Iowa FFA Agricultural Mechanics Career Development Event
2005

State of Iowa
DEPARTMENT OF EDUCATION
Career Education Division
Grimes State Office Building
Des Moines, IA 50319

CONTESTANT NAME _____

CONTESTANT SCHOOL _____
(print clearly)

TEAM PROBLEM SOLVING

Your team's task is to design a variable rate nitrogen application plan for a field with the attached spring soil N test results. As you complete the task, use the following assumptions:

1. This year, this field is planted in corn. Last year it was planted with soybeans. No unusually high amount of rain fell prior to soil sampling. See the "Corn after Corn" section on the "Soil Test-based N recommendations" page of the Nitrogen Fertilizer Recommendations reference.
2. Zone boundaries can only run north-south or east-west, therefore, regions directly north/south or east/west of each other with the same N levels should be in the same management zone. Regions with the same N levels that do not touch, or touch only on the diagonals, should not be in the same management zone.
3. The concentration of the liquid nitrogen fertilizer solution you're using is 1.25 lb Nitrogen per gallon (PPG). To convert lb N/acre (PPG) to gallons/acre (GPA), use $GPA = PPA \div PPG$ so that your units cancel out.
4. The fertilizer applicator is traveling at a speed of 4 miles per hour (MPH) with 30 inch nozzle spacing (W).
5. $GPM = \dfrac{GPA \times MPH \times W}{5940}$
6. You are using a Teejet StreamJet nozzle tip which has a flow rate of 1.5 gallons per minute at pressure of 40 psi (pound per square inch), and nozzle flow rate changes proportionally to the square root of pressure change, i.e. $\dfrac{Q_1}{Q_2} = \sqrt{\dfrac{P_1}{P_2}}$ where Q is flow rate and P is pressure.
7. Assume your maximum flow rate (GPM) is a duty cycle of 100% (ie, "full on", or, the nozzle sprays all the time). See page four of the SSM-5-W handout.

Evaluation Score Sheet

Items	Points Possible	Points Earned
TEAM TOTAL	150	
INDIVIDUAL TOTAL (Team Total ÷ 3)	50	

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TEAM PROBLEM SOLVING

1. What is the most appropriate critical N concentration to use, given no other information? (See assumption 1) ..... _____ (10)
2. Calculate the four N applications rates needed, according to the soil test results (you'll need them all later). What is the highest N application rate (lbs/acre)? ..... _____ (25)
3. How many N application *zones* would you use in this field for a variable rate design? (See assumption 2)..... _____ (10)
4. For your highest application rate, how many gallons per acre (GPA) of this fertilizer solution should be applied? (See assumption 3)..... _____ (20)
5. For the highest GPA, what will be the required flow rate in gallons per minute (GPM) from each nozzle tip? (See assumptions 4 and 5) ..... _____ (20)
6. In order to deliver the required flow rate you calculate in problem 5, what boom pressure you should set up? (See assumption 6) ..... _____ (20)
7. Now, you are asked to set up the modulated spraying nozzle control (MSNC) system to realize the variable application rates that you have decided on. If the MSNC system can be operated at a frequency of 25Hz (i.e., 25 cycles per second), define the duty cycles of each application rate. Also, calculate the nozzle opening time per cycle for every rate. (See assumption 7)

Application Rate	1	2	3	4
Duty Cycle	_____ %	_____ %	_____ %	__100__ %
Opening time/cycle	_____ sec	_____ sec	_____ sec	_____ sec

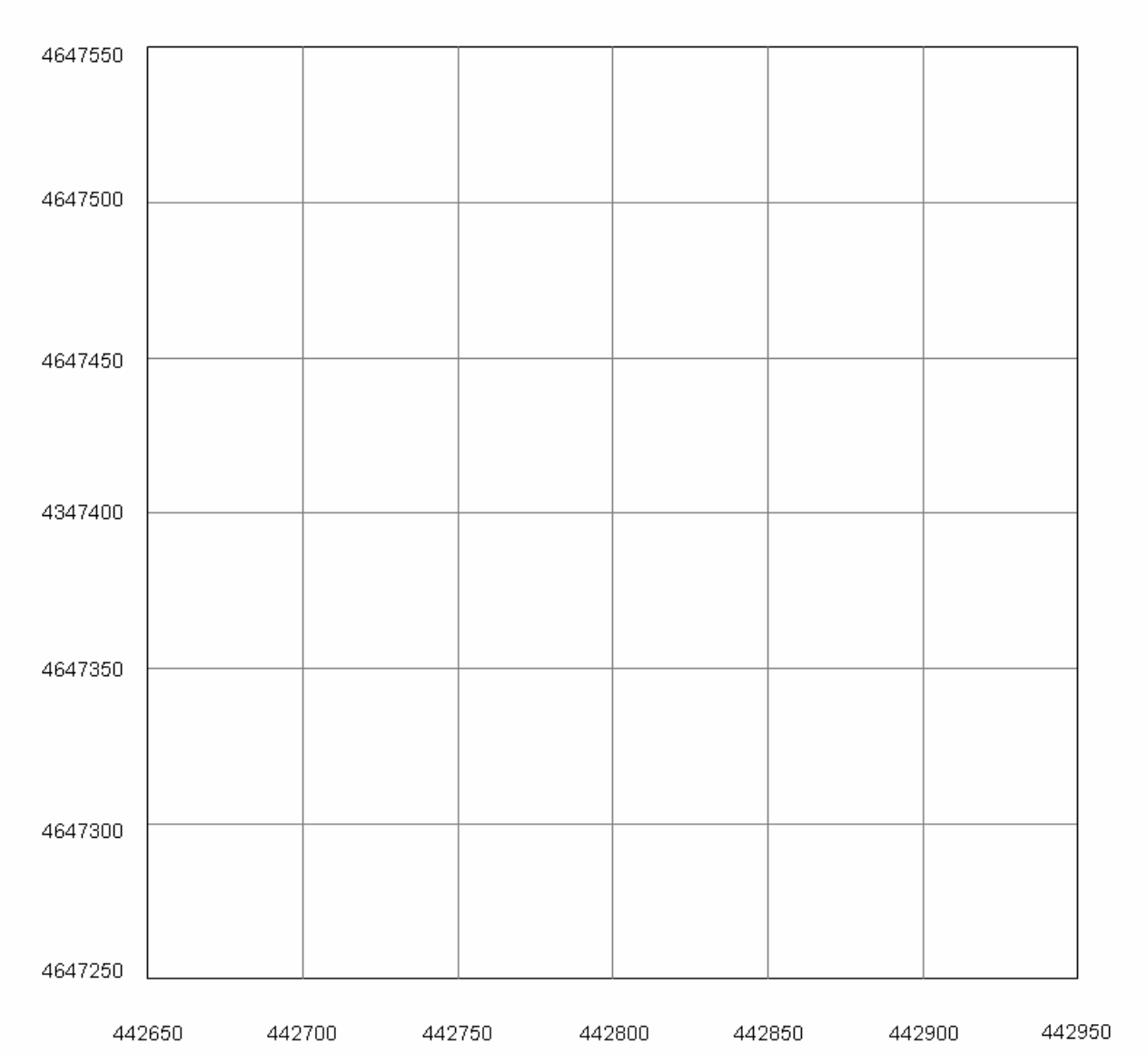
..... _____ (30)

8. If you are given a micro computer with a timer counter having 1 millisecond resolution, what will be the finest flow rate adjustment (in GPM) you can make by using this MSNC system? (Hint: this would mean, for example, that your smallest possible opening time per cycle is 0.001 seconds. See page 6 of the SSM-5-W handout.) ..... _____ (15)

Soil N test results:

UTM Zone 15 coordinates (m)		Nitrate-N level (ppm)
Easting	Northing	
442700	4647300	25
442800	4647300	25
442900	4647300	22
442900	4647400	19
442800	4647400	22
442800	4647400	22
442700	4647500	19
442800	4647500	15
442900	4647500	15

Field Layout:



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TEAM PROBLEM SOLVING - KEY

1. What is the most appropriate critical N concentration to use, given no other information? (See assumption 1) ..... 25 ppm (10)
2. Calculate the four N applications rates needed, according to the soil test results (you'll need them all later). What is the highest N application rate (lbs/acre)? 80 (25)
3. How many N application *zones* would you use in this field for a variable rate design? (See assumption 2)..... 6 (10)
4. For your highest application rate, how many gallons per acre (GPA) of this fertilizer solution should be applied? (See assumption 3)..... 64 (20)
5. For the highest GPA, what will be the required flow rate in gallons per minute (GPM) from each nozzle tip? (See assumptions 4 and 5) 1.29 (20)
6. In order to deliver the required flow rate you calculate in problem 5, what boom pressure you should set up? (See assumption 6) ..... 29.6 psi (20)
7. Now, you are asked to set up the modulated spraying nozzle control (MSNC) system to realize the variable application rates that you have decided on. If the MSNC system can be operated at a frequency of 25Hz (i.e., 25 cycles per second), define the duty cycles of each application rate. Also, calculate the nozzle opening time per cycle for every rate. (See assumption 7)

Application Rate	1	2	3	4
Duty Cycle	(2.5 pts) 0 %	(5 pts) 30 %	(5 pts) 60 %	100 %
Opening time/cycle	(2.5 pts) 0 sec	(5 pts) 0.012 sec	(5 pts) 0.024 sec	(5 pts) 0.04 sec

..... _____ (30)

8. If you are given a micro computer with a timer counter having 1 millisecond resolution, what will be the finest flow rate adjustment (in GPM) you can make by using this MSNC system? (Hint: this would mean, for example, that your smallest possible opening time per cycle is 0.001 seconds. See page 6 of the SSM-5-W handout.) 0.032 (15)