Grain Bin Fan Control Overview:

- **EndZone** is designed to turn grain bin fans on and off while using multiple outside inputs.
- **EndZone** can be set to allow fan operation only when temperature is between two set parameters, a high and low set point.
- **EndZone** can be set to allow fan operation only when relative humidity is between two set parameters, a high and low set point.
- **EndZone** can be connected and automatically turned on by a **Grain Temp Guard®** which has triggered an alarm (activating the fan when temperature and humidity are between the preset high low range).
- **EndZone** the strongest indication/need for this device is in the accurate natural air drying of grain or in the automatic activation of a fan to alleviate a hotspot.
- **EndZone** can be activated by a **Grain Temp Guard®** and allow the external alarm to be active or turned off.
- **EndZone** can help reduce the risk of over drying the grain at the bottom of a bin.
- **EndZone** can be used to accurately add moisture too or remove moisture from soybeans (+/ -1/2%)%) [may not be successful if the grain depth is over 18 to 20 feet] if adequate airflow CFM are present.
- **EndZone** can be used to accurately remove moisture from corn (+/ -1/2%) [may not be successful if the grain depth is over 18 to 20 feet] if adequate airflow CFM are present.
- **EndZone** can allow the fan to be set to “automatic” control, manual “on”, or the “off” position.
- **EndZone** can allow the fan to be set to “automatic” control, monitoring only outside weather conditions with or without a link to a **Grain Temp Guard®.**
- **EndZone** will track how many hours your fans have been activated and allow you to periodically reset the timer to zero when-ever you determine it is appropriate.

Justification or need for this device:

EndZone is a super tool for efficient, cost-effective grain management. How often have you wanted to turn a grain bin fan back off because the temperature had dropped too low or perhaps got to high. More important, the humidity has risen to high so that you are just wasting electricity (considering all monthly access, meter fees and electrical charges, it costs over $17 to operate a 10 hp fan for 12 hours on my farm), or even worse adding moisture to a crop you were attempting to dry.

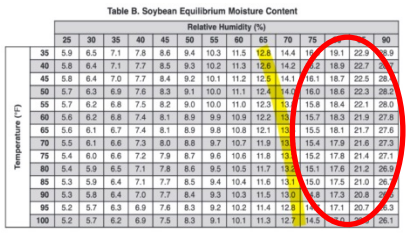

Table B. Soybean Equilibrium Moisture Content

Temperature (°F)	Relative Humidity (%)														
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	5.9	6.5	7.1	7.8	8.6	9.4	10.3	11.5	12.8	14.4	16	19.1	22.9	28.9
40	5.8	6.4	7.1	7.7	8.5	9.3	10.2	11.3	12.6	14.2	16.2	18.9	22.7	28.7
45	5.8	6.4	7.0	7.7	8.4	9.2	10.1	11.2	12.5	14.1	16.1	18.7	22.5	28.4
50	5.7	6.3	6.9	7.6	8.3	9.1	10.0	11.1	12.4	14.0	16.0	18.6	22.3	28.2
55	5.7	6.2	6.8	7.5	8.2	9.0	10.0	11.0	12.3	13.9	15.8	18.4	22.1	28.0
60	5.6	6.2	6.8	7.4	8.1	8.9	9.9	10.9	12.2	13.7	15.7	18.3	21.9	27.8
65	5.6	6.1	6.7	7.4	8.1	8.9	9.8	10.8	12.1	13.6	15.5	18.1	21.7	27.6
70	5.5	6.1	6.6	7.3	8.0	8.8	9.7	10.7	11.9	13.5	15.4	17.9	21.6	27.3
75	5.4	6.0	6.6	7.2	7.9	8.7	9.6	10.6	11.8	13.4	15.2	17.8	21.4	27.1
80	5.4	5.9	6.5	7.1	7.8	8.6	9.5	10.5	11.7	13.2	15.1	17.6	21.2	26.9
85	5.3	5.9	6.4	7.1	7.7	8.5	9.4	10.4	11.6	13.1	15.0	17.5	21.0	26.7
90	5.3	5.8	6.4	7.0	7.7	8.4	9.3	10.3	11.5	13.0	14.8	17.3	20.8	26.5
95	5.2	5.7	6.3	6.9	7.6	8.3	9.2	10.2	11.4	12.8	14.6	17.1	20.7	26.3
100	5.2	5.7	6.2	6.9	7.5	8.3	9.1	10.1	11.3	12.7	14.5	16.9	20.5	26.1

Have you ever thought about why the corn in the bottom of your bin is typically over dried as compared your target; this is the result of running the fans on a day when the humidity was far lower than the target moisture required.

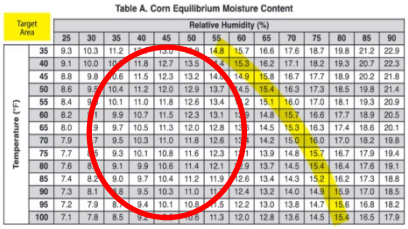

Table A. Corn Equilibrium Moisture Content

Target Area	Relative Humidity (%)												
Temperature (°F)	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	9.3	10.3	11.2	12.0	12.8	13.6	14.4	15.1	15.7	16.6	17.6	18.7	19.8	21.2	22.9
40	9.1	10.0	10.9	11.8	12.7	13.5	14.4	15.3	16.2	17.1	18.2	19.3	20.7	22.3
45	8.8	9.8	10.6	11.5	12.3	13.2	14.1	14.9	15.8	16.7	17.7	18.9	20.2	21.8
50	8.6	9.5	10.4	11.2	12.0	12.9	13.7	14.5	15.4	16.3	17.3	18.5	19.8	21.4
55	8.4	9.3	10.1	11.0	11.8	12.6	13.4	14.2	15.1	16.0	17.0	18.1	19.3	20.9
60	8.2	9.1	9.9	10.7	11.5	12.3	13.1	13.9	14.8	15.7	16.6	17.7	18.9	20.5
65	8.0	8.9	9.7	10.5	11.3	12.0	12.8	13.6	14.5	15.3	16.3	17.4	18.6	20.1
70	7.9	8.7	9.5	10.3	11.0	11.8	12.6	13.4	14.2	15.0	16.0	17.0	18.2	19.8
75	7.7	8.5	9.3	10.1	10.8	11.6	12.3	13.1	13.9	14.8	15.7	16.7	17.9	19.4
80	7.6	8.4	9.1	9.9	10.6	11.4	12.1	12.9	13.7	14.5	15.4	16.4	17.6	19.1
85	7.4	8.2	9.0	9.7	10.4	11.2	11.9	12.6	13.4	14.3	15.2	16.2	17.3	18.8
90	7.3	8.1	8.8	9.5	10.3	11.0	11.7	12.4	13.2	14.0	14.9	15.9	17.0	18.5
95	7.2	7.9	8.7	9.4	10.1	10.8	11.5	12.2	13.0	13.8	14.7	15.6	16.8	18.2
100	7.1	7.8	8.5	9.2	9.9	10.6	11.3	12.0	12.8	13.6	14.5	15.4	16.5	17.9

When low humidity air enters the floor of the bin, it dries the first grain it comes too with no regard as to what you're objective is. With corn, it will irreversibly lower the moisture to an equilibrium balance relative humidity around the grain. At a 65° temperature and 50% relative humidity content on outside air, the grain in the bottom of the bin will be dried to 12% moisture (an excess loss of 3.5% moisture content). It is very difficult to add moisture back to corn, so once over dried, you will suffer the shrinkage loss. For each 1% moisture loss, you have reduced your weight by approximately 1.2%. Based on $4 corn (a round number for easy calculation), this equates to a nickel per bushel or almost $50 per truck load. More often than not, when grain is over dried it is not just one percentage point. It is typically two or three percentage points or more, costing $100-$200 per truck load. If an entire 20,000 bushel bin of corn were over dried by 2 ½ points of moisture, this would approximate $2500.

The fall of 2019 provided many opportunities to use **EndZone** for drying beans, not a usual need (Based on my experience, it will become a common component at my farm. For those of us who pressed on with harvest, we experienced virtually no shatter loss. If the stems would feed to the throat of the combine, virtually all the beans ended up in the hopper). In most years we've all experienced beans that were over dried in the feild. In 2018, my beans came out at around 9%. Through the management afforded by this tool, I was able to add moisture back to the beans bringing them to just under 13% moisture (a value of almost $.50 per bushel, [calculations were conducted using $10 per bushel, a round number for easy calculation]). A return of almost $500 per truck load! The entire system, including 2 **Grain Temp Guard® Alarm HT**'s was paid for with the first five or six loads. Put another way, this could approximate $10,000 on a 20,000 bushel bin of beans.

How does it work:

1) **Managing a condition bin:**
   Once your grain has been cooled or warmed up to the desired storage temperature, from time to time it is appropriate to ventilate the grain in order to break up confections that naturally occur within the stored column. **EndZone** can be set only ventilate with air that is of an appropriate temperature and humidity to not create issues with in the stored grain. It will turn the fans off if the days temperatures and or humidity get too high or too low for the desired outcome as set by the grain storage manager. When weather conditions have returned to the program to parameters, the fans will be reactivated.
   EndZone can be connected with a **Grain Temp Guard®** and Activate fans if a hotspot is detected. In the case of an **Alarm HT**, **EndZone** can activate the fans if abnormal moisture migration has occurred triggering an alarm setting.
2) **Drying corn (crops):**
   EndZone can be set to "only ventilate" with outside air when conditions are appropriate for generating the drying objectives you are looking for. Refer to the appropriate chart at https://farmshopmfg.com/resources/ .

Set the devices so that the fans shut off if the temperature and humidity swing to the left side of the chart resulting in over drying. I personally turn the fans off of the temperature gets too high or the humidity gets too low both resulting in excess moisture removal. On the top side, monitor the moisture and relative humidity

within the upper grain column and activate your fans whenever you have a 2 to 4% relative humidity advantage when looking at the right side of the chart. My corn currently is at 20% moisture and after I warm up to 65°, I will run the fans whenever the relative humidity is at around 86% to 87% or 3 to 4 points lower than the humidity within the grain column, also considering current temperature conditions. As your grain is drying, lower the top and relative humidity at which you are going to allow the fan to operate. With three, four, five points of moisture that need to be removed, you can be a little bolder with your settings, and as you near your target, be more precise.

*Periodically monitor your hour meter and measurements resulting from temperature and humidity within the grain column. If weather conditions are such that the control has not run for extended period of time, closely monitor the stored grain and perhaps periodically turn the fans on for a short period of time. You have a lot of money inside that bin, there is nothing wrong with being a little scared/nervous. Channel it to the appropriate management.

3) **Adding moisture soybeans:**
EndZone can be used to activate the fans when outside air conditions will allow for increasing the relative humidity around the stored grain. Refer to the Soybean equilibrium moisture content chart at https://farmshopmfg.com/resources/ . Run the fan whenever the relative humidity of outside air is above the charted bean moisture and at not to an extreme level. Do not run the fans when relative humidity % exceeds the upper 80s. Running the fans with to high outside relative humidity will result in the beans at the bottom of the bin rapidly over swelling, plugging the floor. This will result in very limited or no airflow and can cause a potential large problem. When dealing with 9% moisture beans, I ran my fans when-ever the relative humidity was between 55% and 85% and increased the lower setting as the moisture increased. When the grain moisture was nearing the desired target, I also lowered the top end of the range trying to keep my parameters closer to a relative humidity of 70%. Ultimately you need to closely monitor the relative humidity inside the grain column to determine your results. In my experience, I typically ran the fans in the evening or at night and/or early in the morning. When the fans were being shut off, I would see a higher relative humidity inside the grain column and this would decline over the next few hours as the beans sucked the moisture out of the air. This two steps forward one step back type of advance continued until I got my beans close to the desired moisture.

***Do not* shut the fans off if you have a large temperature gradient between grain at different levels in the bin, ie. You have frozen the grain at the start of winter and now you need to warm it up to 65° in order to properly dry the grain. In my current bins, the grain is stored at around 25° and when I warm it to 65°, turning the fans off will result in moisture condensation (think about a cold beverage can on a humid day) onto the cold corn above, creating a rot/mold line if the fans remained off for any extended period of time. I like to look for an average temp that brackets my target and leave the fans on until the warming front has traveled clear to the top. After this is completed I will go to work on my grain.**

EndZone is a tool which can make your life easier and your outcomes more precise. It does not have a brain, and requires your periodic monitoring. Occasionally (for me this is daily), look at your hour meter and the results that are occurring within the stored grain column.

Target Area

Table A. Corn Equilibrium Moisture Content

Temperature (°F)	Relative Humidity (%)													
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	9.3	10.3	11.2	12.1	13.0	13.9	14.8	15.7	16.6	17.6	18.7	19.8	21.2	22.9
40	9.1	10.0	10.9	11.8	12.7	13.5	14.4	15.3	16.2	17.1	18.2	19.3	20.7	22.3
45	8.8	9.8	10.6	11.5	12.3	13.2	14.0	14.9	15.8	16.7	17.7	18.9	20.2	21.8
50	8.6	9.5	10.4	11.2	12.0	12.9	13.7	14.5	15.4	16.3	17.3	18.5	19.8	21.4
55	8.4	9.3	10.1	11.0	11.8	12.6	13.4	14.2	15.1	16.0	17.0	18.1	19.3	20.9
60	8.2	9.1	9.9	10.7	11.5	12.3	13.1	13.9	14.8	15.7	16.6	17.7	18.9	20.5
65	8.0	8.9	9.7	10.5	11.3	12.0	12.8	13.6	14.5	15.3	16.3	17.4	18.6	20.1
70	7.9	8.7	9.5	10.3	11.0	11.8	12.6	13.4	14.2	15.0	16.0	17.0	18.2	19.8
75	7.7	8.5	9.3	10.1	10.8	11.6	12.3	13.1	13.9	14.8	15.7	16.7	17.9	19.4
80	7.6	8.4	9.1	9.9	10.6	11.4	12.1	12.9	13.7	14.5	15.4	16.4	17.6	19.1
85	7.4	8.2	9.0	9.7	10.4	11.2	11.9	12.6	13.4	14.3	15.2	16.2	17.3	18.8
90	7.3	8.1	8.8	9.5	10.3	11.0	11.7	12.4	13.2	14.0	14.9	15.9	17.0	18.5
95	7.2	7.9	8.7	9.4	10.1	10.8	11.5	12.2	13.0	13.8	14.7	15.6	16.8	18.2
100	7.1	7.8	8.5	9.2	9.9	10.6	11.3	12.0	12.8	13.6	14.5	15.4	16.5	17.9

Table B. Soybean Equilibrium Moisture Content

Temperature (°F)	Relative Humidity (%)													
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	5.9	6.5	7.1	7.8	8.6	9.4	10.3	11.5	12.8	14.4	16.4	19.1	22.9	28.9
40	5.8	6.4	7.1	7.7	8.5	9.3	10.2	11.3	12.6	14.2	16.2	18.9	22.7	28.7
45	5.8	6.4	7.0	7.7	8.4	9.2	10.1	11.2	12.5	14.1	16.1	18.7	22.5	28.4
50	5.7	6.3	6.9	7.6	8.3	9.1	10.0	11.1	12.4	14.0	16.0	18.6	22.3	28.2
55	5.7	6.2	6.8	7.5	8.2	9.0	10.0	11.0	12.3	13.8	15.8	18.4	22.1	28.0
60	5.6	6.2	6.8	7.4	8.1	8.9	9.9	10.9	12.2	13.7	15.7	18.3	21.9	27.8
65	5.6	6.1	6.7	7.4	8.1	8.9	9.8	10.8	12.1	13.6	15.5	18.1	21.7	27.6
70	5.5	6.1	6.6	7.3	8.0	8.8	9.7	10.7	11.9	13.5	15.4	17.9	21.6	27.3
75	5.4	6.0	6.6	7.2	7.9	8.7	9.6	10.6	11.8	13.3	15.2	17.8	21.4	27.1
80	5.4	5.9	6.5	7.1	7.8	8.6	9.5	10.5	11.7	13.2	15.1	17.6	21.2	26.9
85	5.3	5.9	6.4	7.1	7.7	8.5	9.4	10.4	11.6	13.1	15.0	17.5	21.0	26.7
90	5.3	5.8	6.4	7.0	7.7	8.4	9.3	10.3	11.5	13.0	14.8	17.3	20.8	26.5
95	5.2	5.7	6.3	6.9	7.6	8.3	9.2	10.2	11.4	12.8	14.7	17.1	20.7	26.3
100	5.2	5.7	6.2	6.9	7.5	8.3	9.1	10.1	11.3	12.7	14.5	17.0	20.5	26.1