

LUMBER DRYER LD3000 OWNER'S MANUAL



www.eipl.co.uk

INTRODUCTION

You have probably never seriously considered kiln drying your own lumber before, believing it to be too expensive or too complicated to undertake on a small scale.

Prior to the introduction of the Ebac Small Scale Lumber Dryers this was true. Kiln drying was for the world of specialists: a confusing maze of kiln schedules, sampling techniques, relative humidity's and complex controls – hardly inviting to the small woodworking business which merely wanted to be sure of a regular supply of quality wood at a reliable and consistent moisture content.

Ebac Small Scale Lumber Dryers have changed all that. Whether yours is a one-man business or somewhat larger, whether you are in the woodworking business or woodworking is just your hobby, you do not need any previous experience with drying. As well as being simple to install and operate, Ebac dryers are quiet and cause no pollution.

The Lumber Dryers themselves are installed in easily made chambers of the appropriate size.

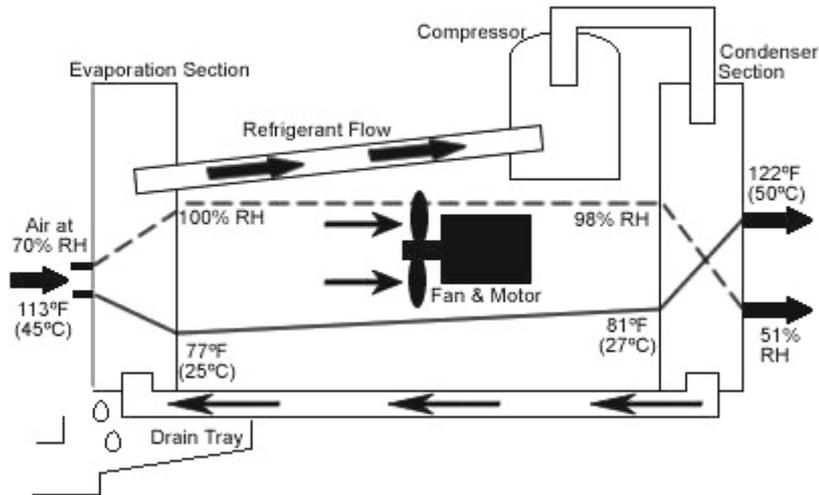
This manual has been designed to guide you through the problems of choosing the correct size of wood dryer for your needs, constructing a suitable chamber and operating the kiln to obtain maximum output of wood.

Use it carefully and thoroughly and you will quickly find out everything that you need to know.

For further information and details of constructions and applications not covered, we will be pleased to offer advice and assistance as required. Please do not hesitate to contact us.

SIMPLIFIED SCHEMATIC DIAGRAM OF LUMBER COMPONENTS

Figure 2



Though the fastest drying is achieved at high temperature, the risks of degrade in the wood, particularly hardwood, increases at high temperature. The general rule is that the lower the temperature the better the quality.

Ebac dryers are designed to operate in the temperature range, which is the best compromise between speed and quality – about 140°F (60°C) and lower. Drying at these temperatures insures that the wood is of the highest quality, and that the equipment is reliable.



Drawing	: - TPC229
Issue	: - 2
Date	: - 10/12/13

UNPACKING

Upon receipt of your LD3000, carefully inspect the shipping container and its contents for any damage. If damage is discovered, contact the Service Department for instructions.

CONTENTS

Your LD3000 shipment consists of the following items:

1. LD3000 Lumber Dryer with Power Cord
2. Discharge Hose
3. STC1 Controller
4. (2) Wall Mounting Brackets
5. (2) 16 – inch Circulation Fans

DRYER CAPACITIES

Table 1 below shows average drying times for the LD3000. Table 2 shows the optimum load capacities for the LD3000. If larger quantities than those shown in Table 2 are dried, drying speed will be proportionately slower. If small quantities are dried, the controls can be adjusted to allow for this.

Table 1 – Average Dying Times in Days*

		MOISTURE CONTENT RANGE			
FROM – TO		50% - 8%	40% - 8%	30% - 8%	20% - 8%
Type	Thickness	Days	Days	Days	Days
Hardwoods**	1"	50	37	25	13
	2"	90	68	45	25
	3"	158	119	81	43
Softwoods	1"	14	10	6	4
	2"	32	25	15	8
	3"	53	40	27	14

* Drying times may vary depending on species, starting moisture content, thickness, and size of load.

** Drying of Claro Walnut is not recommended.

Table 2 – Optimum Lumber Capacities in Board Feet

Lumber Type	Softwoods			Hardwoods		
Thickness (Inches)	1"	2"	3"	1"	2"	3"
LD3000	1440	3210	5400	3000	5150	8875

(Some capacities can be smaller or larger – consult Ebac)

Example 1: You wish to dry 4/4 Oak from a starting moisture content 30% to 8%.

From Table 1, you see that it will take 25 days to dry 4/4 (1") hardwood for 30% to 8%.

Then from Table 2, the optimum capacity for 1" hardwood from the LD3000 is 3000BF. Therefore, 3,000BF can be dried in about 25 days, and 42,000BF in a year. (365/25 days = 14 loads per year x 3,000BF per load).

KILN CHAMBER

LUMBER STACK SIZE

The first step in determining your kiln chamber size is to determine the most suitable lumber stack size (or configuration) for your purposes. This will depend primarily on the longest length board to be dried. Normally, the length of the stacks will be equal to the length of the longest board. If your lumber is in short lengths (i.e.: approximately 3 feet), then the stack length should be multiples of these lengths.

The width and height of the stack can be adjusted to suit your conditions. The “stack” may actually be made up of two or more smaller stacks, or packs.

In order to allow air-flow through the lumber stack, each “layer” must be separated from the below by a spacer or “sticker” of $\frac{3}{4}$ to 1” thickness. The air spaces thus created must be included in the overall stack height when calculating volume.

Use this procedure to determine stack height and width: First select an appropriate width and then calculate stack height including stickers. If this calculated height would result in an awkward height to width, select a new width. See example 2 which follows.

Example 2: Desired kiln capacity is 3,000BF of 1” hardwood, and the longest board is 16 feet. Add 10% to the lumber quantity to allow for non-uniformity in the stack. If that stack width is 6 feet, then each layer of lumber would contain:

$$\text{BF per layer} = 16' \times 6' \times 1" \text{ thick} = 96\text{BF}$$

$$\text{Layers required} = \frac{3,000\text{BF}}{96\text{BF/layer}} \times 1.1 = 34.4 \text{ of } 35 \text{ layers}$$

$$\text{Each layer is } 1" \frac{3}{4} \text{ sticker} = 1 \frac{3}{4} \text{ high}$$

$$\text{Stack height} = 35 \text{ layers} \times 1 \frac{3}{4} \text{ high} = 61 \frac{1}{4} \text{ high (rounded up to } 5 \frac{1}{4} \text{)}$$

Thus, the stack size is:

$$16' \text{ long} \times 6' \text{ wide and } 5 \frac{1}{4}' \text{ high}$$

CHAMBER INTERIOR DIMENSIONS

Having calculated the stack size, it is now possible to calculate the appropriate internal dimensions of the chamber. This is done by adding the required additional space around the stack for the dryer and the fans as well as for good air circulation. Suggested additional space is:

Length: 1'

Width: 2 ½'

Height: 2'

Example 3: Using the information from Example 2, where the stack size is 16' long and 6' wide and 5 ¼' high, we can find the required internal dimensions.

Length: $16' + 1' = 17'$

Width: $6' + 2 \frac{1}{2}' = 8 \frac{1}{2}'$

Height: $5 \frac{1}{4}' + 2' = 7 \frac{1}{4}'$

CHOOSING PROPER INSULATION THICKNESS

The wall thickness (insulation) is very important and is related to the size (surface area) of the chamber.

After adding the required internal clearances to the stack size, the internal dimensions are known, and the approximate chamber surface area can be calculated. Table 3 shows the recommended thickness of insulation (wall thickness) in relation to the total surface area of the walls, ceiling and floor of the chamber.

To determine wall (insulation) thickness we must calculate approximate surface area of the chamber.

Example:

Kiln Dimensions:	8 ½' x 8 ½' x 18' (H x W x L)	
Ends:	8 ½' x 8 ½' x 2 pieces	145 sq.ft
Top and Bottom:	8 ½' x 18' x 2 pieces	306 sq.ft
Front and Back:	8 ½' x 18' x 2 pieces	306 sq.ft
		<u>757 sq.ft surface area</u>

Pick proper insulation thickness from Table 3.

Table 3 – Thickness of Insulation

Surface Area of Chamber in Sq.Ft	500	800	1100	1400	1800	2100
Optimum R-Value	11	16	19	19	21	21

Fiberglass Insulation
R-11 = 3 ½" R-19 – 6"

Blue Styrofoam
R-7 = 1"

The thicknesses in the table are optimum for year round operation. If you wish to increase efficiency during the winter in cold climates, increase thickness by about 50% and remove extra insulation during the summer. This extra insulation may cause the kiln to overheat in the summer.



EXAMPLE KILN SIZES

If you would rather not design the dimensions of you kiln, simply choose the best size for you operation from Table 4.

All of the kiln dimensions shown are exterior dimensions. The load sizes refer to 1” hardwood with 3/4” stickers, and all the wall thickness and air spaces have been added in.

Table 4 – Example Kiln Sizes
(Height x Width x Length)

6’ Lumber

2 Stacks – See 12’ Lumber

8’ Lumber

2 Stacks – See 16’ Lumber

10’ Lumber

10 x 10 x 12 = 3000BF
10 x 9 1/2 x 12 = 2700BF
9 1/2 x 9 1/2 x 12 = 2500BF

12’ Lumber

9 1/2 x 9 1/2 x 14 = 3000BF
9 1/2 x 9 x 14 = 2700BF
9 x 9 x 14 = 2500BF

14’ Lumber

9 x 9 x 16 = 3000BF
9 x 8 1/2 x 16 = 2700BF
8 1/2 x 8 1/2 x 16 = 2500BF

16’ Lumber

8 1/2 x 8 1/2 - 18 = 3000BF
8 1/2 x 8 x 18 = 2700BF
8 x 8 x 18 = 2500BF

CONSTRUCTION OF CHAMBER

Floor:

An insulated concrete floor is recommended.

- Start with a gravel base.
- Lay down 2" of rigid Styrofoam.
- Pour 4" of reinforced concrete.
- Seal concrete with any commercially prepared sealer

Notes: A slightly pitched floor leading to drain may be incorporated. This will be helpful if large amounts of softwood are to be dried.

Should an insulated concrete floor not be feasible, a well-built, insulated wooden floor will work.

See Figure 3.

Wall/Ceiling Construction:

- Make a 2" x 4" studded frame.
- Cover exterior with ½" exterior grade plywood or waferboard.
- Insulate to proper R-Value.
- Staple or tack 4mm. Plastic over insulation prior to installing inside the wall. This vapor barrier protects insulation from moisture.
- Spray paint over staples to prevent corrosion.
- Hang ¼" exterior grade plywood as inside wall.
- Coat the inside wall and ceilings with a vapor barrier grade sealer. This protects the inside walls and ceiling from moisture and insures long life for your kiln. (Aluminized mobile home roofing paint works well).
- Use a silicone caulk to seal up all cracks and seams.

See Figures 4 and 5.

Door Construction:

- The door section should be constructed the same as the walls and ceiling.
- Exterior plywood should overlap the door frame by 3". This will allow space to attach a rubber gasket and enable the door to be bolted to the kiln chamber. Anchor bolts are recommended for continued usage.
- For front loading kilns, hinged double doors are needed.

See Figures 6 and 7.

Fan Truss:

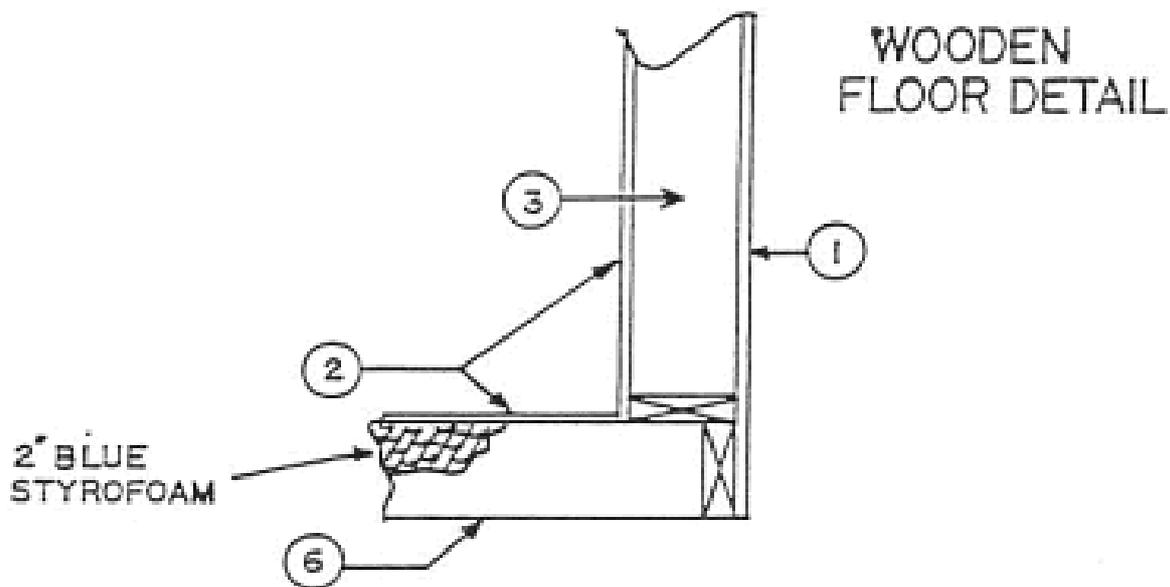
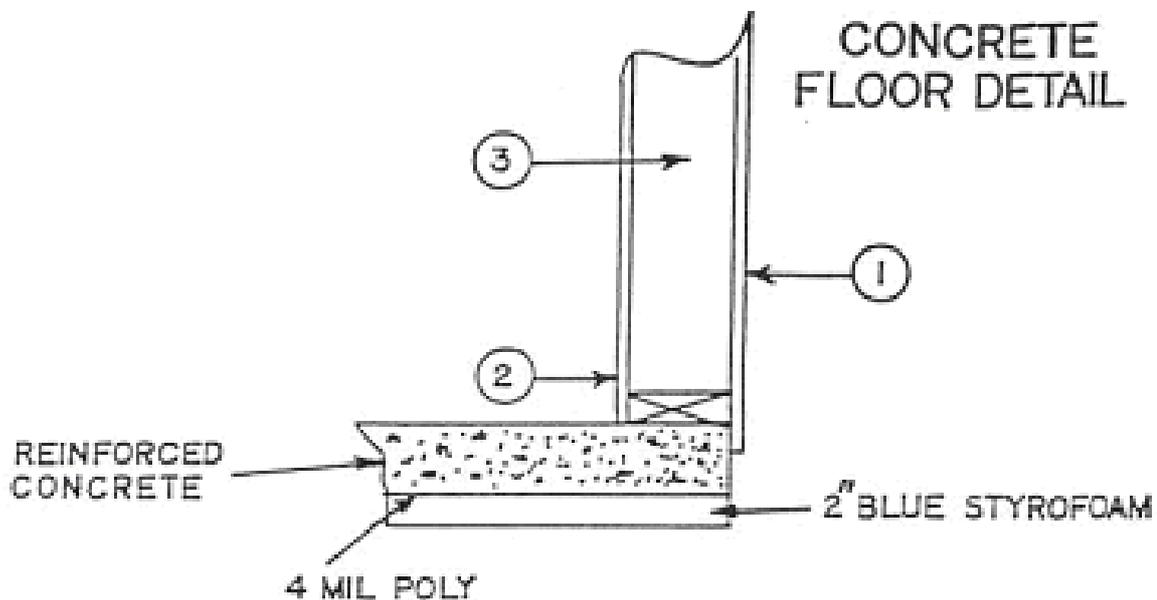
The LD3000 kiln accomplishes air circulation with the aid of two (2) supplemental overhead fans. The 110 Volt, 60 Hz fans are wired in separate from the drying unit.

- The fan truss, which hangs from the ceiling, should run the length of the kiln.
- The truss should be located 18" from the front of the drying unit.
- The truss should be framed with 2" x 42 studs.
- The circulation fans should be evenly positioned within the truss.
- Air flow should move away from the dryer.
- Plywood or waferboard is used to cover the open area of the fan truss.
- For all dry kiln, baffles or curtains should be used above and to the side of the stack to force the air flow through the lumber stack, not around it. Heavy plastic is the most common baffling.

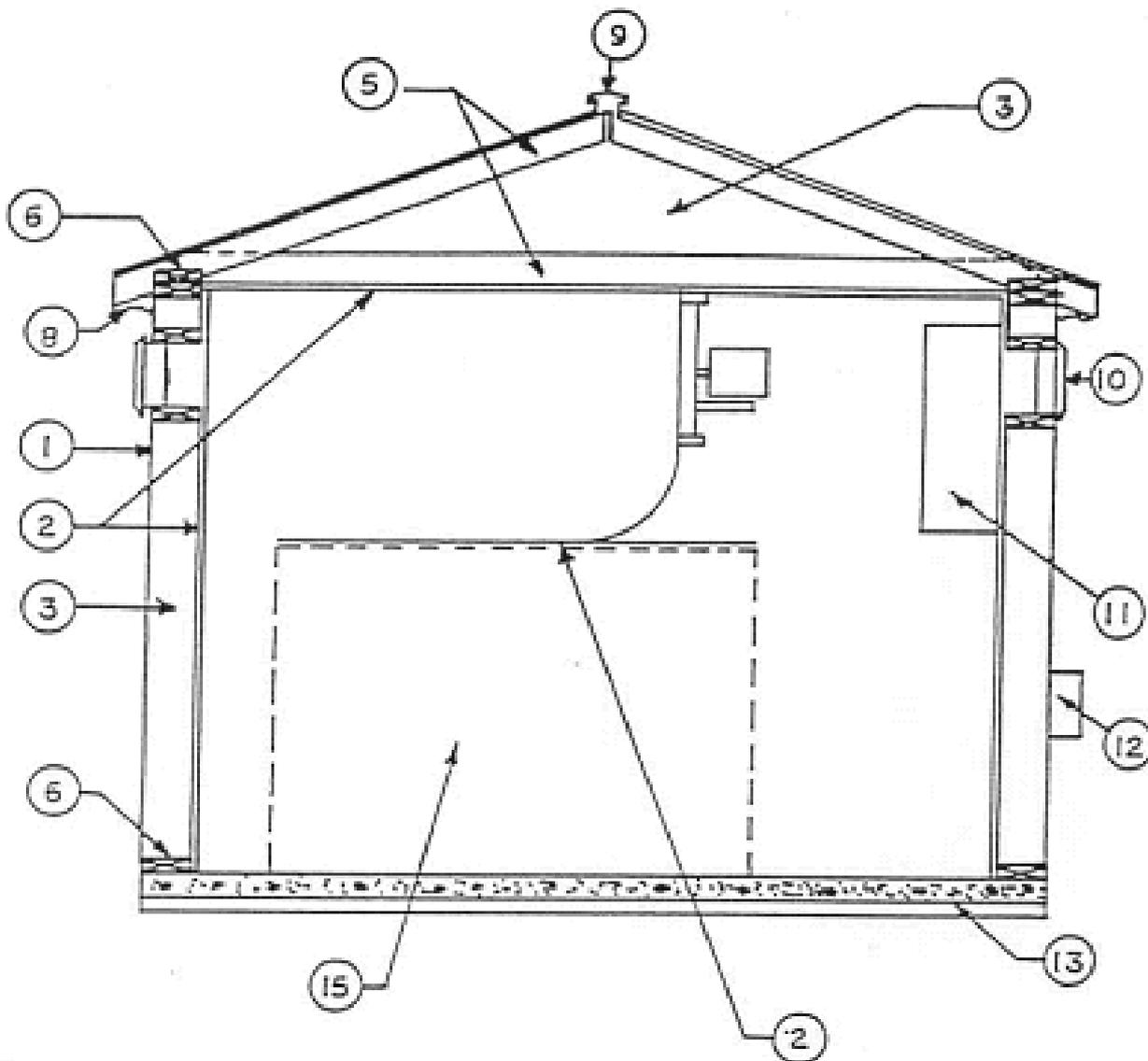
See Figure 8.

Material List: (Numbers correspond with drawings)

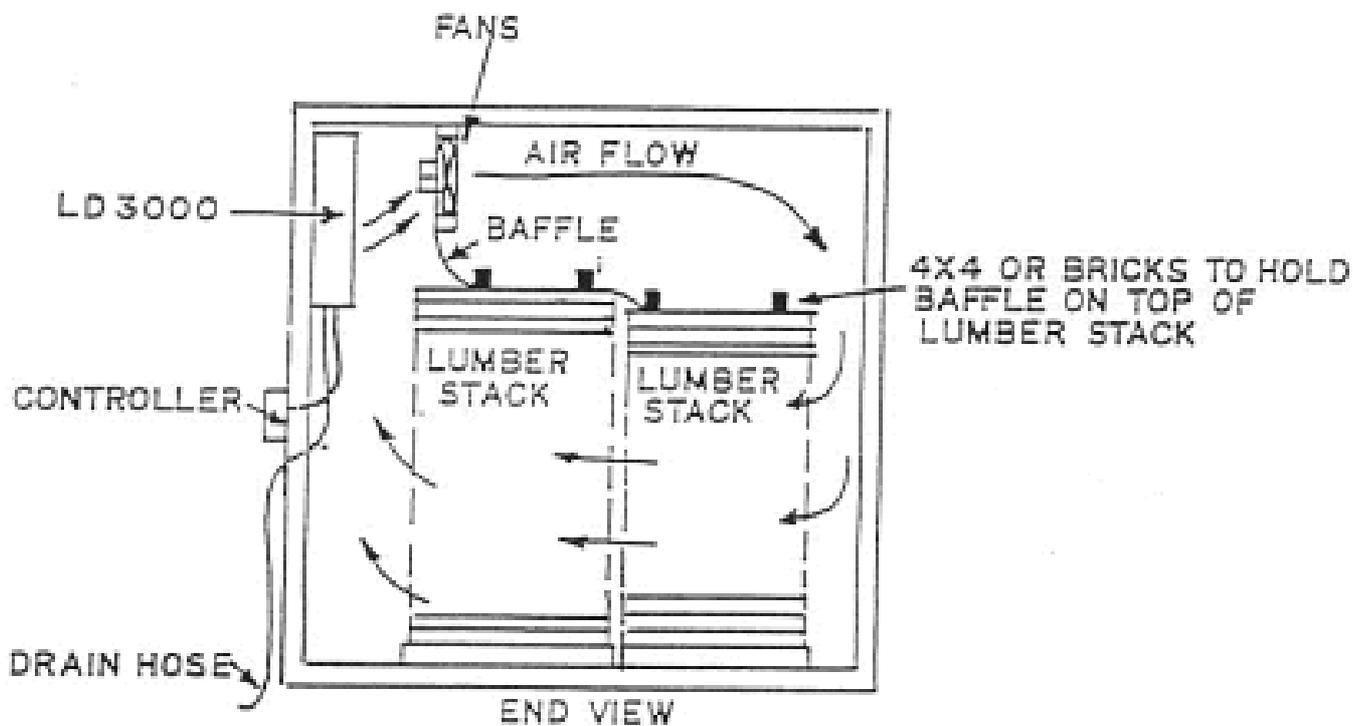
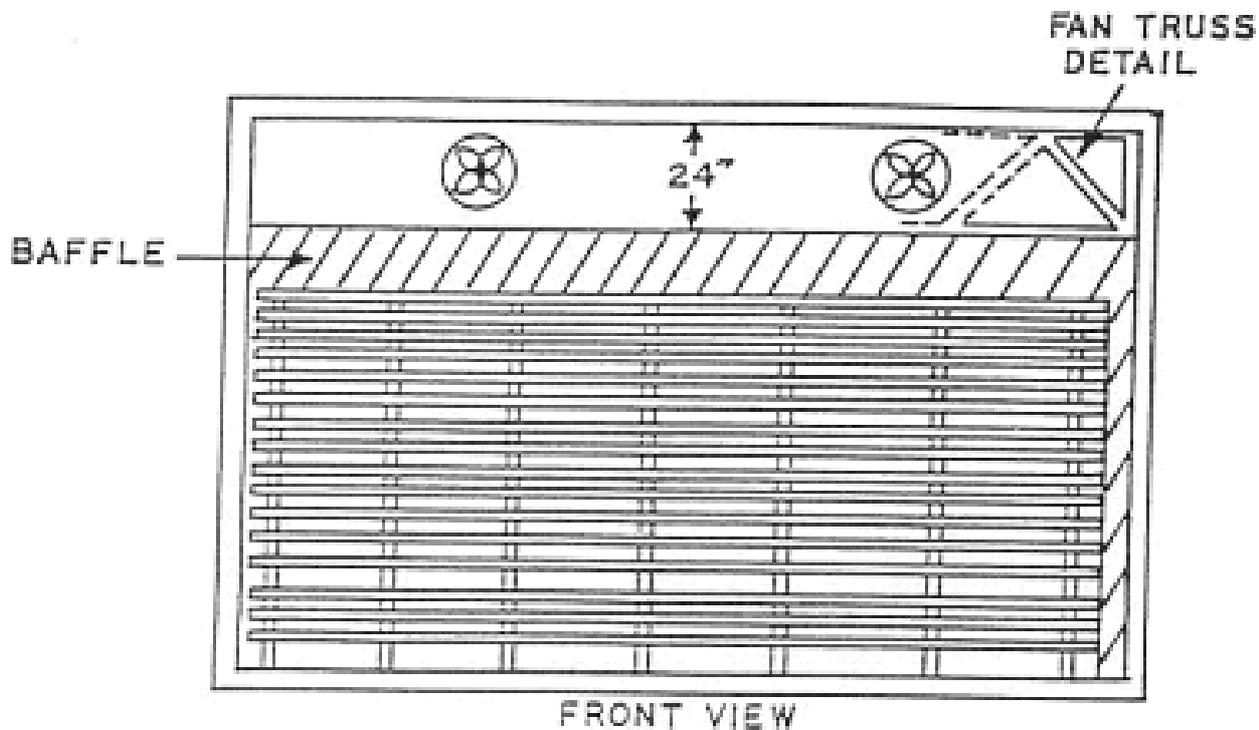
1. 1/4" or 1/2" CDX plywood or article board.
2. 4mil. Poly under CDX plywood or particle board.
3. Fiberglass or Blue Styrofoam insulation.
4. Fiberglass or Blue Styrofoam insulation.
5. 2" x 4" or 2" x 6" Construction.
6. Rubber Gasket (Garage door seal works well).

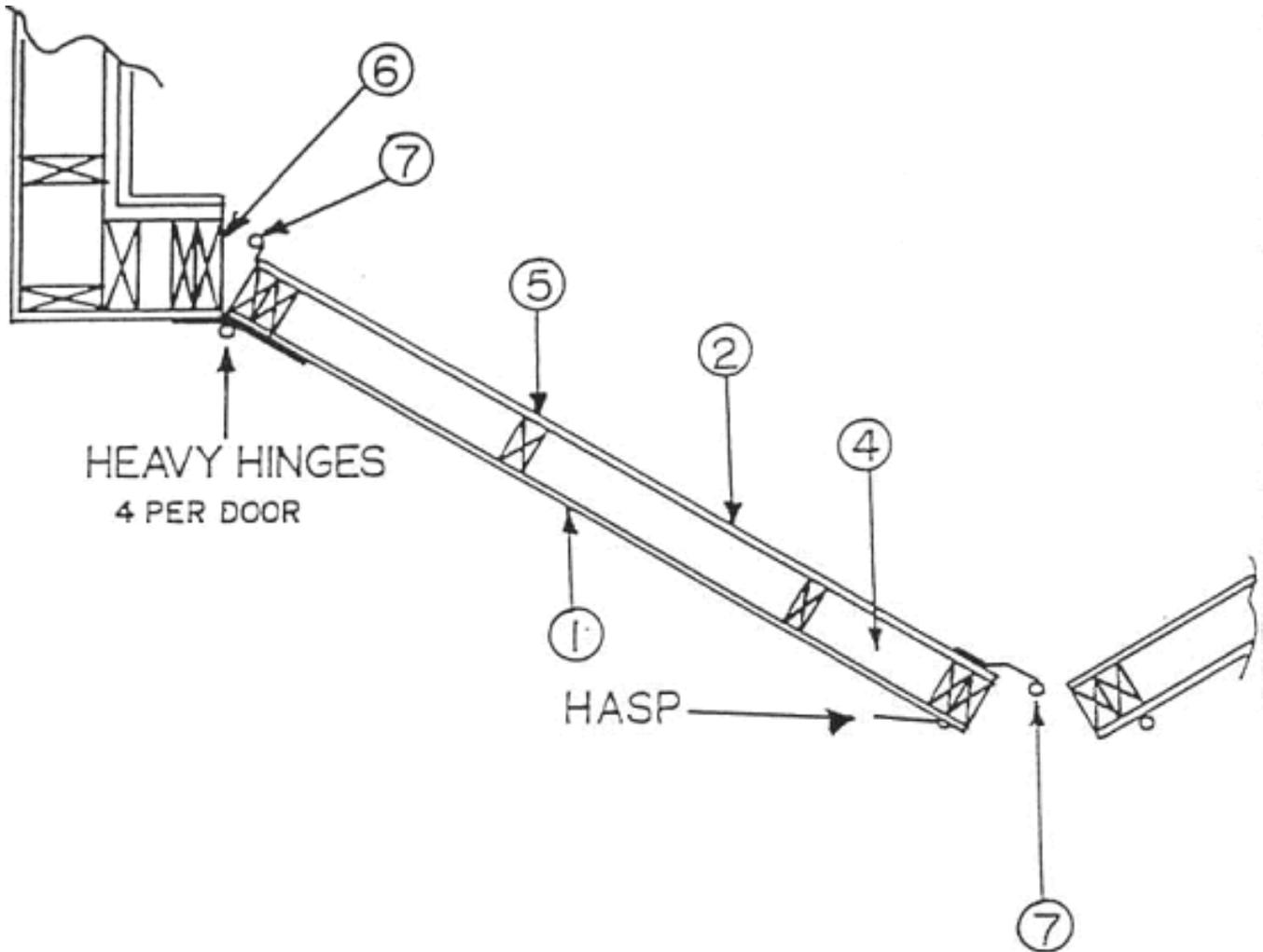


- 1 CDX PLYWOOD OR PARTICLE BOARD
- 2 4 MIL POLY
- 3 FIBERGLASS OR BLUE STYROFOAM INSULATION
- 6 2X4 OR 2X6 CONSTRUCTION

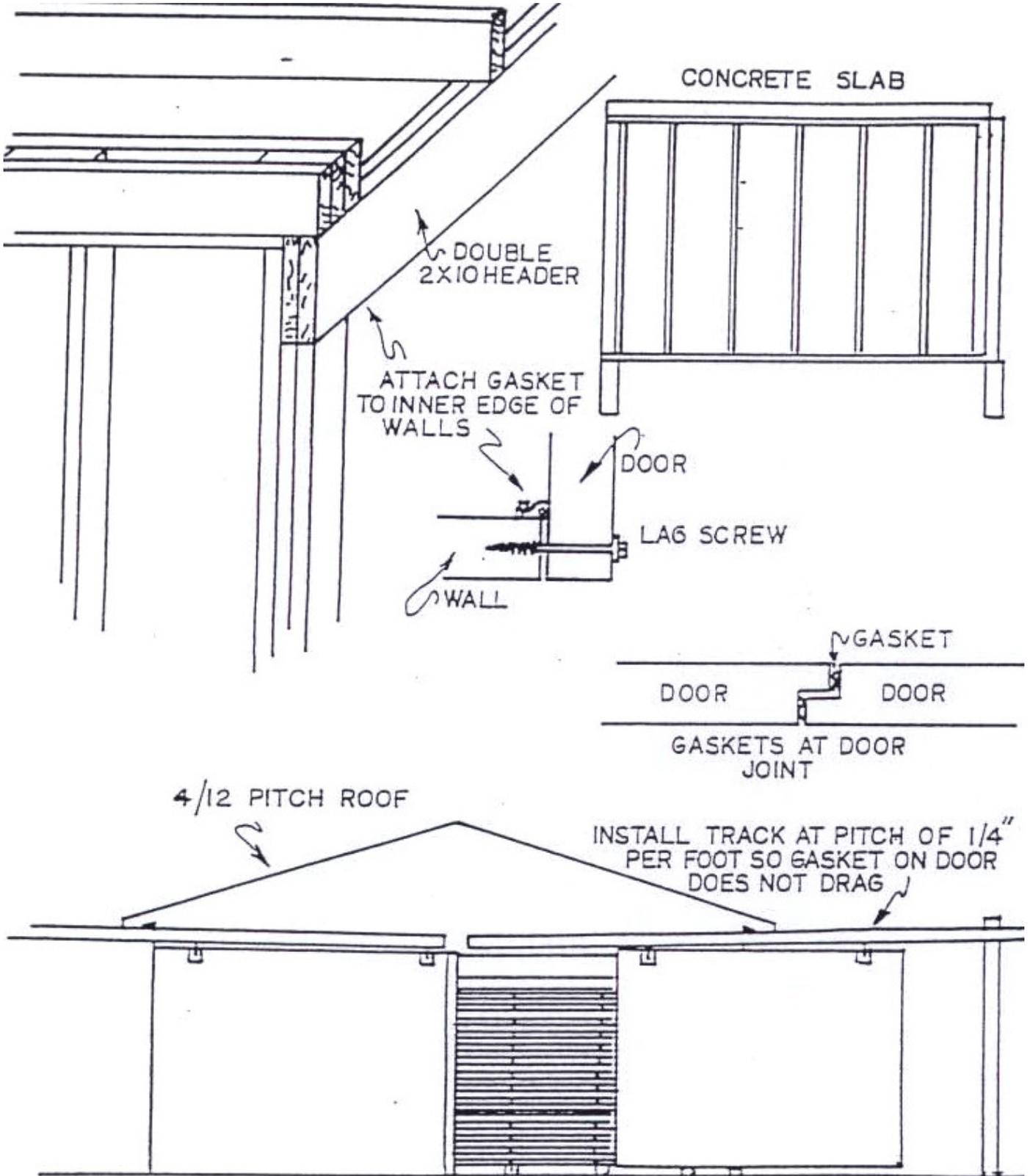


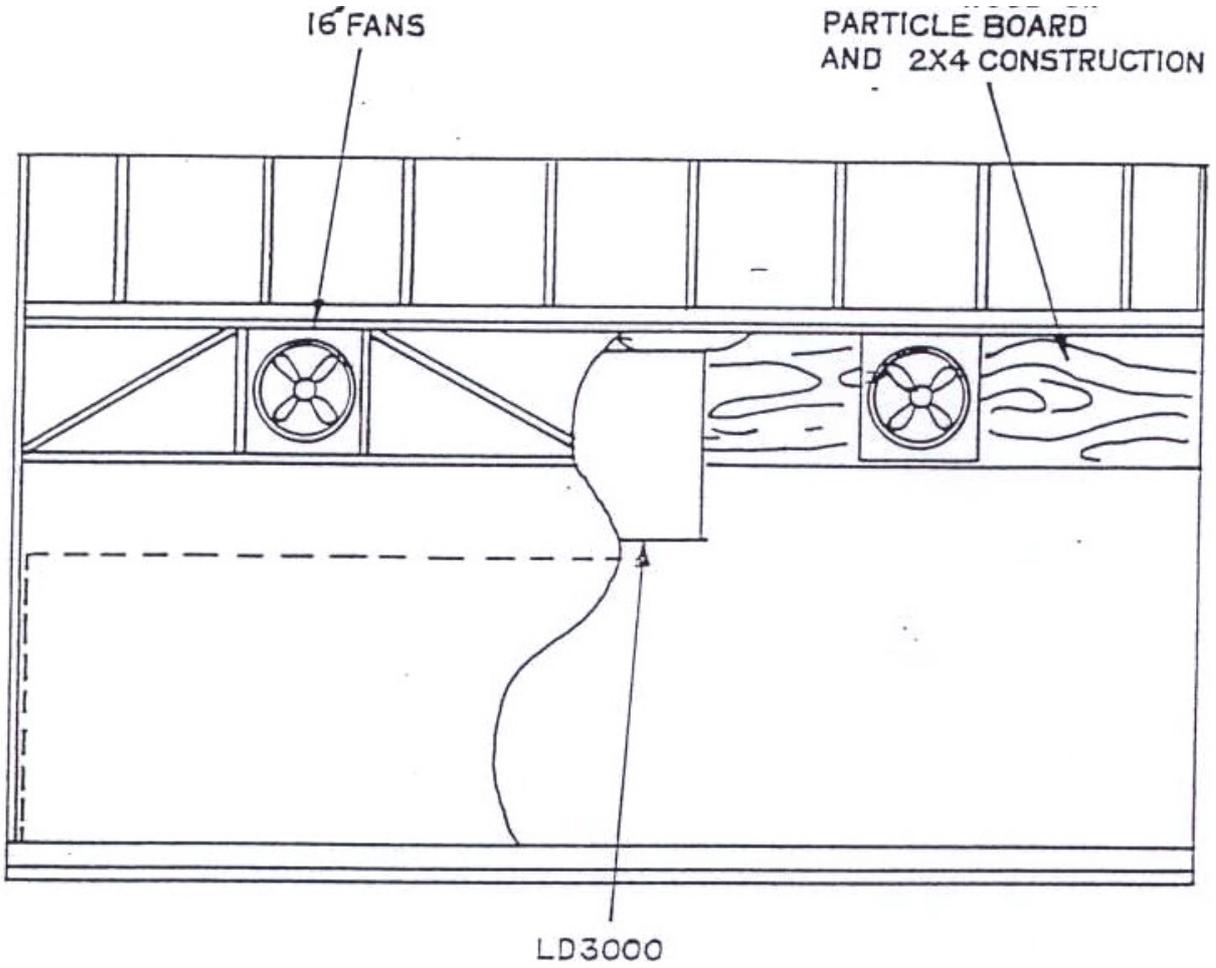
- 1 CDX PLYWOOD OR PARTICLE BOARD
- 2 4 MIL POLY
- 3 FIBERGLASS OR BLUE STYROFOAM INSULATION
- 4 2X4 CONSTRUCTION
- 5 2X4 OR 2X6 CONSTRUCTION
- 6 RIDGE VENT
- 7 HIGH TEMP VENT (OPT)
- 8 LD3000
- 9 UNIVERSAL CONTROLLER
- 10 4" CONCRETE
- 11
- 12
- 13
- 14
- 15





- 1 CDX PLYWOOD OR PARTICLE BOARD
- 2 4 MIL POLY
- 4 FIBERGLASS OR BLUE STYROFOAM INSULATION
- 5 2X4 CONSTRUCTION
- 6 2X4 OR 2X6 CONSTRUCTION
- 7 RUBBER GASKET





INSTALLATION AND TESTING

Installation

All wiring should be carried out by a competent electrical contractor in accordance with local regulations.

The 16-inch circulation fans do not connect to the STC1 Controller. They must be connected to separate switchgear.

<p>Warning: OSHA complying guards are strongly recommended when fans are installed with 7' of floor, working level, or within reach of personnel. Review OSHA codes.</p>

Check the voltage at the power supply to insure correct voltage is 220 Volt +/- 10%, 1 Phase, 60 Hz.

The LD3000 must be plugged into a suitable fused 220 Volt outlet.

Using the mounting brackets provided with the unit, mount the LD3000 4" – 8" from the ceiling, centered on the back wall.

Attach the discharge hose to the drainage nipple.

Locate and drill three (3) holes fro the following:

Discharge hose – ensure that the water discharge will gravity feed from the kiln chamber.

Power cord and Controller cord – Ensure that the power cord reaches the 220 Volt, 1 Phase, 60 Hz outlet and that the controller cord reaches the plug connection on the STC1 Controller.

Use silicone rubber caulking or a similar material to seal the holes after proper installation of the discharge hose, power cord, and controller cord. This will aid in preventing heat loss from the kiln.

TESTING FOR PROPER INSTALLATION

Remove lower front panel by removing four retaining screws.

Warning:	Do not operate the LD3000 for an extended period of time with the covers removed. This will cause improper operation of the machine and may cause damage to components.
-----------------	---

Adjust the temperature control and the drying control on the STC1 Controller to the minimum setting.

Attach the controller cord to the STC1 Controller and latch in place.

Plug the LD3000 power cord into the 220 Volt, 1 Phase, 60 Hz receptacle. (Insure that power to the receptacle has been achieved).

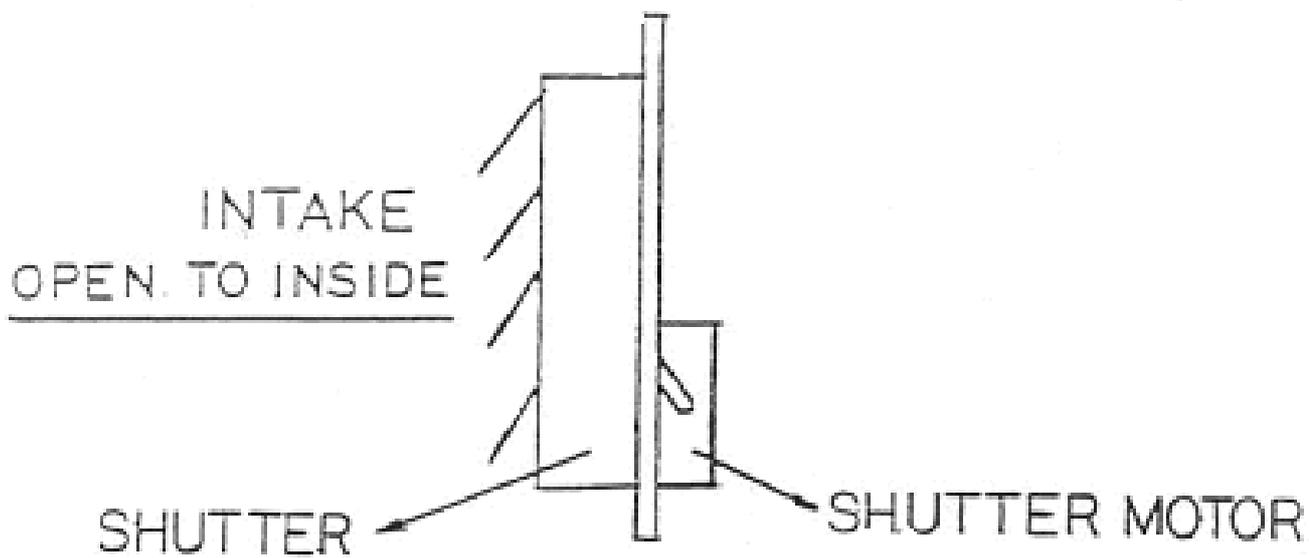
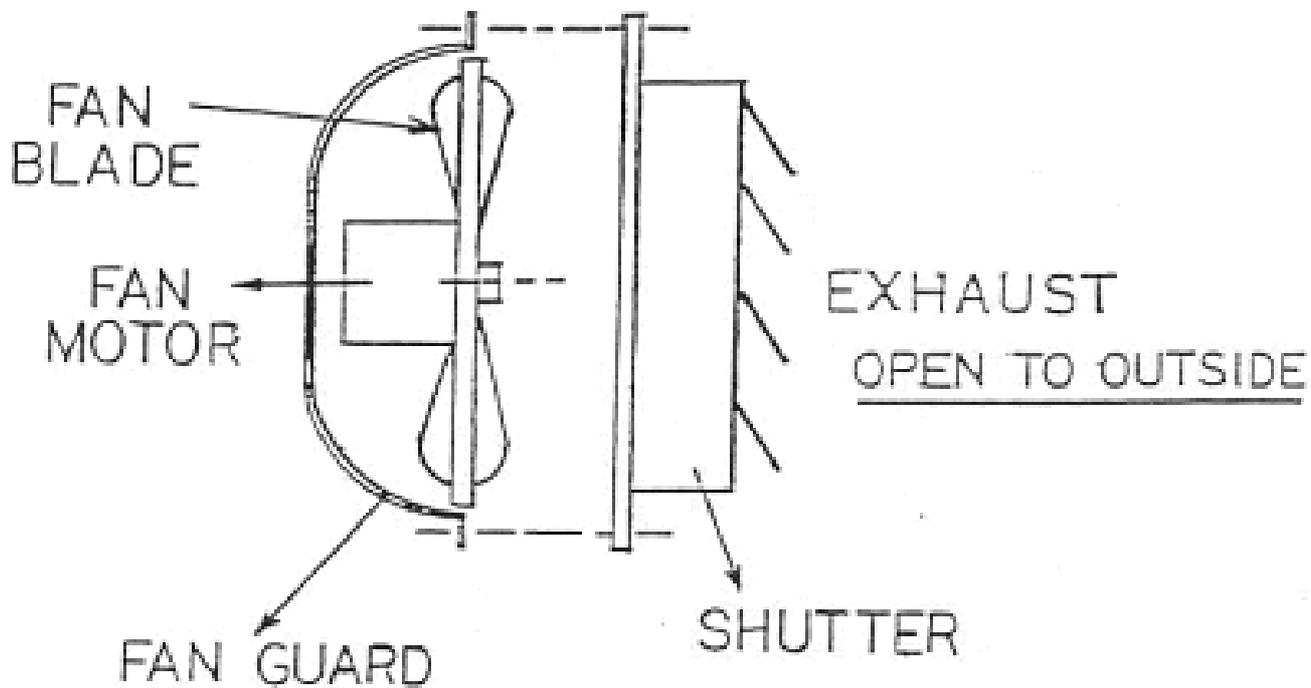
The fans in the LD3000 will start to rotate immediately. Set the STC1 drying control to C and the temperature control to 45°C.

The above settings will result in the following:

1. The heating element will produce heat.
2. After a 6 minute delay, the compressor will start to run.

When the compressor has been running for 6 minutes, the bare copper coils above the draintray should be covered with either frost or condensation. (The last two or three turns on the rear coils may not have frost or condensation because the refrigerant is picking up superheat for the return to the compressor).

After insuring proper operation of the LD3000, disconnect the power cord and reinstall the lower front panel.



TESTING TWO-STAGE OVERHEAT SYSTEM

Disconnect the power cord from the receptacle. Remove the top front panel by removing the six retaining screws. Reconnect the power cord to the receptacle.

<p>Warning: DO NOT reach into the electrical panel with your hand or any tool. This may result in a severe electrical shock or death.</p>
--

Set the drying control on the STC1 Controller to C and the temperature to 45°C.

Gradually reduce the temperature control setting. When the temperature setting equals the temperature indicated by the temperature display, the heater will switch off. This can be verified by observing the C1 Contactor. When this contactor de-energizes, the heat is off. Reduce the temperature control further and the compressor will switch off when the temperature setting is below 5° below the temperature display. This can be verified by observing the C2 contactor. When this contactor de-energizes, the compressor is off (See Figure 9).

Should you have any problems resulting from testing your LD3000 or STC1 Controller, contact the Service Department of assistance.



HIGH TEMPERATURE VENT SYSTEM

If in the event you have purchased a vent system for your LD3000 kiln, please follow these instructions for installation and operation.

Exhaust vent fan, intake shutter motor, and thermostat should be wired by a licensed electrician in accordance with local codes. Assembly should be wired separately from all other Ebac equipment, to a 115 Volt, 60 Hz, 15 Amp supply. Vent fan and shutters will engage automatically if the kiln temperature exceeds the setting on the thermostat control.

The differential on the thermostat has been pre-set at 3°F. This will insure proper operation and control the desired kiln temperature.

Vent fan intake shutter cutouts are 13" square.

Both the vent fan and intake shutter should be mounted at east 3 ½ ft above the kiln floor. Positioning on the same kiln wall or at opposite ends of the kiln is acceptable. However, if positioned on the same wall, allow 6 feet minimum between shutter intake and kiln wall. The exhaust shutter open to the outside, the intake shutter open to the inside of the kiln.

Warning: OSHA complying guards are strongly recommended when fans are installed with 7' of floor, working level, or within reach of personnel. Review OSHA codes.
--

Adjust the vent thermostat knob accordingly as you adjust your STC1 Controller thermostat during your kiln drying run. The vent thermostat and STC1 Controller heater thermostat should be set at the same degree. A handy conversion chart has been included converting °C to °F.

CENTIGRADE	FARENHEIT
10	50
15	59
20	68
25	77
30	86
35	95
40	104
50	122

(maximum for LD3000)

DRYING LUMBER

The best lumber drying results are obtained when the loads of lumber are of the same species, quality, thickness and initial moisture content. However, this is not always possible, particularly in small scale operations. In such situations the drying procedure should follow the slowest wood in the load – i.e., the hardest, thickest, or wettest boards.

The layers of lumber are separated by stickers. The thickness of the stickers is determined by the thickness of the lumber most commonly being dried. Stickers or $\frac{3}{4}$ " are generally used with boards up to $1\frac{1}{2}$ " thick and stickers of 1" for boards thicker than $1\frac{1}{2}$ ". In practice, one set of stickers can be used in a kiln no matter what the lumber thickness.

The layers of stickers should be placed directly above each other to prevent distortion of the boards during drying. The space between columns of stickers should be approximately 18" To 30" for board thickness up to $1\frac{1}{2}$ " and 24" to 48" for board thickness' greater than $1\frac{1}{2}$ ". Put a column of stickers at each end of the stack to support the ends and help reduce checking. The important consideration is that the boards do not sag between rows of stickers.

Gaps in the stack cross-section are reduced by using boards of the same length, which otherwise would result in a non-uniform circulation at these spots. If this is not possible, any gaps/spaces should be blocked with baffles so that the air passes through the stack and not round it.

Before placing the lumber in the chamber, the initial moisture content of the wettest boards should be measured by means of an electronic moisture meter or the over dry method (see Appendix 1). Ebac can provide a suitable moisture meter system to meet your needs at an additional cost.

KILN OPERATING INSTRUCTIONS

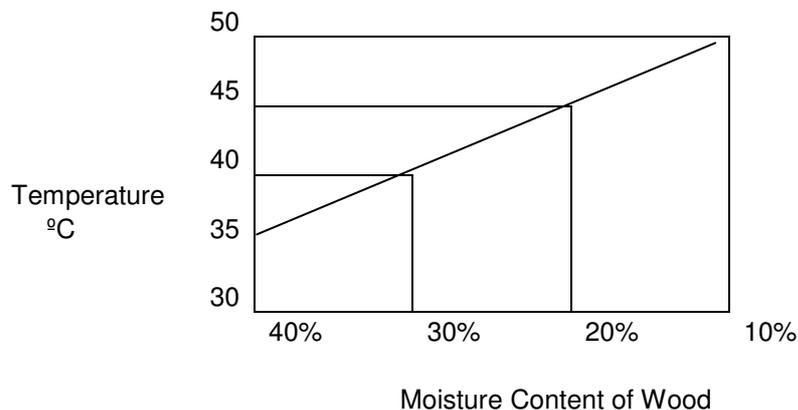
1. Connect the main power cable to a suitable power supply.
2. Select the appropriate setting from the relevant drying control schedule as shown in table 5. Settings are based on the amount and type of lumber to be dried.

Warning: If the Table calls for a setting of “C” (Continuous), set the drying control at 90% at first, until the temperature reaches 38°C (100°F). Position “C” can then be selected.

Below 38°C the dehumidifier requires the 10% off-time to defrost the ice formed on the heat exchanger (cold coil). Above 38°C (100°F), the condensation does not freeze, but drips continuously into the drain tray and out through the drainage hose.

3. Set the temperature control knob on the STC1 Controller at the lower of the following:
 - A. 5°C higher than the kiln temperature (shown on the digital display on the controller); or
 - B. The maximum chamber temperature from the graph below.

The temperature should be increased by 5°C (9°F) every 24 hours, but must NEVER exceed the temperatures shown on graph below. If the temperature does not increase in accordance with the temperature control knob adjustments. (i.e., 24 hours after an increase of 5°C the temperature has risen by a lower amount, e.g. 3°C), this indicates that the heater is operating continuously but the temperature rise has not been achieved. This can be caused by the volume of wood being heated, cold weather conditions, or inadequate insulation. The next temperature setting should be 5°C above the kiln temperature as displayed on the temperature meter.



Two things are very important:

- A. THE RATE OF TEMPERATURE INCREASE MUST NOT BE MORE THAN 5°C (9°F) PER DAY.

Never set the thermostat more than 5°C (9°F) above the present kiln temperature.

Rapid temperature increases cause the relative humidity to suddenly drop leading to surface and end checking of the lumber.

- A. THE KILN TEMPERATURE MUST NOT EXCEED THAT WHICH IS SAFE FOR THE MOISTURE CONTENT OF THE LUMBER.

The maximum chamber temperature, shown on the preceding graph, indicates the maximum safe kiln temperature at every stage of drying.

The temperature graph implies that you must measure the lumber moisture content each time before increasing the temperature when operating above 35°C (95°F). to determine if drying cycle is complete, the lumber moisture content must be actually measured using a moisture meter or the oven dry method.

4. To check that the drying rate is correct, allow the kiln about 3 days to stabilize after starting and then measure the water extracted during a 24-hour period. As the wood dries, the drying control and thermostat may be increased to maintain the water extraction rate.

Completing The Run: When the drying cycle is complete, leave the wood for approximately 24 hours in the chamber with the Drying Control setting reduced to 10% and the thermostat reduced to its lowest setting. This will allow the residual moisture within the wood to become more evenly distributed.

Table 5
Drying Control Settings

LD3000 LUMBER DRYER

CHAMBER LOAD – SOFT WOODS									
Drying Control Setting	1"	4/4	25mm	2"	8/4	50mm	3"	12/4	75mm
	Cu Ft	Board Ft	Cu Mtrs	Cu Ft	Board Ft	Cu Mtrs	Cu Ft	Board Ft	Cu Mtrs
C	120	440	3.4	270	3240	7.7	450	5400	12.8
85	102	1224	2.9	229	2754	6.5	382	4590	10.9
65	78	936	2.2	175	2106	5.0	292	3510	8.3
40	48	576	1.4	108	1296	3.1	180	2160	5.1

CHAMBER LOAD – HARD WOODS									
Drying Control Setting	1"	4/4	25mm	2"	8/4	50mm	3"	12/4	75mm
	Cu Ft	Board Ft	Cu Mtrs	Cu Ft	Board Ft	Cu Mtrs	Cu Ft	Board Ft	Cu Mtrs
C	250	3000	7.4	429	5150	12.2	739	8875	21.1
85	212	2550	6.0	364	4377	10.4	628	7543	17.9
65	162	1950	4.6	278	3347	7.9	480	5768	13.7
40	100	1200	2.8	171	2060	4.9	295	3550	8.4

The above control settings will produce dried wood of good quality, higher than recommended settings can be used to give quicker drying if required. This may result in instances of degrade. If you are in any doubt select only the recommended setting.

Additional Notes on Lumber Drying

As the wood dries, the daily volume of water extracted may decrease. The drying control setting may be increased to compensate for this fall-off in order to achieve a constant daily extraction of water.

When drying a mixture of thickness and/or species of wood, adjust the drying control to the setting applicable for the total load of wood as if it were comprised of the thickness or species requiring the lowest setting. E.g., a mixture of:

- 1000 BF of 1" Oak and
- 2000 BF of 3" Spruce
- 3000 BF (1000 + 2000) of 1" Oak requires a setting of "C"
- 3000 BF of 3" Spruce requires a setting of 65%

Therefore the correct setting for the mixed load is 65%

To prevent overheating during hot weather conditions, particularly if the frying chamber has been very well insulated, water extraction may occasionally be suspended to enable the chamber to cool. This is not a fault condition, however it is an indication that the chamber walls incorporate excessive insulation. This situation can be diagnosed by observing intermittent water extraction when the drying control is set to "C".

In accordance with International practices, temperatures in these instructions are expressed in degrees centigrade (Celsius). The following scale can be used to determine the equivalent temperature in Fahrenheit.

°C	25	30	35	40	45	50	CENTIGRADE
°F	77	86	95	104	113	122	FAHRENHEIT

Appendix I

Oven Drying Method for Determining Equilibrium Moisture Content

If an accurate moisture meter is not available, then moisture content can be determined using the oven dry method. The oven dry method is actually more accurate than moisture meters, but not very convenient. You do need an accurate scale for weighing the wood samples and an oven (a baking oven will do) to bake the samples.

Select a plank from the wood to be dried and cut 6 inches from each end and discard these cutoffs. (They will be much drier than the rest of the piece). Cut several one-inch pieces from one end until you have about a pound in weight. Weigh these and record the wet weight. Weigh the remaining portion of the plank and add it to the middle of the lumber stack in the kiln where it can be retrieved periodically to monitor equilibrium.

Place the 1" sample in a 225°F oven for 24 to 36 hours then weigh again. This is the oven dry weight. Use the formula below to calculate the starting EMC of the sample.

$$\text{EMC} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100\%$$

The moisture content of the lumber in the stack can now easily be monitored by periodically pulling the sample from the stack and weighing it. First, however, calculate the future dry weight of the plank by using the EMC just calculated.

$$\text{Plank Dry Weight} = \frac{\text{Wet Weight}}{1 + \frac{\text{EMC}}{100}}$$

Now having calculated the plank dry weight, use the formula above for determining EMC to monitor drying progress.

Example

You have weighed you 1” samples and they weigh 1.35 lbs. The remaining plank weighs 15.4 lbs and is added to the lumber stack in the kiln and the dryer can be turned on. After drying the samples 36 hours in an oven, you weigh them and the weight is 0.94 lb.

$$\text{Starting EMC} = \frac{1.35\text{lb.} - 0.94\text{lb.}}{0.94\text{lb.}} \times 100 = 44\%$$

Now calculate the future dry weight of the plank in the kiln:

$$\text{Plank Dry Weight} = \frac{15.4}{1 + \frac{44}{100}} = 10.7\text{lb.}$$

After a few weeks of drying, the plank is removed from the stack and weighs 12.2lb.

$$\text{Starting EMC} = \frac{12.2\text{lb.} - 10.7\text{lb.}}{10.7\text{lb.}} \times 100 = 14\%$$

Appendix II

Troubleshooting

In case of trouble, first check that all instructions in the manual have been carefully followed. Next, go through the following chart. If the problem is still not resolved, call Ebac Industrial Products Ltd. In most cases, a simple phone call will resolve the question.

System Overview

Air is drawn into the dryer where the moisture is extracted from it. Moisture is extracted when the air is passed through the evaporator coil. The coil is cooled to a temperature lower than dew point temperature of the air and hence condensation forms on it.

The dryer consists of 7 parts:

1. Fan motor draws the air through the unit.
2. Compressor which drives the refrigeration circuit.
3. Evaporator coil – cold section of the refrigeration circuit.
4. Condenser Coil – hot section of the refrigeration circuit.
5. Capillary tube – separates the hot and cold section of the refrigeration circuit with regard to gas flow.
6. Auxiliary heater.

The STC1 Controller controls the power to the dryer and controls the amount of water to be extracted by operating the compressor in accordance with the drying control setting, i.e. : a 25% setting will run the compressor for 15 minutes in each hour. The fan runs continuously regardless of the drying control setting. The auxiliary heater runs only when the thermostat setting is greater than the kiln temperature, once the desired temperature is achieved, the heater shuts off.

<u>Symptoms</u>	<u>Possible Fault</u>
Unit completely inoperative	1. <u>No power at receptacle.</u> Check fuse, etc., feeding receptacle
<p>Normal Operation but Low Water Extraction</p> <p>Kiln Temperature above 100°F (38°C)</p>	<p>1. <u>Normal Start-UP.</u> It usually takes 3 to 4 days for a new load of lumber to stabilize and for water output to reach normal levels</p> <p>2. <u>Dry Lumber.</u> As the moisture content of the lumber drops below about 10%, you will notice a drop in water extraction. If not at continuous the timer may be advanced to maintain rate, but the moisture content of the lumber should be checked at this point to avoid over-drying.</p> <p>3. <u>Compressor Overheating.</u> If the kiln temperature is over rating for the unit, thermal circuit breaker in compressor may be opening. Reducing temperature by removing insulation, or lowering drying control setting. Do not lower thermostat setting.</p> <p>4. <u>Refrigerant Gas Loss From Circuit.</u> A refrigerant loss can be recognized by operating unit outside the kiln and check for severe freezing of a small proportion, less than half of the evaporator coil (cold coil) at temperatures above 68°F and relative humidity above 30%. Normally the coil freezes evenly.</p> <p>5. <u>Blocked or Frozen Drain Hose.</u> Water may be flooding kiln.</p>
<p>Normal Operation but Low Water Extraction</p> <p>Kiln Temperature Below 95°F (35°C)</p>	<p>1. If drying control knob is set at continuous, coils may be icing up. Set back to 90% until the temperature rises above 100°F (38°C).</p> <p>2. At temperatures below about 75°F (35°C), lumber is slow to give up its moisture. Raise the kiln temperature to maintain drying speed.</p>

<u>Symptoms</u>	<u>Possible Fault</u>
<p>Low Kiln Temperature Normal Water Extraction</p>	<p>1. As long as water extraction is normal, kiln temperature cannot be too low. In fact, the lower the temperature the better the wood quality. The insulation thickness' in Table 1 provides for 50°F (28°C) temperature rise over the outside temperature at continuous drying control setting. Lower settings will give lower temperature rise.</p>
<p>Mold or Mildew on Lumber</p>	<p>1. This condition is not harmful to the lumber, but can be minimized with improved airflow or higher kiln temperature.</p>
<p>Bottom Layer or Two of Lumber Not Dry</p>	<p>1. This is caused by large temperature differences (greater than 5°F) from top to bottom of the kiln. Greater airflow or a better door seal will usually improve this.</p>
<p>Temperature in Kiln Continues to Rise Above Thermostat Setting</p>	<p>**DO NOT LOWER THERMOSTAT SETTING**</p> <p>1. Thermometer on controller may need to be adjusted. If extraction maintains at normal rate, check temperature in the kiln with thermometer at the base of the dryer. If the temperature reads lower or higher than the thermometer needle on the controller, call Ebac for adjustment procedure.</p> <p>2. If temperature reads the same and extraction ceases or slows substantially, you may have a "temporary over-insulation situation". Simply peel back a corner of insulation from the top of you kiln chamber. If this does not remedy the situation in 24 hours, call Ebac.</p>



Drawing	: - TPC229
Issue	: - 2
Date	: - 10/12/13

Appendix III
Drawings and Specifications



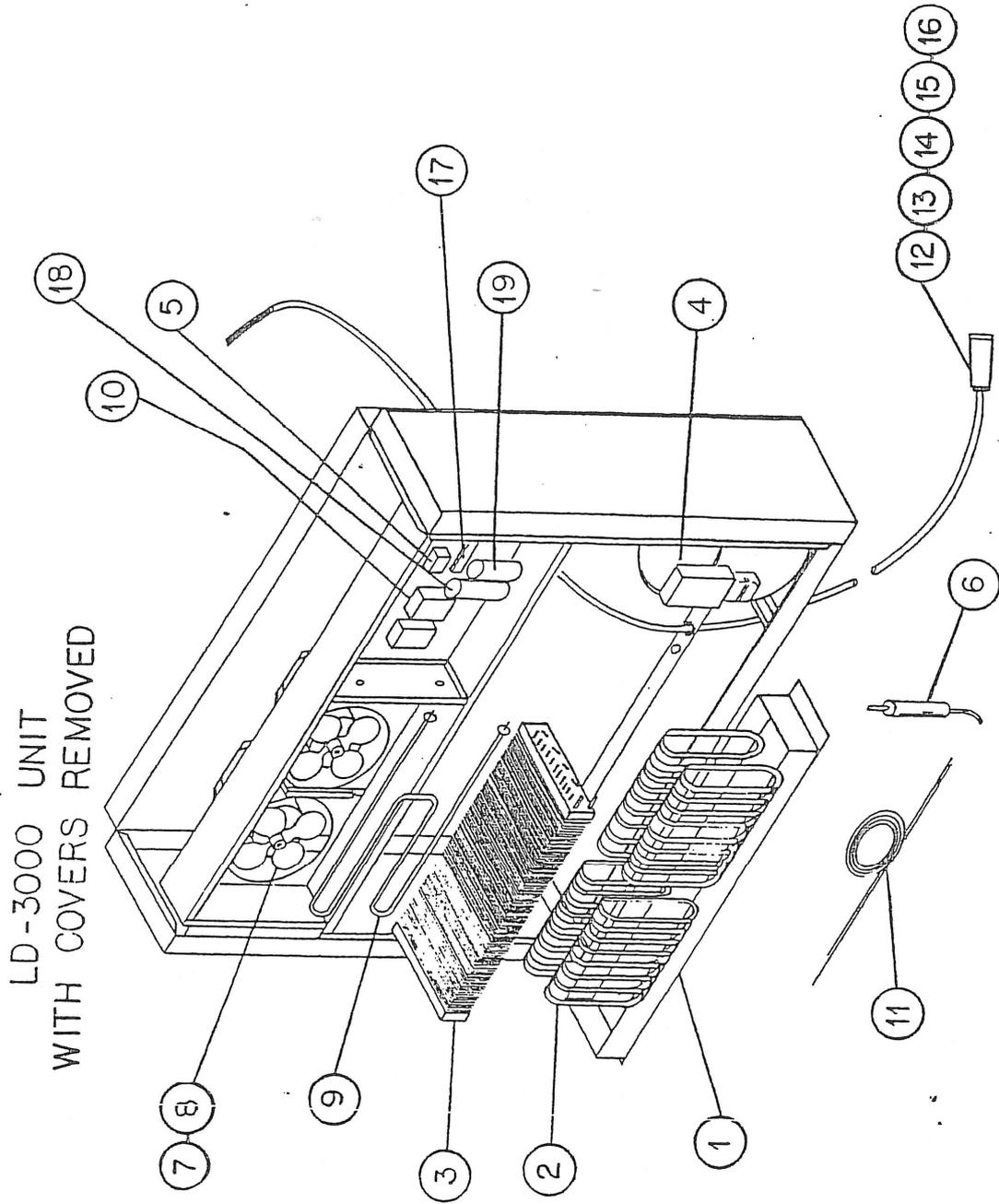
Drawing	: - TPC229
Issue	: - 2
Date	: - 10/12/13

LD3000 SPECIFICATIONS

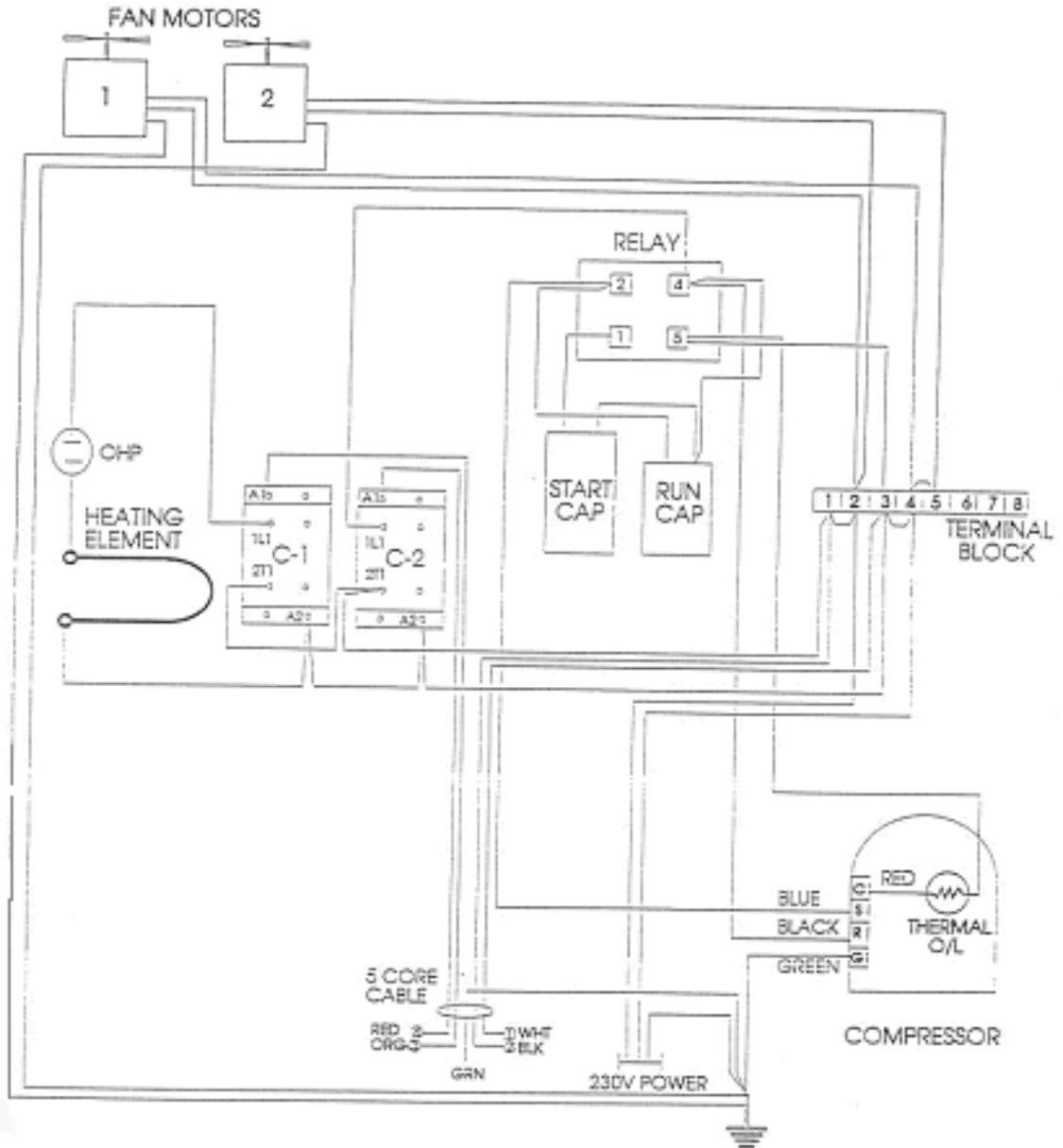
Height:	33"
Width:	43"
Depth:	12"
Weight:	167lbs
Airflow:	600 CFM
Power Rating (Dryer):	1100W (Max)
Power Rating (Heater):	1500W (Operates Intermittently)
Power Supply:	208/203V, 60Hz, 1 Phase. 12 Amps
Maximum Operating Temperature:	50°C (122°F)
Finish:	Epoxy/Vinyl Coated Steel
Refrigerant Type:	R22
Refrigerant Charge:	1 lb. 6oz.
Special Features:	Stainless Steel Water Collection Tray for Corrosion Resistance

SPARE PARTS LIST LD3000

DESCRIPTION	EBAC PART NO.	QUANTITY
1. Drain Tray	2830225	1
2. Evaporator Coils	2830214	2
3. Condenser Coil	3020723	1
4. Compressor	3022193	1
5. Potential Relay	3830216	1
6. Filter Dryer	3820902	1
7. Fan Blade	3840100	2
8. Fan Motor	3830102	2
9. Heating Element	2830202	1
10. Contactors	3830301	2
11. Capillary Tubing (0.036ID)	3821904	70"
12. 5 Core Cable	3831214	10'
13. Crimp Contacts	3833912	5
14. Hood	3833802	1
15. Female Insert	3833801	1
16. Cable Seal	3833803	1
17. Terminal Block	3831403	1
18. Start Capacitor (72-88 MF/330VAC)	3830910	1
19. Run Capacitor (15MF/370VAC)	3830902	1



LD3000 WIRING DIAGRAM





Drawing	: - TPC229
Issue	: - 2
Date	: - 10/12/13



Drawing	: - TPC229
Issue	: - 2
Date	: - 10/12/13



Drawing	: - TPC229
Issue	: - 2
Date	: - 10/12/13

UK Head Office

Ebac Industrial Products Ltd
St Helens Trading Estate
Bishop Auckland
County Durham
DL14 9AD

Tel: +44 (0) 1388 664400
Fax: +44 (0) 1388 662590

www.eipl.co.uk
sales@eipl.co.uk

American Sales Office

Ebac Industrial Products Inc
700 Thimble Shoals Blvd.
Suite 109, Newport News
Virginia, 23606-2575
USA

Tel: +01 757 873 6800
Fax: +01 757 873 3632

www.ebacusa.com
sales@ebacusa.com

German Sales Office

Ebac Industrial Products Ltd.
Gartenfelder Str. 29-37
Gebäude 35
D-13599, Berlin
Germany

Tel: +49 3043 557241
Fax: +49 3043 557240

www.eip-ltd.de
sales@eip-ltd.de