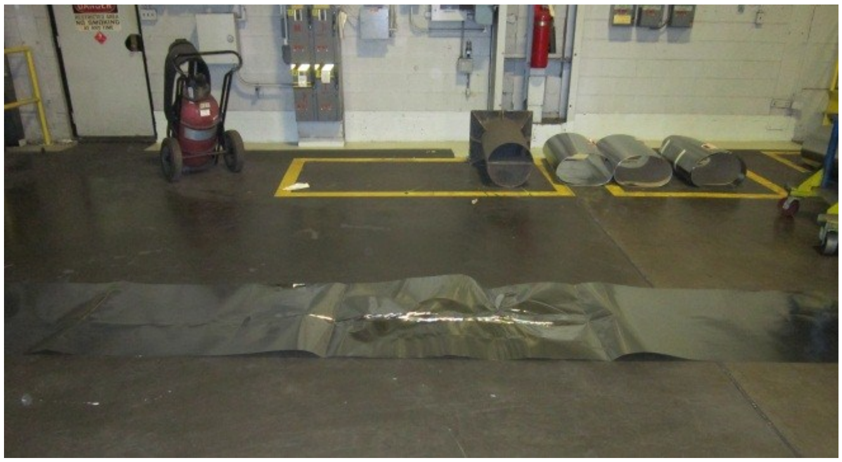

Figure 1-8: 20 Feet of damaged metal sheet

This problem does not occur every time a new roll is started; however, it does take extra time to straighten the metal sheet for the operator, and costs the company money every time there is wasted metal. To some people, a few wasted feet of metal is not a significant issue, but from the cost of wasted material mentioned above, one can see that it does add up throughout the year.

Operators have been avoiding this problem by not using the current in-feed conveyor. Instead of using the conveyor and hoping the metal sheet is fed straight into the pinch rolls, operators have been climbing up a ten-foot step ladder to feed the metal sheet perfectly into the pinch rolls. This is a huge safety hazard for any operator and is against Silgan's safety policy. The first reason for this rule is because the metal sheet is heavy and awkward to carry up a ten-foot tall ladder. Another reason is that the operator's hand could get sucked into the pinch rolls; the metal sheet is extremely sharp and could cut the operator very easily. With these problems occurring on the coating line, Silgan's equipment engineering group was asked to help fix the problem.

1.1.4 Similar Coil Coating Lines

There are similar coil coaters like the one at the Hammond, IN plant that operate the same way. Since the coil lines have to run continuously, the rolls have to be in-line. The newer coil lines have better designed metal sheet in-feeds, where the metal sheet

Figure 1-9: Coil line in-feed, Shanghai, China

does not have to go up ten feet and over the first roll. The newer designs have the rolls offset in height and the framing is not as bulky as the older machines.

The coil coating line from Figure 1-9 is at Shanghi Fenghang Industrial Automatic Equipment facility [4]. They specialize in debugging integrated equipment for processing metal sheets [4]. As depicted in Figure 1-9, the conveyor extends out to the large roll and the metal sheet is fed up to the pinch rolls via a conveyor. There is no record of any issues with this line, but making an assumption that this facility would be having similar problems that Silgan is facing with their in-feed coil coating line because the in-feed conveyor and roll set-up in Shanghai looks very similar to Silgan's coil coater in-feed at Hammond.

Another coil line similar to the line Silgan uses is a Red Bud Industries coil line that is installed at Stripco, Inc [5]. The in-feed on the Red Bud coil line is a little different, but some of the same issues are present. The machine in Figure 1-10, does not have a conveyor to allow the coil line to feed up the metal sheet; therefore, an operator

Figure 1-10: Red Bud coil line at Stripco, Inc

has to physically put the sheet into the pinch rolls. This is the same issue that Silgan is having with their coater; operators are putting the sheets into the pinch rolls by hand, which puts the operator at risk of injury. Although the Red Bud line is not as high as the one in Hammond, IN, it is still a safety hazard to allow operators to handle the metal sheet by hand. This system at Stripco, Inc is a similar design to what is at Silgan's Hammond, IN plant and it could benefit from the findings of this research.

1.1.5 Coil Cutting Line Straightener

There are many areas throughout the 28 Silgan manufacturing plants where the same or similar issues are occurring when feeding metal sheet stock. One such area is on a specific Minster servo feed machine that is at numerous Silgan plants. The Minster servo feed machines are on coil cutting lines where a large five-foot in diameter roll is cut into smaller sheets to later be coated and converted to can ends. The Minster machine is

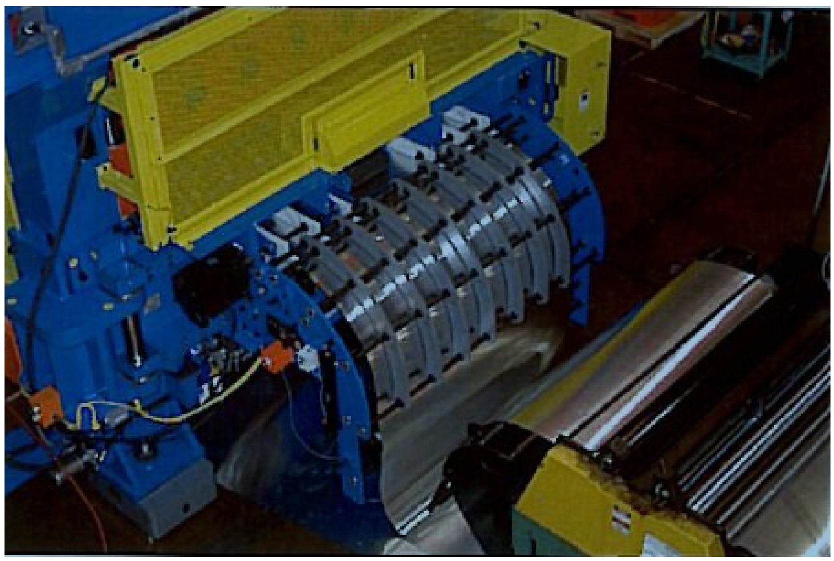

Figure 1-11: Minster servo feed drive machine

placed right before the shear, where it allows slack to build up so the sheet has time to start and stop when the shear cuts the metal sheet [3]. The slack is built up in the build-up loop because it would be too hard to start and stop a 20-ton metal roll of metal every second [3]. The metal roll continuously pays out the metal sheet at a constant speed, and the slack is taken and replenished at a consistent rate to keep up with the shear. As the servo drive pulls the metal sheet from the build-up loop, it is moving so fast that it causes the metal sheet to sway and jerk around. Therefore, on the Minster machine, there is a swing away-bracket that prevents the metal sheet from jumping off the track due to the swaying and jerking. However, it does not keep the sheet aligned perfectly. The swing-away brackets are simply guide bars that keep the sheet on the track [3]. The tolerance between the metal sheet and the sway bars is so large that it allows the metal sheet the freedom to float back and forth. This issue is similar to the conveyor at the Hammond,

Figure 1-12: Swing away bracket

IL plant, where the light plate allows the metal sheet to float until about halfway up the conveyor until the conveyor belt finally grabs the metal sheet.

The Minster press could use a differently-designed swing away bracket to help keep the alignment of the metal sheet straight all the time. This alternate design would happen by decreasing the tolerance between the table and the sway brackets. If the sway brackets tolerance were to be decreased to a point at which they almost touched, the bars would have to be replaced with rollers so the sheet could still pass through the machine without scuffing the metal sheet. By decreasing the tolerance, the jerk and sway would lessen because the freedom of the metal sheet would be minimized.

1.1.6 Roller Bar Coil Line

After doing some research and looking at all of Silgan's 28 plants, a straightener was found that is similar to the machine that was described in section 1.1.5 at Silgan's Rochelle, IL facility. This machine is a little older, but performs the same job as the

Figure 1-13: Roller bars mounted on the out-feed of the coil line servo feed machine

Minster servo drive feed machine. Instead of having swing away bars on the machine, custom roller bars were installed instead because of metal sheet control issues. Therefore, rollers were installed on the top and bottom of the out-feed of the straightener to sandwich the metal sheet.

This straightener on the coil cutting line at Rochelle has implemented the suggestions as suggested in section 1.1.5. This machine has decreased the tolerance by actually sandwiching the metal sheet between two rollers, which gives complete control of the metal sheet exiting the machine and decreases the jerk and sway in the build-up loop. After talking to the plant mechanics, when the straightener had the old swing away bars they were having so much trouble with alignment and markings so the roller bar design was installed. The plant mechanics inferred that after the roller bars were installed

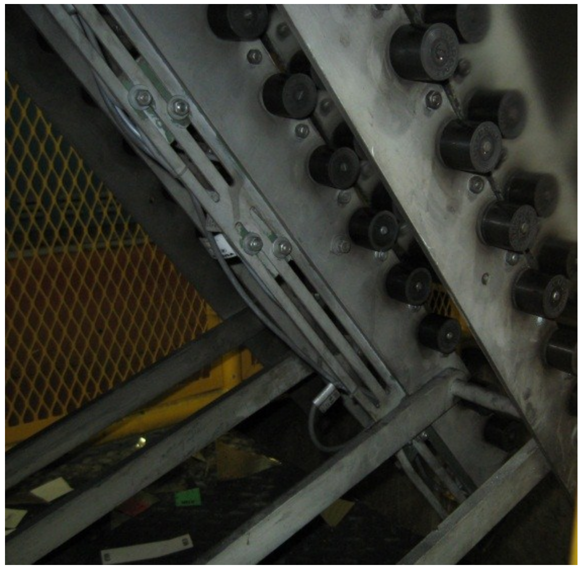

Figure 1-14: Under side of the rollers that sandwich the metal sheet

on the coil line, there was less damage on the metal sheet with markings from the swaying and jerking and better sheet handling as it would enter the shear. The control gained from adding the rollers was enormous compared to only having the guide bars.

1.2 Sheet Metal Wrinkling

Wrinkling is one of the most common and difficult obstacles in sheet metal forming. Wrinkling is a plastic buckling process in which the wavelength of the mode in one direction is very short [20]. The mode is based on the local curvatures and thicknesses of the metal sheet, as well as the material properties and the stresses on the area. Wrinkling can be related to certain shell buckling modes and can be useful in predicting and understanding wrinkling.

1.2.1 Plastic Bifurcation Theory

One theory that is used for wrinkling theory is the plastic bifurcation theory for thin plates and shells. In order for this theory to be applied, there are a few assumptions that are assumed; the metal sheet is assumed to be isentropic in the unstressed state and uniform over the region where there is a uniform thickness throughout the sheet [20]. According to the theory and shallow shell approximations, buckling from the uniform membrane gives incremental stretching ($\dot{E}_{\alpha\beta}$) and bending strains ($\dot{K}_{\alpha\beta}$) [21].

$$\left(\dot{E}_{\alpha\beta}\right) = \frac{1}{2}\left(\dot{U}_{\alpha\beta} * \dot{U}_{\beta\alpha}\right) + b_{\alpha\beta}\dot{W} \tag{1-1}$$

$$\dot{K}_{\alpha\beta} = -\dot{W}_{\alpha\beta} \tag{1-2}$$

Where $\dot{U}_{\alpha}$ $(\alpha, \beta = 1{,}2)$ are the incremental displacements in the X_1 and X_2 directions, $\dot{W}$ is the incremental buckling displacement normal to the middle surface of the metal sheet, and $b_{\alpha\beta}$ is the curvature tensor of the middle surface [21]. From Equations (1-1) and (1-2) above, the stretching and bending strains result in causing stress resultants $\dot{N}_{\alpha\beta}$ and bending moments $\dot{M}_{\alpha\beta}$.

$$\dot{N}_{\alpha\beta} = t\bar{L}^{-\alpha\beta k\gamma}\dot{E}_{k\gamma} \tag{1-3}$$

$$\dot{M}_{\alpha\beta} = \frac{t^3}{12}\bar{L}^{\alpha\beta k\gamma}\dot{k}_{k\gamma} \tag{1-4}$$

Where t is the metal sheet thickness and $\bar{L}$ is the plane stress incremental moduli [22]. Now that the stress resultants and moments are determined, the critical stress state for buckling equation is calculated using the bifurcation functional theory:

$$F\left(\dot{U}, \dot{W}\right) = \int \left[\frac{t^3}{12}\bar{L}^{\alpha\beta k\gamma}\dot{k}_{\alpha\beta}\dot{k}_{k\gamma} + t\bar{L}^{\alpha\beta k\gamma}\dot{E}_{\alpha\beta}\dot{E}_{k\gamma} + N^{\alpha\beta}\dot{W}_{,\alpha}\dot{W}_{,\beta}\right] ds \tag{1-5}$$

In Equation (1-5), S is the area of the metal sheet middle surface where the wrinkles occur. When F > 0 for all $\dot{U}, \dot{W}$ warrants that bifurcation will not occur and when F=0 bifurcation is possible [23]. Using Equations (1-1)-(1-5) from the plastic bifurcation theory, it is a reliable method for relating the metal sheet geometry and material properties to determine the formation of wrinkling on a metal sheet surface.

1.2.2 Donnell-Mushtari-Vlasov Theory

The Donnell-Mushtari-Vlasov theory is another wrinkling concept based on the plastic buckling and shallow shell theory [20]. The DMV theory uses the Hutchinson bifurcation functional that involves substituting fields that represent wrinkling into the functional. When assuming incompressibility and pre-wrinkling loading is proportional, then the theory can be used to model the material behavior. Using the power law hardening relationship, the first principal direction reduces to:

$$\sigma_1^{cr} = K\left[\frac{1+r}{\sqrt{3(1+2r)}} * \frac{t}{R_2} * \sqrt{n} * \alpha_1^{1-\frac{1}{n}}\right]^n \tag{1-6}$$

$$\gamma_1^{cr^2} = \frac{2\sqrt{3}\sqrt{n}}{\frac{1+r}{\sqrt{1+2r}} - \frac{(1-n)\sqrt{1+2r}}{(1+r)} * \frac{1}{\alpha_1^2}} \tag{1-7}$$

Where R_2 is the radius of curvature in the second principal direction, K is a constant, n is related to the number of values, and r is the average Lankford strain ratio [25].

$$\alpha_1 = \left[1 - \frac{2r\alpha}{1+r} + \alpha^2\right]^{\frac{1}{2}} \tag{1-8}$$

α_1 is the proportionality factor of the principal stress in the second direction over the principal stress over the first direction [25].

$$f_\sigma = \frac{\sigma_1}{\sigma_1^{cr}} \tag{1-9}$$

When the wrinkling risk factor f_σ is greater than 1, a wrinkling risk exists on the material surface.

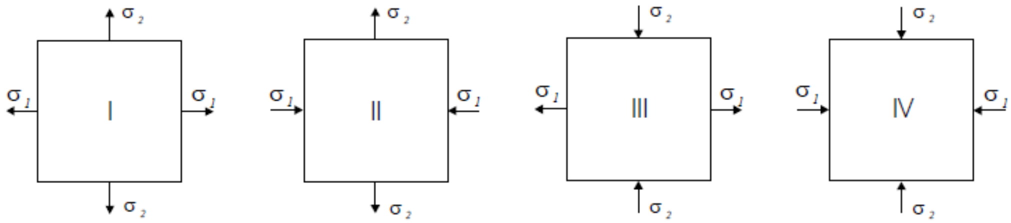

Figure 1-15: Possible wrinkling directions

Figure 1-15 above shows the different combinations in which wrinkling can occur. As stated in the DMV theory, the wrinkling depends on the orientations of the principal stresses on either side of the metal mesh that are analyzed [21]. The Donnell-Mushtari-Vlasov theory is used highly in the finite element analysis software because the theory demonstrates the use of adaptive meshes in the material for wrinkling prediction analysis.

1.2.3 Finite Element Analysis

As the metal sheet thickness becomes thinner and thinner, the more prominent the issue of wrinkling becomes. A study was done by the Netherlands Institute for Metals Research where they analyze wrinkling theory [13]. From their research, they showed that the issue of wrinkling theory is larger than the geometries they have studied. However, with using finite element analysis (FEA) software and finite element method

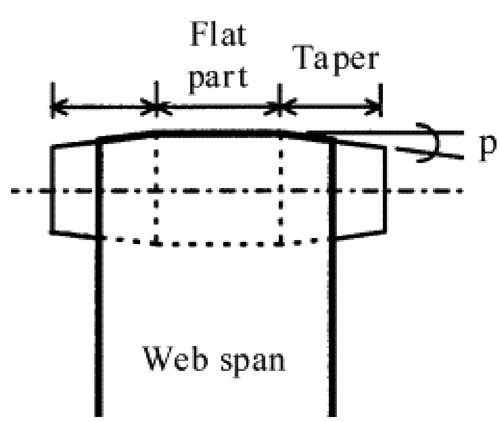

Figure 1-16: Visual of strip over the tapered roll

(FEM) calculations, wrinkling assumptions can be shown. In another journal, engineers analyzed a flat metal sheet being pulled by an advancing roll using FEA software [14].

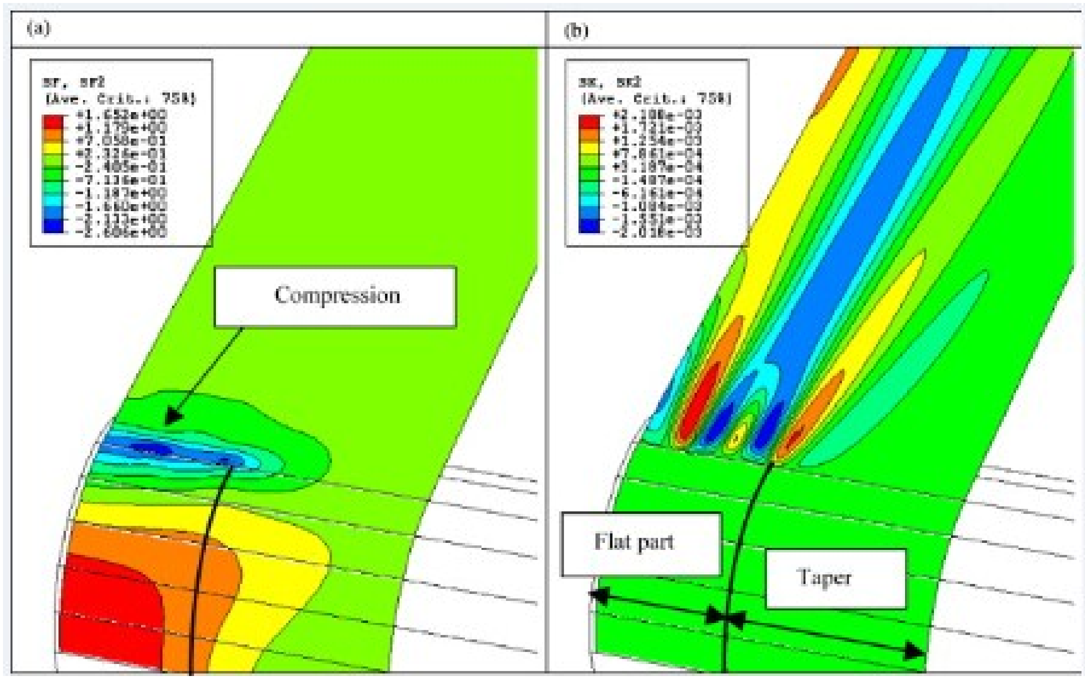

Figure 1-17: Metal sheet being pulled over the tapered roll

FEA uses its adaptive mesh to help determine the location and details of the wrinkles on the metal part it is analyzing [24]. In this study, a metal sheet was analyzed as it passed through a continuous processing line. Within the process the flat metal strip was run over a tapered roll under tension, shown in Figure 1-16 and analyzed using FEA [14].

In Figure 1-17 above, as the metal sheet gets past the taper on the tensioning

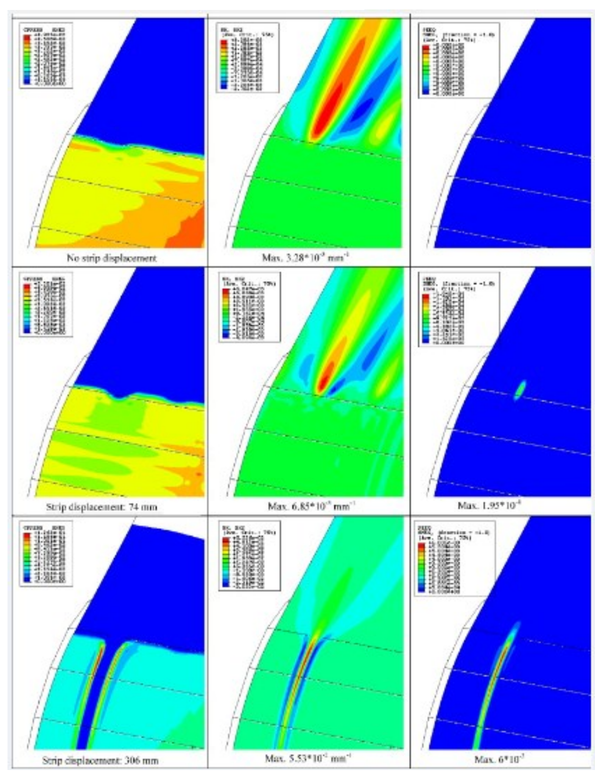

Figure 1-18: Simulation of forming a wrinkle

roll, it causes much stress in the metal sheet. When the tensioning roll pulls the sheet, it creates a compression region 90 degrees from the maximum tension location [14]. This compression region in the metal sheet causes it to form a bubble. When bubbles get large enough, a wrinkle will form. From the findings in Figure 1-17, they simulated the formation of a wrinkle using FEA, Figure 1-18. This figure shows the metal sheet contacting the roll in three different locations, ultimately forming a wrinkle [14]. Figure 1-19 shows a 3-D visual of the formed simulated wrinkle from the trial.

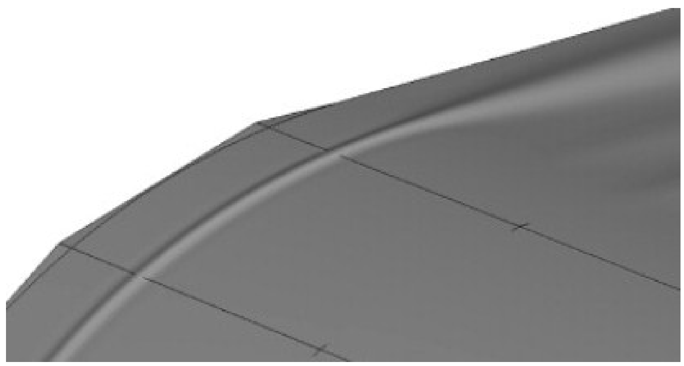

Figure 1-19: Simulated 3-D wrinkle

Comparing the findings of the study with the pinch rollers that are installed on the Hammond, IN coil coating line, some of the same issues exist. When the metal sheet is not fed into the pinch rolls straight, the roll acts as if it is a tapered roll such as the one found in the study. If the metal sheet is not fed into the pinch rollers straight, a compression region forms within the sheet, forming the bubble. The further misaligned the metal sheet is, the larger the compression region is and the bigger the bubble will be which then ultimately forms the start of the wrinkle in the sheet. From what was analyzed in this study, connections are being created as to why the wrinkles are being formed. It was found that there must be a consistent tension on the metal sheet where no compression regions will form.

1.2.4 Arc Roller

Coil coating lines sometimes have an issue with feeding thin metal sheets over feed rollers throughout the coil coating line process. To reduce the wrinkling while the metal sheets are running over the rollers, a special roller design was invented. The rollers are called the Arcostretcher AV rollers [27]. The specially designed rolls are bowed in

Figure 1-20: Arcostretcher AV bowed roller

the middle of the roll in order to keep the metal sheet stretched over the top. This allows the top of the metal sheet to always be in tension and the bottom side of the sheet to always be in compression [27]. If the metal sheet changes from tension to compression or vice versa, this is when wrinkling occurs. Many coil lines have gone forward in using these bowed rolls because it eliminates any potential for wrinkling to occur where a normal roller still has the potential.

CHAPTER 2: Understanding the Issues

With any problem, there is a reason why the problem has occurred. For the in-feed conveyor at Hammond, there are numerous predictions and assumptions as to why the metal is not being fed into the pinch rollers straight.

2.1 Analyzing the Problems

One of the first issues that the current conveyor design has is that it was not designed for light gauge metal. Silgan is always looking for ways to make a better lightweight and cheaper cost can for the customer. Since technology and Silgan's expertise has grown in the can-making field, they are able to make cans out of lighter gauge metal. In the past, Silgan's lightest gauge metal was 80 gauge and today the lightest gauge is 55 gauge metal [1].

One of the first issues is how the sheet is fed up the conveyor. If the metal sheet is not heavy enough, the conveyor will not be able to pull the metal sheet up until the sheet is halfway up the belt. With heavier gauge metal, the plate weight will cause the metal sheet to hit the conveyor sooner, which will convey the metal sheet up straight to the pinch rollers. When operators are running the lighter gauge metal up the conveyor, it either buckles, causing it to fall back down the conveyor, or it veers off to the right side of the conveyor.

Another issue with the current conveyor are the magnets behind the rubber conveyor belt. As shown in Figure 2-21, there are two magnetic strips 1" x 18.5" long behind the rubber conveyor belt. When testing the magnetism on the magnets by placing a 4" x 4" 105 gauge and 55 gauge metal sample over the magnets, the samples barely

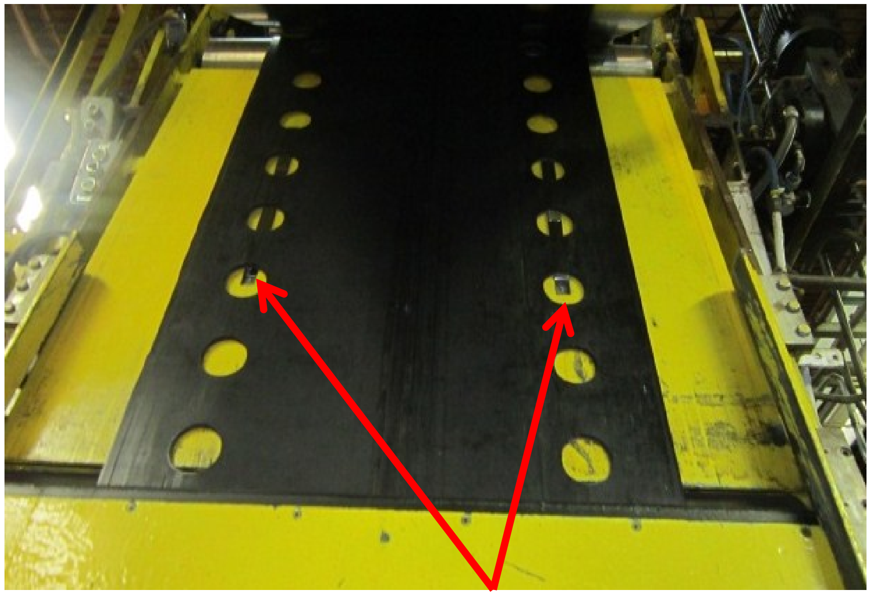

Figure 2-21: Magnetic strips

held any attraction at all. Since both samples had the same magnetic attraction toward the magnets, this does not explain why the heavier gauge metal goes up the conveyor fine, but not the lighter gauge metal.

When looking at all the times the metal sheet would feed up crooked to the pinch rollers, 90% of the time it went crooked to the right side [32]. When the back side of the conveyor was inspected, another issue was found. When the conveyor sets the angle up to the five-foot metal roll, there is only one hydraulic cylinder supporting the conveyor angle position on the left (operator) side. When the angle is set and the dead plate is extended, the conveyor has an enormous moment of inertia hanging out. A test was performed when the angle on the conveyor was in position up to the five-foot metal roll and either side of the conveyor was measured from the corner to the ground. The test showed that the conveyor sagged 9/16th of an inch lower on the side that did not have the hydraulic cylinder (motor side) on it. This is why whenever the metal sheet went up crooked, it veered off to the right side of the conveyor and not the left.

2.2 Safety Hazards

Ultimately, if the metal sheet does not feed into the pinch rolls with a ± 1" tolerance, it will create unwanted stresses in the metal sheet and cause wrinkling. Once the wrinkle has started, it causes a crease until the sheet moves within the tolerance. When the metal sheet crinkles 10 to 20 feet, it takes extra time for the operator to prepare the roll for coating. When the sheet crinkles, the operator has two options. One is to use the hydraulic sheer at the top of the line to cut the damaged sheet into one foot sections or two, reverse the pinch rolls, cut off the damaged sheet by hand, and then feed the sheet back up again. Since both of these options take extra time on the operators behalf, operators have been using a ladder to place the metal sheet in the pinch rolls instead of using the conveyor. To do this, operators take the end of the metal sheet, climb up the ten-foot ladder, and place the sheet into the pinch rollers straight. This is a big safety hazard for three reasons: One; the operators are climbing up a ten-foot ladder while handling an awkward three-foot wide heavy metal sheet, which creates a risk of falling off the ladder. Two; the edges of the metal sheet are thin and act like razor blades when objects are run along the edges. Operators are required to wear gloves whenever handling the metal sheets, but if an operator would fall off the ladder, gloves or clothing would still not provide adequate protection from the metal sheet edge. Three; the operators could get his or her hand or shirt caught in the pinch rollers. Before the operator climbs up the ladder with the metal sheet, he or she turns the pinch rollers on so they are always turning. If the operator leans over or loses his or her balance, he or she could easily get their shirt or hand caught in the pinch rollers. Another point is that while the operator is on the top of the ladder, the on and off switch for the pinch rollers are on the ground. So, if he or she did get caught in the pinch rollers, there would be no way for the operator to turn the rollers off.

Another safety risk involved for operators is when the metal sheet wrinkles in the pinch rollers and the operator has to back the sheet out of the pinch rollers. When operators do this most of the time the sheet buckles and falls back down the conveyor. With ten feet of metal sheet falling back down the conveyor, it could fall in any direction putting the operators at risk. With the sheets as sharp as they are, if the operators are in the wrong place at the wrong time, then an accident could occur.

CHAPTER 3: Conceptual Design

After reviewing the issues that the plant currently faces, a conceptual design was created. Since the metal sheet is not heavy enough for the conveyor to pull it up until it is halfway up the conveyor, the proposed design uses contact rollers. The metal sheet advances straight up at the beginning of the conveyor when it comes off the roll, so if there is no chance for the metal sheet to float or shift over then the alignment issue would be solved. Therefore, with rollers installed at the beginning of the conveyor, the sheet will remain straight and the conveyor will convey it up to the pinch rollers. A 3-D model was created using Inventor for the concept. It uses three roller bars to distribute the force on the metal sheet equally, 2- 80/20 bars, and mounting plates to allow it to be clamped to the sides of the conveyor.

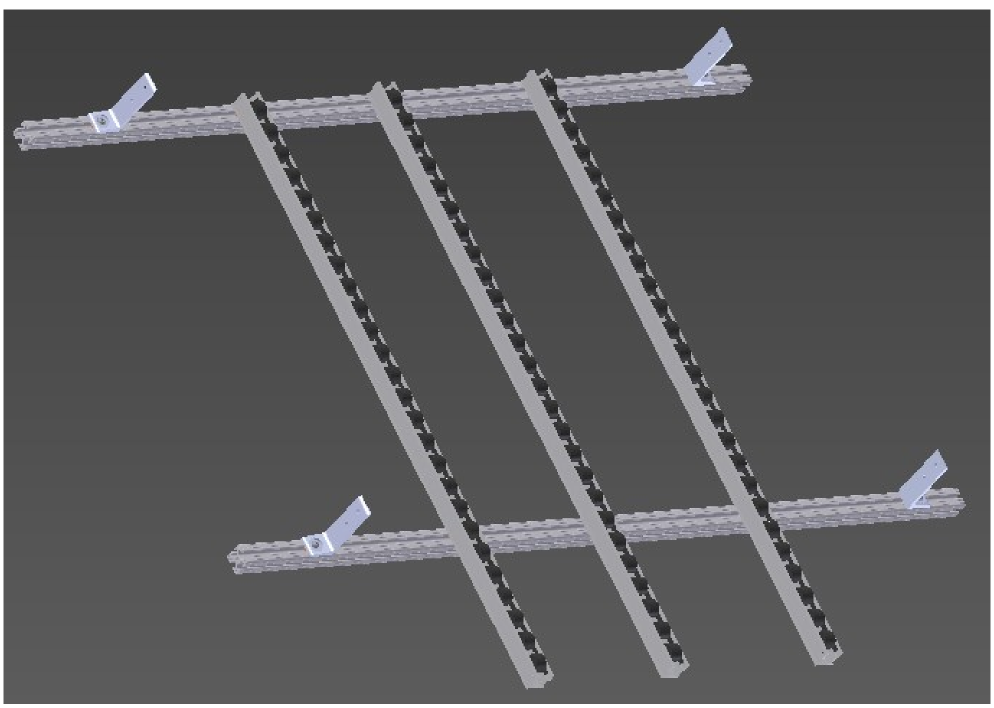

Figure 3-22: Roller 3-D model concept design

3.1 Conceptual Design Calculations

Since three roller bars were used to distribute the load on the metal sheet, the bars needed to be evenly spaced and avoid the conveyor belt holes. If the rollers were mounted over the conveyor holes, the rollers could cause the metal sheet to warp as the sheet goes underneath the rollers, therefore the roller spacing R_S was calculated:

$$R_S = L_c - A * 2 \tag{3-10}$$

Where L_c is the conveyor length and A is the hole distance. For this conveyor system, $L_c = 33.25\ in$ and A = 3.5 in.

$$R_S = 33.25 \text{ in} - 3.5 \text{ in} * 2 = 26.25 \text{ in}$$

From Equation (3-10) it was determined to place the rollers 1.5 inches inside the conveyor belt on either side, and the third roller bar was directly placed in the center.

In addition to placement, the pressure applied to the metal sheet was also determined to be 20 psi. This allows for the sheet to have enough force to contact the belt, but it is not enough force to damage the sheet.

After collecting information from the operators, supervisors, and equipment at Hammond, the conceptual design was built to be trialed. The trial occurred February 9th 2012 while the coil line was down for cleaning and maintenance.

3.2 Prototype Test

During the trial, numerous tests were performed to test the current conveyor system and the prototype concept system. The first tests were solely with the current system, where the metal sheet was fed up to the pinch rolls and back down five times. A scrap roll of 55-pound plate with a diameter of 35 inches was used for the test. The first three times the metal sheet was fed up normally, with the five-foot roll coiled perfectly straight. Out of those three times, two of them went into the pinch rolls crooked, at 1-2” outside of the pinch roll tolerance zone. The next two times, the top two layers on the five-foot roll were offset 0.5” to either side of the roll and then fed up the conveyor. When the roll was offset to the left (operator side), the roll went into the pinch roller straight. The reasoning for this is because the left side is higher, due to the hydraulic cylinder support located on that side. When the roll was offset to the right (motor) side, the sheet was fed into the pinch rollers crooked at ≈ 2” outside the pinch roller tolerance.

After the five trials were run on the current conveyor system, the prototype roller design was put on the conveyor. Describing the roller prototype from Figure 3-23, there are three rollers mounted on an 80/20 frame that is meant to sandwich the metal sheet between the rubber conveyor and the rollers. The prediction for the rollers are to allow for the conveyor to grip the metal sheet sooner and to help keep the metal sheet aligned straight. Otherwise if the sheet is misaligned the rollers are predicted to help re-align the sheet as it gets fed up to the pinch rollers.

Figure 3-23: Roller design

Figure 3-24: Prototype roller design mounted for testing

The 80/20 frame for the design was clamped to the conveyor sides for the test. The dead plate extension for the conveyor had to remain extended due to the clamps that were mounted on the sides for the test. The rollers were mounted so they were in direct contact with the rubber conveyor belt. Figure 3-24 above shows the roller design mounted on the conveyor.

The 55-gauge metal sheet was run up the conveyor to test the roller design five times. During the first run, the metal sheet was solely fed up the conveyor to see how it would work, and there were no issues at all. The sheet was fed up and was sandwiched in between the conveyor belt and the rollers, which brought the metal sheet up straight to the pinch rollers. The second run was performed the same way, but this time the mandrel speed was increased which fed up the metal sheet faster. As a result, the metal sheet hit the end of the roller bracket instead of sliding underneath the roller. During the last three runs, the metal sheet was purposely offset to the right side to see if the rollers would help re-align the sheet. During the third run which was offset 0.5", the sheet fed up and re-aligned itself. During fourth run, when fed up the sheet re-aligned itself to be just within the pinch roll tolerance, but did not re-align perfectly. During last run, the top three layers of metal sheet on the coil were offset 0.75" to the motor side. When feeding up the metal sheet, the sheet began re-aligning itself; however because it wasn't perfect, the coil was stopped and backed down the conveyor and then fed back up again and the metal sheet was then re-aligned straight into the pinch rollers. The rollers supplied pressure between the conveyor and the metal sheet, which allowed the sheet to reverse and go back down in order to re-align straight.

Prototype Testing				
	Trial	Description	Straight	Misaligned
Current System	1	Fed Straight		X
	2	Fed Straight	X	
	3	Fed Straight		X
	4	0.5" Left Offset	X	
	5	0.5" Right Offset		X
Prototype	1	Fed Straight	X	
	2	Fed Straight	X	
	3	0.5" Right Offset	X	
	4	0.5" Right Offset	X	
	5	0.75" Right Offset	X Reversed	

Table 3-1: Prototype testing results

When analyzing Table 3-1 for the prototype test, the results show that the roller system will help and provide pressure to keep the metal sheet feeding straight and to help in correcting misalignment issues. The rollers allowed the metal sheet to make contact with the belt sooner, which allowed the sheet to be fed up the conveyor more quickly. The

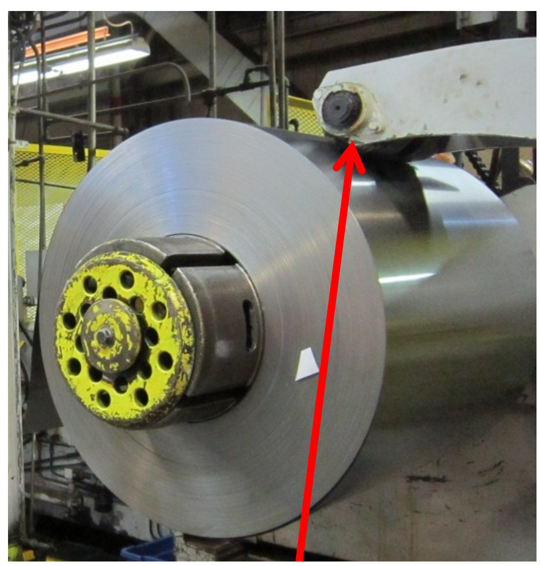

Figure 3-25: Roll hold down unit

pressure that was applied to the metal sheet prevented the sheet from feeding up crookedly. Because the rollers provide down pressure against the conveyor, the hold down unit shown in Figure 3-25, which holds the 5 foot rolls on the mandrel, was able to be lifted off the roll without the metal sheet sliding down the conveyor. This allows more flexibility if the operator needs to reverse the coil to re-align the metal sheet.

3.3 Trial Recommendations

After the prototype design was tested, some recommendations for the final design proposed solution were established:

- Implement the roller design onto the conveyor belt to help adjust for mis-alignment.
- Mount gradual bars on the rollers to ensure that the metal sheet is fed under the rollers and not over them.
- Mount the roller design on the framework above the conveyor system. The sides

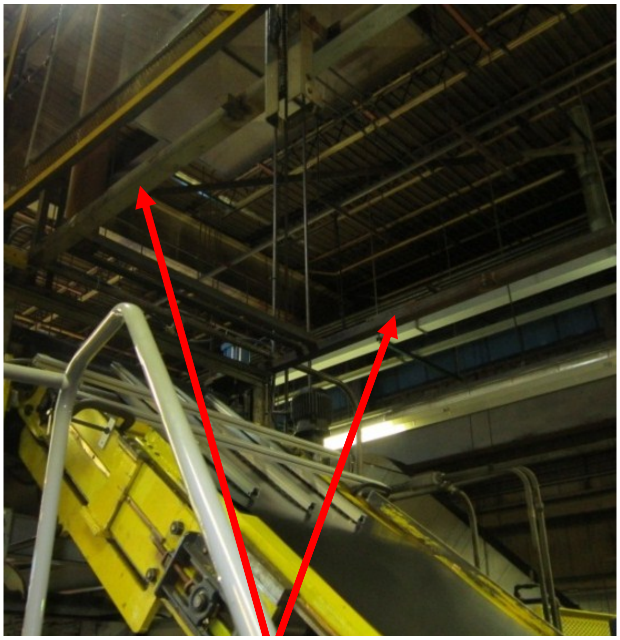

Figure 3-26: Frame work where roller design will be mounted

of the conveyor are too cluttered and have limited mounting space available.

- Use pneumatic cylinders to raise and lower the rollers from the top framework to the conveyor belt surface. This will allow for the conveyor to be placed at different angles.
- Install a second hydraulic cylinder on the left (motor) side to eliminate conveyor offset. Currently there is only one hydraulic cylinder on one side of the conveyor. When a measurement was taken on each side, the conveyor was sloping down by 9/16" on the side with no hydraulic cylinder. This could be a cause to the metal sheet shifting off to one side when fed up the conveyor.

Figure 3-27: Back side of the conveyor

- All of the recommendations listed will be implemented on the final design. The prototype test and trial was proved to be successful and helpful in the process of moving forward to the final design.

CHAPTER 4: Proposed Solution

4.1 Design

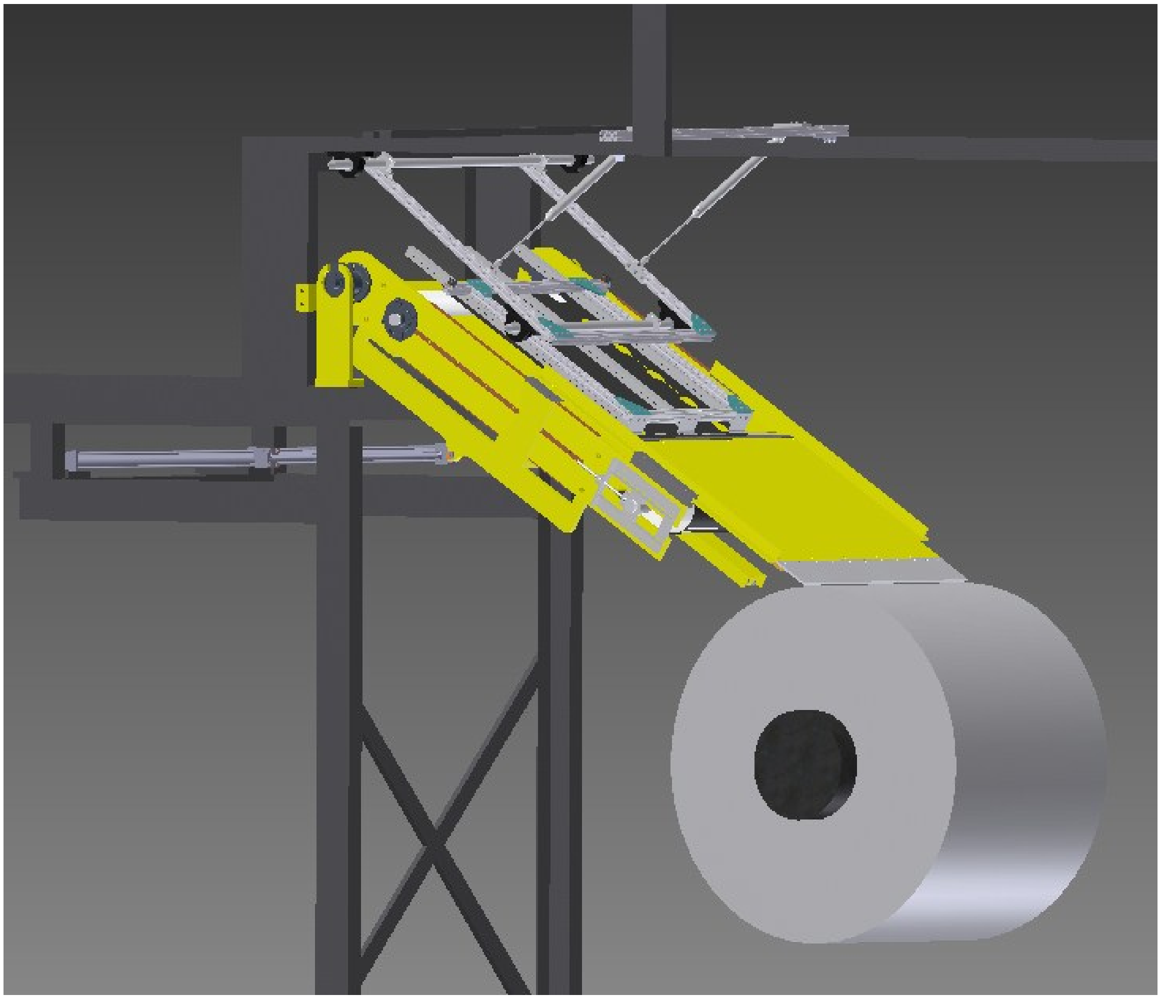

Figure 4-28: Proposed solution

The proposed design will be based off of the knowledge gained from the operators, supervisors, and the prototype test, please refer to Figure 4-28 above. As recommended from the prototype test, the sides of the conveyor are too cluttered and there is not enough room for the roller system. Also, once the metal sheet is fed into the pinch rollers, the roller system needs to be able to retract so it is not touching the metal sheet. Therefore, the proposed solution is going to be fixed to the existing upper metal framework above the conveyor. The roller system will use the same three roller bars used for the prototype. The framework that will hold the roller bars will be constructed with 80/20 because of its ease of assembly, strength, and lightweight material. The system will be pivoting from the front and middle back, where pillow block bearings will be used for a smooth fluid motion. There are two pneumatic cylinders mounted on the back of the roller system to lift and lower the roller design to and from the conveyor. The rollers will be free-floating because the system is on a pivot. This is to allow the rollers to adjust to any angle the conveyor will be set at. The rollers will be set off balance so the weight of the rollers will cause the roller frame to hit rubber stops and always be in the right orientation. The system will be controlled by a dual pressure regulator and Mac valve that will allow 70 psi to raise the system and 20 psi to lower the system. There will be a proximity sensor and a pressure sensor incorporated into the system to ensure that the roller design remains in the home position, and to make sure that the right pressure is applied to the conveyor at all times. The operator will only have two extra buttons then they currently have to raise and lower the rollers. Figure 4-29 shows the final roller design.

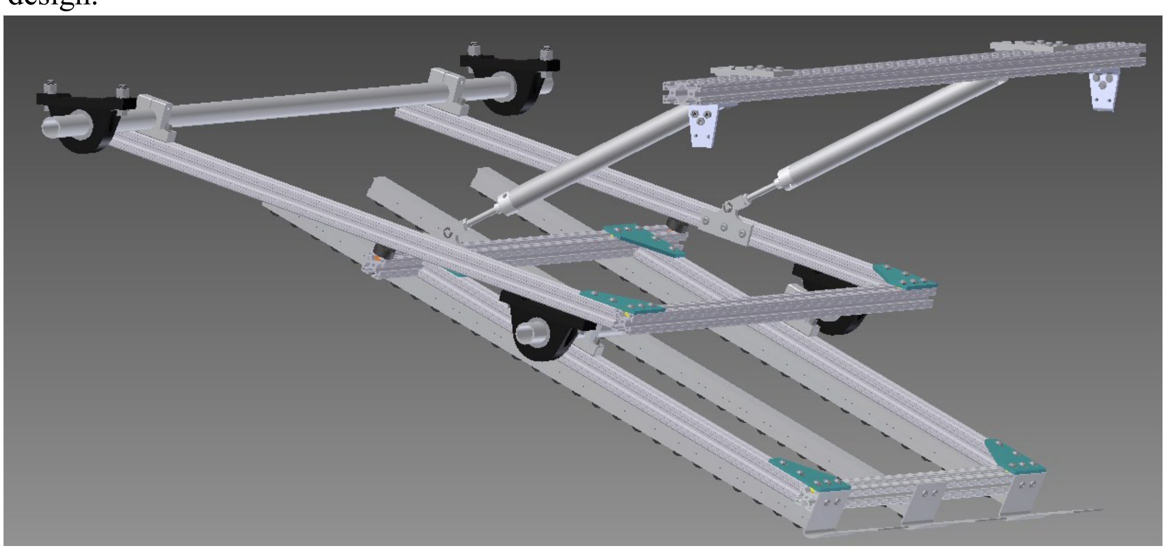

Figure 4-29: Roller design

The second part of the proposed design will be to add a second hydraulic cylinder to the right side of the existing conveyor (refer to Figure 4-30 below). To fix the offset of the conveyor, an identical hydraulic cylinder will be purchased and mounted to the right (motor) side of the conveyor. A custom bracket was designed to fit onto the right side of the conveyor without hitting the existing hydraulic motor. The bracket does restrict the dead plate from coming up as far as it does by 2.75 inches. As a result of this, the home proximity sensor for the dead plate needs to be lowered by 2.75 inches as well. Two additional custom cylinder mounting brackets were designed to ensure that the hydraulic cylinders are at the same location and because of existing space restrictions on the right side. The additional hydraulic cylinder will tee off of the existing hydraulic cylinder, causing no extra buttons for the operator.

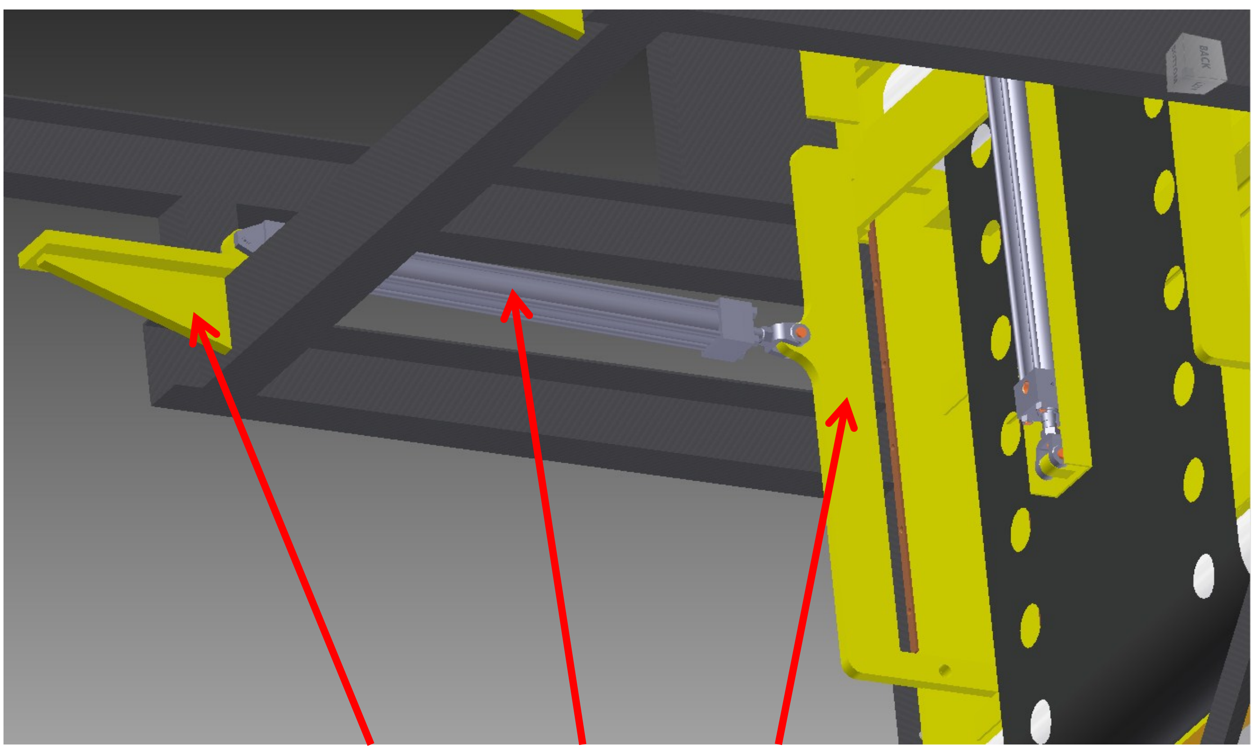

Figure 4-30: Adding the rear bracket, hydraulic cylinder and front bracket to the conveyor

4.2 Calculations

Throughout the design process, a few calculations had to be performed to ensure that the right parts were purchased for the roller design. The first set of calculations were performed to determine the proper pneumatic cylinder diameter. The roller design is cantilevered from the framework. Therefore, the moments were calculated to determine and make sure that the pneumatic cylinders would be able to raise and lower the design with the 100 psi plant air supply. The maximum bending moment M_A exerted by the rollers:

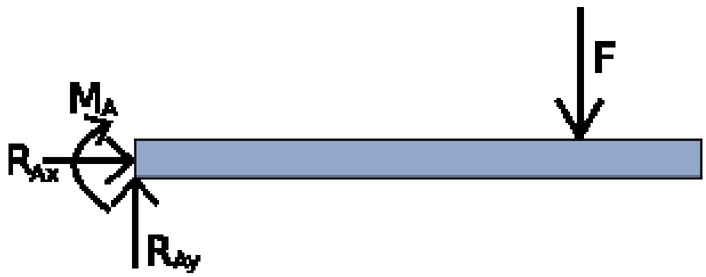

Figure 4-31: Free body diagram of roller design bending moment diagram

$$\sum M_A = F * D \tag{4-11}$$

Where F is the force in pounds and D is the distance in inches from the center of gravity to the cantilever point. Using the 3D modeling software inventor that the design was drawn up on, an estimated weight for the roller system was determined to be 51.85lbs which was used as the force F. Also using Inventor, the center of gravity where the force acts from on the design was found to be 32.08 inches from the pivot point which was used as distance D. When the roller design is in the up position, this will be where the design has the largest bending moment and greatest force that the pneumatic cylinders will have to overcome.

$$\sum M_A = (51.853\ lbs) * (32.08\ in) = 1663.44\ in - lbs$$

For determining what diameter of cylinder required for operation, both a 1-1/2" and 2" cylinder was used.

Bimba Pneumatic Cylinder Specs			
		D1	**D2**
1-1/2"	in	1.50800	0.43700
	m	0.03830	0.01110
2"	in	2.01000	0.62500
	m	0.05105	0.01588

Table 4-2: 1-1/2" and 2" Bimba pneumatic cylinder specifications

Now knowing the maximum force that the pneumatic cylinders have to overcome, the equation is worked backwards using the cylinder mount distance from the end of roller system as D= 24.284 inches instead of using the center of gravity distance to find the force F_y in the vertical direction. Equation (4-12) is also multiplied by 2 because there are two cylinders that will raise the rollers assembly.

$$\sum M_A = F_y * D * 2 \tag{4-12}$$

$$\sum M_A = 1663.44\ in - lbs = (Fy) * (24.284\ in) * 2$$

$$Fy = 34.24 in - lbs$$

The roller design will not be raised as high where the 80/20 frame is horizontal with the floor. Using Inventor, the angle θ was measured from horizontal to the 80/20 frame which was 17.26^{o} to determine the cylinder lifting force F.

$$\mathrm{Fy} = \mathrm{F} * \sin(\theta) \tag{4-13}$$

$$34.24\ \mathrm{in} - \mathrm{lbs} = \mathrm{F} * \sin(17.26°)$$

$$\mathrm{F} = 115.43\ \mathrm{lbf} \rightarrow 0.51346\ \mathrm{KN}$$

Using the required force F needed and the Bimba pneumatic cylinder diameters D_1 and D_2 (from Table 4-2), the air pressure P required to lift the roller design can be solved for:

<u>1-1/2" Cylinder</u>:

$$F = P * A \tag{4-14}$$

$$F = P * \frac{\pi}{4}(D_1^2 - D_2^2) \tag{4-15}$$

$$0.51346\ KN = P * \frac{\pi}{4} * [(0.03830\ m)^2 - (0.01110\ m)^2]$$

$$P = 486.53\ kpa \rightarrow 71\ psi$$

<u>2" Cylinder</u>:

Using Equations (4-14) and (4-15) for the 2" cylinder results:

$$0.51346\ KN = P * \frac{\pi}{4} * [(0.05105\ m)^2 - (0.01588\ m)^2]$$

$$P = 277.66\ kpa \rightarrow 41\ psi$$

The calculations show that both the 1-1/2" and 2" diameter cylinders will work for the roller design. The 1-1/2" diameter pneumatic cylinders were chosen for the design because they are smaller, cheaper, and will be able to operate with no issues using the supplied 100 psi plant air. The pressure required to lower the roller design does not have an impact on the cylinder selection because it does not require as much force as raising the roller design requires.

Another calculation performed was to determine the force for the hydraulic cylinder brackets. The same hydraulic cylinder that is currently being used will be the same make and model for the cylinder that will be added to the motor side of the conveyor. Since one cylinder operates the conveyor with no issues, calculations do not have to be made for adding the second. However, calculations were performed to determine the strength of the rear bracket for the hydraulic cylinder. For the calculation, the maximum hydraulic pressure that the Parker cylinder can accept is found to be 3,000 psi [8]. From this, a simple calculation was used to determine the area of the cylinder to define the maximum force F_{Max} that the cylinder can exert on the rear hydraulic bracket:

$$A = \frac{\pi}{4}(D_1^2) \tag{4-16}$$

$$A = \frac{\pi}{4}(2.0^2\ in) = 3.14\ in^2$$

$$F_{Max} = 3.14\ \cancel{in^2} * \frac{3{,}000\ lbs}{\cancel{in^2}} = 9{,}424\ lbs$$

Since the maximum force will occur when the cylinder is pushing, the cylinder rod does not have to be accounted for when calculating the area. After calculating the maximum force that the hydraulic cylinder can produce, the rear hydraulic bracket was analyzed using FEA analysis using the maximum force found. For the analysis, 9,500 lbs was used for the maximum force.

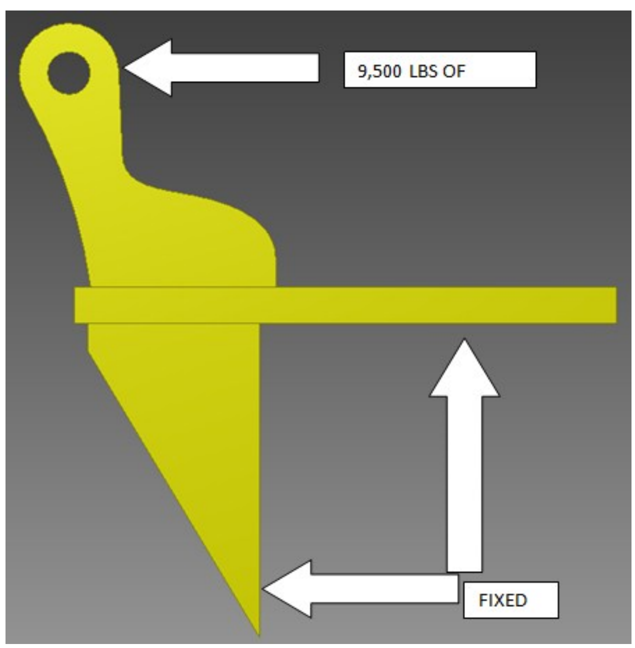

Figure 4-32: Free body diagram of the rear hydraulic cylinder bracket

After running the program through the Abaquis package, Figure 4-33 shows the results.

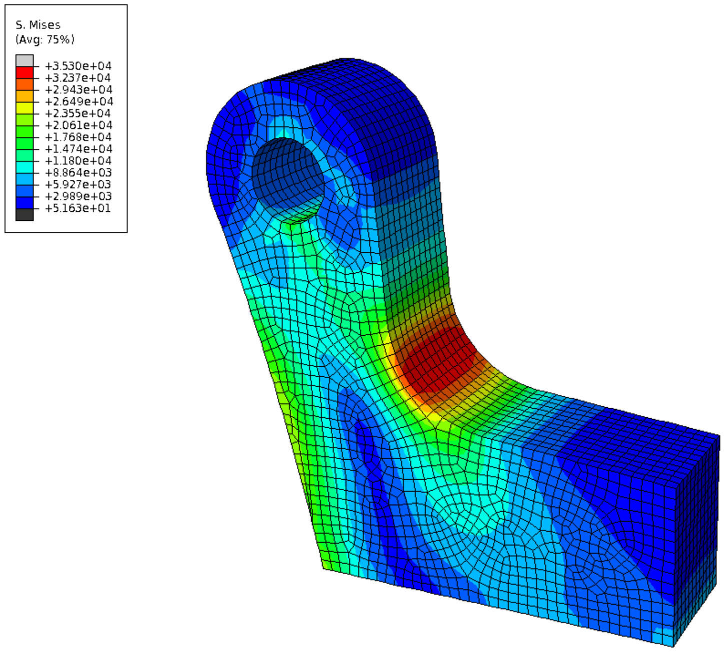

Figure 4-33: FEA analysis of the rear hydraulic mounting bracket

The analysis shows that the maximum stress point is at the corner of the bracket yielding a maximum stress of 35 ksi. The rear hydraulic bracket is being made with ASTM A572 steel, which has a maximum yield stress of 50 ksi. The FEA analysis shows that the rear bracket is well below the material yield stress; therefore, no permanent deformation will occur when using the hydraulic cylinder.

4.3 Timing Sequence

The timing sequence below shows the sequence in which the operator will need to operate the system. The system will be programmed this way for safety reasons and to ensure that the metal sheet will not get damaged when starting or retracting the conveyor and roller system.

Starting a New Roll:

1 Place roll on the mandrel

2 Set the angle of the feed conveyor

- There is a proximity switch that controls when the conveyor is in the home (vertical down position)

3 Extend the dead plate of the feed conveyor to the roll outer diameter

- Another proximity switch makes sure the dead plate is in the home (all the way up position)
- The angle of the conveyor, sequence #2, cannot be adjusted unless the dead plate is in the home position

4 Lower the rollers to the conveyor surface

- A proximity sensor controls the home position (up) for the rollers
- A pressure sensor monitors the down pressure on the conveyor surface to be in a range from 20 to 40 psi

5 Start the conveyor belt

6 Start the pinch rollers

7 Feed the roll up using the mandrel

Once the System is Running:

1 Raise the rollers until the system hits the shut-off home proximity switch

2 Retract the dead plate to the home proximity switch

3 Lower the conveyor table in the vertical home position

4.4 Parts List

All of the parts for the roller design and the addition of the second hydraulic cylinder are listed in Appendix A.

The coil line assembly parts list from Table A-3 are the parts for the upper assembly. The upper assembly parts are mainly for adding the second hydraulic cylinder to the existing conveyor. This includes the new hydraulic cylinder brackets, the hydraulic cylinder, and all the necessary hardware.

The coil line feeder assembly parts list from Table A-4 are the parts for the roller assembly. All of the parts listed are for the complete package for the installation of the mechanical components for the roller design.

The coil line electrical components found in Table A-5 are the electrical components for the roller assembly. There are no electrical components for the upper assembly. The electrical components are everything that will control the roller system and will allow it to function.

4.5 Final Design

After finishing the design work for the proposed solution, the project was presented to the supervisors, operators, and plant managers at the Hammond, IN plant. The design was presented and an explanation was provided as to how this would solve the issues at the plant. After asking a few questions and further understanding a few more things for the design in more detail, the plant personnel approved the roller design. After the roller design was approved, the proposed solution could go into the final design stage. During the final design stage, the parts are detailed on drawings in order to be made, manufactured, and assembled. Once the parts were detailed, the entire design was reviewed by another equipment engineer. The finished drawings were then sent to the plant services department, where the entire project was sent out to be quoted for the parts, labor, and assembly of the roller design. When the quotes were received, a project engineer wrote up the project and the capital money was requested from the company. The final design has now gone through the approval stage, during which the upper managers, plant managers, and accounting department review and sign off on the project. The design package was ordered the week of October 22, 2012 through NEFF Engineering. All parts will be ordered and the entire assembly will be assembled at NEFF Engineering. Once NEFF starts on the order, there is a six-week lead time for acquiring the parts and finishing the build.

CHAPTER 5: Conclusions and Future Work

5.1 Installation

As aforementioned in section 4.5, this project has a six-week lead time to be completed once the order is sent into NEFF Engineering. The roller design will come fully assembled, but not for the addition of the second hydraulic cylinder. Before the rollers and the second hydraulic cylinder can be installed, some work needs to be done.

For the roller design, there are a few things that have to be moved or modified on the existing framework in order for the system to be installed. The first thing is a guarding bracket that is mounted to where the roller pillow block must be mounted. The guarding bracket needs to be cut off on the bottom side, and the rest of the bracket will remain welded to the framework. This will allow enough room for the pillow block to be installed.

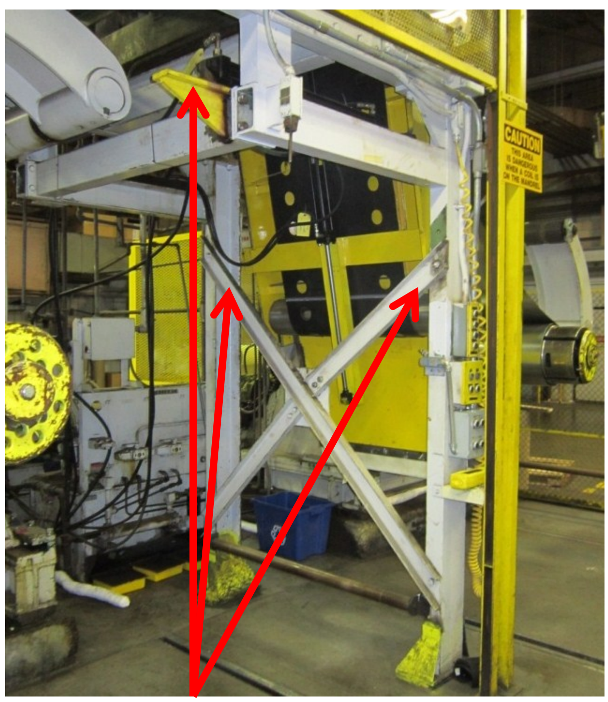

Figure 5-34: The bracing on the motor side needs to be lowered; cylinder mounting bracket needs to be ground off and welded to match the motor side

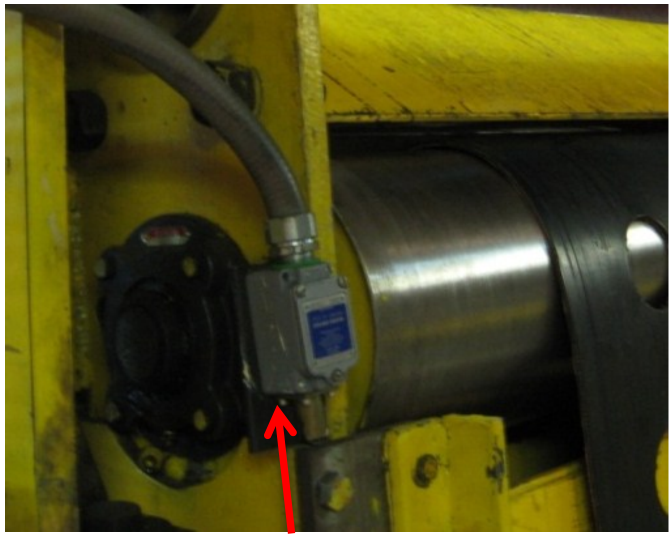

Figure 5-35: Dead plate sensor

In order to add the second hydraulic cylinder, three modifications must occur. First, the existing cross-bracing on the back side of the conveyor needs to be lowered on the motor side where the new cylinder will be going. The bracing needs to be lowered to the same height as the bracing on the existing cylinder side. Second, the dead plate sensor needs to be moved down on the front side of the conveyor. With the custom hydraulic cylinder bracket being installed around the conveyor motor, the dead plate will not be able to retract as far as it currently does. Therefore, the sensor must be moved 2.75 inches down from its current location, (See Figure 5-35). The third modification required for the installation of the second hydraulic cylinder is to modify the existing hydraulic mounting bracket. The cylinder mounting bracket will be ground off, and a new bracket will be welded in place to match the exact location of the new mounting bracket for the new hydraulic cylinder.

After these modifications are performed, the two components can be installed. The roller system requires ten bolts to be fastened to the existing framework, the plant air to be hooked up to the valve, and the electrical switch to be hooked up. After the roller system is installed, there will need to be adjustments to the regulator and roller position. The home position sensor also needs to be fastened to the existing framework with two bolts, and then be wired into the system logic and adjusted for exact positioning. To install the second hydraulic cylinder, some more work has to be performed. For the cylinder bracket, four 1" holes need to be drilled through the conveyor side to mount the bracket. Then, the new rear bracket needs to be aligned and welded into place. The existing side rear cylinder bracket needs to be modified as aforementioned. The existing cylinder hydraulic lines need to be teed off, and then hooked up to the new cylinder.

5.2 Summary of Design

The roller system was designed as a simple system that will fix the problems that the plant is having. The design utilizes 80/20 parts which are lightweight, easy to use, and easy to adjust. In using the 80/20 components, almost the entire system is adjustable, which is great for dialing in the process so the problem can be resolved. The design uses a dual regulator with a three-position valve. The dual regulators allow two different pressures to be used for the raising pressure and lowering pressure. This helps the system work well by allowing the capability for it to adjust if more pressure or less pressure is needed for the down force. The three-position valve is a great built-in safety system because every time the air pressure is off, the valve goes into the center safe position. This allows no air to leave or enter the valve, which keeps the rollers stationary even if the plant air were to shut off. This prevents the roller system from crashing down if the cylinders lose air pressure or break an airline. The design also had bearings and slip bushings for ease of motion and to prevent wear from occurring. The last key to the design that was incorporated was the place it was mounted. Since it is being mounted on the upper existing framework, the rollers when in the home position are completely out of the way. Mounting the rollers on top allows for the rollers to be out of the way of the coating process when the line is running.

The design for adding the second hydraulic cylinder was copied from what existed. The current cylinder has been working for years; therefore, the same design was copied as closely as possible for the other side. Because of the conveyor motor, the bracket was lowered, causing a custom front and rear bracket to be made. Other than the custom brackets, the design for the second cylinder includes the same Parker cylinder that exists on the current design and getting the front and rear bracket locations to line up with either side of the conveyor.

5.3 Future Work

After the complete cylinder and roller package is installed at the Hammond, IN coil coating line, the problems that the plant was having will hopefully be solved. Though this is the only continuous roll coil coating line in the Silgan Containers Company, Silgan utilizes thousands of conveyors, tracks, coil cutting and coil punching lines throughout all of their plants. From the research found, there are similar coil line set-ups that will be able to benefit from the roller design and research gathered. Therefore, looking toward the future, the roller design could be used to help metal sheet to be conveyed, eliminating damage and safety issues with the final product.

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Appendix A: Parts List

Coil Line Upper Assembly Parts List				
Item #	**Description**	**Vendor**	**Part #**	**Qty**
1	Roll Feed Assy, Coil Line Table	Assembly	8CL57617	1
1	Parker 31" Long Hydraulic Cylinder	Parker	2.00CBB2HCT14AC 31.0	2
1	Mounting Plate, Limit Switch	Custom	6CL58187	3
1	Mounting Bracket, Hydraulic, Right	Custom	8CL58188	4
1	Mounting Bracket, Hydraulic, Left	Custom	8CL58189	5
1	Feed Roll, Angle Bracket, Left	Custom	6CL58193	6
1	Switch, Limit NEMA Type 4	Alan Bradley	802T-A	7
1	Actuator, Limit Switch 1-1/2" X 3/4" D	Alan Bradley	802T-W1	8
2	10-32 X 2" Hex Screw	80/20		9
2	10-32 Washer	80/20		10
2	10-32 Lock Washer	80/20		11
2	10-32 Hex Nut	80/20		12
2	5/16"-18 X 7/8" Hex Screw	80/20		13
2	5/16" Flat Washer	80/20		14
2	5/16"-18 Hex Nut	80/20		15
2	1"-8 X 1-3/4" Hex Screw	80/20		16
2	1"-8 X 2-3/4" Hex Screw	80/20		17
2	1"-8 Hex Nut	80/20		18

Table A-3: Coil line upper assembly parts list

Coil Line Feeder Assembly Parts List				
Item #	**Description**	**Vendor**	**Part #**	**Qty**
3	Roller Bar 4 Meter	Quixx Smart	A4MS	1
3	Feed Bar, In-Feed	Custom	6CL58190	2
2	Mounting Bracket, Cylinder	Custom	6CL58191	3
2	Mounting Plate, Air Cylinder	Custom	6CL58192	4
1	Base Plate, Valve	Custom	6CL58106	5
2	8 Hole Inside Corner Bracket	80/20	4513	6
1	T- Slotted Profile, 1530 Lite X 65"	80/20	1530 LITE X 65	7
2	T-Slotted Profile, 1515 Lite X 44.25"	80/20	1515 LITE X 44_25	8
2	T-Slotted Profile, 1515 Lite X 42.00"	80/20	1515 LITE X 42_0	9
2	T-Slotted Profile, 1515 Lite X 33.25"	80/20	1515 LITE X 33.25	10
1	T-Slotted Profile, 1515 Lite X 33.00"	80/20	1515 LITE X 33.00	11
1	Ground Polished Steel Tube, 1515 Tube X 72"	80/20	5015 TUBE X 72	12
1	Ground Polished Steel Tube, 1515	80/20	5015 TUBE X 48	13

	TUBE X 48"			
4	1-1/2" Food Grade Sealed Ball Bearing	McMaster	3730T28	14
2	Lubricated Sleeve Bearing, 1/2"OD, 3/8"ID, 3/8"Length	McMaster	6391K172	15
2	Air Cylinder, 1-1/2" Bore X 16" Stroke	Bimba	C-1716-DPW-D-229-F-D-231-1-2-14A-15	16
1	MAC Valve With PR92C-KECA-9 Regulator	Neff Eng	92B-JAF-BAA-DM-DDAP-1DM-9	17
1	3/8" OD Speed Control 1/4" NPT	SMC	ASN2-N02-S	19
3	Air Fitting	SMC	KQ2L11-35S	20
3	"T" Tube Fitting 3/8" OD	SMC	KQ2T11-00	21
4	Single Horizontal Base, 1-1/2"	80/20	5880	22
2	Rubber Bumper, 1-1/2"	80/20	2849	23
6	5 Hole 90° Joining Plate	80/20	4351	24
20	Standard T-Nut	80/20	3203	25
19	Double Economy T- Nuts	80/20	3279	26
8	Triple Economy T- Nuts	80/20	3285	27
8	1/4"-20 X 5/8" Bolt, SHCS	80/20	3067	28
12	5/16"-18 X 1/2" Bolt, SHCS	80/20	3106	29
44	5/16"-18 UNC X 11/16" Lg. Flngd, BHCS	80/20	3330	30
14	5/16"-18 X 7/8, BHSCS	80/20	3119	31
12	5/16"-18 X 1- 1/4" Bolt	80/20	3123	32
2	#6-32 x 1-1/2" Cap Screw	80/20		33
2	#6-32 Hex Nut	80/20		34
2	#6-32 Lock Washer	80/20		35
6	1/4"-20 x 1" Hex Bolt - UNC	80/20		36
6	1/4" Narrow-Flat Washer	80/20		37
4	1/4" Flat Washer	80/20		38
14	1/4" Lock Washer	80/20		39
6	1/4"-20 Hex Nut	80/20		40
26	5/16" Flat Washer	80/20		41
4	1/2"-13 x 1-3/4" Hex Bolt - UNC	80/20		42
4	1/2" Flat Washer	80/20		43
4	1/2" Lock Washer	80/20		44
4	1/2"-13 Hex Nut	80/20		45
1	3/8" Air Lines, ~20'	80/20		46
1	3/8" to 1/4" Quick Fitting	SMC	KQ2H07-11A	47
1	1/4" Quick Fitting to 1/8" NPT Female Thread	SMC	KQ2F07-34A	48
1	Pressure Switch Sensor	Honeywell	480-2041-ND	49

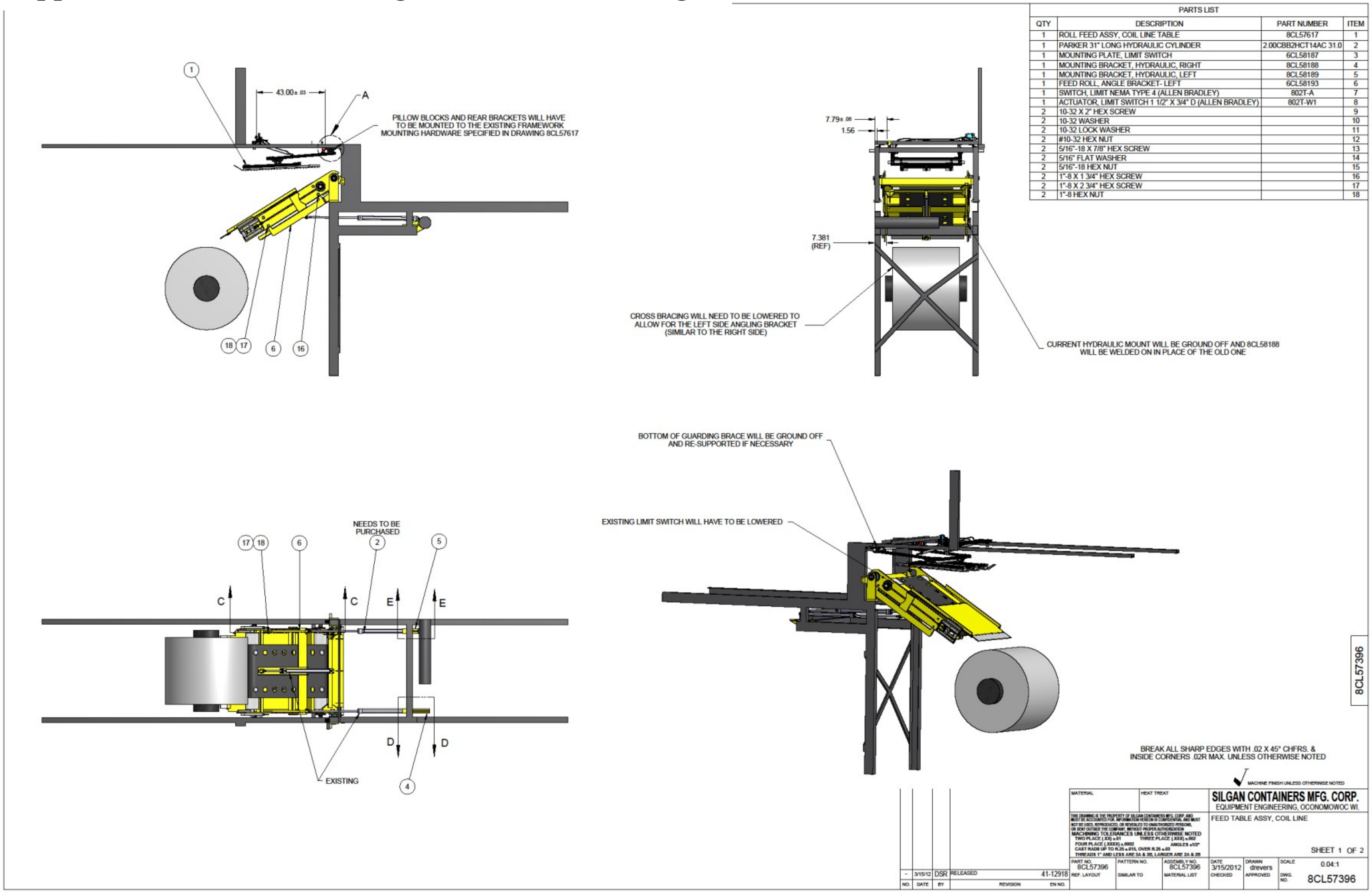
		Sensing		
1	4-Pin MAC Valve Connector 19"	Mencom Corp	MDC-4MR-2-0.5M	50
1	M12 Female Connector Straight Cable 5M	Murr	PVC-0B	51
2	1/8" NPT to 3/8" Tube Elbow	SMC	KQ2L11-34AS	52
2	1/8" Male to 1/4" Female Reducer	McMaster	50785K260	53
2	1/4" NPT to 3/8" Tube Dual Speed Control	SMC	ASD430F-N02-11S	54

Table A-4: Coil line feeder assembly parts list

Coil Line Electrical Components				
Item #	**Description**	**Vendor**	**Part #**	**Qty**
1	Push-Button, 30mm, blk, 1NO	Allen-Bradley	800T-A2D1	4
2	Selector Switch, blk, 1NO/1NC	Allen-Bradley	800T-H2A	1
3	Legend Plate, 30mm, UP	Allen-Bradley	800T-X556	1
4	Legend Plate, 30mm, DOWN	Allen-Bradley	800T-X503	1
5	Control Box, 12x14	-	-	1
6	Terminal Block, 2-pt Pass-Thru	Allen-Bradley	1492-xx	26
7	Cover for 1492 TB	Allen-Bradley	1492-N36	1
8	Clamp for 1492 TB	Allen-Bradley	1492-xx	2
9	Din Rail, 15mm, 10" Long	-	-	1
10	Relay, 3-pole, 120VAC Coil	Allen-Bradley	700-HA33A1	2
11	Relay Base, 3-pole	Allen-Bradley	700-HN101	2
12	PLC-5 Input Module, 16-pt, 120V	Allen-Bradley	1771-IAD	1
13	PLC-5 Output Module, 16-pt, 120V	Allen-Bradley	1771-OAD	1
14	Misc Parts - Wires, Cables, etc	-	-	1
15	Legend Plate, 30mm, RAISE	Allen-Bradley	800T-X535	1
16	Legend Plate, 30mm, LOWER	Allen-Bradley	800T-X526	1
17	Legend Plate, 30mm, OUT	Allen-Bradley	800T-X534	2
18	Legend Plate, 30mm, IN	Allen-Bradley	800T-X515	2
19	Legend Plate, 30mm, START	Allen-Bradley	800T-X547	1
20	Legend Plate, 30mm, red, STOP	Allen-Bradley	800T-X550	1
21	Legend Plate, 30mm, JOG FWD	Allen-Bradley	800T-X518	2
22	Legend Plate, 30mm, JOG REV	Allen-Bradley	800T-X519	2
23	Legend Plate, 30mm, yel, E-STOP	Allen-Bradley	800T-X504Y	1

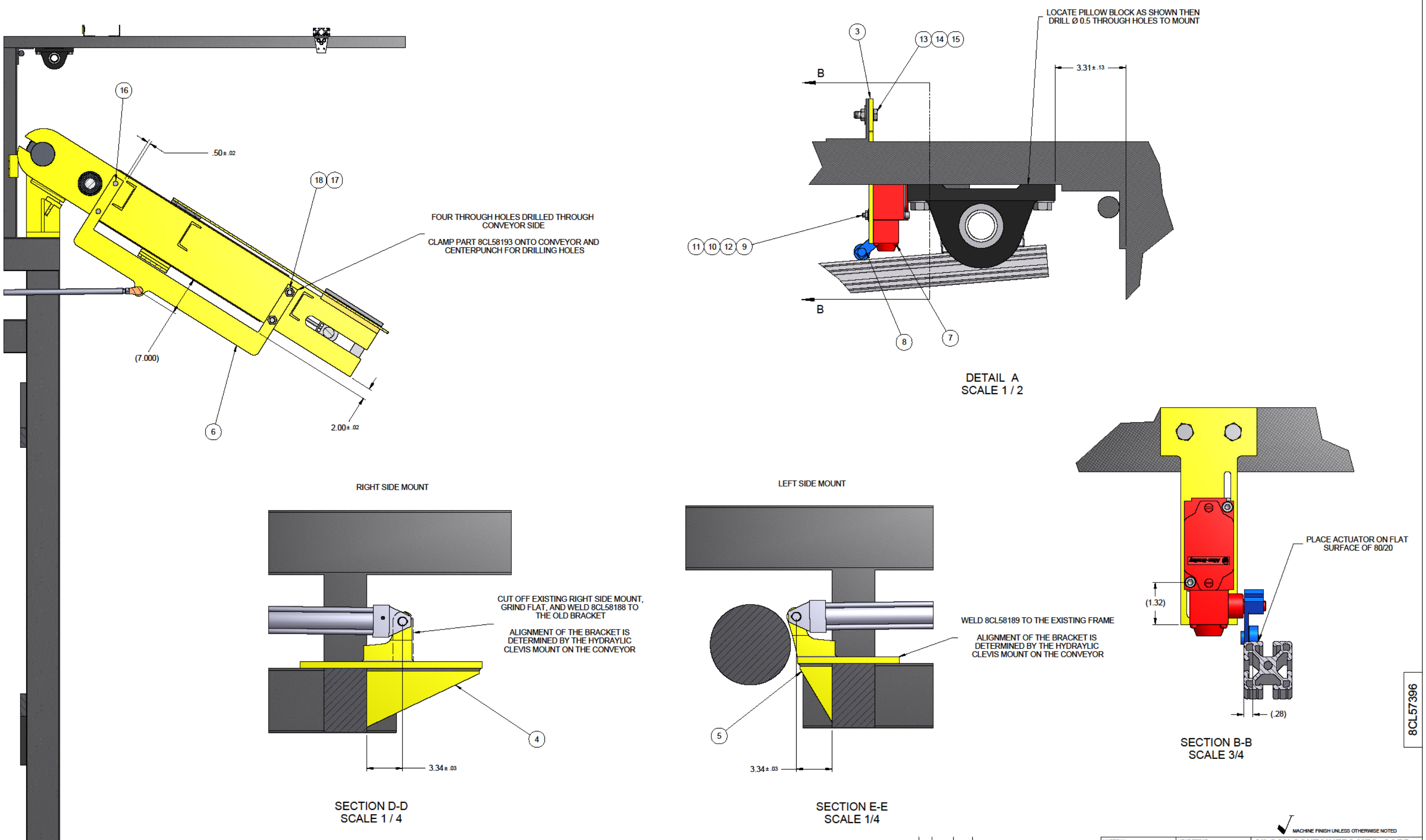
Table A-5: Coil line feeder assembly electrical parts list

Appendix B: Detailed Drawings of Final Roller Design



PARTS LIST

QTY	DESCRIPTION	PART NUMBER	ITEM
1	ROLL FEED ASSY, COIL LINE TABLE	8CL57617	1
1	PARKER 31" LONG HYDRAULIC CYLINDER	2.00CBB2HCT14AC 31.0	2
1	MOUNTING PLATE, LIMIT SWITCH	6CL58187	3
1	MOUNTING BRACKET, HYDRAULIC, RIGHT	8CL58188	4
1	MOUNTING BRACKET, HYDRAULIC, LEFT	8CL58189	5
1	FEED ROLL, ANGLE BRACKET- LEFT	6CL58193	6
1	SWITCH, LIMIT NEMA TYPE 4 (ALLEN BRADLEY)	802T-A	7
1	ACTUATOR, LIMIT SWITCH 1 1/2" X 3/4" D (ALLEN BRADLEY)	802T-W1	8
2	10-32 X 2" HEX SCREW		9
2	10-32 WASHER		10
2	10-32 LOCK WASHER		11
2	#10-32 HEX NUT		12
2	5/16"-18 X 7/8" HEX SCREW		13
2	5/16" FLAT WASHER		14
2	5/16"-18 HEX NUT		15
2	1"-8 X 1 3/4" HEX SCREW		16
2	1"-8 X 2 3/4" HEX SCREW		17
2	1"-8 HEX NUT		18



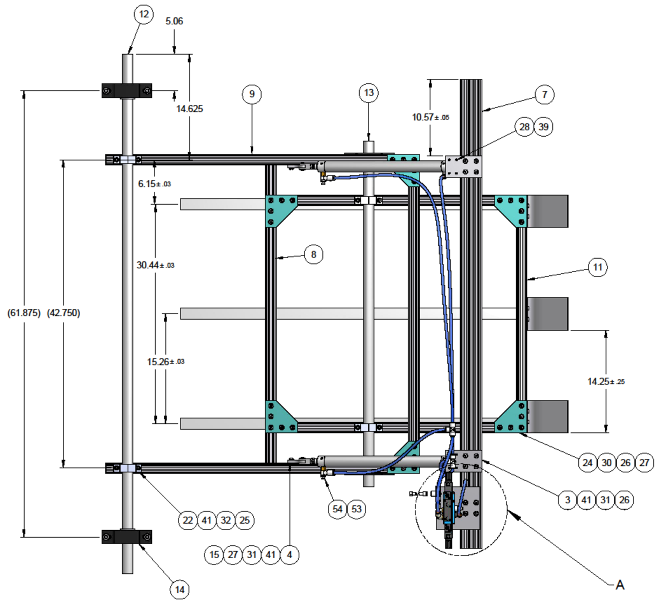
SECTION C-C
SCALE 0.13 : 1

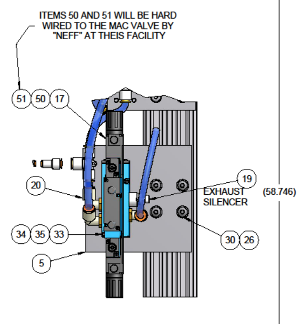
MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL	HEAT TREAT	SILGAN CONTAINERS MFG. CORP. EQUIPMENT ENGINEERING, OCONOMOWOC WI.
THIS DRAWING IS THE PROPERTY OF SILGAN CONTAINERS MFG. CORP. AND MUST BE ACCOUNTED FOR. INFORMATION HEREON IS CONFIDENTIAL AND MUST NOT BE USED, REPRODUCED, OR REVEALED TO UNAUTHORIZED PERSONS, OR SENT OUTSIDE THE COMPANY, WITHOUT PROPER AUTHORIZATION MACHINING TOLERANCES UNLESS OTHERWISE NOTED TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002 FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2° CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03 THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B		FEED TABLE ASSY, COIL LINE SHEET 2 OF 2

PART NO. 8CL57396	PATTERN NO.	ASSEMBLY NO. 8CL57396	DATE 3/15/2012	DRAWN drevers	SCALE 0.04:1
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 8CL57396





DETAIL A
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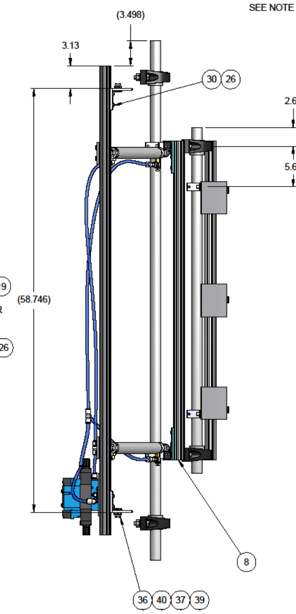
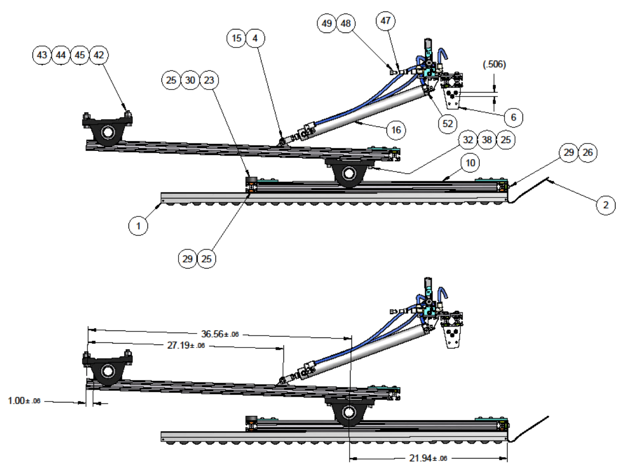
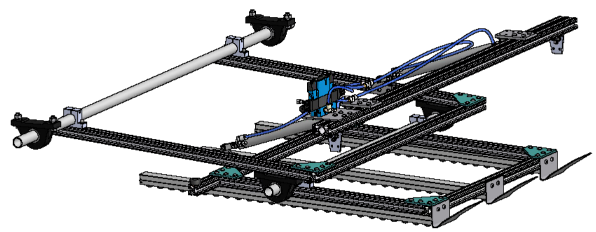




PARTS LIST			
QTY	DESCRIPTION	PART NUMBER	ITEM
3	ROLLER BAR 4 METER, "QUIXX SMART"	A4MS	1
3	FEED BAR, INFEED	6CL58190	2
2	MOUNTING BRACKET, CYLINDER	6CL58191	3
2	MOUNTING PLATE, AIR CYLINDER	6CL58192	4
1	BASE PLATE, VALVE	6CL58106	5
2	8 HOLE INSIDE CORNER BRACKET, "80/20"	4513	6
1	T- SLOTTED PROFILE, 1530 LITE X 65,"80/20"	1530 LITE X 65	7
2	T-SLOTTED PROFILE, 1515 LITE X 44.25, "80/20"	1515 LITE X 44_25	8
2	T-SLOTTED PROFILE, 1515 LITE X 42.00, "80/20"	1515 LITE X 42_0	9
2	T-SLOTTED PROFILE, 1515 LITE X 33.25, "80/20"	1515 LITE X 33.25	10
1	T-SLOTTED PROFILE, 1515 LITE X 33.00, "80/20"	1515 LITE X 33.00	11
1	GROUND POLISHED STEEL TUBE, 1515 TUBE X 72, "80/20"	5015 TUBE X 72	12
1	GROUND POLISHED STEEL TUBE, 1515 TUBE X 48, "80/20"	5015 TUBE X 48	13
4	1 1/2" FOOD GRADE SEALED BALL BEARING "MCMASTER"	3730T28	14
2	LUBRICATED SLEEVE BEARING, 1/2OD, 3/8ID, 3/8LENGTH "MCMASTER"	6391K172	15
2	AIR CYLINDER, 1 1/2" BORE X 16" STROKE, "BIMBA"	C_1716_DPW_D_229__F_D_231_1__2_14A-15	16
1	MAC VALVE WITH PR92C-KECA-9 REGULATOR	92B-JAF-BAA-DM-DDAP-1DM-9	17
1	3/8 OD SPEED CONTROL 1/4 NPT "SMC"	ASN2-N02-S	19
3	AIR FITTING, "SMC"	KQ2L11-35S	20
3	"T" TUBE FITTING 3/8 OD "SMC"	KQ2T11-00	21
4	SINGLE HORIZONTAL BASE, 1 1/2", "80/20"	5880	22
2	RUBBER BUMPER,1 1/2", "80/20"	2849	23
6	5 HOLE 90° JOINING PLATE "80/20"	4351	24
20	STANDARD T-NUT, "80/20"	3203	25
19	DOUBLE ECONOMY T NUTS "80/20"	3279	26
8	TRIPLE ECONOMY T NUTS "80/20"	3285	27
8	1/4-20 X 5/8" BOLT, SHCS, "80/20"	3067	28
12	5/16-18 X 1/2" BOLT, SHCS, "80/20"	3106	29
44	5/16-18 UNC X 11/16" Lg. Flngd,BHCS, "80/20"	3330	30
14	5/16-18 X 7/8, BHSCS, "80/20"	3119	31
12	5/16-18 X 1 1/4" BOLT, "80/20"	3123	32
2	#6-32 x 1 1/2" CAP SCREW		33
2	#6-32 HEX NUT		34
2	#6-32 LOCK WASHER		35
6	1/4-20 x 1" Hex Bolt - UNC		36
6	1/4" NARROW- FLAT WASHER		37
4	1/4" FLAT WASHER		38
14	1/4" Lock Washer		39
6	1/4-20 Hex Nut		40
26	5/16 FLAT WASHER		41
4	1/2-13 x 1 3/4" Hex Bolt - UNC		42
4	1/2" FLAT WASHER		43
4	1/2" Lock Washer		44
4	1/2-13 Hex Nut		45
1	3/8" AIR LINES, ~20'		46
1	3/8 TO 1/4 QUICK FITTING "SMC"	KQ2H07-11A	47
1	1/4 QUICK FITTING TO 1/8 NPT FEMALE THREAD "SMC"	KQ2F07-34A	48
1	PRESSURE SWITCH SENSOR "HONEYWELL SENSING"	480-2041-ND	49
1	4-PIN MAC VALVE CONNECTOR 19" "MENCOM CORP"	MDC-4MR-2-0.5M	50
1	M12 FEMALE CONNECTOR STREIGHT CABLE 5M "MURR"	PVC-0B	51
2	1/8 NPT TO 3/8 TUBE ELBOW "SMC"	KQ2L11-34AS	52
2	1/8 MALE TO 1/4 FEMALE REDUCER "MCMASTER"	50785K260	53
2	1/4 NPT TO 3/8 TUBE DUAL SPEED CONTROL, "SMC"	ASD430F-N02-11S	54

SEE NOTE → item 1. Rows 22 and 46–54 are marked with revision symbol A.

NOTE: ITEM #1 IS PURCHASED IN A 4 METER SECTION, THEREFORE ONLY A QUANTITY OF ONE WILL NEED TO BE PURCHASED AND THEN CUT INTO 3, 48" SECTIONS.



8CL57617

NOTE: REMOVE GUARD MOUNTING BRACKET ON U CHANNEL FRAME (FRONT SIDE) TO ALLOW FOR ACURATE BEARING MOUNTING POSITION

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. & INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

SEE SHEET 2 FOR AIR PIPING CONNECTIONS

MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
A	9/19/12	DSR	ADDED ITEMS 47 to 54; ADDED 1 QTY TO ITEM 21, ITEM 46 1/4 TO 3/8	41-12918
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL | HEAT TREAT

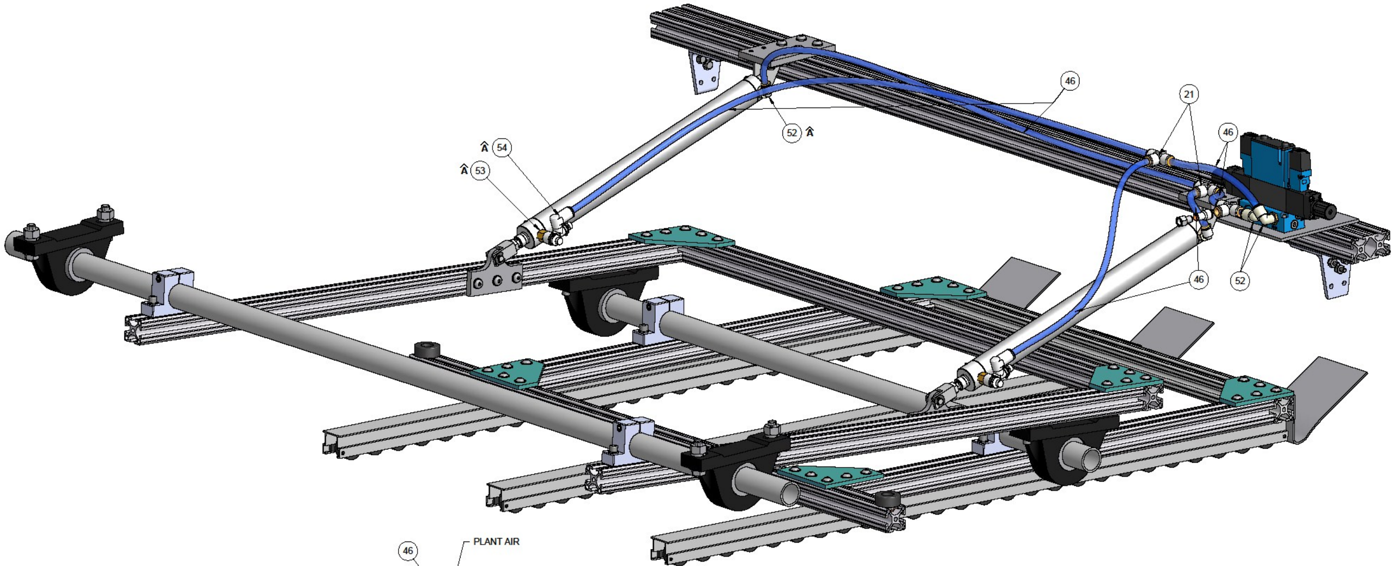
SILGAN CONTAINERS MFG. CORP.
EQUIPMENT ENGINEERING, OCONOMOWOC WI.

MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

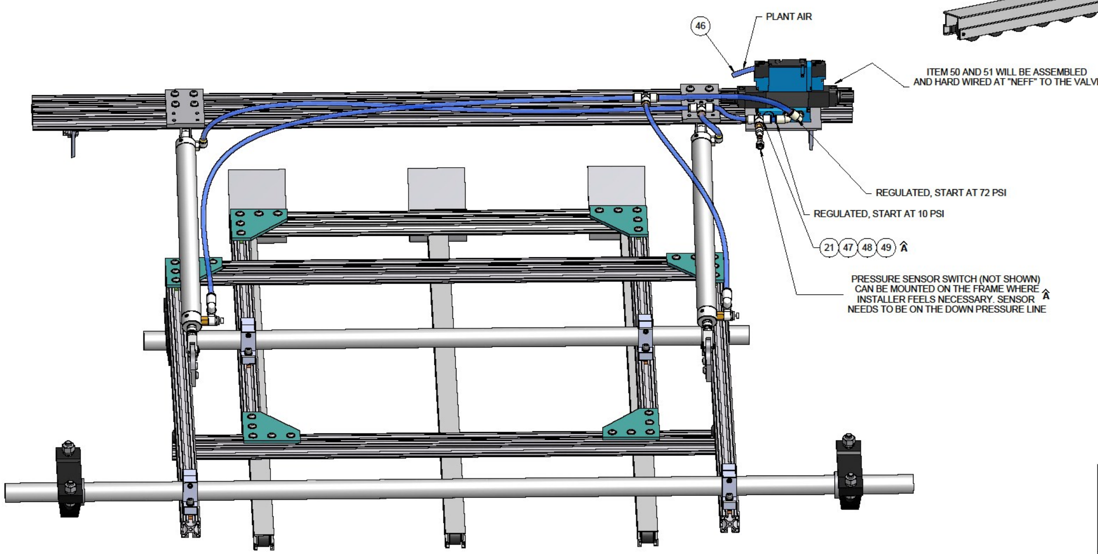
ROLL FEED ASSY, COIL LINE TABLE
COIL LINE FEED TABLE ASSY

SHEET 1 OF 2

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
8CL57617		8CL57396	1/27/2012	DSR	1:7
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 8CL57617



SCALE 1/3:1



SCALE 1/3:1

8CL57617

MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
A	9/19/12	DSR	ADDED ITEMS 47 to 54; ADDED 1 QTY TO ITEM 21, ITEM 48- 1/4 TO 3/8	41-12918
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL	HEAT TREAT	SILGAN CONTAINERS MFG. CORP. EQUIPMENT ENGINEERING, OCONOMOWOC WI.
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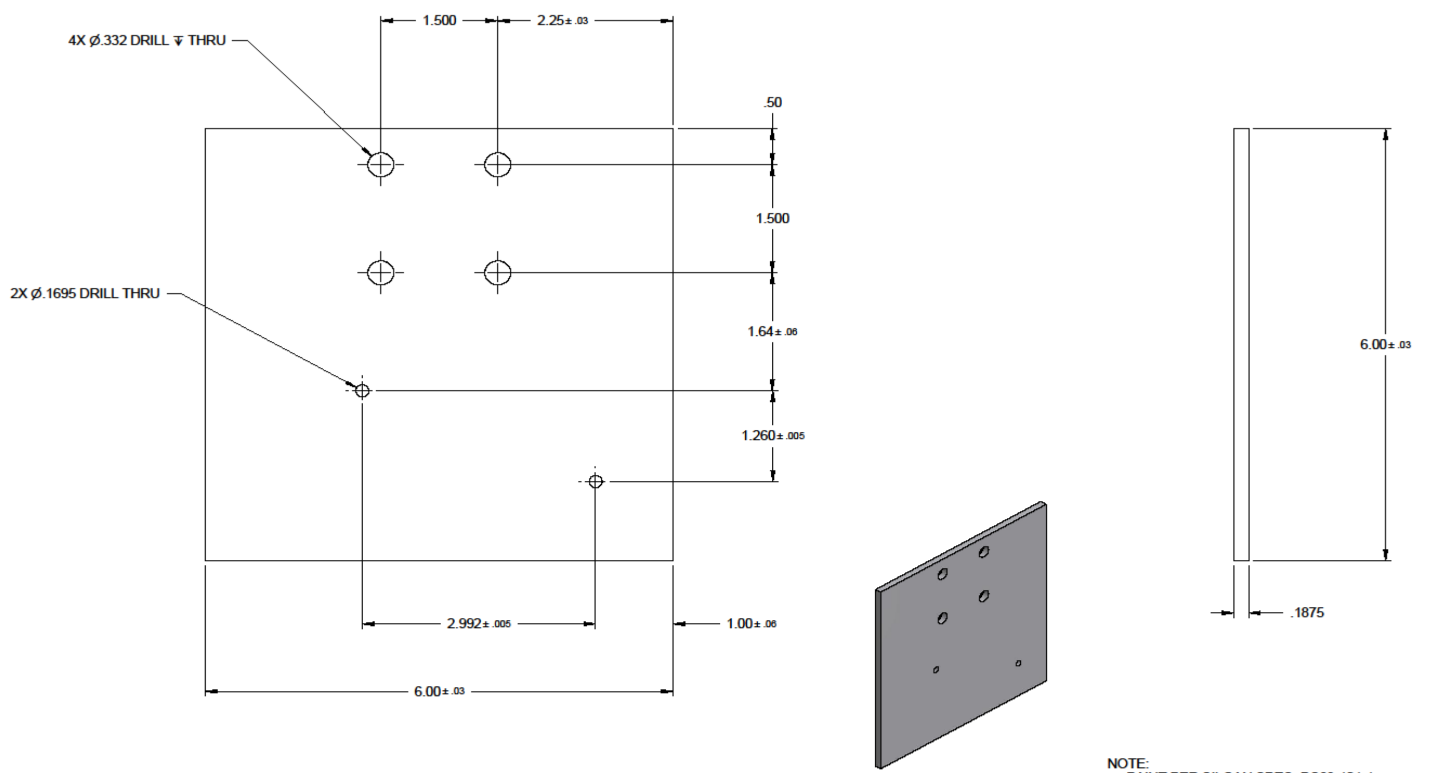
PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
8CL57617		8CL57396	1/27/2012	DSR	1:7
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 8CL57617



6CL58106

NOTE:
PAINT PER SILGAN SPEC. DS69-101-1

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL 1018 C.R. STEEL	HEAT TREAT		SILGAN CONTAINERS MFG. CORP. EQUIPMENT ENGINEERING, OCONOMOWOC WI.			
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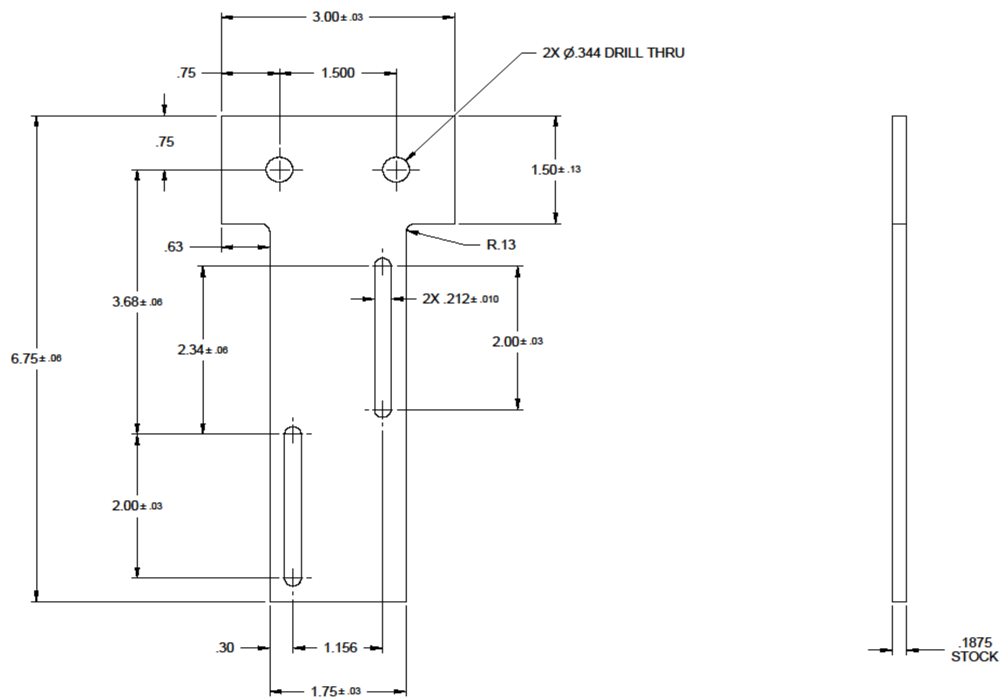
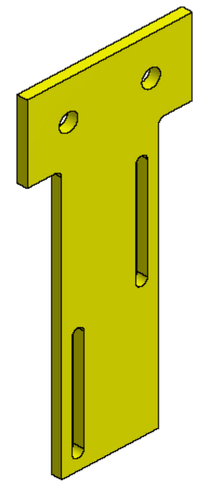
PART NO. 6CL58106	PATTERN NO.	ASSEMBLY NO. 8CL57617	DATE 1/27/2012	DRAWN DSR	SCALE FULL	
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58106	





NOTE:
PAINT PER SILGAN SPEC. DS69-101-1

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 MACHINE FINISH UNLESS OTHERWISE NOTED

6CL58187

MATERIAL	HEAT TREAT	SILGAN CONTAINERS MFG. CORP. EQUIPMENT ENGINEERING, OCONOMOWOC WI.
1018 C.R. STEEL		

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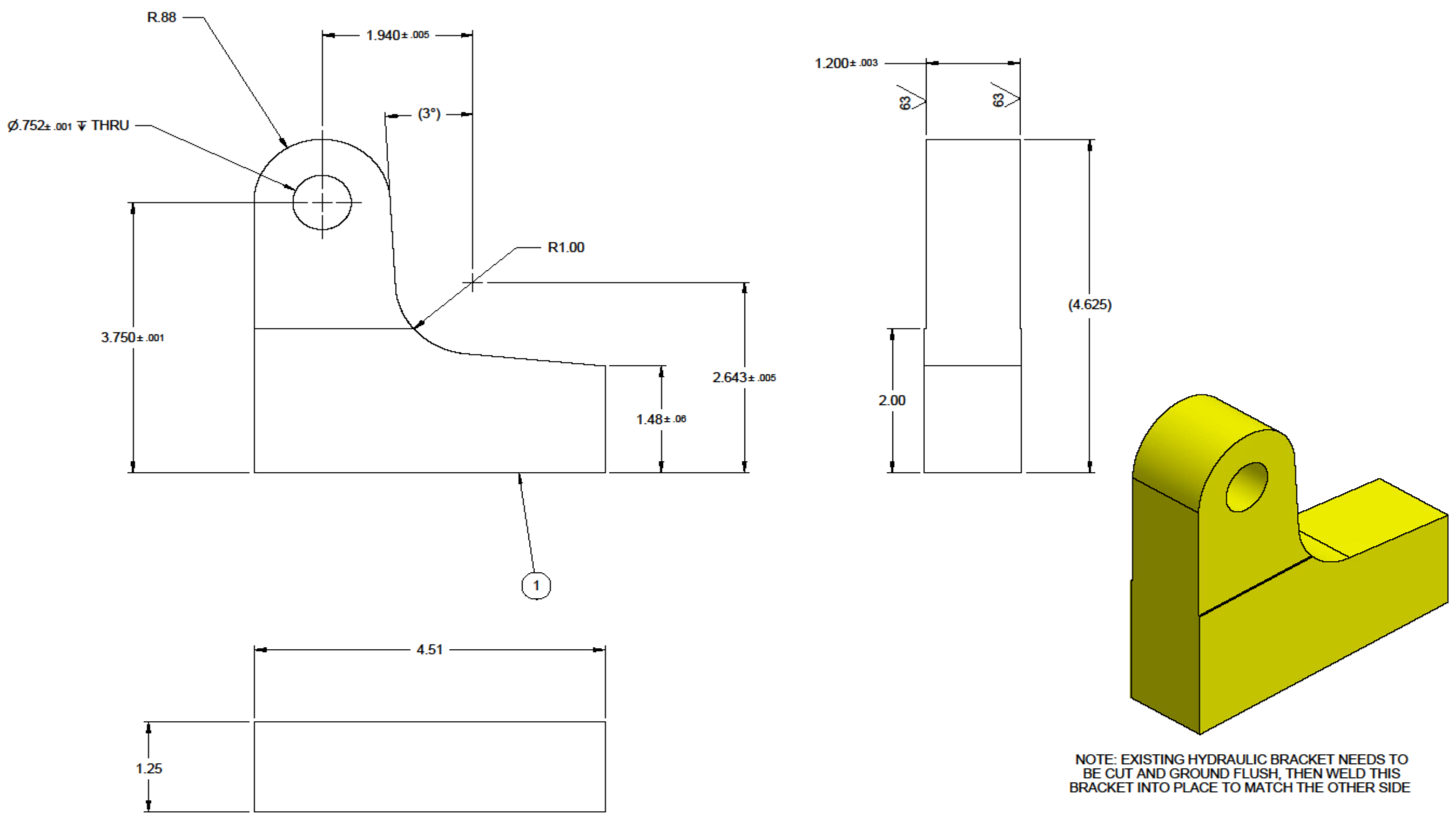
MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

MOUNTING PLATE, LIMIT SWITCH
COIL LINE FEED TABLE ASSY

SHEET 1 OF 1

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58187		8CL57396	1/27/2012	DSR	FULL
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58187

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918



NOTE: EXISTING HYDRAULIC BRACKET NEEDS TO BE CUT AND GROUND FLUSH, THEN WELD THIS BRACKET INTO PLACE TO MATCH THE OTHER SIDE

6CL58188

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. & INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 ✓ MACHINE FINISH UNLESS OTHERWISE NOTED

RAW MATERIAL LIST			
QTY	DESCRIPTION	MATERIAL	ITEM
1	1 1/4" X 5" FLAT-5" LG.	ASTM A572	1

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL: SEE TABLE
HEAT TREAT:

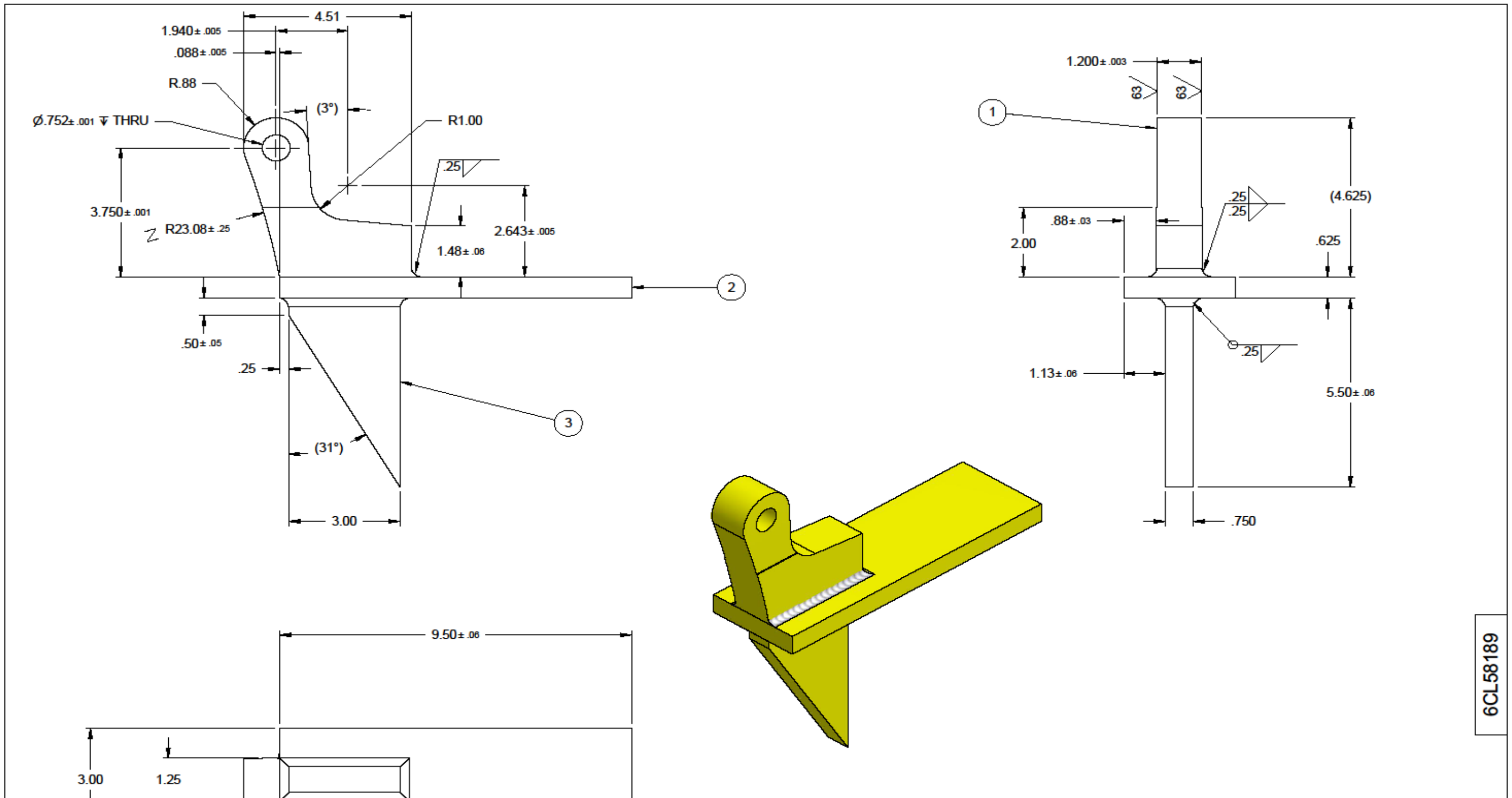
SILGAN CONTAINERS MFG. CORP.
EQUIPMENT ENGINEERING, OCONOMOWOC WI.

MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

MOUNTING BRACKET, HYDRAULIC CYL., RIGHT
RIGHT SIDE
COIL LINE FEED TABLE ASSY

SHEET 1 OF 1

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58188		8CL57396	1/27/2012	DSR	FULL
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58188



BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 √ MACHINE FINISH UNLESS OTHERWISE NOTED

RAW MATERIAL LIST

QTY	DESCRIPTION	MATERIAL	ITEM
1	1 1/4" X 5" FLAT -5" LG.	ASTM A572	1
1	5/8" X 3" FLAT - 9 1/2" LG.	ASTM A572	2
1	3/4" X 3" FLAT - 5 1/2" LG.	ASTM A572	3

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL: SEE LIST
HEAT TREAT:

SILGAN CONTAINERS MFG. CORP.
EQUIPMENT ENGINEERING, OCONOMOWOC WI.

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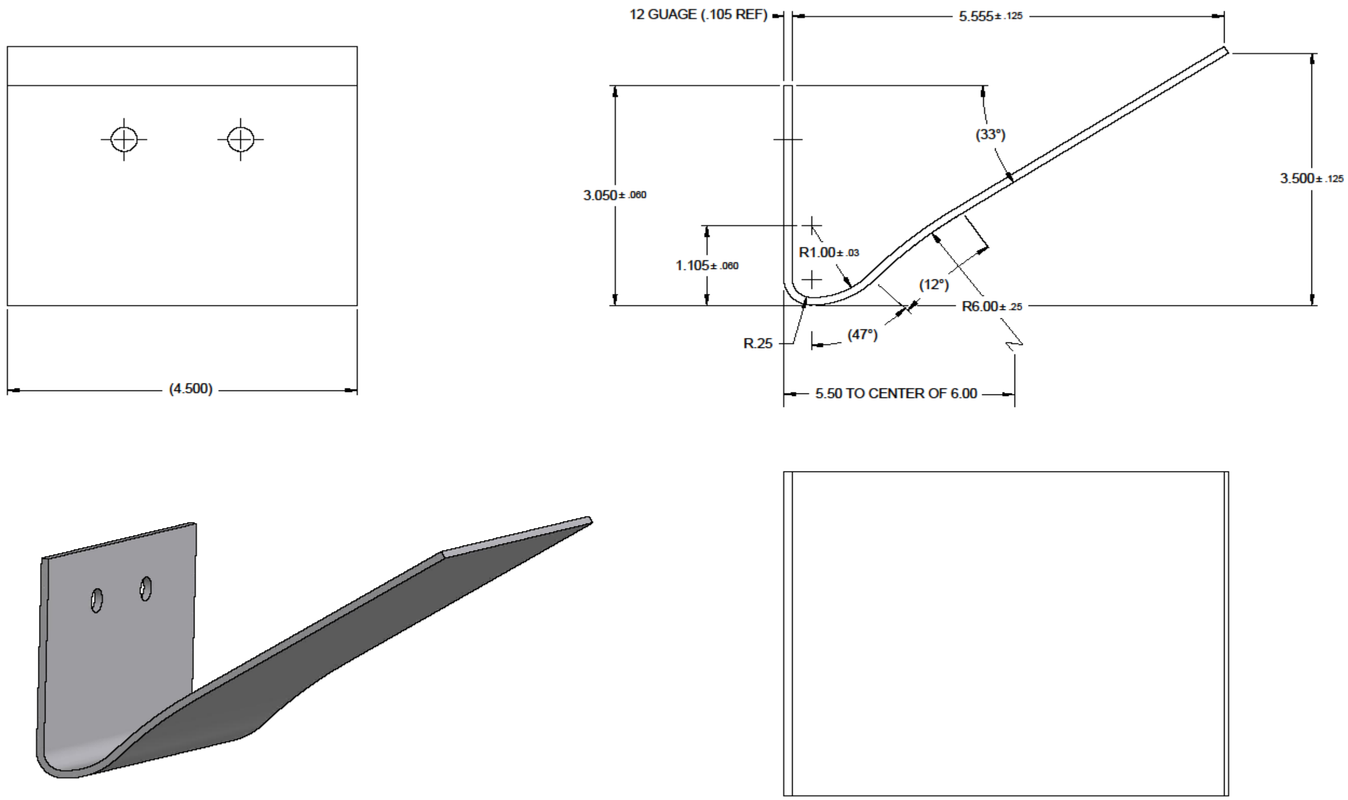
MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

MOUNTING BRACKET, HYDRAULIC CYL., LEFT SIDE
COIL LINE FEED TABLE ASSY

SHEET 1 OF 1

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58189		8CL57396	1/27/2012	DSR	1:2
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58189



BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 MACHINE FINISH UNLESS OTHERWISE NOTED

6CL58190

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL: STAINLESS STEEL TYPE 304	HEAT TREAT	**SILGAN CONTAINERS MFG. CORP.** EQUIPMENT ENGINEERING, OCONOMOWOC WI.

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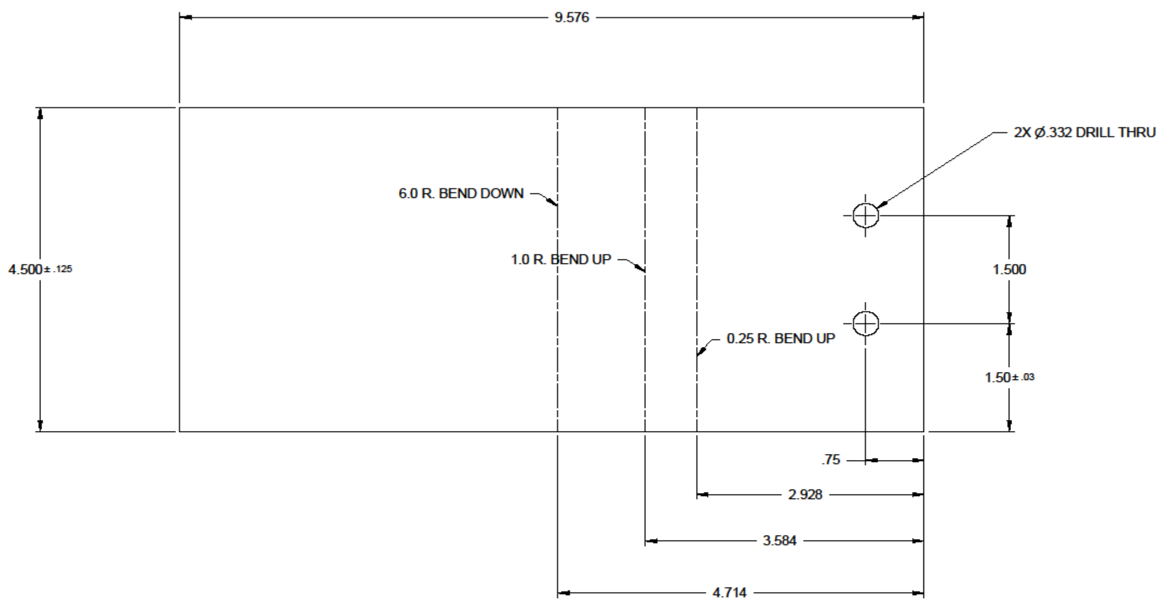
MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

FEED BAR, INFEED
ROLL FEED ASSY
COIL LINE FEED TABLE ASSY

SHEET 1 OF 2

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58190		8CL57617	1/27/2012	DSR	FULL
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58190



6CL58190

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 MACHINE FINISH UNLESS OTHERWISE NOTED

MATERIAL	HEAT TREAT	SILGAN CONTAINERS MFG. CORP.
STAINLESS STEEL TYPE 304		EQUIPMENT ENGINEERING, OCONOMOWOC WI.

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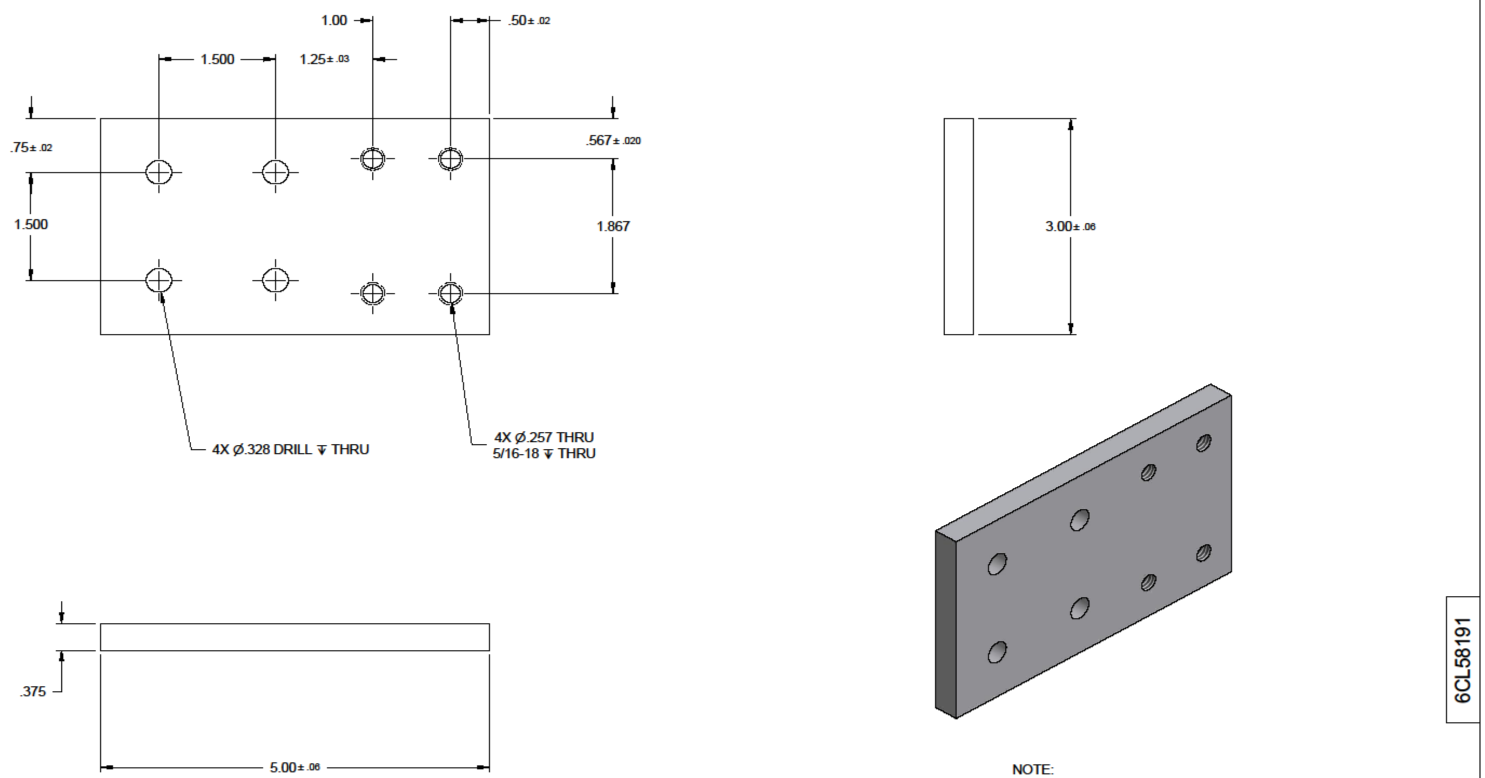
MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

FEED BAR, INFEED
ROLL FEED ASSY
COIL LINE FEED TABLE ASSY

SHEET 2 OF 2

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58190		8CL57617	1/27/2012	DSR	FULL
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58190

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918



NOTE:
PAINT PER SILGAN SPEC. DS69-101-1

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

MATERIAL 1018 C.R. STEEL		HEAT TREAT	**SILGAN CONTAINERS MFG. CORP.** EQUIPMENT ENGINEERING, OCONOMOWOC WI.		
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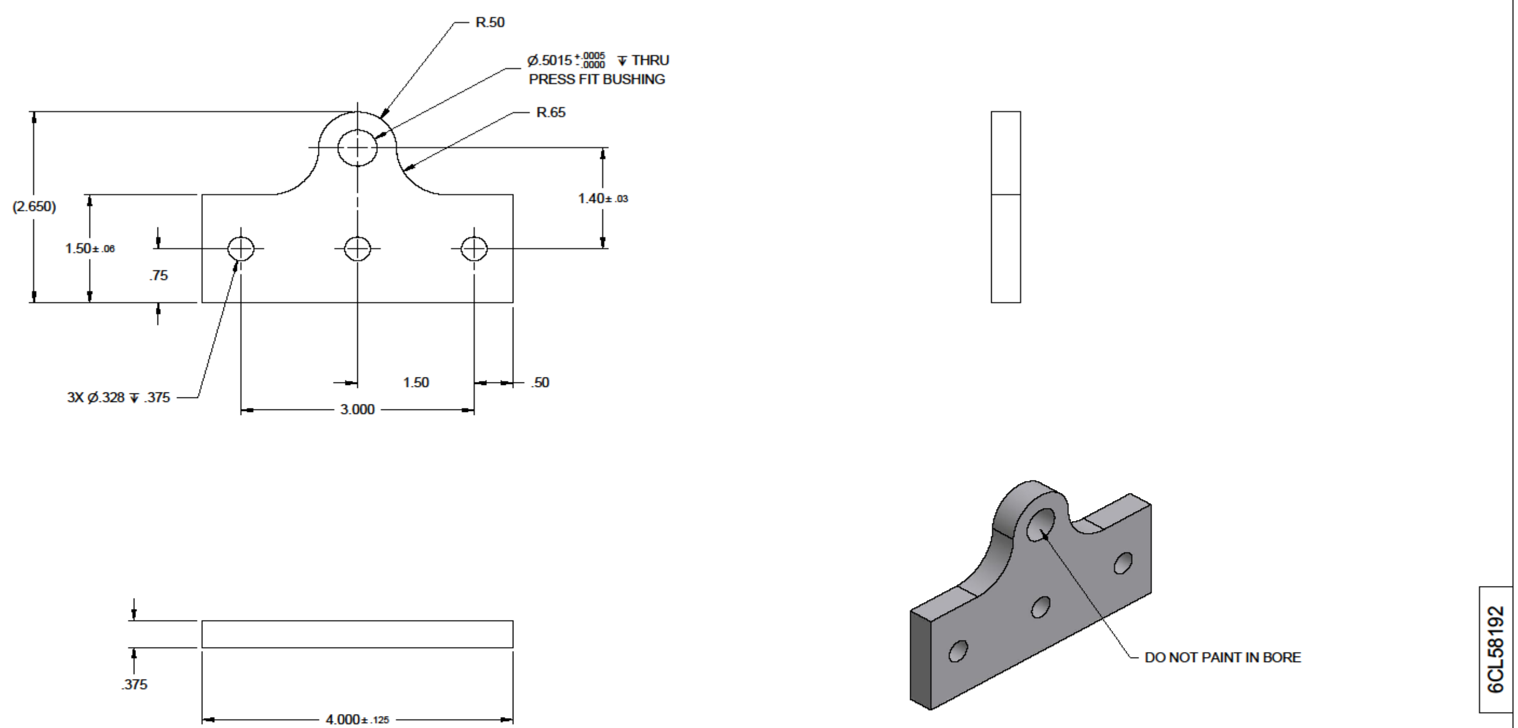
PART NO. 6CL58191	PATTERN NO.	ASSEMBLY NO. 8CL57617	DATE 1/27/2012	DRAWN DSR	SCALE FULL
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58191



NOTE:
PAINT PER SILGAN SPEC. DS69-101-1

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. &
INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

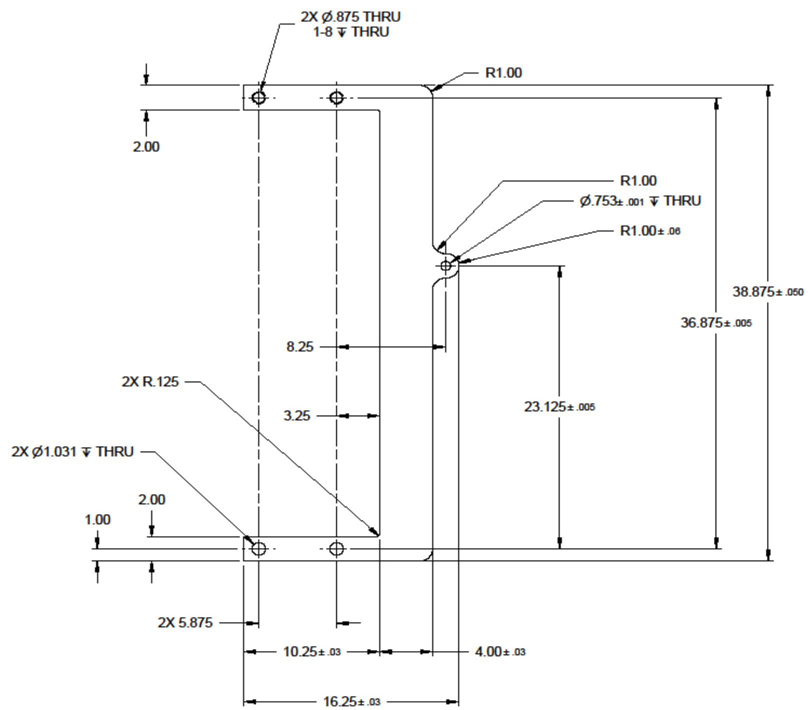
MATERIAL 1018 C.R. STEEL	HEAT TREAT	SILGAN CONTAINERS MFG. CORP. EQUIPMENT ENGINEERING, OCONOMOWOC WI.

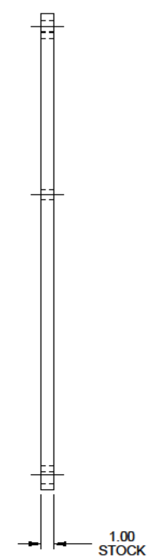
MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

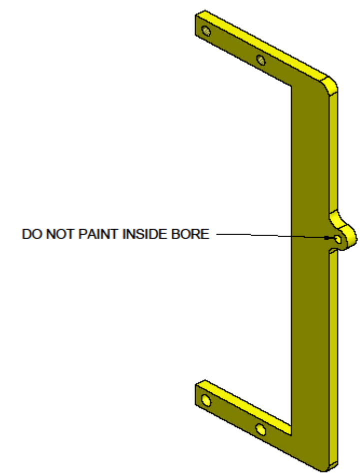
MOUNTING PLATE, AIR CYLINDER
ROLL FEED ASSY
COIL LINE FEED TABLE ASSY

SHEET 1 OF 1

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58192		8CL57617	1/27/2012	DSR	FULL
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58192







6CL58193

NOTE:
PAINT PER SILGAN SPEC. DS69-101-1

NOTE: FOUR 1" THROUGH HOLES NEED TO BE DRILLED IN THE LEFT SIDE OF THE CONVEYOR FOR MOUNTING OF THIS BRACKET

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. & INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

125 √ MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
-	3/15/12	DSR	RELEASED	41-12918

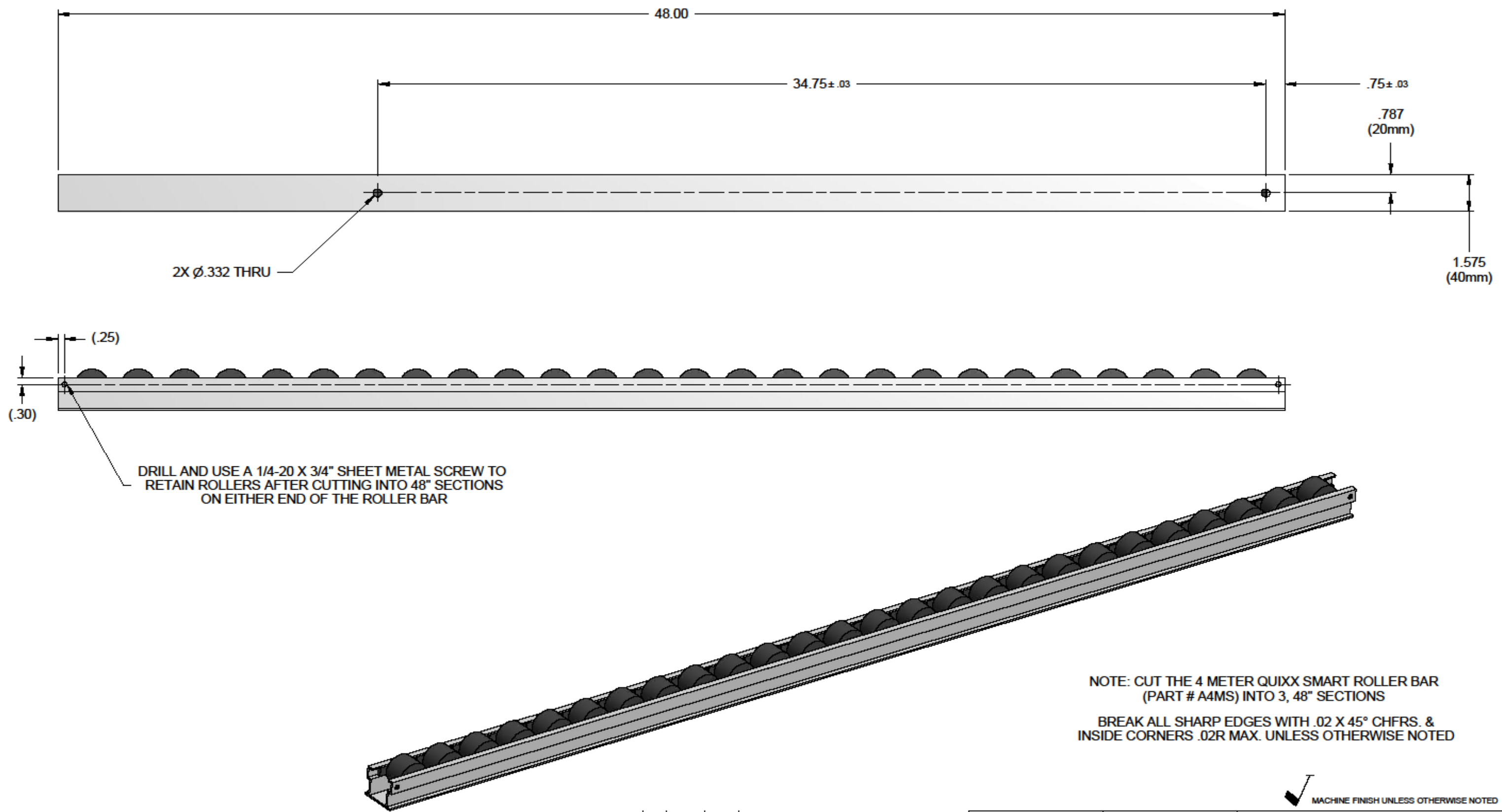
MATERIAL 1018 C.R. STEEL	HEAT TREAT	**SILGAN CONTAINERS MFG. CORP.** EQUIPMENT ENGINEERING, OCONOMOWOC WI.

MACHINING TOLERANCES UNLESS OTHERWISE NOTED
TWO PLACE (.XX) ±.01 THREE PLACE (.XXX) ±.002
FOUR PLACE (.XXXX) ±.0002 ANGLES ±1/2°
CAST RADII UP TO R.25 ±.015, OVER R.25 ±.03
THREADS 1" AND LESS ARE 3A & 3B, LARGER ARE 2A & 2B

FEED ROLL, ANGLE BRACKET - LEFT
LEFT SIDE HYDRAULIC BRACKET
COIL LINE FEED TABLE ASSY

SHEET 1 OF 1

PART NO.	PATTERN NO.	ASSEMBLY NO.	DATE	DRAWN	SCALE
6CL58193		8CL57396	1/27/2012	DSR	.17:1
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58193



6CL58627

NOTE: CUT THE 4 METER QUIXX SMART ROLLER BAR (PART # A4MS) INTO 3, 48" SECTIONS

BREAK ALL SHARP EDGES WITH .02 X 45° CHFRS. & INSIDE CORNERS .02R MAX. UNLESS OTHERWISE NOTED

MACHINE FINISH UNLESS OTHERWISE NOTED

NO.	DATE	BY	REVISION	EN NO.
-	7/16/12	DSR	RELEASED	41-12918

MATERIAL	HEAT TREAT	SILGAN CONTAINERS MFG. CORP. EQUIPMENT ENGINEERING, OCONOMOWOC WI.		
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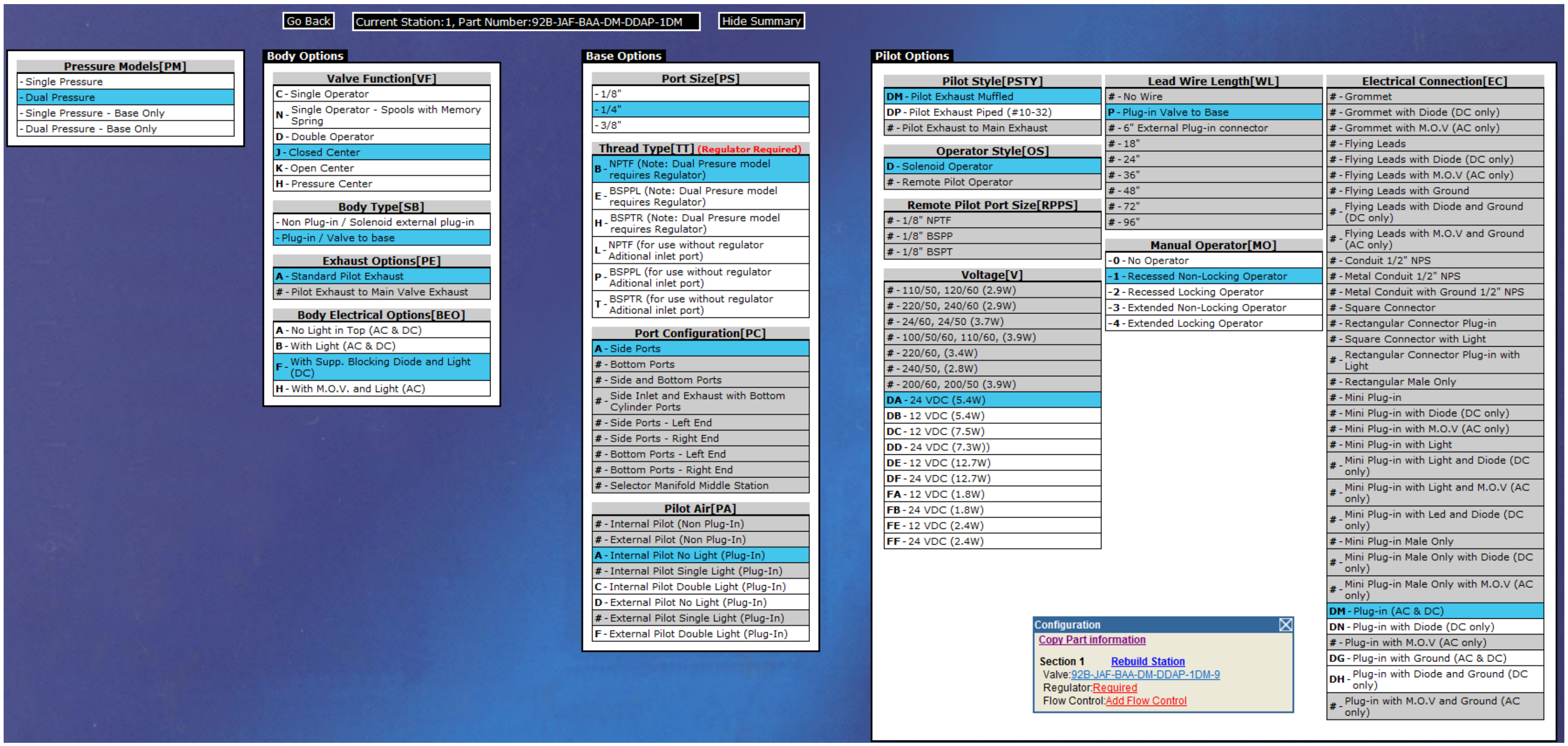
PART NO. 6CL58627	PATTERN NO.	ASSEMBLY NO. 8CL57617	DATE 7/16/2012	DRAWN DSR	SCALE 1/3:1
REF. LAYOUT	SIMILAR TO	MATERIAL LIST	CHECKED	APPROVED	DWG. NO. 6CL58627

Appendix C: Part Specification Sheets

<u>Mac Valve:</u> 92B-JAF-BAA-DM-DDAP-1DM



Parker Cylinder: 2.00CBB2HCT14AC31.00

Parker

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Home > Industrial Cylinder Division > Products > INDUSTRIAL HYDRAULIC CYLINDERS > TIE ROD HYDRAULIC CYLINDERS

2H HEAVY DUTY HYDRAULIC CYLINDERS

Features:

- **Construction:** Steel, Tie rod design; Repairable
- **Standards:** NFPA Heavy Duty Hydraulic, ANSI/(NFPA) T3.6.7R2-1996
- **Bore Size:** 1 1/2" through 6"
- **Strokes:** Available in any practical length
- **Piston Rod Diameter:** 5/8" to 4"
- **Operating Medium:** Hydraulic oil
- **Mounting Styles:** 18 Standard
- **Nominal Pressure:** 3000 psi (See catalog for details)
- **Standard Operating Temperature:** -10°F to +165°F
- **Optional High Temperature Option:** -10°F to 250°F
- **Rod Ends:** Three standard choices; specials to order
- **Cushions:** Optional at either or both ends
- **Ports:** SAE "O" ring are standard, others are available

Configure Product:
Configure

Configure 3D CAD:
Configure CAD

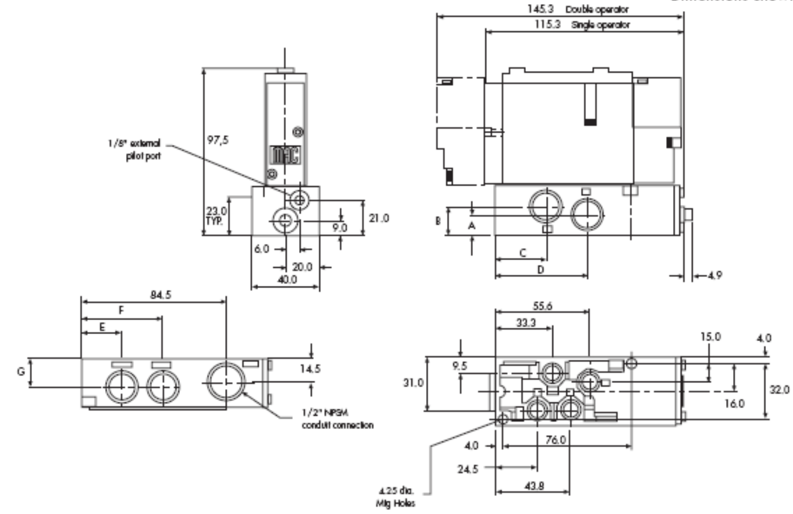
Theoretical Push Forces for Hydraulic Cylinders — Push Force

Cylinder Bore Ø	Piston Area (Sq. In.)	Cylinder Push Stroke Force in Pounds at Various Pressures						
		100	250	500	1000	1500	2000	3000
1.50	1.77	177	443	885	1770	2651	3540	5310
2.00	3.14	314	785	1570	3140	4712	6280	9420
2.50	4.91	491	1228	2455	4910	7363	9820	14730
3.25	8.30	830	2075	4150	8300	12444	16600	24900
4.00	12.57	1257	3143	6285	12570	18850	25140	37710
5.00	19.64	1964	4910	9820	19640	29453	39280	58920
6.00	28.27	2827	7068	14135	28270	42412	56540	84810
7.00	38.49	3849	9623	19245	38490	57727	76980	115470
8.00	50.27	5027	12568	25135	50270	75398	100540	150810
10.00	78.54	7854	19635	39270	78540	117810	157080	235620
12.00	113.10	11310	28275	56550	113100	169650	226200	339300
14.00	153.94	15394	38485	76970	153940	230910	307880	461820
16.00	201.06	20106	50265	100530	201060	301590	402120	603180
18.00	254.47	25447	63620	127230	254470	381700	508940	763410
20.00	314.16	31416	78540	157080	314160	471240	628320	942480

<u>Mac Valve:</u> 92B-JAF-BAA-DM-DDAP-1DM

DIMENSIONS

Dimensions shown are metric (mm)

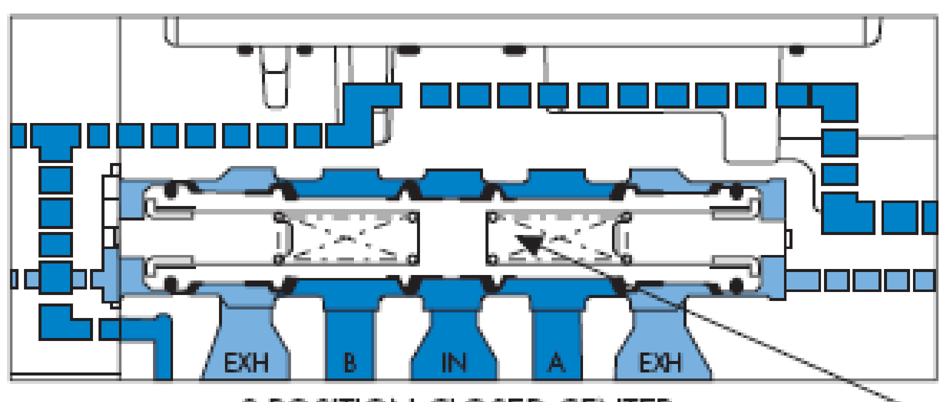


DIM.	A	B	C	D	E	F	G
1/8"	12.5	18.0	31.0	54.0	23.5	46.5	18.0
1/4"	12.5	18.0	31.0	54.0	23.5	46.5	18.0
3/8"	12.0	17.0	30.0	54.0	23.5	47.5	17.0

150

Consult "Precautions" page 327 before use, installation or service of MAC Valves..

B



3 POSITION CLOSED CENTER

Mac Valve Regulator: PR92C-KECA-9

Series PR92C

100% OF PRODUCTION TESTED 100%

WARRANTY 18 MONTHS

TECHNICAL DATA

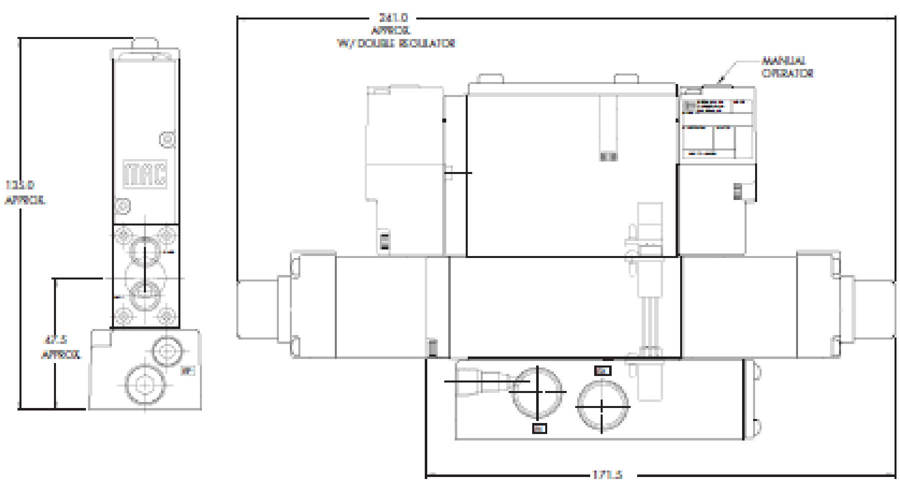
Fluid :	Compressed air, inert gases
Pressure range :	0 to 120 PSI
Regulating range :	0 to 120 PSI
Lubrication :	Not required, if used select a medium aniline point lubricant (between 180°F to 210°F)
Filtration :	40 µ
Temperature range :	0°F to 120°F (-18°C to +50°C)
Flow :	0.8 C_v

Spare parts :
- R-92003 : end plate kit
- R-92003-01: by-pass end plate kit
- Gage kit 0 – 160 PSI : N-92006-01
- Gage kit 0 – 100 PSI : N-92006-02
- Gage kit 0 – 60 PSI : N-92006-03

Options:
- Pressure range: PR92C-xxxA (A 0 to 120 PSI)
  - B 0 to 80 PSI
  - C 0 to 30 PSI
  - D 0 to 120 PSI "A" end, 0 to 80 PSI "B" end
  - E 0 to 120 PSI "B" end, 0 to 80 PSI "A" end
  - F 0 to 120 PSI "A" end, 0 to 30 PSI "B" end
  - G 0 to 120 PSI "B" end, 0 to 30 PSI "A" end
  - H 0 to 80 PSI "A" end, 0 to 30 PSI "B" end
  - J 0 to 80 PSI "B" end, 0 to 30 PSI "A" end

DIMENSIONS

Dimensions shown are metric (mm)



Consult "Precautions" page 327 before use, installation or service of MAC Valves.

Bimba Pneumatic Air Cylinder: C-1716-DPW-D-229-F-D-231-1-2-14A

1-1/2" Bore Air Cylinders

- Ground and Polished, High Strength Carbon Steel Piston Rod Standard — 303 Stainless Steel Rod Optional — Bronze Rod Guide Bushing Standard
- Force Exerted Approximately 1.7 of Air Line Pressure
- Enclosed Spring Force: 7 lbs. Relaxed — 14 lbs. Compressed
- Rod Wipers Available on D, DP, DX, DXDE, and DXDEH Models

OPTIONS:

NO CHARGE:

- *PORTS ROTATED (K)*

**Front port rotated 90° on BF models.*

- *NO THREAD (NT)*
- *SIDE PORTED REAR HEAD (Q)*
  Add .19" to nose mount overall length and DNR; BF and BFT add .38"
- *PIVOT BUSHING (Y)*
  .375" ID (use D-620-1 pivot bracket)

SINGLE AND REVERSE ACTING BUMPERS (B)
- *$3.50 additional*
- *Add .125 to overall length*

DOUBLE ACTING BUMPERS (B)
- *$5.45 additional*
- *Add .125 to overall length*

EXTRA EXTENSION (EE)
- *Single, reverse and double acting, add $1.50 per inch of extension*
- *DXDE, add $2.20 per inch of extension; extension added to each end*
- *DXDE hollow rod, add $2.35 per inch of extension; extension added to each end*

DOUBLE ACTING FAILSAFE
(JS = Spring Return, JR = Spring Extend)
- *Add $12.40 to base price + $1.75 to stroke adder*
- *See page 1.65 and 1.66 for overall length adders*

HEAVY SPRINGS (H) are standard on all single acting block front and block rear mount, and all reverse acting and stroke adjust models.
For all other single acting, add $2.45
- *Spring Force: 8.5 lbs. relaxed —17 lbs. compressed*

OPTIONS continued...

MAGNET (prefix M) — Add $15.50
- *Single and reverse acting add .125" to overall length*
- *Stainless steel rod becomes standard with this option*
- *Must specify track(s) for use with miniature position sensing (T2, T3, T4) — add $3.20 per track. See page 1.9 for track location details. See Switch Products, page 9.3 for switch selection information.*

LOW TEMPERATURE (N)
Temperature Range: -40° to 200°F
- *Single acting add $1.40*
- *Reverse acting add $1.80*
- *Double acting add $2.70*
- *DXDE add $3.35*

HIGH TEMPERATURE "U" CUPS (V)
Temperature Range: 0° to 400°F (-18° to 205°C)
- *Single acting add $6.25*
- *Double acting add $15.50*
- *DXDE add $19.85*
- *Reverse acting add $10.70*

ROD WIPER (W)
(not available in standard single acting)
(now available in block mount)
- *Double acting add $3.20*
- *DXDE add $6.40*

STAINLESS STEEL ROD (prefix SR)
- *Add $3.30*
- *Standard on DX, DXDE, DXDEH, DNR, DXNR, All block mounts, and M option*

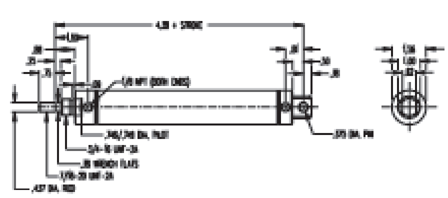
LOW PRESSURE HYDRAULIC (HL)
- *250 psi maximum*
- *Double acting models only*
- *Option specified as a prefix*
- *Add $19.50*

☐ Enter Stroke Length as 3rd Digit

17☐-DP

$39.40
BASE PRICE
Add $2.85 per inch of stroke

***Double Acting** – Pivot Type – Air Return – Rear Pivot Mounting*
Standard Stroke Lengths:
½", 1", 1½", 2", 2½", 3", 4", 5", 6", 7", 8", 9", 10", 11", 12"
Maximum Stroke – 32"
Optional Stainless Steel Rod
Optional Rod Wiper
Optional Accessories:
D-231-1 Piston Rod Clevis
D-229 Pivot Brackets
Base Weight: .73
Adder Per Inch of Stroke: .08



McMaster-CARR Bronze Bushing: 6391K172

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CATALOG PAGE 1129 PRINT FORWARD THIS PAGE BOOKMARK THIS PAGE PAGE OPTI

Lubricated Bronze Sleeve Bearings

SAE 841—Also called Oilite®, this porous material is impregnated with 19% SAE 30 oil. The oil reduces wear as well as required maintenance.

Graphite SAE 841—This porous material is impregnated with a graphite-based material, which provides low-friction dry lubrication in a wide range of temperatures.

SAE 863—Also called Super Oilite®, this material is similar to SAE 841 but contains more iron for greater strength. **Note:** Color is silver because of the iron.

View tolerance information for these bearings.

Bearing Material	Temperature Range	P max	V max	PV max
SAE 841	10° to 220° F	2,000	1,200	50,000
Graphite SAE 841	-30° to 700° F	1,600	1,000	40,000
SAE 863	10° to 220° F	4,000	225	35,000

OD	Lg.	SAE 841	Each	Graphite SAE 841	Each	SAE 863	Each
For Shaft Dia.: 1/8"							
1/4"	1/8"	6391K113	$0.59	9368T95	$0.37	2868T31	$0.43
1/4"	1/4"	6391K111	.68	9368T96	.44	2868T32	.44
1/4"	3/8"	6391K112	.59	9368T97	.50	2868T33	.38
For Shaft Dia.: 3/16"							
1/4"	1/4"	6391K122	.45	9368T98	.37	2868T34	.33
1/4"	3/8"	6391K125	.74	9368T99	.40	2868T35	.55
1/4"	1/2"	6391K124	.82	9368T101	.43	2868T36	.59
1/4"	5/8"	6391K123	.85	9368T102	.50	2868T37	1.27
5/16"	1/4"	6391K114	.66	9368T41	.47	2868T38	.35
5/16"	3/8"	6391K115	.50	9368T42	.56	2868T39	.46
5/16"	1/2"	6391K116	.50	9368T43	.63	2868T41	.47
For Shaft Dia.: 1/4"							
5/16"	1/4"	6391K126	.37	9368T11	.71	2868T42	.33
5/16"	1/2"	6391K127	.69	9368T12	1.14	2868T43	.53
5/16"	3/4"	6391K401	.65	9368T105	.60	2868T44	.64
3/8"	1/4"	6391K131	.67	9368T13	.53	2868T1	.71
3/8"	3/8"	6391K136	.74	9368T14	.63	2868T2	.74
3/8"	1/2"	6391K132	.99	9368T15	.73	2868T3	.82
3/8"	5/8"	6391K133	.84	9368T44	.87	2868T45	.64
3/8"	7/8"	6391K134	1.03	9368T109	1.10	2868T46	.98
3/8"	1"	6391K135	.71	9368T16	1.09	2868T47	.58
1/2"	1/2"	6391K141	1.07	9368T112	1.30	2868T48	.85
1/2"	5/8"	6391K402	1.97	—	—	2868T49	1.28
1/2"	3/4"	6391K142	1.49	9368T113	1.57	2868T51	1.26
1/2"	1"	6391K143	2.30	9368T114	1.94	2868T52	1.52

For Shaft Dia.: 5/16"

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- Sealing
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CATALOG PAGE 1129 PRINT FORWARD THIS PAGE BOOKMARK THIS PAGE PAGE OPTION

1/2"	3/4"	6391K142	1.49	9368T113	1.57	2868T51	1.26
1/2"	1"	6391K143	2.30	9368T114	1.94	2868T52	1.52

For Shaft Dia.: 5/16"

OD	Lg.	SAE 841	Each	Graphite SAE 841	Each	SAE 863	Each
3/8"	1/4"	6391K403	.84	9368T45	.40	2868T53	.45
3/8"	3/8"	6391K152	.70	9368T46	.47	2868T54	.62
3/8"	1/2"	6391K153	.74	9368T115	.54	2868T55	.67
3/8"	5/8"	6391K154	.71	9368T116	.60	2868T56	.59
3/8"	3/4"	6391K155	.71	9368T117	.67	2868T57	.62
3/8"	1"	6391K156	1.48	9368T118	.80	2868T58	3.38
7/16"	1/4"	6391K161	.50	9368T119	.56	2868T59	.61
7/16"	3/8"	6391K162	.50	9368T47	.70	2868T61	.62
7/16"	1/2"	6391K163	.60	9368T48	.84	2868T62	.67
7/16"	5/8"	6391K164	.87	9368T49	1.00	2868T63	.68
7/16"	3/4"	6391K165	.95	9368T121	1.10	2868T64	.74
7/16"	1"	6391K166	1.06	9368T122	1.30	2868T65	1.50
1/2"	3/8"	6391K404	1.08	9368T123	1.00	2868T66	.76
1/2"	1/2"	6391K405	1.14	9368T124	1.16	2868T67	.76
1/2"	3/4"	6391K406	2.16	9368T125	1.44	2868T68	.79
1/2"	1"	6391K443	1.89	9368T126	1.70	2868T69	1.49
1/2"	1 1/4"	6391K444	2.07	9368T127	1.93	2868T71	1.96
For Shaft Dia.: 3/8"							
1/2"	1/4"	6391K171	.50	9368T17	.60	2868T4	.53
1/2"	3/8"	**6391K172**	.71	9368T18	1.01	2868T5	.55

Catalog Page | Bookmark

SAE 841 Bronze Sleeve Bearing for 3/8" Shaft Diameter, 1/2" OD, 3/8" Length

Bearing Tolerance Information

Each

ADD TO ORDER

In stock

OD	Lg.	SAE 841	Each	Graphite SAE 841	Each	SAE 863	Each
1/2"	1/2"	6391K173	.65	9368T19	1.23	2868T6	.62
1/2"	5/8"	6391K174	.95	9368T51	1.10	2868T72	.59

<u>SMC Dual Speed Control Silencer:</u> ASN2-N02-S

<u>SMC Dual Speed Controller:</u> ASD430F-N02-11S

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ASD-D, Dual Speed Controller, Flat Head Screwdriver Adjustable

Series ASD, combines a meter-in and meter-out dual speed controller in a single body. The series is available with PT or NPT ports and one-touch fittings are standard. Tamper proof and flat head screwdriver adjustable versions are also available for extra protection against inadvertent operation.

- Adjust flow rate with a flat head screw driver
- Prevents inadvertent manual operation
- Meter-in and meter-out types easily determined by the flow direction symbol on the body
- Inch or metric sizes available for all models
- One-touch fittings

Configuration Options

Part Number is Complete

ASD 4 3 0 F - N 02 - 11 S D

Select Product Options

Select values from the drop down lists or make appropriate selections to configure the part number.

Body Size	4 (1/4 Basis)
Thread	N (NPT)
Port Size	02 (1/4)
Applicable Tube OD	11 (3/8")
Sealant	S (Sealant)

Options in:
- Gray are not compatible with other selected option value.
- Red conflict with another selected option value.
- Amber are not recommended.

CAD Downloads

- View 3D Model
- View 2D Drawing
- Download CAD File

Related Files

- Series Catalog

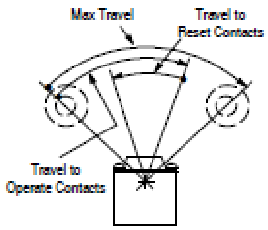
Related Products

Allen Bradley Limit Switch: 802T-A

802T Lever Type • Maintained Contact and Neutral Position

Plug-in Style Oiltight Switches

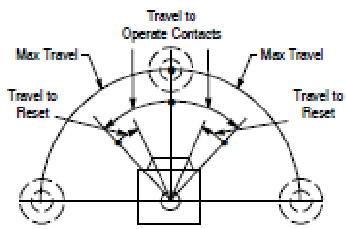
Range of Operation



Maintained Contact Models

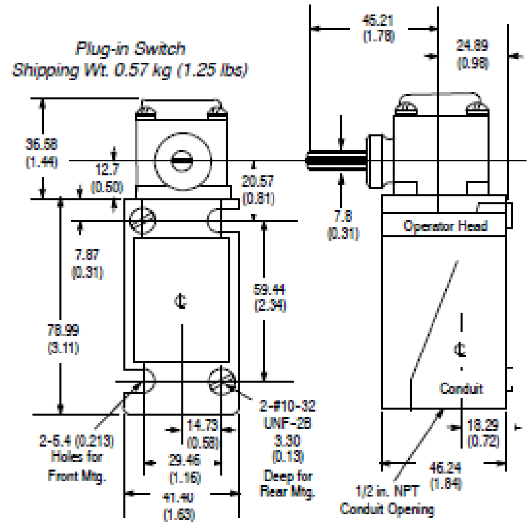
Switch Without Lever

Switch Without Lever and Base

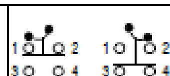
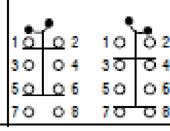


Neutral Position Models

Approximate Dimensions [mm (in.)]



Product Selection—Maintained Contact Models

No. of Circuits	Lever Movement vs. Contact Operation		Torque to Operate (Max.)	Travel to Operate Contacts (Max.)	Max Travel	Travel to Reset Contacts (Max.)	Cat. No.	
							Switch w/o Lever	Switch w/o Lever & Base
2	Clockwise or Counterclockwise		0.31 N•m (2.75 lb•in)	70° ❶	88° ❶	32°	802T-AMP	802T-AMP1
4	Clockwise or Counterclockwise		0.32 N•m (2.8 lb•in)				802T-AMTP	802T-AMTP1

❶ From one maintained position to another.

Allen Bradley Limit Switch: 802T-A

Description

Bulletin 802T limit switches are ideal for applications in which heavy duty pilot ratings, small size, a high degree of versatility and a rugged NEMA Type 4, 13 and 6P❶ construction are desirable. An important factor in the automation of industry, these limit switches are being applied extensively on conveyor systems, transfer machines, automatic turret lathes, milling and boring machines, radial drills, and many other types of modern, high speed production equipment.

A wide variety of operating heads and operating levers are available. Operating heads can be mounted in four positions, 90° apart.

Features

- Front mount for simplified mounting
- Plug-in style for ease of wiring
- Side rotary, wobble stick, cat whisker,

Specifications

Enclosure Rating	NEMA 4, 13, 6P❶ and IP67
Pollution Degree	3
Certifications	UL Listed, CSA Certified CE Marked for applicable directives
Ambient Temperature [C (F)]❷	-18…+110° (0…+230°) Exception: Wobble stick and cat whisker devices are rated from -18…+54° (0…+130°)

AC Contact Rating (Maximum per Pole, 50 or 60 Hz, 2 Circuits Same Polarity)

NEMA Rating Designation	Max Voltage	A		Continuous Carrying Current	VA	
		Make	Break		Make	Break
A600 AC-15	120	60	6.00	10	7200	720
	240	30	3.00	10	7200	720
	480	15	1.50	10	7200	720
	600	12	1.20	10	7200	720
B600❸ AC-15	120	30	3.00	5	3600	360
	240	15	1.50	5	3600	360
	480	7.5	0.75	5	3600	360
	600	6	0.60	5	3600	360

AC Contact Rating (Maximum per Pole, 50 or 60 Hz, 4 Circuits Same Polarity)

NEMA Rating Designation	Max Voltage	A		Continuous Carrying Current	VA	
		Make	Break		Make	Break
A300	120	60	6.00	10	7200	720
	240	30	3.00	10	7200	720

DC Contact Rating (Maximum per Pole)

Circuits	Voltage Range	Current Rating
2	115-125	0.4 A
	230-250	0.2 A
	550-600	0.1 A
4	115-125	0.4 A
	230-250	0.2 A

McMaster-CARR Food Grade Bearing: 3730T28

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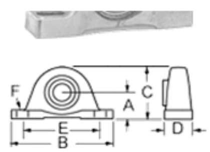

With USDA H1 Solid Polymer-Polyethylene Grease—Made to ABEC-3 dimensional tolerance standards with sealed bearing inserts to block out dirt. USDA H1 lubricant is solid and long-wearing so it won't leak out of the bearing. Temperature range is 5° to 212° F.

With USDA H1 Food-Grade Oil—Made to ABEC-1 dimensional tolerance standards with shielded bearing inserts to block out dirt. USDA H1 oil is permanently sealed into the bearing. The housing has a corrosion-resistant coating. Temperature range is –30° to +250° F.

For technical drawings and 3-D models, click on a part number.

For Shaft Dia.	Ctr. Ht. (A)	Dynamic Load Cap., lbs.	Max. rpm	O'all Lg. (B)	O'all Ht. (C)	Base Wd. (D)	Ctr.-to-Ctr. (E)	Bolt Slot Size (F) Lg.	Bolt Slot Size (F) Wd.		Each
With USDA H1 Solid Polymer-Polyethylene Grease											
3/4"	1 5/16"	2,890	6,450	5"	2 9/16"	1 1/2"	3 25/32"	7/16"	25/32"	5057N11	$53.74
1"	1 7/16"	3,150	5,600	5 1/2"	2 25/32"	1 1/2"	4 1/8"	7/16"	13/16"	5057N1	91.98
1 3/16"	1 11/16"	4,400	4,650	6 1/2"	3 9/32"	1 7/8"	4 5/8"	9/16"	15/16"	5057N5	96.26
1 1/4"	1 7/8"	5,750	4,000	6 9/16"	3 21/32"	1 7/8"	5 1/8"	9/16"	15/16"	5057N3	93.62
1 7/16"	1 7/8"	5,750	4,000	6 9/16"	3 21/32"	1 7/8"	5 1/8"	9/16"	31/32"	5057N7	103.54
1 1/2"	1 15/16"	6,550	3,550	7 1/4"	3 27/32"	2 1/8"	5 3/8"	9/16"	1 1/32"	5057N2	121.26
1 3/4"	2 1/8"	7,350	3,300	7 15/32"	4 3/16"	2 1/8"	5 7/8"	9/16"	1 1/8"	5057N6	121.60
1 15/16"	2 1/4"	7,900	3,050	8 1/8"	4 1/2"	2 3/8"	6 7/32"	11/16"	15/16"	5057N4	154.78
2"	2 1/2"	9,750	2,750	8 5/8"	4 31/32"	2 3/8"	6 15/16"	11/16"	15/16"	5057N8	208.86
2 7/16"	2 3/4"	11,800	2,450	9 1/2"	5 7/16"	2 3/4"	7 13/32"	23/32"	1 5/32"	5057N9	263.26
With USDA H-1 Food Grade Oil											
3/4"	1 5/16"	2,860	1,120	5"	2 1/2"	1 1/4"	3 13/16"	13/16"	29/64"	3730T21	79.91
1"	1 7/16"	3,150	935	5 1/8"	2 3/4"	1 7/16"	4 1/64"	49/64"	29/64"	3730T22	87.25
1 1/8"	1 11/16"	4,380	795	5 63/64"	3 15/64"	1 37/64"	4 5/8"	59/64"	35/64"	3730T23	103.98
1 3/16"	1 11/16"	4,380	795	5 63/64"	3 15/64"	1 37/64"	4 5/8"	59/64"	35/64"	3730T24	103.98
1 1/4"	1 11/16"	4,380	795	5 63/64"	3 15/64"	1 37/64"	4 5/8"	59/64"	35/64"	3730T25	103.98
1 1/4"	1 7/8"	5,730	685	6 19/64"	3 21/32"	1 49/64"	4 31/32"	53/64"	35/64"	3730T26	123.87
1 7/16"	1 7/8"	5,730	685	6 19/64"	3 21/32"	1 49/64"	4 31/32"	53/64"	35/64"	3730T27	123.87
1 1/2"	1 15/16"	6,900	610	6 57/64"	3 29/32"	1 57/64"	5 11/32"	15/16"	35/64"	**3730T28**	138.73
1 15/16"	2 1/4"	7,890	470	8"	4 1/2"	2 1/8"	6 3/16"	1 1/16"	45/64"	3730T29	173.49

CAD | Catalog Page | Bookmark

Lubricated Cast Iron Mounted STL Ball Brng for 1-1/2" Shaft Diameter

ABEC Bearing Tolerance Information

Each

ADD TO ORDER

In stock

Honeywell Sensing Pressure Sensor: 480-2041-ND

Keywords:

In stock
Lead free
RoHS Compliant

Search Again

Product Index > Sensors, Transducers > Pressure > 76053-00000350-01

All prices are in US dollars.

Digi-Key Part Number	480-2041-ND
Quantity Available	Digi-Key Stock: 33 Can ship immediately
Manufacturer	Honeywell Sensing and Control
Manufacturer Part Number	76053-00000350-01
Description	SWITCH PRESSURE N.O. 35PSI
Lead Free Status / RoHS Status	Lead free / RoHS Compliant

Price Break	Unit Price	Extended Price
1	31.75000	31.75
10	25.25300	252.53
25	23.66000	591.50
50	22.63920	1,131.96
100	21.75780	2,175.78
250	20.72176	5,180.44
500	19.99496	9,997.48
1,000	19.33000	19,330.00

Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

Quantity | Item Number | Customer Reference

480-2041-ND | Add to Order

When requested quantity exceeds displayed pricing table quantities, a lesser unit price may appear on your order.
You may submit a request for quotation on quantities which are greater than those displayed in the pricing table.

Datasheets	Pressure Switches Line Guide
Product Photos	076053 00000350 01
Catalog Drawings	5000 Series
Standard Package	25
Category	Sensors, Transducers
Family	Pressure
Series	5000
Pressure Type	Switch
Operating Pressure	25 ~ 50 PSI

Mac Valve 4-Pin Connector: MDC-4MR-2-0.5M

PIN #	COLOR
1	BROWN
2	WHITE
3	BLUE
4	BLACK

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	7/28/2004	

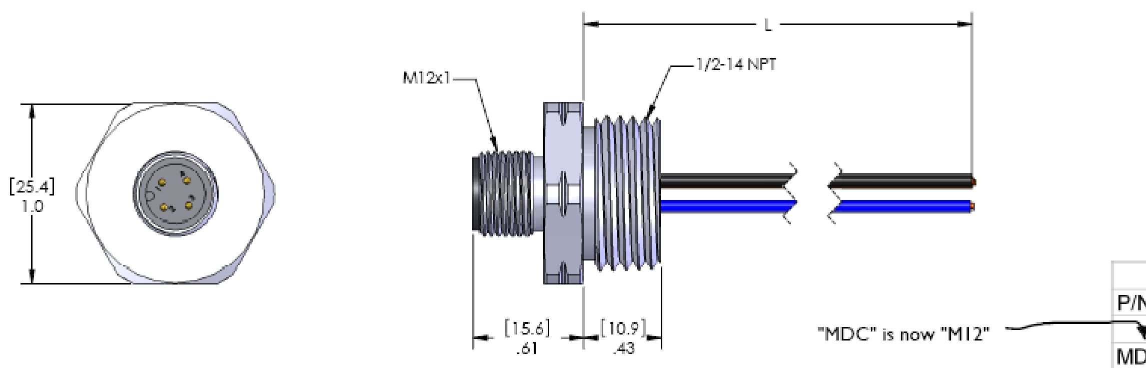

TABLE A	
P/N	L
MDC-4MR-2	12"
MDC-4MR-2-0.5M	19"
MDC-4MR-2-1M	40"
MDC-4MR-2-2M	79"
MDC-4MR-2-3M	118"
MDC-4MR-2-5M	197"
MDC-4MR-2-10M	393"

AN O-RING AND LOCKNUT ARE INCLUDED ON LENGTHS OF 19" AND LONGER.

MATERIALS:	
BODY:	ANODIZED ALUMINUM
INSERT:	POLYAMIDE
CONTACTS:	GOLD PLATED COPPER ALLOY
WIRE:	UL1007 22AWG
O-RING:	NBR
LOCKNUT:	ZINC PLATED STEEL

APPROVALS:	
US	UL RECOGNIZED
CANADA	C-UL RECOGNIZED

PROPRIETARY AND CONFIDENTIAL

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SPECIFICATIONS	
VOLTS	300V
AMPS	4A
TEMP	105°C

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES AND [MM]
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	BEM	
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

MENCOM CORPORATION
TITLE:

SIZE	DWG. NO.	REV
B	MDC-4MR-2-ZZ	A

SCALE: 2:1 WEIGHT: SHEET 1 OF 1

Murr M12 Female Connector: PVC-0B

INTERNET-DATASHEET of Art.-No. 7000-12221-0140500

MURR ELEKTRONIK

stay connected

M12 female connector straight with cable PVC-OB 4x0,34 yellow 5m

Female straight
4-pole
Art.-No. 7005 - M12 Lite - (plastic hexagonal screw) on request

Image