INSTALLATION
AND
INSTRUCTION MANUAL

FOR

Boone

BAC
AERATION
CONTROLLER

SPECIAL NOTE

<u>READ THIS ENTIRE BOOKLET BEFORE PROCEEDING WITH THE INSTALLATION</u>

BOONE AERATION &ENVIRONMENTAL
1773-219TH LANE - P.O. BOX 369
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TOLL FREE NUMBER - 1-800-265-2010

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INSTALLATION INSTRUCTIONS AND RATINGS

1. Open the BAC door and remove the panel. This is done by removing the four black caps on the panel mounting screws. Remove the four panel mounting screws and gently lift the panel out of the box.

2. Mount the BAC enclosure on the south side of the bin and in a well ventilated area. This will give the truest temperature and humidity readings.

3. Drill a hole in the enclosure for the conduit entrance and run wires to the unit.

4. Attach the green wire to earth ground. The black (L1) and white (L2) wires provide power to the unit.

5. The red wires (F1 and F2) provide switching contacts to operate the BAC controlled equipment.

6. After making the wiring connections, reinstall the panel.

7. The BAC unit is ready for operation.

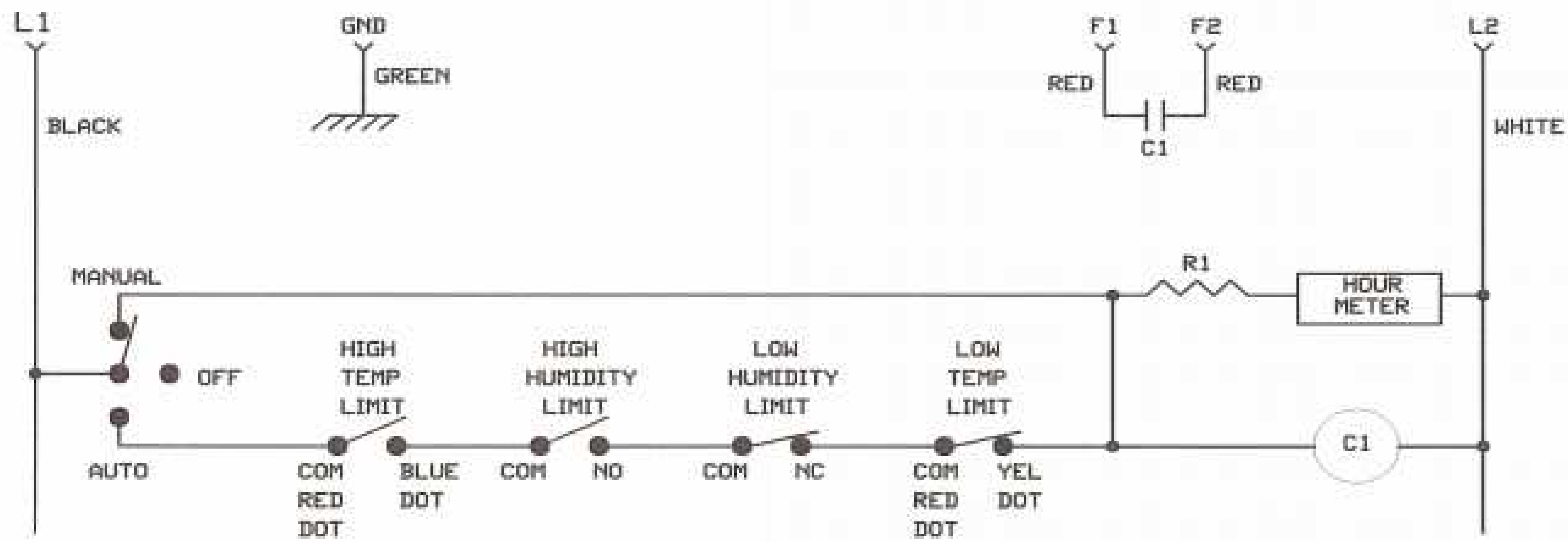
Electrical Contact Ratings: (F1 to F2)

20 Amps @ 110 Volt

20 Amps @ 220 Volt

10 Amps @ 440 Volt

DWG. NO.:181013 | PRINT 1



VOLTAGE	RESISTOR - R1
120VAC	NONE REQUIRED
240VAC	NONE REQUIRED
440VAC	20K 5W 5%

BOONE CABLE WORKS & ELECTRONICS, INC.	
BAC WIRING SCHEMATIC	DATE: 12-16-95
	DRAWN BY: KLB
	DWG NO.: 181013

OPERATION INSTRUCTIONS

General: Your grain should be cooled in stages. Start immediately after storage. Final grain temperatures of 30 degrees to 40 degrees have been found most satisfactory in minimizing insect activity, mold growth and convection currents. The BAC Aeration Controller allows you to make optimum use of atmospheric conditions favorable to aeration. This is accomplished by using the following controls.

Selector Switch Position:

Auto: System automatically operates during favorable atmospheric conditions.

Manual: Fans may be operated independently of controls.

Off: Control will not command fan operation.

Temperature Low Limit: Prevents non-uniform cooling by eliminating introduction of temporary cold fronts into grain. Prevents cooling below final desired temperature. During aeration stages set low limit 20 degrees below high limit. During last aeration stage set low limit 10 degrees below desired grain temperatures.

Temperature High Limit: Limits highest atmospheric temperature used for aeration. Set control at least 10 degrees below present grain temperature.

Humidistat Low Limit: Allows for setting a low moisture limit on the incoming air.

Humidstat High Limit: Prohibits introduction of moisture laden air to grain minimum suggested setting, 60%; maximum suggested setting, 80%.

OPERATION INSTRUCTIONS
FOR
GRAIN AERATION SYSTEMS

Grain aeration is the process of forcing quantities of outside air through grain while it is in storage.

The following instructions clearly state the purpose of aeration and how a system should be operated to accomplish these purposes.

I. PURPOSE OF AERATION

1. Maintain Quality
2. Insect Control
3. Reduce Storage Costs
4. Hold Tough Grain
5. Removal of Odors

1. MAINTAIN QUALITY

The primary purpose of aeration is to maintain the quality of sound grain during storage. The following operating instructions were prepared with this purpose in mind.

Quality of grain can be maintained indefinitely if the MOISTURE CONTENT is held below the figures shown in Chart I or if the grain temperature is lowered and held there.

CHART I

MAXIMUM MOISTURE CONTENTS OF GRAIN
FOR
STORAGE PERIODS OVER ONE YEAR

TYPE GRAIN	MOISTURE CONTENT
Corn	13%
Soybeans	11%
Oats	13%
Sorghum	13%
Wheat	13.5%
Barley	13%

Equilibrium relative humidity at 77°F for the above moisture contents ranges between 60% - 65%.

Mold growth, which is effected primarily by moisture and temperature, is the major cause of grain deterioration while in storage. It is therefore, the primary purpose of aeration to prevent this situation from occurring. Mold spores, which are present on all grains, will remain dormant under the following conditions.

A. The relative humidity of the air surrounding the mold must be below 65%. This is the condition of the air in equilibrium with grain at about 13% moist wet basis at 80°F. See Chart IV.

B. The air temperature must be below 60°F when the relative humidity is 65%. As the air temperatures decrease, mold growth is evident in the storage of frozen foods.

C. Foreign material and cracked grain should be held to a minimum. Under identical conditions of temperature and moisture, mold will grow faster on damaged grain than on sound grain.

CHART II

TEMPERATURE RELATIONSHIP TO MOLD RESPIRATION
FOR
SOYBEANS AT 18.5% MOISTURE (1)
(Milners & Geddes)

TEMPERATURE °F	RESPIRATION RATE (2)
77	33.6
86	39.2
95	71.8
104	154.7
113	13.1

(1) Chart shows relationship only, data is not approved for design purposes.
(2) Carbon dioxide in MG per 100 G. dry matter per 24 hours.

D. Lack of oxygen will prevent the respiration required for mold growth. Although this is accomplished in air tight silos used for holding high moisture grain, conventional type grain storage structures will normally allow enough oxygen to pass naturally through the grain to sustain mold respiration.

It can be shown that if the grain temperature is different than the outside air temperature, there will be air movement by convection through the grain, resulting in a moisture accumulation in some areas.

Aeration maintains grain quality by preventing moisture build-up above the safe storage level and by reducing grain temperatures.

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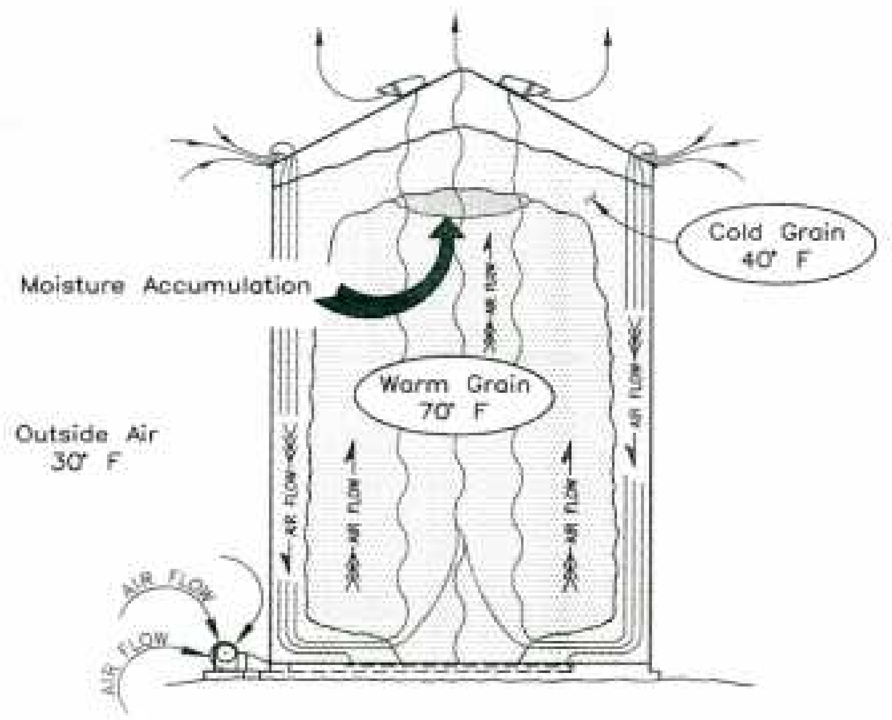

CONVECTION CURRENTS
OCCUR WHEN AERATION
SYSTEM IS INOPERATIVE

MOISTURE ACCUMULATION

WARM GRAIN 70°

COLD GRAIN 40°

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	MOISTURE ACCUMULATION CAUSED BY NORMAL FALL AND WINTER CONVECTION CURRENTS	JOB NO: P/I: P/N:	DATE: 12/1/95 REVISION: DWG: 181010

2. INSECT CONTROL

A. Applying Fumigants

Aeration systems can be used to apply fumigants and to make the fumigation more effective. At best, the application of fumigants in flat storage is difficult and should be done only by individuals specializing in this work. The aeration system may be used in one of two ways; as an open or as a recirculating system. The latter appears to be the most effective and convenient. In order to make the aeration system recirculating, a flexible duct is used to connect the discharge side of the fan to the over-space (space between the top of the grain and roof).

Using the aeration system in applying fumigants has the advantage of distributing the fumigants more uniformly throughout the grain bulk. This condition is also obtained under a fairly wide range of grain temperatures.

The tightness of the storage building and the duct systems is important since pressure differences must exist to provide flow of fumigants through the grain while the fans are in operation.

In any case, the exact procedure to be followed in applying fumigants requires the supervision and attention of specialists engaged in this type of work. Only brief mention is made here to point out its advantages in fumigating grain.

B. Reduced Insect Activity

The cool temperatures obtained by the aeration of grain is effective in controlling insects by rendering them inactive and preventing them from feeding. Also, hatching and the development of larva is practically eliminated at temperatures below 55°F.

The exposing of insects to extremely low temperatures (15°F) for a few days will kill most of the common grain insects. This practice is done quite frequently in the northern states. It must be remembered, though, that the grain temperature should be raised again to the recommended storage level to prevent condensation in the warmer weather.

3. <u>REDUCE STORAGE COSTS</u>

Storage costs are reduced when an aeration system is used to control moisture and temperature by eliminating the necessity of empty storage space for turning grain.

The labor power costs of turning grain are also eliminated, as is the possible damage and loss of weight experience in this operation.

4. <u>HOLD TOUGH GRAIN</u>

Grains with moisture contents higher than that safe for storage may be held for a period of time in aerated bins because the lower temperature dissipates any heat that is generated by molds and keeps the mold activity to a minimum by reducing temperatures. This practice is found to have application when receiving damp grain in quantities greater than the capacity of the dryers. Various experiences have been reported on the length of time that grains of different moisture contents can be held. But these are somewhat unpredictable because the maximum holding time depends on the grain moisture content, the air temperature, initial grain temperature, mold infestation, and the air flow rate. Some reports indicate that grain with moisture content of 20 percent has been held for a period of three weeks during the fall of the year.

5. <u>REMOVAL OF ODORS</u>

Many storage odors and other objectionable odors can be eliminated by aerating the grain periodically. Some of these can be dissipated with a small amount of aeration, while others are more persistent. The possibilities of using an aeration system for removing odors or otherwise keeping a fresh smell in the grain should not be overlooked. Experience in operating fans periodically will soon indicate the amount of ventilation that is required to use the aeration system for this purpose.

II. GENERAL OBJECTIVES

As previously stated, to maintain quality, the grain temperature should be equal to outside temperature or reduced below 50°F or both. This is accomplished by operating the fans only during the desired outside air temperature.

The cooling process is accomplished in a zone that passes at a fairly uniform rate through the grain with the grain ahead of the zone at initial temperature and the grain behind the zone at outside air temperature (See Fig. 2).

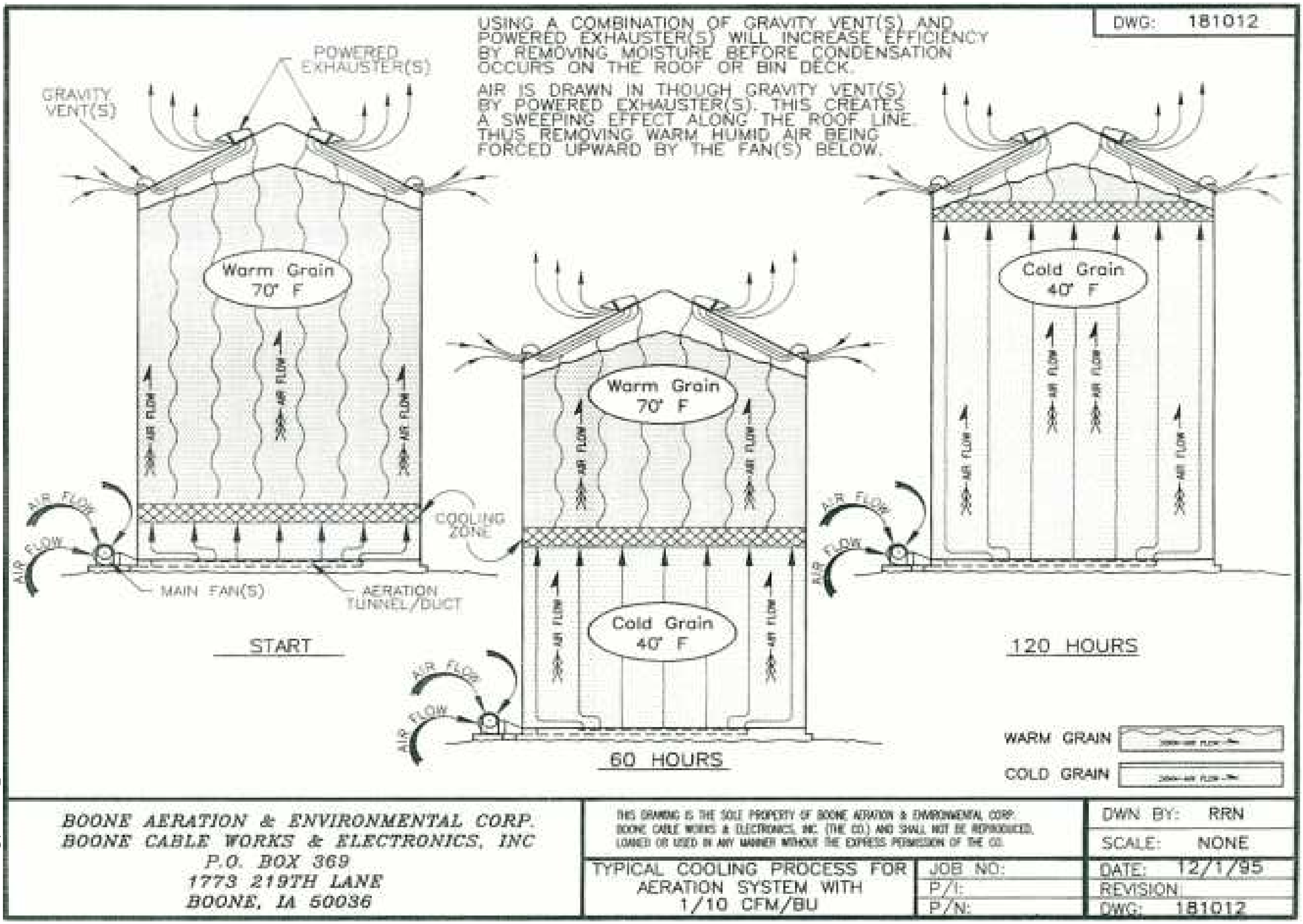
Total cooling time consists of many consecutive stages as shown previously.

The time required for this zone to pass completely through the grain is referred to as COOLING TIME and depends upon the air flow rate and condition of outside air. See Chart III. The total cooling time is the time required for a number of different cooling zones to pass through the grain.

CHART III

ESTIMATED COOLING TIME (IN HOURS)

RATE	SUMMER	FALL	WINTER
1/5 cfm/bu	40	60	80
1/7 cfm/bu	56	84	112
1/10 cfm/bu	80	120	160
1/15 cfm/bu	120	180	240
1/20 cfm/bu	160	240	320
1/25 cfm/bu	200	300	400
1/30 cfm/bu	240	360	480
1/35 cfm/bu	280	420	560


DWG: 181012
USING A COMBINATION OF GRAVITY VENT(S) AND POWERED EXHAUSTER(S) WILL INCREASE EFFICIENCY BY REMOVING MOISTURE BEFORE CONDENSATION OCCURS ON THE ROOF OR BIN DECK.
AIR IS DRAWN IN THOUGH GRAVITY VENT(S) BY POWERED EXHAUSTER(S). THIS CREATES A SWEEPING EFFECT ALONG THE ROOF LINE. THUS REMOVING WARM HUMID AIR BEING FORCED UPWARD BY THE FAN(S) BELOW.
GRAVITY VENT(S)
POWERED EXHAUSTER(S)
Warm Grain 70° F
Cold Grain 40° F
AIR FLOW
COOLING ZONE
MAIN FAN(S)
AERATION TUNNEL/DUCT
START
60 HOURS
120 HOURS
WARM GRAIN
COLD GRAIN
BOONE AERATION & ENVIRONMENTAL CORP.
BOONE CABLE WORKS & ELECTRONICS, INC
P.O. BOX 369
1773 219TH LANE
BOONE, IA 50036
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TYPICAL COOLING PROCESS FOR AERATION SYSTEM WITH 1/10 CFM/BU
JOB NO:
P/I:
P/N:
DWN BY: RRN
SCALE: NONE
DATE: 12/1/95
REVISION:
DWG: 181012

Since one of the main purposes of aeration is to control moisture, the fans should not be operated during periods of high humidity. Whenever the humidity of the air is above that shown in Chart IV for any given grain and moisture content, there will be movement of moisture from the air to the grain. Although a strict application of Chart IV would indicate air should not be passed through 13% moisture corn, when it is above 60% relative humidity, it has been found that, in general, fans can be operated at any relative humidity up to 80% without adding appreciable moisture to the grain. The reason being that when the air passes through the grain, it rises in temperature, reducing its relative humidity to a safe level. Also, during a normal season, there will be enough time of operation below 60% R.H. to offset the periods of operation between 60% and 80% R.H.

CHART IV

EQUILIBRIUM RELATIVE HUMIDITY
FOR
GRAINS AT VARIOUS MOISTURE CONTENT
% wet basis ASAE Data D245.4, Chung Equation

TYPE GRAIN	RELATIVE HUMIDITY				
	30%	45%	60%	75%	90%
Corn	8.4	10.5	12.6	15.1	19.3
Soybeans	5.3	7.9	10.6	13.8	18.9
Rice	8.9	10.4	12.0	14.1	17.4
Wheat	8.7	10.6	12.5	14.9	18.8
Milo	9.1	10.8	12.6	14.8	18.4

Grain and air at 80°F.

III. OPERATION

1. GENERAL EQUIPMENT CHECK

Before the fans are turned on for continuous operation, the wiring to the electric motors should be checked for proper voltage, phase power and rotation. The fans are marked to show proper rotation. The fans should be properly marked grounded to prevent shock and the wire screen guard (occasionally omitted on centrifugal fans with exhaust shutters) should be bolted firmly in place.

The duct work between the building and fan should be checked for air leaks and sealed to insure efficient operation. Also, any valves that may be used for controlling air flow to various bins should be inspected for proper setting.

The openings at the top of the building should be inspected to make certain they are open and of adequate size. There should be a total open area above the grain equal to at lease twice the outlet area of all the fans.

2. METHODS OF OPERATION

There are many various methods used in the operation of an aeration system, depending upon the type storage, grain, area of the country and purpose to be accomplished. Normally there are two basic methods of operation used in North America when maintaining grain quality is the primary purpose. They are SEASONAL AND CONTINUOUS.

A. SEASONAL

The objective of this method is primarily to cool the grain uniformly during the cold months to prevent the harmful convection current during this season, as shown in FIG. 1, and also to take advantage of this low temperature to reduce mold growth and control insects through the following winter months.

The air flow may be upward or in a downward direction through the grain, exhausting warm air via ventilators or through the fan. Operation should be started as soon as the grain is placed in storage and the outside air is 5° to 10°F cooler than the grain temperature. Fan operation should continue through the fall and winter continually reducing grain temperatures to the average monthly temperature. This is accomplished by continually checking the grain temperatures in the grain layers and restricting fan operation to periods when the outside air temperature is 10°F cooler and the humidity does not exceed 80% R.H. This operation is simplified with automatic fan controls by continuously setting the high limit thermostat 10°F lower than grain temperature in the upper one-half of the bin and with the humidistat set at 80% R.H. This applies if aeration is in a downward design. Also, the Rolfes automatic control is equipped with a low limit thermostat that ca be set 10° to 20°F below the high limit setting to conserve power costs by only allowing the fans to operate when the outside temperature is in the desired range. This operation is continued until the final desired temperature is reached. This temperature should not be lower than 40°F.

A method for estimating what month this final temperature can be reached is to check the cooling time required for the design air flow rate in Chart III and then from local weather data charts (see typical Chart V). Find the month that there can be expected the adequate number of hours available with temperatures in the desired final temperature range, plus - minus 10°F.

Example: Given: (1) Air flow rate - 1/20 cfm/bu
(2) Final desired temperature - 40°F
(3) Location - Chicago, Illinois

1. From Chart III, winter cooling time for 1/20 is 240 hours.
2. From Weather Data Chart V for Chicago there can be expected 250 hours between 54° and 30° in the month of March.

CHART V

TEMPERATURE OCCURRENCE TABLES
IN HOURS PER MONTH FOR CHICAGO, ILLINOIS
TEMPERATURES IN DEGREES (F) FOR AIR BELOW 70% RELATIVE HUMIDITY

Month	74°-55°	54°-40°	39°-30°	29°-20°	19°-10°
January	0	16	6	75	67
February	5	67	96	70	23
March	20	103	147	103	29
April	101	187	78	10	0
May	255	98	4	0	0
June	169	9	0	0	0
July	119	0	0	0	0
August	139	0	0	0	0
September	313	26	0	0	0
October	187	161	27	0	0
November	58	151	105	60	11
December	4	43	61	61	48

When the final desired temperature of the entire mass of grain is reached, (The surest method to check this is with an electronic temperature system) the fans should be restricted to operation in a plus - minus 5°F range of temperature. The fans should be shutoff manually and capped.

The seasonal method of operation is usually used in large flat storage buildings where the grain is held in storage for long periods of time and the air distribution is usually not as uniform as in vertical storage bins. This method is also used in many vertical storage bins, especially where grain is to be stored for a year or more or where tough grain is to be stored.

In general, the required air flow rates are higher than those used in continuous aeration, although the yearly operating costs are lower since the fans are only operated during part of the year.

B. CONTINUOUS

Continuous aeration is where the fans are operated at least a portion of time during each month of the year. The primary objective of continuous aeration is to keep the grain close to outside air temperature throughout the entire year to prevent convection air currents and the resulting moisture migration. Some advantage is taken of cooler evening temperatures in summer months.

In the continuous method of operation, the fans are operated throughout the entire year cooling the grain in the fall and winter and rewarming it in the spring and summer. A mean temperature is selected for each month, See Chart VI, and fans should be operated when the temperature of any part of the stored grain is higher than those shown in the chart. For example, if the stored grain temperature in August in the North Central States is 75°F or higher, fans should be operated between 55°F. During September, the grain can be cooled to about 55°F by operating the fans between temperatures of 45°F and 65°F. In this manner, the grain can be cooled in succeeding months to the desired temperature. This method permits prompt cooling of warm summer-harvested grain immediately after it is stored to minimize mold growth and insect activity. It is recommended for this reason. It is necessary that each fan be equipped with automatic backdraft shutter in this method of operation to prevent reverse air flow during the short periods the fans are not operating.

CHART VI

SUGGESTED MAXIMUM MONTHLY OPERATING AIR TEMPERATURES
FOR COOLING GRAIN IN SPECIFIED AREA (Degrees F)

Month	Central (1) Plains	North (1) Central	South (2) East	South (1) West
July	85	75	85	90
August	85	75	85	90
September	70	65	85	80
October	60	55	70	70
November	50	45	60	60
December	50	45	45	60
January	50	45	45	50
February	50	45	50	50
March	50	45	55	50
April	60	55	60	60
May	70	65	75	70
June	85	75	80	85

(1) Allows about 12 or more hours of operation each day under normal conditions.
(2) Allows approx. 6 hours of operation each day at relative humidities below 80%.

More specifically, the procedure for continuos aerating of grain should be as follows:

1. Determine temperature of the stored grain. Before starting the fans, the temperature of the grain in different parts should be taken to determine whether any cooling can be accomplished.

2. Start fans as soon as practical after the grain is placed in storage. Start the fans providing cooling can be accomplished under (1) above. Otherwise, delay operation until the maximum monthly air temperature given in Chart VI is the same or less than that of the grain. Fans may be operated in one of two ways: (a) with automatic controls or (b) with manual control. With automatic controls, set the high limit thermostat at a temperature corresponding to the month and area in Chart VI. Set the low limit thermostat 20 degrees below the high limit thermostat. Set the high limit humidistat at 80 percent during the summer and fall months and at 70 percent during the winter months.

3. Check temperature of the grain as cooling progresses. Check temperatures in enough places to determine the progress of cooling. When the temperature of the grain next to the floor at all points midway between the ducts (or in case of the average low and the wall or partition) is within a few degrees of the average low and the high limit temperature settings, stop the fan if the final cooling temperature has been reached.

4. For a second stage or further cooling, proceed as in (2). Set upper limit thermostats to correspond to those in Chart VI. The second step of cooling may be started before the first stage is completed. This overlap of cooling will result in fewer hours of fan operation.

5. Continue with additional stages of cooling until all grain is cooled to the desired temperature for the month.

   The continuous method of operation is used where grain is to be moved quite frequently. Also in small diameter cylindrical bins where air distribution is quite good. The recent trends have been more toward this method of operation probably due to the lower equipment costs, which are the result of the low air flow rates used in this method.

OVERSPACE COOLING

During the operation of the aeration fans, the overspace exhausters must also be running. Their function is to remove any moisture laden air that has transferred from the grain to the surrounding air. These exhausters are usually a low pressure, high volume fan and require free air from additional gravity ventilators. This permits a sweeping action across the top of the grain and hence, the control of potential condensation. For best operation, they should be turned on at the same time as the aeration fans and left running even after the aeration fans have been turned off.

During the heat of the day in the summer months, there is an advantage to cool the space above the grain. These fans may be thermostatically or manually controlled.

IV. MAINTENANCE

The fan blade on axial flow fans and the wheel on centrifugal fans should be cleaned occasionally to prevent dirt accumulation, which could result in an out of balance blade, causing serious vibration.

The bearings in all electric motors do not require greasing, but it is good practice to check motors and grease annually. (See motor manufacture's recommendations)

The floor duct should be checked for grain leaks occasionally during unloading. Also, the outside surface of the perforated ducts should be cleaned with a wire brush occasionally to keep the perforations open. This is especially required in buildings that the grain is unloaded only once in every few years.

The automatic controls used to operate the fans should be checked occasionally to be certain they are properly operating the fans. Also, the humidistat should be checked for calibration and recalibration if necessary as described on the control instruction sheet.

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
32°	11.7	12.4	13.0	13.6	14.3	15.0	15.6	16.4	17.2	18.1	19.1	20.4	22.0	
40°	11.0	11.7	12.3	13.0	13.6	14.3	15.0	15.8	16.5	17.4	18.5	19.8	21.4	
50°	10.2	10.9	11.5	12.2	12.8	13.6	14.2	15.0	15.8	16.8	17.8	19.1	20.8	CORN
60°	9.6	10.2	10.9	11.6	12.2	12.9	13.6	14.4	15.2	16.2	17.2	18.5	20.2	
70°	9.0	9.7	10.3	11.0	11.6	12.4	13.1	13.9	14.7	15.6	16.7	18.0	19.7	
80°	8.4	9.1	9.8	10.5	11.1	11.9	12.6	13.4	14.2	15.1	16.2	17.6	19.3	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
32°	6.8	7.7	8.6	9.4	10.2	11.1	12.0	12.9	14.0	15.2	16.4	18.1	20.1	
40°	6.6	7.4	8.3	9.1	10.0	10.8	11.7	12.7	13.7	14.9	16.2	17.8	19.9	
50°	6.2	7.1	8.0	8.8	9.7	10.5	11.4	12.4	13.4	14.6	15.9	17.6	19.6	SOYBEAN
60°	5.9	6.8	7.6	8.5	9.4	10.2	11.1	12.1	13.1	14.4	15.6	17.3	19.4	
70°	5.6	6.5	7.3	8.2	9.1	9.9	10.8	11.6	12.9	14.1	15.4	17.1	19.1	
80°	5.3	6.2	7.1	7.9	8.8	9.7	10.6	11.5	12.6	13.8	15.1	16.8	18.9	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
32°	11.0	11.6	12.1	12.6	13.1	13.6	14.2	14.8	15.4	16.2	17.0	18.0	19.3	
40°	10.6	11.1	11.6	12.1	12.6	13.2	13.7	14.3	15.0	15.7	16.5	17.6	18.9	
50°	10.1	10.6	11.1	11.6	12.1	12.7	13.2	13.8	14.5	15.3	16.1	17.2	18.5	RICE
60°	9.7	10.1	10.6	11.2	11.7	12.2	12.8	13.4	14.1	14.8	15.7	16.7	18.1	
70°	9.2	9.8	10.2	10.8	11.3	11.8	12.4	13.0	13.7	14.5	15.3	16.4	17.7	
80°	8.9	9.4	9.9	10.4	10.9	11.5	12.0	12.7	13.3	14.1	14.9	16.1	17.4	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
32°	9.7	10.3	10.9	11.5	12.1	12.8	13.4	14.2	14.9	15.8	16.8	18.0	19.6	
40°	9.5	10.1	10.7	11.4	12.0	12.6	13.3	14.0	14.8	15.6	16.6	17.9	19.5	
50°	9.3	9.9	10.5	11.2	11.8	12.4	13.1	13.8	14.6	15.5	16.4	17.7	19.3	WHEAT
60°	9.1	9.7	10.3	11.0	11.6	12.2	12.9	13.6	14.4	15.3	16.3	17.5	19.1	
70°	8.9	9.5	10.1	10.8	11.4	12.0	12.7	13.5	14.2	15.1	16.1	17.3	18.9	
80°	8.7	9.4	10.0	10.6	11.2	11.9	12.5	13.3	14.0	14.9	15.9	17.2	18.8	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
32°	10.1	10.7	11.2	11.8	12.3	12.9	13.5	14.2	14.9	15.7	16.6	17.8	19.2	
40°	10.0	10.5	11.0	11.6	12.2	12.8	13.4	14.1	14.7	15.6	16.5	17.6	19.1	
50°	9.7	10.3	10.8	11.4	12.0	12.6	13.2	13.9	14.5	15.4	16.3	17.4	18.9	MILO
60°	9.5	10.1	10.6	11.2	11.8	12.4	13.0	13.7	14.3	15.2	16.1	17.3	18.7	
70°	9.3	9.9	10.4	11.0	11.6	12.2	12.8	13.5	14.2	15.0	15.9	17.1	18.6	
80°	9.1	9.7	10.2	10.8	11.4	12.0	12.6	13.3	14.0	14.8	15.7	16.9	18.4	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
0°	11.7	12.4	13.0	13.6	14.3	15.0	15.6	16.4	17.2	18.1	19.1	20.4	22.0	
4.5°	11.0	11.7	12.3	13.0	13.6	14.3	15.0	15.8	16.5	17.4	18.5	19.8	21.4	
10.0°	10.2	10.9	11.5	12.2	12.8	13.6	14.2	15.0	15.8	16.8	17.8	19.1	20.8	CORN
15.5°	9.6	10.2	10.9	11.6	12.2	12.9	13.6	14.4	15.2	16.2	17.2	18.5	20.2	
21.0°	9.0	9.7	10.3	11.0	11.6	12.4	13.1	13.9	14.7	15.6	16.7	18.0	19.7	
26.5°	8.4	9.1	9.8	10.5	11.1	11.9	12.6	13.4	14.2	15.1	16.2	17.6	19.3	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
0°	6.8	7.7	8.6	9.4	10.2	11.1	12.0	12.9	14.0	15.2	16.4	18.1	20.1	
4.5°	6.6	7.4	8.3	9.1	10.0	10.8	11.7	12.7	13.7	14.9	16.2	17.8	19.9	
10.0°	6.2	7.1	8.0	8.8	9.7	10.5	11.4	12.4	13.4	14.6	15.9	17.6	19.6	SOYBEAN
15.5°	5.9	6.8	7.6	8.5	9.4	10.2	11.1	12.1	13.1	14.4	15.6	17.3	19.4	
21.0°	5.6	6.5	7.3	8.2	9.1	9.9	10.8	11.6	12.9	14.1	15.4	17.1	19.1	
26.5°	5.3	6.2	7.1	7.9	8.8	9.7	10.6	11.5	12.6	13.8	15.1	16.8	18.9	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
0°	11.0	11.6	12.1	12.6	13.1	13.6	14.2	14.8	15.4	16.2	17.0	18.0	19.3	
4.5°	10.6	11.1	11.6	12.1	12.6	13.2	13.7	14.3	15.0	15.7	16.5	17.6	18.9	
10.0°	10.1	10.6	11.1	11.6	12.1	12.7	13.2	13.8	14.5	15.3	16.1	17.2	18.5	RICE
15.5°	9.7	10.1	10.6	11.2	11.7	12.2	12.8	13.4	14.1	14.8	15.7	16.7	18.1	
21.0°	9.2	9.8	10.2	10.8	11.3	11.8	12.4	13.0	13.7	14.5	15.3	16.4	17.7	
26.5°	8.9	9.4	9.9	10.4	10.9	11.5	12.0	12.7	13.3	14.1	14.9	16.1	17.4	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
0°	9.7	10.3	10.9	11.5	12.1	12.8	13.4	14.2	14.9	15.8	16.8	18.0	19.6	
4.5°	9.5	10.1	10.7	11.4	12.0	12.6	13.3	14.0	14.8	15.6	16.6	17.9	19.5	
10.0°	9.3	9.9	10.5	11.2	11.8	12.4	13.1	13.8	14.6	15.5	16.4	17.7	19.3	WHEAT
15.5°	9.1	9.7	10.3	11.0	11.6	12.2	12.9	13.6	14.4	15.3	16.3	17.5	19.1	
21.0°	8.9	9.5	10.1	10.8	11.4	12.0	12.7	13.5	14.2	15.1	16.1	17.3	18.9	
26.5°	8.7	9.4	10.0	10.6	11.2	11.9	12.5	13.3	14.0	14.9	15.9	17.2	18.8	

AIR TEMPERATURE	RELATIVE HUMIDITY													COMMODITY
	30	35	40	45	50	55	60	65	70	75	80	85	90	
0°	10.1	10.7	11.2	11.8	12.3	12.9	13.5	14.2	14.9	15.7	16.6	17.8	19.2	
4.5°	10.0	10.5	11.0	11.6	12.2	12.8	13.4	14.1	14.7	15.6	16.5	17.6	19.1	
10.0°	9.7	10.3	10.8	11.4	12.0	12.6	13.2	13.9	14.5	15.4	16.3	17.4	18.9	MILO
15.5°	9.5	10.1	10.6	11.2	11.8	12.4	13.0	13.7	14.3	15.2	16.1	17.3	18.7	
21.0°	9.3	9.9	10.4	11.0	11.6	12.2	12.8	13.5	14.2	15.0	15.9	17.1	18.6	
26.5°	9.1	9.7	10.2	10.8	11.4	12.0	12.6	13.3	14.0	14.8	15.7	16.9	18.4	