Engineering Selection Module

TEST PREPARATION GUIDE

RESTRICTED
PROPRIETARY
INFORMATION

ENGINEERING SELECTION MODULE
ANSWER SHEET

	Practice Test 1				Practice Test 2				
		a.	b.	c.	d.		a.	b.	c.	d.
1.	O	O	O	O	**1.**	O	O	O	O
2.	O	O	O	O	**2.**	O	O	O	O
3.	O	O	O	O	**3.**	O	O	O	O
4.	O	O	O	O	**4.**	O	O	O	O
5.	O	O	O	O	**5.**	O	O	O	O
6.	O	O	O	O	**6.**	O	O	O	O
7.	O	O	O	O	**7.**	O	O	O	O
8.	O	O	O	O	**8.**	O	O	O	O

ATTENTION

The materials in this review booklet are designed to assist you in preparing for the Engineering Selection Module (ESM) by giving you some insight into the types of questions that you will see on the actual test. This should also help focus your review of the basic skills needed to do well on the ESM.

The ESM is a validated employment test providing objective and accurate information regarding a candidate's likelihood of succeeding on the job. The ESM was designed to measure skills and abilities required to perform a variety of first level engineering jobs within AT&T and its subsidiaries.

This review will provide you with two practice tests along with the correct answers and explanations. Although these practice tests have a similar format to the actual ESM test, they are shortened versions. The actual test questions will vary in content and difficulty.

INTRODUCTION

The ESM consists of a 2½ hour written timed test with 53 multiple-choice questions.

What's Being Tested

The ESM is designed to measure engineering aptitude through the application of basic technical problem-solving skills. This test is a simulation exercise in which you are working for a fictitious company.

What's Important

The ability to use problem-solving skills and the provided background information to answer a variety of questions is important. In addition to answering questions concerning current customers and their service requirements, you will be required to estimate future growth or decline trends and to choose recommended courses of action.

What You Should Know

Using basic math functions (addition, subtraction, division, and multiplication) will be essential in solving these problems. Previous experience in the field of engineering is NOT necessary in order for you to work with the simulation materials.

Directions

This simulation exercise will provide you with background information and data that you will use to answer the multiple-choice questions. Use only given or implied information to determine your answers. Attempt all questions—there is no penalty for guessing.

What You Should Do

This exercise is entirely self-contained. All of the information needed to answer the multiple-choice questions can be determined from the background material provided. Spend a few minutes familiarizing yourself with the background material before actually using it to work on the questions. Since some questions build upon one another, it might be helpful to note the question number next to the work you do on the scratch paper provided. This may be referenced at a later time.

PRACTICE TEST INSTRUCTIONS

On the following pages you will find two practice tests. For each test, there is a set of background data with sample questions. The first practice test is only a simple version of the thinking that will be included in the actual ESM test. The second practice test more closely approximates the difficulty level of the actual ESM test. Both practice tests are shortened versions of the actual ESM.

To complete the practice tests, first read over the background information and data carefully. Then use this information to answer the corresponding questions. Mark your responses on the answer sheet provided. Do not mark on the sample questions since you will not be allowed to mark on the actual ESM test booklet.

After completing each practice test, turn to the answers and explanations section. Check each of your answers and use the given explanations in order to reason through each problem.

Take these practice questions as if you were taking the real test: time yourself exactly as indicated below, do not allow interruptions, record your answers in the appropriate section on the test answer sheet, and DO NOT MARK ON THE PRACTICE TEST BOOKLET as you are not allowed to write in the actual test booklet. You are not allowed to use a calculator to work these problems on the actual test and should not use one to answer these practice questions.

You will need:

Sharpened #2 pencils
An ESM practice test answer sheet (Provided on Page 2 of this Guide)
Scratch paper
A timer

Each Practice Test contains 8 questions to be answered in 20 minutes.

To begin Practice Test 1, set your timer to 20 minutes, turn the page and begin working.

ENGINEERING SELECTION MODULE
PRACTICE TEST 1

BACKGROUND INFORMATION—PRACTICE TEST 1

Assume today's date is January 1, 2015 and you have been asked to review Area #1 (see schematic on the following page). You are to assume that all pairs of cable can be used and growth rates will remain the same.

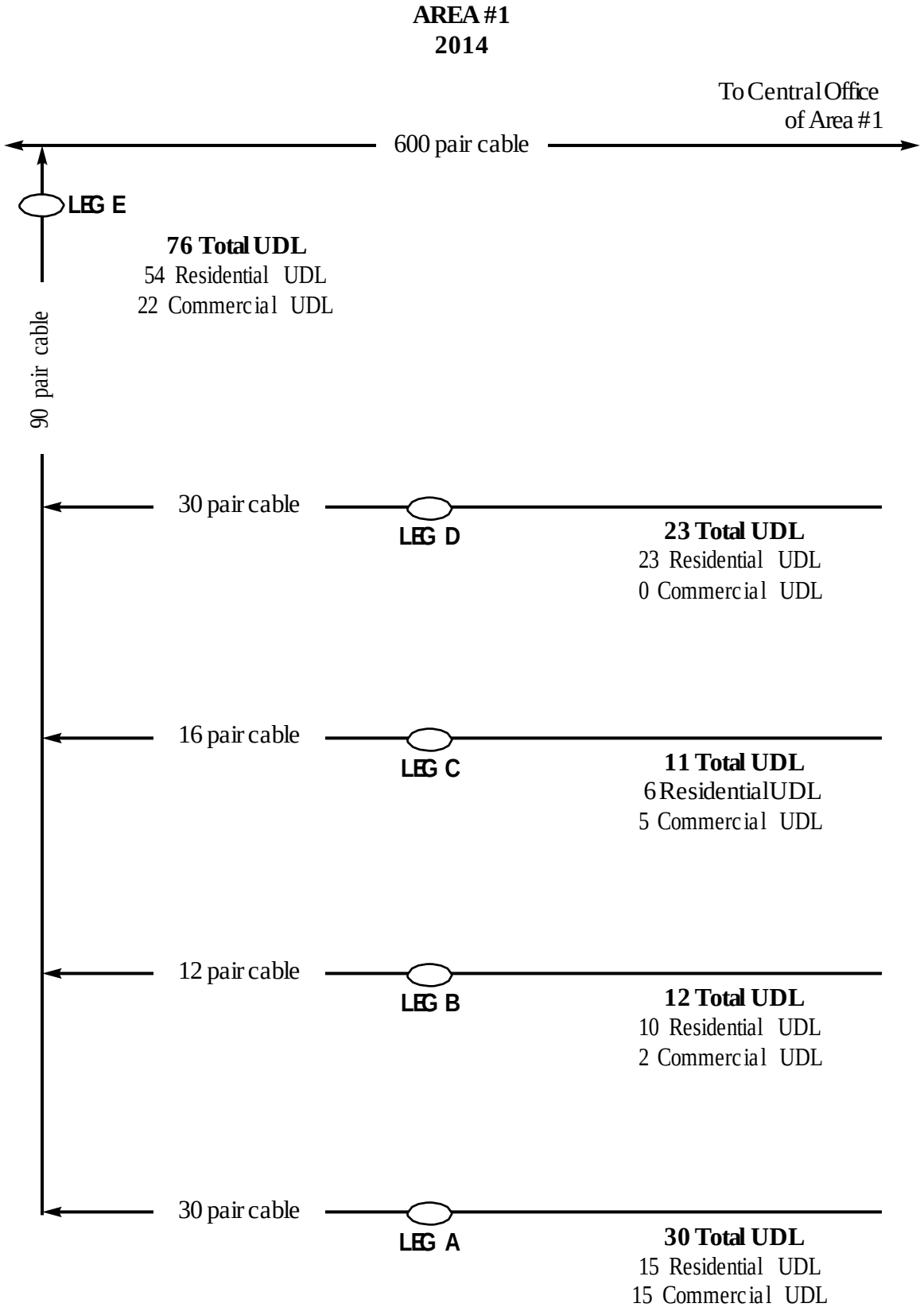
Under existing guidelines:

A cable is considered exhausted when all possible pairs in that cable are working.
For any sizing considerations, a residential UDL uses two lines and a commercial UDL uses one line.
One pair cable consists of two working lines—for residential locations, both lines in a pair cable will be used; for commercial locations, only one line will be used, leaving the other line unusable.

Assume Leg E is the sum total of Legs A, B, C, & D.

Use the following chart to determine growth. The numbers shown for 2010 through 2014 represent the number of working lines at the end of each year.

YEAR	2010	2011	2012	2013	2014
LEG A	25	30	35	40	45
LEG B	16	17	19	20	22
LEG C	13	14	15	16	17
LEG D	34	37	40	43	46
LEG E	88	98	109	119	130


AREA #1
2014
To Central Office
of Area #1
600 pair cable
LEG E
76 Total UDL
54 Residential UDL
22 Commercial UDL
90 pair cable
30 pair cable
LEG D
23 Total UDL
23 Residential UDL
0 Commercial UDL
16 pair cable
LEG C
11 Total UDL
6 Residential UDL
5 Commercial UDL
12 pair cable
LEG B
12 Total UDL
10 Residential UDL
2 Commercial UDL
30 pair cable
LEG A
30 Total UDL
15 Residential UDL
15 Commercial UDL

QUESTIONS—PRACTICE TEST 1

1. What is the expected number of working lines for Leg E for the year 2016?
a.) 149 b.) 150 c.) 151 d.) 152

2. Assuming there are 25 commercial UDL for Leg E in 2016, how many residential UDL will be handled by Leg E?
a.) 51 b.) 58 c.) 63 d.) 101

3. How many commercial locations are expected in 2017 for Leg A?
a.) 0 b.) 15 c.) 30 d.) 60

4. What cable leg(s) would you replace to provide for growth for the next three years?
a.) A b.) B c.) A & B d.) C, D, & E

5. What leg will reach exhaust at year-end 2017?
a.) A b.) B c.) C d.) D

6. For Leg E, consider years 2010 through 2014. What was the average yearly rate of growth?
a.) 10.5 b.) 10 c.) 11 d.) 11.5

7. As of today, how many more residential lines could the system absorb in Legs A, B, C, and D?
a.) 2 b.) 6 c.) 12 d.) 14

8. Assume that by year-end 2016, Leg B was replaced with a 15 pair cable and Leg E with a 91 pair cable. When will Leg B reach exhaust?
a.) 2018 b.) 2019 c.) 2020 d.) 2021

ANSWERS & EXPLANATIONS—PRACTICE TEST 1

1. (C) Looking at the increase in the number of working lines per year for each leg, a pattern emerges. For example, Leg A has an increase of five lines per year. Following this pattern, the number of lines at the end of years 2015 and 2016 can be estimated. Each of the patterns for Legs A-E is shown in the table below. Once the number of lines is figured for each leg for the years 2015 and 2016, the answer can be found by either adding the number of lines in the year 2016 for Legs A-D (since Leg E is the sum of Legs A-D) or by looking at the pattern for Leg E.

YEAR	2010	2011	2012	2013	2014	2015	2016	PATTERN
LEG A	25	30	35	40	45	50	55	+5, +5, +5, +5, ...
LEG B	16	17	19	20	22	23	25	+1, +2, +1, +2, ...
LEG C	13	14	15	16	17	18	19	+1, +1, +1, +1, ...
LEG D	34	37	40	43	46	49	52	+3, +3, +3, +3, ...
LEG E	88	98	109	119	130	140	151	+10, +11, +10, +11, ...

2. (C) Referring to the table in Answer #1, the total working lines for Leg E at the end of 2016 is 151. If there are 25 commercial UDL for Leg E, each of which take only one line, then there are 126 (151 – 25) available working lines. Since residential UDL require two lines, 63 (126 / 2) residential UDL will be handled by Leg E.

3. (A) Expanding the table in Answer #1 one more year, the total working lines for Leg A at the end of 2017 is 60. Knowing from the schematic that Leg A has a 30 pair cable capacity, the only possible combination of residential and commercial locations is 30 residential and 0 commercial locations (30 res. UDL x 2 lines).

4. (B) To provide for growth for the next three years, each cable leg must have enough line capacity to meet the expected demand. Expand the table in Answer #1 through 2017. Remembering that one pair cable consists of two working lines, compare the total number of working lines expected in 2017 to the total capacity on the schematic. Since Leg B has a capacity of 12 cables or 24 working lines, but by year 2017, 26 working lines will be needed, Leg B will need to be replaced. All other legs do not need to be replaced until after three years.

5. (A) Remember that a cable is considered exhausted when all possible pairs in that cable are working and that a cable pair consists of two working lines. Leg A will reach exhaust (30 pair cable or 60 working lines) at year-end 2017. Leg B will reach exhaust during 2016, Leg C at year-end 2029, and Leg D during 2019.

6. (A) To find the average yearly rate of growth for Leg E, first subtract the number of working lines at the end of 2010 from the number in 2014 (130 - 88 or 42). Then divide that number by the number of years of growth between 2010 and 2014 (42 / 4 or 10.5).

7. (C) The total number of UDL in Legs A & B is at capacity (30 for Leg A and 12 for Leg B). Leg C has 11 total UDL and 16 pair cable, thus could absorb 5 residential UDL. Leg D has 23 total UDL and 30 pair cable, so is able to absorb 7 residential UDL. A total of 12 residential UDL could be absorbed.

8. (C) Replacing Leg B with a 15 pair cable increases the capacity to 30 working lines. Using the growth patterns, estimate the total working lines at the end of each year through 2021. As shown, Leg B will reach exhaust during 2020.

YEAR	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
LEG B	23	25	26	28	29	31	32

ENGINEERING SELECTION MODULE
PRACTICE TEST 2

BACKGROUND INFORMATION—PRACTICE TEST 2

Assume you are an electrical engineer working for the city of Powerville. There are two classes of customers served by the city:

Residences

Businesses

The Main Distribution center feeds into the Distribution Sub-station, which is further subdivided into four Satellite Centers: Willow Street, Palm Street, Elm Street, and Birch Street. See the schematic of Powerville on page 13.

Electricity consumption is defined as the wattage or kilowatts/hour used by customers. Electricity is delivered through cables with different wire gauges. The larger the wire gauge, the greater the maximum wattage deliverable.

As in the Engineering Simulation Exercise, you will be asked to forecast trends, determine customer service needs, and provide recommendations based on a number of assumptions. This section of the test is self-contained and all the information you need is either explicit or implied by the following charts and schematic.

In answering each question, assume that the Central cable "a" is the sum of cables "b", "c", "d", and "e".

Distribution of Powerville Customers by Satellite Center

Satellite Center	Residences	Businesses
Willow Street	50%	10%
Palm Street	30%	25%
Birch Street	10%	25%
Elm Street	10%	40%
	100%	100%

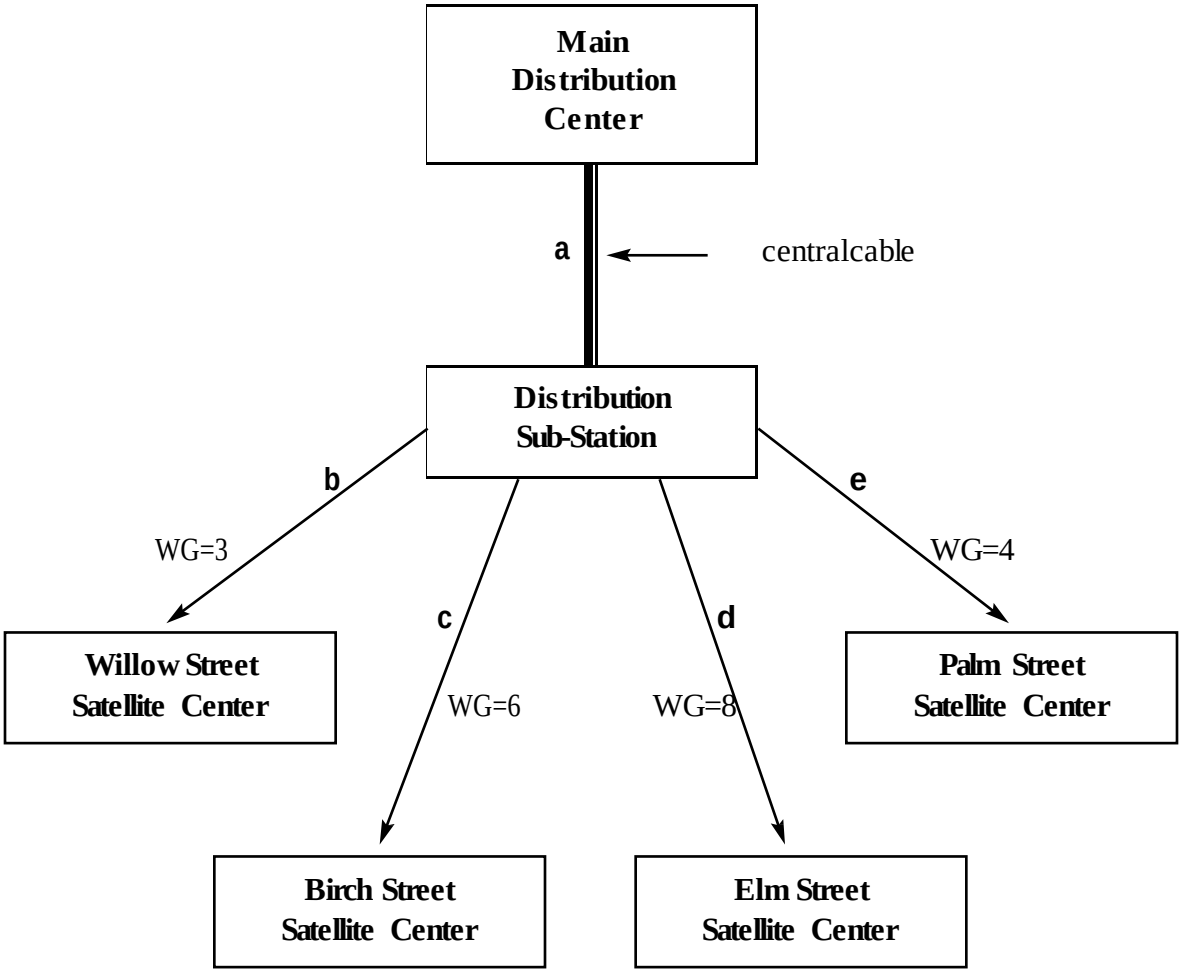
Average Hourly Electricity Consumption Per Customer Class in Powerville (kilowatts/hr)

	2011	2012	2013	2014	2015
Residences	10	11	13	16	20
Businesses	80	90	98	104	108

Maximum Wattage per Wire Gauge

Wire Gauge	Maximum Wattage (kilowatts/hr)	Wire Gauge	Maximum Wattage (kilowatts/hr)
1	2000	21	12000
2	2500	22	12500
3	3000	23	13000
4	3500	24	13500
5	4000	25	14000
6	4500	26	14500
7	5000	27	15000
8	5500	28	15500
9	6000	29	16000
10	6500	30	16500
11	7000	31	17000
12	7500	32	17500
13	8000	33	18000
14	8500	34	18500
15	9000	35	19000
16	9500	36	19500
17	10000	37	20000
18	10500	38	20500
19	11000	39	21000
20	11500	40	21500

POWERVILLE ELECTRICAL NETWORK



WG = wire gauge

QUESTIONS—PRACTICE TEST 2

1. If the trend continues, when will the average hourly electricity consumption start to decrease for businesses?
a.) 2016 b.) 2017 c.) 2018 d.) 2019

2. Assuming there are 40 residences and 5 businesses served by Willow Street Satellite Center, when will a wire gauge upgrade become necessary?
a.) 2018 b.) 2019 c.) 2020 d.) 2021

3. Assuming electricity consumption will double for Birch Street Satellite Center in 2016 requiring a wire gauge with twice the current maximum wattage, what would be the minimum size wire gauge required for the central cable?
a.) 21 b.) 27 c.) 30 d.) 39

For questions 4 to 8, assume there is an equal number of residences and businesses in Powerville.

4. Which station consumed the most electricity in 2015?
a.) Willow Street Satellite Center
b.) Birch Street Satellite Center
c.) Elm Street Satellite Center
d.) Palm Street Satellite Center

5. Which station will consume the most electricity in 2020?
a.) Willow Street Satellite Center
b.) Birch Street Satellite Center
c.) Elm Street Satellite Center
d.) Palm Street Satellite Center

6. What percentage of total electricity consumption will businesses represent for Palm Street Satellite Center in 2017?
a.) 45.5% b.) 74.7% c.) 78.0% d.) Cannot determine

7. Which of the following courses of action would be most appropriate for Palm Street Satellite Center?
a.) Replace the wire gauge with a larger one in 2015
b.) Replace the wire gauge with a smaller one in 2016
c.) Replace the wire gauge with a larger one in 2016
d.) Replace the wire gauge with a larger one in 2017

8. In the face of escalating residential electricity consumption, the city of Powerville decided to make it a goal for Willow Street residential hourly consumption not to exceed business consumption for 2016. What is the minimum percentage decrease in residential electricity consumption you would recommend as a goal for 2016?
a.) No need to decrease electricity consumption b.) 6% c.) 12% d.) 14%

ANSWERS & EXPLANATIONS—PRACTICE TEST 2

1. (C) To answer this question, you have to infer the growth rate in hourly electricity consumption for businesses. The growth rate for each customer class is shown in the table below. The growth rate for each class follows a pattern. The average hourly electricity consumption for Residences, for example, increases by 1 between 2011 and 2012, by 2 between 2012 and 2013 and so on. Once the pattern is identified, you can determine when the average hourly electricity consumption starts to decrease for businesses (in 2018).

	2011	2012	2013	2014	2015	2016	2017	2018	Pattern
Res	10	11	13	16	20	25	31	38	+1, +2, +3, +4, +5...
Bus	80	90	98	104	108	110	110	108	+10, +8, +6, +4, +2...

2. (D) All three charts have to be used to solve this problem. First, the current maximum wattage has to be determined for Willow Street Satellite Center. On the schematic, you can see that Willow Street has a wire gauge of 3. Referring to the "Maximum Wattage per Wire Gauge" chart, a wire gauge of 3 can deliver up to 3000 kilowatts/hour.

The next step is to forecast the average hourly consumption for the years 2018 through 2021 using the growth patterns found in Answer #1.

	2018	2019	2020	2021
Residences	38	46	55	65
Businesses	108	104	98	90

The final step then is to calculate total hourly consumption given the assumptions of the problem and determine when a wire gauge upgrade becomes necessary. According to this question, Willow St. Satellite Center has 40 residences and 5 businesses. Calculate hourly consumption by multiplying the average hourly consumption (from the table) by the number of residences and then the number of businesses. A wire gauge upgrade becomes necessary in 2021:

(65 kw/hr for res. x 40 res.) + (90 kw/hr for bus. x 5 bus.) = 3050 total kw/hr

3. (D) In order to solve this problem, it is necessary to use the schematic and the "Maximum Wattage per Wire Gauge" chart. First, add together the maximum wattage associated with each of the four satellite wire gauges.

Satellite	Wire Gauge	Maximum Wattage
Willow Street	3	3000
Palm Street	4	3500
Birch Street	6	4500
Elm Street	8	5500
Total		16,500

Adding the wattage associated with doubling the current maximum wattage for Birch Street (4500) equals 21,000 kilowatts/hour (16,500 + 4,500 = 21,000). Referring again to the "Maximum Wattage per Wire Gauge" chart, you can see that 21,000 kw/hr will need a wire gauge of 39.

For questions 4 to 8, you are asked to assume that there is an equal number of residences and businesses in Powerville. This is a crucial assumption upon which solutions to these questions depend. For the sake of simplicity, let us assume that there are 100 residences and 100 businesses in Powerville. In so doing, the percentages in the "Distribution of Powerville Customers by Satellite Center" chart actually become numbers/proportions of customers for each satellite. These proportions are necessary to answer questions 4 to 8.

4. (C) Multiply the proportion of customers of each satellite by the average hourly consumption of residences and businesses for 2015. Elm Street has the highest total wattage in 2015.

(20 kw/hr for res. x 10 res.) + (108 kw/hr for bus. x 40 bus.) = 4520 total kw/hr

5. (C) The solution process is similar to that in question 4. One additional step is needed to determine the average hourly consumption for residences and businesses in 2020. Refer to the table in Answer #2 for this information. Elm Street once again has the highest wattage in 2020.

(55 kw/hr for res. x 10 res.) + (98 kw/hr for bus. x 40 bus.) = 4470 total kw/hr

6. (B) Again you need to infer the growth rate of hourly electricity consumption to solve this problem (Refer to the table in Answer #1). Then, you need to multiply the proportion of customers for Palm Street by the average hourly consumption for residences and businesses in 2017.

31 kw/hr x 30 res. = 930 total kw/hr for res.
110 kw/hr x 25 bus. = 2750 total kw/hr for bus.
To determine the percent of total electricity consumption represented by businesses for Palm St, divide the total kw/hr for businesses by the total kw/hr for both businesses and residences combined.

2750 total kw/hr for bus. / (930 total kw/hr for res. + 2750 total kw/hr for bus.) = 74.7% of total electricity consumption represented by businesses for Palm St.

7. (D) Using the "Maximum Wattage per Wire Gauge" chart, determine the maximum wattage for wire gauge "e" associated with Palm Street Satellite center (wire gauge 4 = 3500 kilowatts/hr). Since the question concerns the replacement of the wire gauge, you must calculate the total hourly electricity consumption for 2015, 2016, and 2017. This is done by multiplying the customer proportions by the forecasted average hourly consumption for each year (use the table in Answer #1). Then decide whether the numbers obtained are smaller or larger than the maximum wattage allowed for Palm Street and choose an answer accordingly.

In 2017, total wattage needs for Palm Street would be 3680 kilowatts/hour requiring a wire gauge upgrade.

(31 kw/hr for res. x 30 res.) + (110 kw/hr for bus. x 25 bus.) = 3680 total kw/hr

8. (C) First, calculate the hourly electricity consumption for Willow Street in 2016, both for residences and businesses.

Residences: 25 kw/hr x 50 res. = 1250 total kw/hr
Businesses: 110 kw/hr x 10 bus. = 1100 total kw/hr

The residential consumption would exceed business consumption in 2016; therefore, we would have to reduce it by 12% to bring consumption down to business levels.

(1250 total kw/hr for res. – 1100 total kw/hr for bus.)/1250 total kw/hr for res. = 12% reduction needed in residential consumption