METAL BUILDING CONSTRUCTION

USING THE MIC-240 ABM K-SPAN MACHINE

by

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ABSTRACT

The process of constructing a metal system has always been fairly similar to construct. Although there are many companies that produce, manufacture, and construct metal buildings, the construction effort has been the same. The typical steps are to construct the foundation and floor slab, then erect the steel columns, and roof beams. Once this was completed, the next step was to add Purlins and joists. The final step was to attach and seam together the roof system.

There is a different type of metal building system called a K-Span. This metal building does not follow conventional metal building construction methods. In order to construct a K-Span metal building, a special K-Span machine is required. With this machine, a K-Span seamer, and coils steel stock material, a metal building can be constructed. The folks at M.I.C. Industries have taken a different approach to construction of metal building systems by producing a machine that bends, corrugates, and produces curved panel that acts as a structural members not requiring steel columns or steel beams for internal structural support. These curved panels once seamed together, produces a unique, complete and usable metal building.

1. OBJECTIVE

The purpose of this report is to introduce a new type of metal building called a K-Span, although it's been around for many years, It is not as widely known in the civilian sector as Butler buildings. The K-Span Building has been the standard military utility building that serves as offices buildings, Hangers, and storage spaces in the field.

The final part of this report will entail a comparison and a contrast to the more famous Butler buildings using a simple K-Span storage building with a similar storage Butler building.

2. INTRODUCTION OF METAL BUILDINGS

Metal building systems have become the conventional method for construction of commercial or industrial buildings in the United States. In the past two decades, metal building systems sales have become the major market player in low-rise non-residential buildings of up to 150,000 sq. ft. in floor space. This is the primary market for metal buildings. Today's metal building system are representative of banks, showrooms, offices, shopping centers, free standing retail stores, and a broad range of service structures, as well as industrial and institutional application. (Metal Building Manufactures Association booklet)

Advances in technology along with new construction techniques have made today's metal buildings compatible with ordinary construction

materials such as: glass, brick, masonry, and wood. These metal buildings also offer a wide range of sizes and shapes from dynamic expanses of glass to brick fascias are becoming more popular. Metal building systems first emerged in the 1940's as a new and distinct method of construction. Metal building systems are sold by manufacturers to licensed contractors who design and construct the buildings for customers. This concept of the contractor designing and ultimately constructing the metal buildings has grown into what we consider a design-build concept. The benefits are far reaching, for it eliminates the mis-communication and finger pointing between designer and contractor when something goes awry because in a design-build environment designer and contractor are one in the same.

Advantages in the speed of construction and the economy have made the metal building system a preferred method of construction in the commercial and industrial applications. A metal building system consists of a series of factory manufactured components. These components include: Primary and secondary framing, roof, wall, and accessory subsystems. Once the factory has manufactured these systems, they are shipped to the local metal building system contractor for construction. Using state of the art techniques and precise in-plant manufacturing equipment, manufacturers can produce elements that are sheared, punched, and precisely shaped by matching to the customers exact specification. The components of the metal building system are designed together as a system to work together

supporting, and forming a building structure that meets design specifications, code requirements, locks out weather and limits heat gain and heat loss.

3. INTRODUCTION OF BUTLER BUILDINGS:

Butler manufacturing has been around for many years, and they have cornered the market on sales today. The company has developed a research center that constantly tests new materials from steel and coatings to the less obvious fasteners and sealants. Metal buildings today are so esthetically advanced there is no visible difference between typical conventional concrete, or brick buildings. One major reason is for the use of brick fascias, concrete masonry unit block walls and huge expanses of glass. See example figure below:

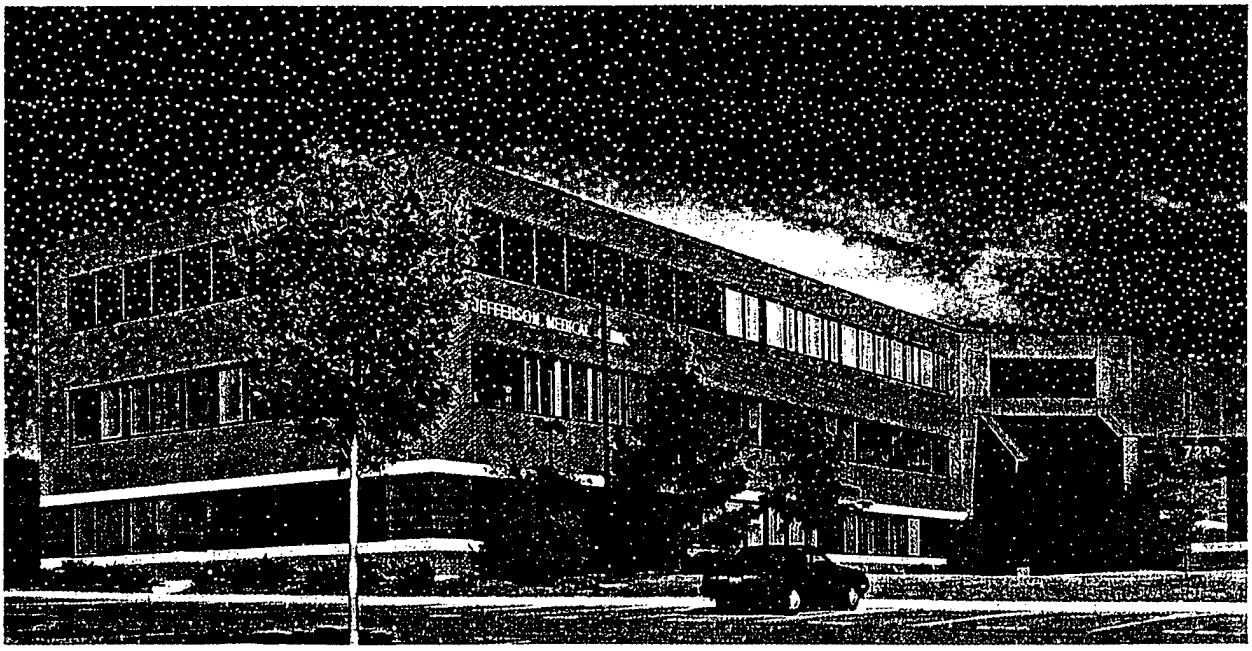


Figure 1: Example of metal building with brick fascia

4. CONSTRUCTING A TYPICAL METAL BUILDING SYSTEM

For this report a simple Butler storage building will be used for comparison with a K-Span. Butler buildings like any other metal building begins with the foundation and slab. Since a simple Butler metal building will be used for comparison, the walls which can be brick or CMU, will be metal in order to save on the construction cost. The next phase of constructing the Butler building will be to erect the columns and roof beams using steel members. This is accomplished using a crane to get the members in place. The roof beams and the wall columns are bolted together in place.

Steel metal girts are then bolted in place approximately half the distance up the walls columns. These girts are to provide stability and support the corrugated wall metal sheets. The walls are constructed of 36 inch wide 1 1/2 inch corrugated metal sheets, .035 inches thick called the "Butlerib" wall system. These corrugated wall metal sheets are then bolted to the girts for rigidity. The entire wall system of 36 inch panels each will be seamed together to form a rigid wall system. See the figure below.

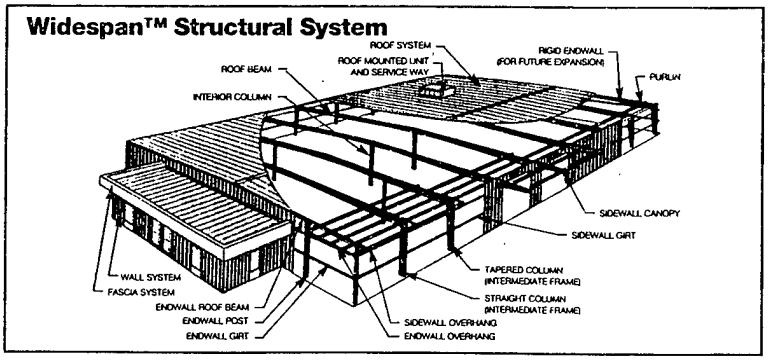


Figure 2: Example cut-away of typical metal building

Roof purlins will then be erected and tied into the roof beams. The final stage of the roof system is the corrugated "Butlerib" MR-24 roof system. The roof system is constructed the same as the wall system and seamed together similarly also. Butler manufacturing has developed the modern single membrane floating monolithic metal roof system called the CMR-24. The CMR-24 roof system is seamed together and once seamed, is considered to be monolithic. This system uses a 360 degree double lock seam. See example figure below.

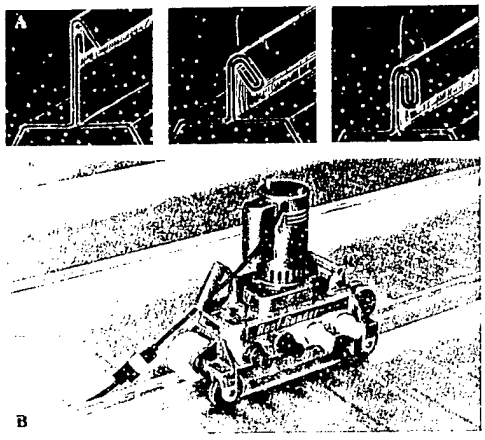


Figure 3: Picture of 360^0 double lock seam and seamer

Roof clips securely attach the roof panels to the supporting structural by stainless steel tabs which are roll formed into the panel seams. Stainless steel tabs are more than 50% stronger than other galvanized standing seam tabs. The clips allow for 1 1/2 inch travel to accommodate expansion and contraction of the metal roof. This permits buildings up to 500 ft. wide without special expansion joints. The MR-24 roof system is available in 24

and 26 gage aluminum/zinc coated steel. There is a special coating of fluoropolymer called Butler-Cote 500 FP which contains 70% Kynar 500/Hylar 5000 resin. See figure below:

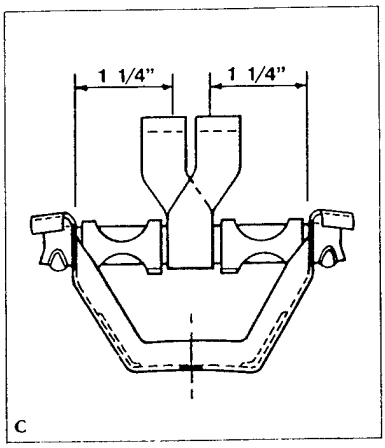


figure 4: Special roof clips designed by Butler Manufacturing Company

Butler has also perfected the delta truss system which works well with roof system requiring ventilation. The delta joist system provides a space in the center of the truss for ventilation ducting. See figure below.

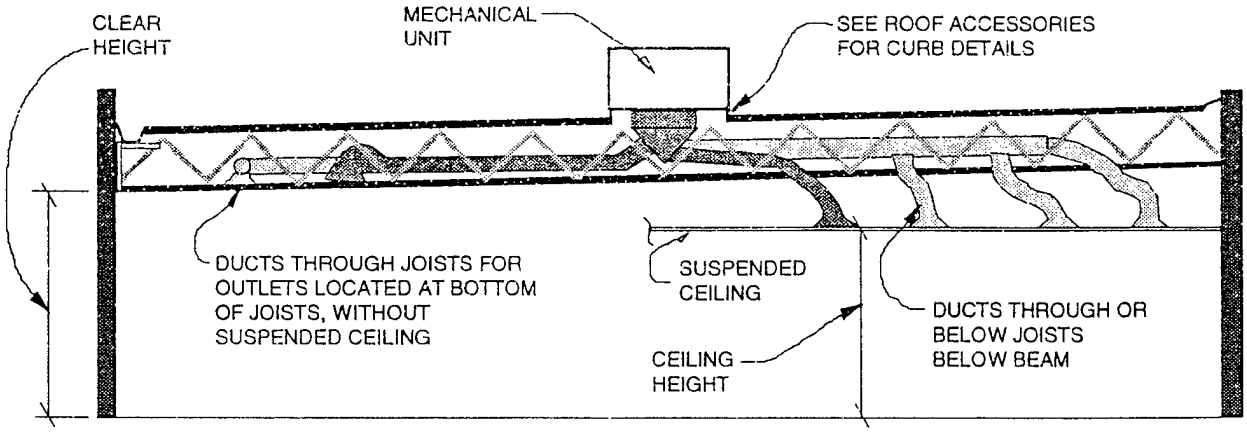


Figure 5: Example of Delta truss roof system

5. INTRODUCTION TO K-SPAN

MIC industries, the manufacturers of the K-Span, has made it simple to construct pre-engineered buildings by designing a machine that can change the size of your building with the touch of a button, and requires the bare minimum in the way of construction material, coil steel. The construction process will be discussed later in this chapter.

MIC Industries have designed two automated building machines for construction of Pre-engineered buildings. They are the MIC-120 and the MIC-240. The two machines are identical in every way except the MIC-120 produces a corrugated panel one foot in width and the MIC-240 produces a panel twice that size (two feet in width). Appendix A shows K-Span equipment specs.

Military applications and use of this type of building have been tested and have worked very well. Military commanders can benefit from a low cost (less than twenty thousand dollars) aircraft hanger, storage or utility building that requires little to no planning for construction. Transportation of these machines can be accomplished by land, sea, or air.

6. CAPABILITIES:

The MIC-240 ABM is capable of constructing a building as small as 48' wide by 18' high to as large as 120' wide by 40' high with an unlimited length. A trained crew can construct 10,000 square feet of building space

per day. Navy "Seabee" Battalions and the Air Force "Redhorse" Battalions are capable and trained for such in-the-field construction.

7. CONSTRUCTION

Step 1. Choosing a construction site. A major consideration is the slope of the terrain. If the slope is too great then construction problems can arise. This is due to the weight of the panels bending or distorting the shape of the curved sections to the point where it is impossible to assemble the building.

An important caution is to beware of overhead electrical wires. See an illustration below for an example of a level foundation site. OSHA standards requires the crane to have a clearing of at least twenty feet from electrical wires. Utility access is also a consideration for choosing a site. Water, electrical , phones, natural gas, are all possible utilities to use in the building. See appendix E and F for a typical jobsite layout. The K-Span building sits on angled steel which is part of the foundation. See below for a typical jobsite.

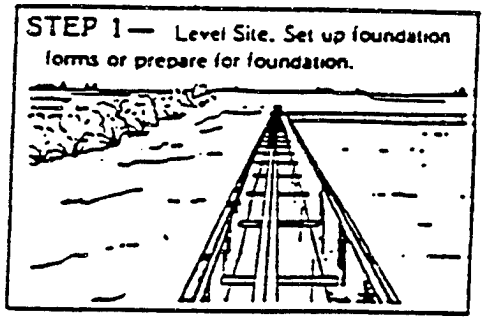


Figure 6: Foundation layout for K-Span

Step 2. Coil steel is then mounted on the MIC-240 ABM. The P-240 tables are placed and the coil steel is processed through the straight panel side onto the tables. See appendix G and H for further details. The illustration below also shows this operation.

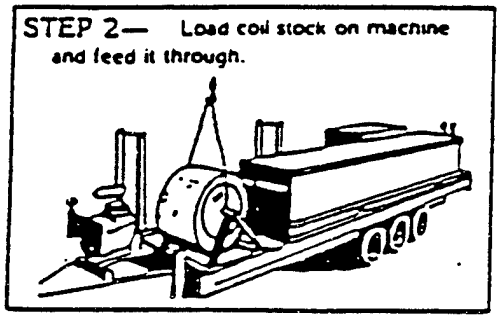


Figure 7: Set up K-Span machine

Step 3. The coil steel is then fed through the P-240 section and the corrugated straight panels are formed. See illustration below.

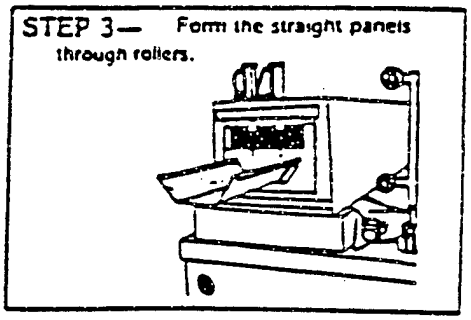


Figure 8: Forming straight panels

Step 4. Next, the automatic stops should be adjusted on the P-240 tables so the panels are stopped at exactly the right length. A mark should be made

on the tables where the tabs for the overhead lights are to be placed. Appendix I and the below illustration shows this procedure.

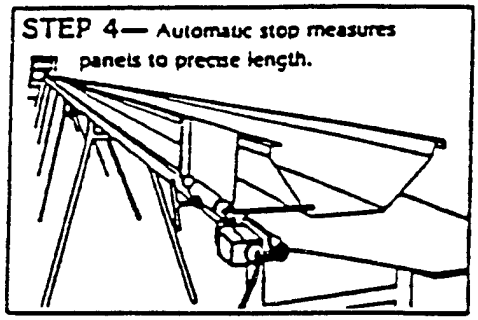


Figure 9: Automatic stop of straight panels

Step 5. The panels are then cut to the desired length using the hydraulically powered guillotine cutter on the K-Span machine. Appendix I and the below illustration shows this procedure.

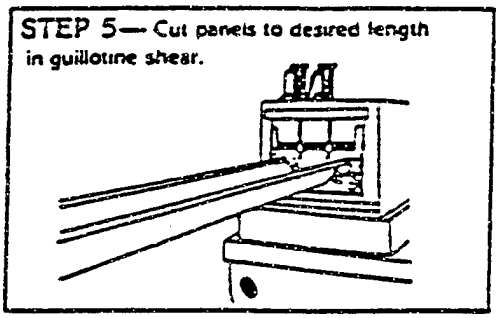


Figure 10: Cut straight panels at desired length

Step 6. The straight panel is then turned onto its side and slid over to the curved side entrance and it is then run through the C-240 machine. The illustration below shows this procedure.

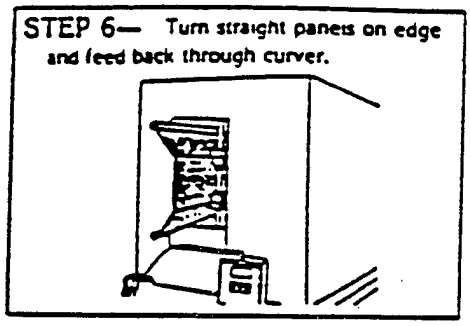


Figure 11: Feeding straight panels through curve side of machine

Step 7. The curved panels produced from the C-240 tables are lifted off the tables and staged on the ground in an assembly area. This step requires some muscle. An average of fifty pounds per person is recommended for this step. For a panel weighing five hundred pounds, ten personnel should be used (Appendix J illustrates panel weights). New sections are clamped together so the R-240 seaming machine can seam the sections of three. See appendix K and L and the illustration on the following page for the procedure.

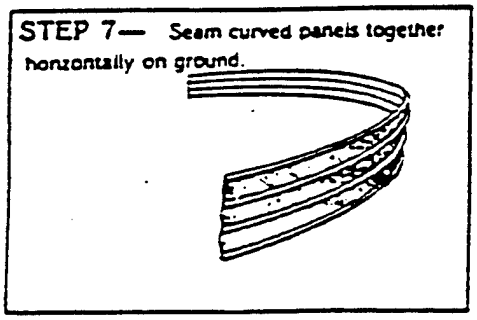


Figure 12: Seaming of curved panels together

Step 8. With the crane crew in place, a special panel lifting rigging device (Appendix M) is attached and the sections are hoisted by crane onto the angled steel on the construction site. See appendix N and the illustration below.

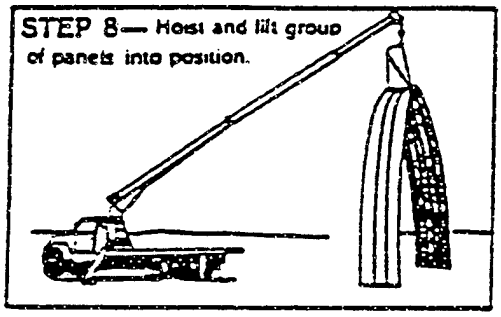


Figure 13: Hoisting groups of panels into position with a crane

Step 9. Once the first panel is hoisted in place by the crane, guy ropes attached to the panels are secured. The next section is then hoisted, and the two sections are seamed together. Appendix O and P along with and the illustration below.

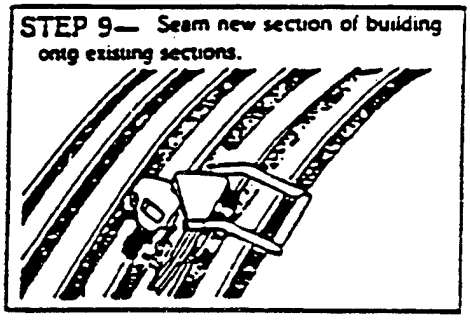


Figure 14: Seaming new sections onto existing sections

Step 10. The panels are then tack welded in place to the angled steel. The steel is not very thick, so caution should be taken not to burn through the steel during the tack welding process. The illustration below shows this step.

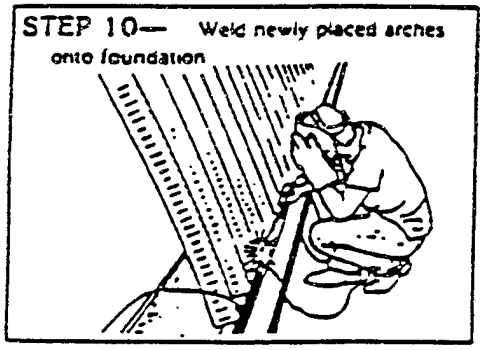


Figure 15: Tack welding new sections to foundation angle steel

Step 11. Once all the curved panels are in place, the end walls are then constructed, placed, tack welded and cut to fit the curved panels. Appendix Q and the illustration below shows this procedure.

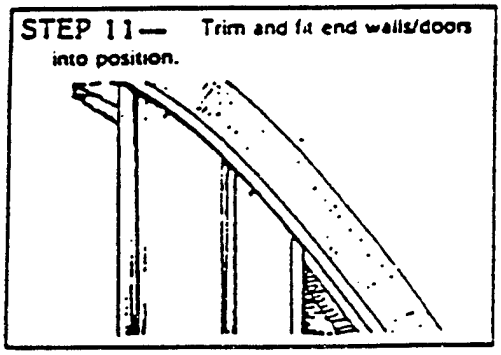


Figure 16: Trimming and fitting end walls

Step 12. Once the end walls are completed, concrete is then placed into the forms. Appendix R and the illustration below shows this procedures.

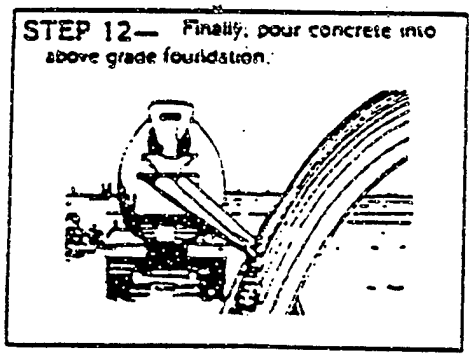


Figure 17: Placing concrete into foundation

The crew size for construction of the example building listed in appendix J is as follows:

TABLE 1:

MINIMUM Crew members	IDEAL Crew members	FUNCTION Description of functions
1	1	MIC-240 ABM operator
4	6	Move straight panels to curved side table
10	10	Lift curve panels to staging area
3 from above	3	Clamp and seem sections of three
4	4	Guy rope holders
TOTAL 19	**24**	

8. PERFORMANCE CHARACTERISTICS:

The MIC-240 ABM has three major components to the system; #1 The P-240, otherwise called the straight panel machine; #2 the C-240, otherwise called the curved panel machine; and #3 the R-240 seamer. Both the P-240 and the C-240 are powered by a diesel engine with a chain drive and hydraulic controls. The R-240 is an electric powered seamer that can take either 110volts or 220 volts and 9KW. The P-240 and the C-240 can

produce panels at the rate of sixty linear feet per minute, while the R-240 seamer produces thirty linear feet of seamed panels per minute. The production capabilities of the K-Span machine is limited by the seamer. One way to overcome this problem is to get an additional seamer.

Other performance limiters to the K-Span machine is the effects of the weather. The weather can affect production. For example, very cold weather can cause start up problems for the diesel engine. Extremely hot temperatures can also produce problems for the construction crews. Excessively high winds can create a problem for the crane erection crew. With the right wind speed and direction, the panel section can act as a sail and lift the guy rope handlers off the ground. As a result, construction is limited by wind speeds of less than twenty miles per hour. Usually the crane has more stringent requirements for operating it in high wind conditions than does the MIC-240 ABM.

9. SAFETY:

Typical construction clothing is required in order to use the MIC-240 ABM. These include a hard hat because of crane operations hoisting very heavy paneled sections overhead and into position. Steel toed boots are also required for the same reason as the hard hat requirements. Any one of these steel panels weigh in excess of four hundred and fifty pounds, so accidentally dropping a panel on someone's toe could leave them with serious problems.

Common sense dictates to wear a steel toed boot. Since the panels are made of steel, handling these panels requires gloves. The edges of the steel are quite sharp and could easily cause serious serrated cuts if the crew is careless and not paying attention. The seamers are crimping devices that pull two panels together and seams them. As a result, it is recommended that gloves should not be worn during seaming because they could get caught and pull the fingers into the seamer, creating serious injury. See appendix B for additional safety requirements when operating the MIC-240 ABM.

10. ENVIRONMENTAL:

There are no toxic substances or hazardous materials used in the MIC-240 ABM K-Span machine. The diesel fuel used to operate the engine can be filled on the job site. Any spillage of the diesel fuel requires clean up and disposal in an environmentally sound manner.

11. LIST OF ITEMS FURNISHED:

See the following page for a list of items furnished with the MIC-240 ABM K-Span machine. Appendix C also lists additional items.

TABLE 2: List of required equipment for K-Span

1. MIC-240 ABM (Super Span) Mobile Manufacturing System Consists of:			
1	P-240 Panel Forming Machine	1	9kw 110/220 Volt electric generator
3	R-240 Panel Seaming Machine	1	Lunette eye hitch
1	C-240 Curving Machine	1	Pintle hitch
1	T-240 Trailer w/ one (1) spare wheel and tire	1	Hand crimper assembly
22	Runout tables with adjustable legs and connectors	4	Panel attaching brackets
1	Spreader bar and lifting cable assemblies	1	Panel measure assembly w/125 ft. cord
1	Diesel engine	1	PC-240 Power Crimper
2	Operating manuals	1	Vinyl full machine cover
7	Vinyl covers		
1	ABM Foundation Forms Set, 600 linear feet		
2. Model KE-440 (110 volt) metal cutting power shears with 5 each blade kits			
3. Adjustable 9R vise clamps (50 each)			

12. SHIPPING, HANDLING AND STORAGE:

Air shipment can be accomplished by military aircraft such as: C-130 Hercules, C-141 Starlifter, C-5 Galaxy, or the new addition to the Air Force cargo fleet, the C-17. Other modes of transportation, such as by sea can also be accomplished. Hitching this trailer mounted construction machine to

the back of a typical troop transport (two and a half ton cargo truck) can also be a mode of land transportation. Containerized loading in a standard forty by ten foot container can also be accomplished. See Appendix D. Shipping should be done with the coil steel mounted so the rollers are prevented from hitting each other and causing damage. Once at the final destination, the steel can be removed. If the machine will not be used for a long term, then it is best to store it indoors out of the elements; however, if this is not possible, the machine should be covered with a vinyl cover. Start the machine every ninety days and let it run at operating temperature. Also, run through the hydraulic levers and controls. It is best not to have fuel in the tank if storage is for a long time; therefore, run the engine until it is out of fuel. Finally disconnect the battery.

13. K-SPAN PROBLEM AREAS:

Lack of proper corrosion prevention can cause several problems: An example of this is rusting at the of the edges of the seamed panels. This is due to an inadequate paint peeling or flaking off the steel at the seams and exposing the steel to inclement weather. This is due to the steel coils not being treated correctly with a rust or corrosion preventative during the manufacturing process. Another problem is the lack of corrosion preventative on the angled steel. Although the angled steel is inside the concrete foundation, rust can occur in a corrosive rich environment such as

near the ocean and bleeding of the rust to the surface of the concrete will cause additional rust to start at the base of the curved panels. Both examples can lead to structural problems, but with adequate treatment of the steel and a good paint preservation program these can be overcome.

14. K-SPAN SUMMARY

Although the K-Span building is quick and easy to construct at a very low cost, there are several problems that accompany steel buildings that can lead to structural problems. These problems include corrosion, but they can all be prevented by proper manufacturing techniques and an aggressive paint preservation program.

On the other hand, there are several benefits to constructing the K-Span building. One of these is the mobility of the K-Span machine and the minimal amount of materials required for construction. These make the K-Span buildings very suitable for the military or for a rapid construction requirement application. Uses are limited only to the imagination. Some of these include an aircraft hanger, a storage building or a utility space. The MIC-240 ABM can produce a building as small as forty eight feet wide to one hundred and twenty feet wide with an unlimited length. The machine can produce 1,500,000 linear feet of panels before it requires major replacement of parts. Although the limiting factor is the coil steel material, with an adequate supply, the major benefit of the K-Span building over other

metal buildings is realized because there are many different building size variation in which a touch of a button can produce, and no structural engineer is required to perform calculation.

15. DESIGN SPECIFICATIONS OF A UTILITY SPACE

For a comparison between both buildings a designed spec listed below is used. The objective is to determine the cost of the shell of a building. This means without lights or doors or any other frills. The comparison will be based on the shell of a building, and nothing else. for the following specifications

- 70 mile per hour wind load
- Live load of 12 PSF
- 4000 square feet of usable storage space
- No Utilities
    - Lighting
    - Water
    - Phones
    - HVAC
- Provide a ten foot opening for a roll-up door
- Door opening must have 18' eave height
- interior must be clear span

16. COST COMPARISON OF K-SPAN & BUTLER BUILDING

TABLE 3: Cost comparison

	BUTLER BUILDING	K-SPAN
Direct Cost	18,342	12,550
Overhead (12%)	2,201	1,506
Profit (6%)	1,232	843
Price	$21,776	$14,900

Again, the cost comparison shown above is for the shell of a building with no lights, doors, or ventilation. Any item that is required for both buildings was eliminated from the design specifications. The objective is to determine the actual cost of the shell of a K-Span building and compare it to the actual cost of the shell of a Butler buildiung. For the simple Butler storage building the final price is approximately 1.5 times as much as the K-Span building. Further breakdown of the direct cost could not be attained. As a result, the only comparison to make is the final direct cost. The Butler building structure can also include insulation, which is not an option for the K-Span building. The insulation would add a cost of $3,036.

17. COMPARISON

The Butler building is the top of the line when it comes to metal buildings. The Butler manufacturing company has researched and developed roof systems and delta trusses in order to produce a building that is sophisticated and pleasant. Butler's metal building system also works well together with brick, glass, and CMU to make an architecturally beautiful structure. Butler buildings are the way to go if the building desired is to function as an office building or industrial building, but if the building is to function as an unsophisticated storage building or a simple utility space, then the K-Span is a viable alternative. As shown in the cost breakdown section, the K-Span is indeed a less expensive alternative.

The K-Span which has been shown to be a versatile structure consists of the bare minimum in the way of construction material coil steel stock. Butler buildings require internal structural components such as: Steel columns and beams along with the corrugated steel metal sheets. The corrugated sheets in the Butler building are thinner than the K-Span because the sheet steel does not function as a structural member as in the K-Span building.

K-Span does not require a manufacturing plant to fabricate the building and ship it to the construction site for assembly like the Butler building. The K-Span is already designed for many different sizes in the technical manual. All that is required is a selection of the building size, the

touch of a button the change the size of the panel lengths, and finally, to construct the building. As a result, the K-Span is more versatile of the two buildings.

Appendix A: Provides a detailed list of equipment and specifications for the K-Span machine. The list includes dimensions of the machine, engine requirements etc. Appendix A is listed on the following page.

APPENDIX A

MIC-240 SUPER K-SPAN EQUIPMENT SPECIFICATIONS

Dimensions	: 35'7"
Width	: 7'6"
Height	: 7'10"
Deck Height	: 2'11"
Deck Area (width x length)	: 7'4" x 30'0"
(*)Weight (gross) lbs.	: 25,300 lbs.

Construction: Welded steel and precision machined parts (trailer, deck former, curver, run out table and seamers)

Axle	: 3 @ 7,000 lbs.
Battery	: 420 AMP, 12 Volt DC
Brakes	: Air over Hydraulic
Drive System	: Hydraulic
Power Plant	: Diesel 3 Cylinder 38 H.P.
Fuel Tank Capacity	: 12.2 U.S. gallons
Paint	: High grade industrial finish
Tires	: 950 R x 16.5 - "E" Range
Wheels	: 16.5 x 6.75

Miscellanous tools/spare parts: Generator 110/220V, electric and manual tools as well as miscellaneous spare parts supplied when applicable or as an option at extra charge.

(*) Steel coils not included in the gross weight.

The right is reserved to make changes at any time, without notice, in prices, colors, materials, equipment, specifications and models. Check with M.I.C. Industries, Inc. for up-to-date information.

Appendix B: Provides a list of safety features and precautions to use when working with or around the 240-ABM machine at the construction site. This should be studied and followed by all personnel working around the machine.

APPENDIX B

ATTENTION TO ALL PERSONS WORKING WITH OR AROUND THE ABM MACHINERY AND THE CONSTRUCTION SITE

Assign one qualified, trained and equipped person with authority as SAFETY SUPERVISOR on every job.

Read operator and engine manuals prior to operation of machines and related equipment.

Observe proper safety precautions constantly. The many moving parts can cause serious injury.

Never tow the ABM System with coil stock loaded on the spool.

Use care when working with coil stock. Coils are very heavy and can cause serious injury or equipment damage.

Personnel must always wear gloves to handle coils and panels.

Before starting, walk around machine to assure all is safe. Announce "CLEAR" loudly before starting the engine.

Do not attempt to make adjustments or repairs while the machine is running. Use care that no one starts the machine while it is being worked upon.

Keep fingers clear of gears, rollers and clamps.

Keep control box locked when not in use.

After all adjustments are performed, never operate the machinery with the side or top metal cover panels removed.

After removing run-out tables - SET THE TRANSPORTING RACK UNDER THE MACHINE!

The operator must stay at the control station while forming panels.

As panels are being formed, especially curved panels, an assistant operator is to guide the leading end of the panel to prevent collision with stationary objects such as side rollers.

TO AVOID SERIOUS HAND INJURY - DO NOT PLACE HAND ON ANY PORTION OF THE PANEL THAT CAN COME IN CONTACT WITH A PANEL ROLLER

Never attempt to form panels in winds greater than 20 mph or where the potential for wind gusts exist.

Avoid wearing any loose clothing around machinery and equipment.

Never use any electrical devices when building or ground is wet.

Keep all electrical cords clear of rollers during operation.

Hard hats should be used when overhead work is being performed.

Keep all spectators and non-working persons completely clear of the work area.

Follow safety precautions outlined by the manufacturers' Owners Manual for tools, cords and seaming machines.

Appendix C: Provides a detailed list of test equipment furnished by MIC industries. This list is provided with the purchase of the ABM-240 or the ABM-120 machine.

APPENDIX C

Tools and Test Equipment Furnished *

MANUAL TOOLS LISTED BELOW ARE FURNISHED WITH THE ABM SYSTEM			
1	Tool box w/hinged top and tray	1	Roller chain stretcher
1	16 oz. ball peen hammer	1	Roller chain breaker
1	6" combination pliers	1	8" phillips tip screwdriver
1	Needle nose pliers	1	Aviation type left-handed snips
1	8" standard tip screwdriver	1	Aviation type right-handed snips
1	6" standard tip screwdriver	1	10" adjustable wrench
1	Hack saw w/blades	1	15" adjustable wrench
1	Open end wrench set including: 1/4", 5/16", 3/8", 7/16", 1/2", 9/16", 3/4", 13/16", 7/8", 15/16", 1" and 1-1/8" sizes		
1	3/8" square male drive reversible ratchet		
1	3/8" square drive x 6" long extension		
1	3/8" square drive socket wrench set including: 3/8", 7/16", 1/2", 9/16", 5/8", 11/16", and 3/4" sizes		
1	"T" Handle hex key wrench set including: 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 7/32", 1/4", 5/16" and 3/8" sizes		
1	"L" Handle hex wrench key set including: 3/32" 7/64", 1/8", 9/64", 5/32", 3/16", 7/32", 1/4", 5/16" and 3/8" sizes		
1	0.000" to 1.000" precision micrometer		
1	Feeler gauge marked metric & inch decimal		

*Note: M.I.C. Industries, Inc., reserves the right to make changes to this list as it deems necessary.

Appendix D: This appendix provides instructions on how to transport the ABM machine in a container. The container is trailer mounted.