Appendix B – Helpful Info:

State Code Information

Michigan Rule 460.3301 Metered Measurement of Electricity Required; Exceptions

1. All electricity that is sold by a utility shall be on the basis of meter measurement, except where the consumption can be readily computed or except as provided for in a utility's filed rates.
2. Where practicable, the consumption of electricity within the utility or by administrative units associated with the utility shall be metered.

Michigan Rule 460.3505 Utility Line Clearance Program

Each utility shall adopt a program of maintaining adequate line clearance through the use of industry-recognized guidelines. A line clearance program shall recognize the National Electric Safety Code standards that are adopted by reference in R 460.811 et seq. The program shall include tree trimming.

Michigan Rule 460.3605(2) Metering Electrical Quantities

Every reasonable effort shall be made to measure at one point all the electrical quantities necessary for billing a customer under a given rate.

Michigan Rule 460.3702 Standard Nominal Service Voltage; Limits; Exceptions

1. Each utility shall adopt and submit standard nominal service voltages.
2. With respect to secondary voltages, the following provision shall apply:
   a. For all retail service, the variations of voltage shall be not more than 5% above or below the standard nominal voltage as submitted pursuant to subrule (1) of this rule, except as noted in subrule (4) of this rule.
   b. Where 3-phase service is provided, the utility shall exercise reasonable care to ensure that the phase voltages are balanced within practical tolerances.
3. With respect to primary voltages, the following provisions shall apply:
   a. For service rendered principally for industrial or power purposes, the voltage variation shall not be more than 5% above or below the standard nominal voltages as submitted pursuant to subrule (1) of this rule, except as noted in subrule (4) of this rule.
   b. The limitations in subdivision (a) of this subrule do not apply to special contracts in which the customer specifically agrees to accept service with unregulated voltage.
4. Voltages outside the limits specified in this rule shall not be considered a violation if the variations are infrequent fluctuations or occur from adverse weather conditions, service interruptions, causes beyond the control of the utility, or voltage reductions that are required to reduce system load at times of supply deficiency or loss of supply.

Michigan Rule 460.813 Standards of Good Practice; Adoption by Reference

Parts 1, 2, and 3 and sections 1, 2, 3, and 9 of the National Electrical Safety Code, 1997 edition (ANSI-C2-1997), are adopted by reference in these rules as standards of accepted good practice. Parts 1, 2, and 3 and sections 1, 2, 3, and 9 of the National Electrical Safety Code, 1997 edition (ANSI-C2-1997) are available from the Michigan Public Service Commission, P.O. Box 30221, Lansing, MI 48909, (at a cost), or from the Institute of Electrical and Electronics Engineers, Service Center, P.O. Box 1331, Piscataway, NJ 08855-1331, (at a cost).

Lightning Protection

Lightning damage due to induced electrical surges from nearby lightning strikes is a common problem. Glaciated sand or gravel soil, common to the area, creates poor grounding conditions. Average soil resistivities in the area of 250,000 ohm - cm or more are typical. Per IEEE 142-1982 (the Green book on grounding) and based on actual field results, the following are typical:

A. One rod: 800 ohms or more.
B. Ten-rod deep ground: 150 ohms or more.
C. Six-inch drilled well 100 feet deep: 85 ohms or more

Because of poor grounding conditions, it is critical to bond all metallic systems. The theory is that by bonding everything, there will be little or no difference in potential between metallic systems (therefore minimizing damage). Bonding is also done for safety and code reasons. If you are correcting bonding problems, it is important to bond everything. Partial bonding could actually aggravate problems. Bonding should be done to the grounding electrode system in the following cases:

1. Drilled well casings - Code requires the equipment ground to be bonded to the well casing and the case of the water pump. In residential cases, this is often only a #12 copper. The drilled well is the best ground in the area. Consequently, the Company recommends at least a # 6 copper bond. This bond will minimize lightning damage to submersible pumps. This bond can be done by drilling the well casing 12 inches above grade and using a self-tapping bolt. It can also be attached to the grounding bolt on newer well casing caps
2. Metallic water piping and hydronic heating systems.
3. Natural gas or LP gas piping if built with black iron pipe. Bonds are desirable on other piping systems, but there are potential problems with bonds damaging the pipe.
4. TV antenna systems - Code requires these to be grounded to a rod by the most direct path possible. It is also important to bond this to the electrical system.
5. Satellite dishes - There should be a ground rod at the dish and a bond to the electrical system. See NEC 810.21 for information. Also, a three-prong outlet and surge suppressor is helpful at the controller. Note that the newer small dishes are not metallic and so avoid many of the bonding issues.
6. Lightning rod systems - It is important to bond this to the electrical system.
7. Structural Steel.
8. Cable TV and telephone grounds where they enter the building.

Surge suppressors can also help. It is important, however, that all bonding be completed first. Note that plug-in type surge suppressors will only work on properly installed three-prong outlets. Surge suppressors (lightning arrestors) that are installed at the main disconnect must be installed on the load side of a breaker or fuse. Note that a lightning surge will be over before the breaker can trip. Also, note that these devices do fail and the breaker protection will take the arrester off line. If the arrester is wired ahead of the main, arcing can continue, causing a fire.

"Isolated grounds" on electrical wiring refer to insulated and isolated equipment grounds going back to the bond at the main electrical disconnect. Totally isolated grounding systems are potentially very dangerous and, in almost all cases, do not comply with electrical codes.

Energy Conversion Factors

Fuel	Energy Content	Unit Price	Heat Conversion Efficiency	Cost Per Million BTU*	Break Even Cost
Natural Gas	100,000 BTU/therm	$.76/therm	90%	$8.44	$.76/therm
Propane	91,600 BTU/gallon	$1.25/gallon	90%	$15.16	$.70/gallon
#2 Fuel Oil	139,400 BTU/gallon	$2.50/gallon	80%	$22.42	$.94/gallon
#6 Fuel Oil	150,000 BTU/gallon	$3.00/gallon	80%	$25.00	$1.01/gallon
Kerosene	135,000 BTU/gallon	$3.00/gallon	85%	$26.14	$.97/gallon
Electric Resistance	3,412 BTU/KWH	$.13/KWH	100%	$38.10	$.029/KWH
Electric Heat Pump	3,412 BTU/KWH	$.13/KWH	200%	$19.05	$.058/KWH
Wood, Hardwood	24,000,000 BTU/cord	$200.00/cord	60%	$13.89	$122/cord
Wood Pellets	8,000 BTU/lb	$200.00/ton	80%	$15.63	$108/ton
Shelled corn	6,970 BTU/lb	$4.00/50 lbs	75%	$15.30	$2.21/50 lbs
Coal	13,100 BTU/lb	$200.00/ton	75%	$10.18	$166/ton

Energy Conversion Factors

1 CF (Cubic Foot)	= Approx. 1,000 BTU
1 CCF	= 100 CF = 1 Therm
1 MCF	= 1,000 CF
1 Therm	= 100,000 BTU
1 MBH	= 1,000 BTU/HR
1 Boiler HP	= 42 CFH
1 HP	= 746 Watts
1 Dekatherm	= 10 Therms = 1000 CF

*Note: Costs noted in the above table are based on average fuel rates and are for informational purposes only.

Using a Generator:

- There are several ways to connect your generator to your home's wiring circuit. However, the generator must be electrically isolated from Uppco's distribution system.
    - A double-throw transfer switch, or similarly approved isolation switch, must be installed to isolate the generator from Uppco's distribution system.
    - Be sure to obtain the proper electric permits and have your installations inspected.
    - The double-throw or throw over switch may be manually or automatically operated. Customer-owned generating equipment shall not operate in parallel with the Company's system except under specific contract with the Company covering the conditions of such operation.
- Never operate a generator in your home, garage, basement or any other enclosed area.
- A generator should be at least 4 feet from enclosed areas, doors, windows, and fresh air intakes where exhaust fumes and carbon monoxide can enter the home. Proper ventilation is critical.
- A temporary canopy can be constructed over the portable generator to keep it dry. Leave adequate room for proper ventilation.
- Always read the owner's manual carefully following all manufacturer instructions and precautions before starting and operating your generator.
- Overloading your generator can cause damage to the generator and any connected appliance or component.
    - By alternating your appliances, you can stay within your portable generator's output.
- Start your generator before connecting appliances or equipment.
- Before shutting down your generator, turn off connected equipment.
- Most refrigerators and freezers are good for about 24 hours if the door is not opened. Beyond that, four to six hours of run time on a generator is usually adequate per day. Follow good food preservation practices, as suggested by "The Extension Service" or other similar authorities.
- Never plug a portable generator into a wall outlet; you could damage your home's wiring

- When using a portable generator, connect appliances to the generator using flexible extension cords with current ratings adequate for the appliances being served.
- A double-throw transfer switch is not required when a portable generator serves appliances via a properly rated extension cord, i.e., refrigerators, freezers, space heaters, etc.

If you are installing a permanent standby generator system, consult an expert. There are other potential problems in addition to the need for the transfer switch. One problem is Ground Fault Interrupters (GFI's) installed on most portable generators. Another problem is that some generators are rated to only supply 240 volt or 120 volt loads and not both at the same time (120 / 240 rating-center tapped).

Care also needs to be taken in sizing generators. Normally, generators must be oversized to handle the in-rush of a starting motor. Also, they need to be oversized if there is a lot of electronic load on it. A special concern with electronic loads is the operation of the generator as it runs out of fuel (the internal voltage regulation may not be able to protect electronic equipment connected to the generator).

Basic Calculations

Full-Load Currents

Single Phase				
KVA	**120**	**240**	**277**	**480**
5	41.7	20.8	18.1	10.4
10	83.3	41.7	36.1	20.8
15	125	62.5	54.2	31.3
25	208	104	90.3	52.1
37.5	313	156	135	78.1
50	417	208	181	104
75	625	313	271	156
100	833	417	361	208
167	1392	696	603	348
250	2083	1042	903	521
333	2775	1388	1202	694
500	4167	2083	1805	1042

Full Load Current = $\frac{\text{KVA x 1000}}{\text{Circuit Voltage}}$

Three Phase			
KVA	**208**	**240**	**480**
15	41.6	36.1	18.0
30	83.3	72.2	36.1
45	125	108	54.1
75	208	180	90.2
112.5	312	271	135
150	416	361	180
225	625	541	271
300	833	722	361
500	1388	1203	601
750	2082	1804	902
1000	2776	2406	1203
1500	4164	3609	1804
2000	5552	4811	2406
2500	6940	6014	3007
3000	8327	7217	3609

Full Load Current = $\frac{\text{KVA x 1000}}{\text{1.732 x Circuit Voltage}}$

Ohms Law: $V = IR$ $I = \frac{V}{R}$ $R = \frac{V}{I}$

Power (P) – $VI = I^2R = \frac{V^2}{R}$

$KVA = \sqrt{[(KW)^2 + (KVAR)^2]}$
KW = pf x KVA pf = power factor

1 HP = 746 watts

Rough 50 Hz Rated Motor Conversions
6/5 of HP rating for 60 Hz operation
6/5 of voltage rating for 60 Hz operation
50 Hz Std. Voltage is 220/380 which is
Similar to 277/480 at 60 Hz.

Formula for Timing an Electric Meter that has a Disc:

Watts = $\frac{\text{(3600)(\# of revolutions)(Kh)(multiplier)}}{\text{(Seconds)}}$ RPM = $\frac{\text{120 x frequency}}{\text{\# of poles}}$

Kh comes off of the meter nameplate.

Multiplier is 1 on smaller installations. Large installations should have a well-marked multiplier.

Maximum Fault Currents

Voltage	Entrance Size	Pole or Pad Mounted Transformer	Fault Current at Transformer	Fault Current with 25 foot Service	Fault Current with 50 foot Service	Fault Current with 75 foot Service	Fault Current with 100 foot Service	Assumed Service Conductors	X/R Values at Secondary Side of Transformer		Assumed Transformer Size
									With Pole Transformer	With Pad Mounted Transformer	
Single Phase 120/240	**200**	Either	(3) **4,500**	4,300	4,100	3,900	3,800	3c3/0	1.0	0.9	15
	200	Either	(3) **7,900**	7,400	6,900	6,500	6,100	3c3/0	1.4	1.4	25
	200	Either	**14,300**	12,800	11,600	10,500	9,500	3c3/0	2.0	1.6	50
	400	Either	**25,500**	22,700	20,300	18,400	16,700	3c350	2.3	2.4	100
	600	Either	**39,600**	35,500	29,500	29,000	24,700	2-3c350	12.9	19.6	167
	800	Either	**49,900**	46,600	43,600	40,900	38,000	6-700	22.9	14.2	250
Three Phase 120/208	**200**	Either	**15,800**	12,200	9,800	8,100	6,900	4c3/0	1.4	2.3	75
	400	Either	**35,500**	27,600	21,700	17,600	14,800	4c350	2.0	8.9	150
	600	Either	**57,300**	42,100	32,700	26,500	22,300	2-4c350	2.3	9.1	300
	800	Either	**57,300**	48,800	42,100	36,800	32,700	8-700	2.3	9.1	300
	1200	Either	**71,600**	64,500	58,600	53,600	49,200	16-700	12.9	12.8	500
	1600	Either	**71,600**	65,900	60,900	56,600	52,700	20-700	12.9	12.8	500
	2000	Pad Mounted	**71,600**	66,800	62,500	58,700	55,200	24-700	xx	14.6	750
	2000	Pole	99,700	90,800	83,100	76,400	70,600	24-700	20.2	xx	3-250
Three Phase 277/480	**200**	Either	**13,300**	12,300	11,300	10,400	9,600	4c3/0	2.0	13.1	150
	400	Either	**25,100**	22,800	20,800	19,100	17,600	4c350	2.8	17.5	300
	600	Either	**34,500**	31,600	29,100	26,900	24,900	2-4c350	6.6	15.9	500
	800	Pad Mounted	**34,500**	33,000	31,600	30,300	29,000	8-700	xx	11.5	750
	800	Pole	38,000	36,400	34,800	33,200	31,800	8-700	14.9	xx	3-250
	1200	Pad Mounted	**34,500**	33,700	33,000	32,300	31,600	16-700	xx	11.9	1000
	1200	Pole	47,800	46,400	45,100	43,900	42,700	16-700	25.3	xx	3-333
	1600	Pad Mounted	**34,500**	33,900	33,300	32,700	32,200	20-700	xx	12.2	1500
	1600	Pole	60,700	58,900	57,300	55,700	54,100	20-700	26.9	xx	3-500
	2000	Pad Mounted	**46,200**	45,400	44,500	43,700	42,900	24-700	xx	13.3	2500
	3000	Pad Mounted	**46,200**	45,500	44,800	44,100	43,500	28-1000 cu	xx	13.3	2500

Note: This Table Applies Only for Cases with One Service Fed from a Transformer

Notes:

1. WARNING: This information assumes a dedicated transformer feeding one customer. If a transformer feeds a large entrance and a small service is also tapped from that transformer, the fault current will be much higher than shown here for the small entrance. Call the Company for information in this case.
2. These tables are worst-case fault currents. Fault currents depend on distance from substation, type of feeder, type (overhead vs. underground) and size of transformer, size and length of service, etc. Call the Company for information on specific locations, sizes and voltages not given.
3. Minimum of 22 kA service entrance equipment required.
4. Meter sockets are exempt from fault current requirements per NEC 230.66, manufacturer testing issues.

Mobile Home Services

Mobile Home General Information

1. **Definition**:
A mobile home as defined by the NEC 550.2 is as follows: "A factory assembled structure or structures transportable in one or more sections, that is built on a permanent chassis and designed to be used as a dwelling without a permanent foundation where connected to the required utilities, and that includes the plumbing, heating, air conditioning, and electric systems contained therein." Mobile homes can be identified by a red rectangular Department of Housing and Urban Development (Federal HUD) inspection label on the outside corner of the home. Manufactured homes (Ex. Wausau Home), on the other hand, can be identified by a state inspection sticker on the electrical panel or inside of the closet door or similar location. These are often referred to as UDC homes (Uniform Dwelling Code).

2. **General Code:**
Mobile homes are built and inspected by the Federal Department of Housing and Urban Development. The external electrical wiring for mobile homes is covered by State Electrical Inspection requirements. As per the electrical code, a mobile home is always a mobile home. That is different than many local zoning ordinances. Zoning ordinances often allow mobile homes to be redefined if they are mounted on a permanent foundation. The external electrical wiring requirements for a mobile home are covered under NEC 550 with specific information on the service entrance equipment under NEC 550.32.

3. **Practical Effect**:
Mobile homes must be fed with an external electrical meter and external disconnect as per NEC 550.32. The NEC also requires provisions for a feed from that disconnect to an accessory building or other piece of equipment (such as a well). Provisions should also be made for a 15 or 20 amp, 120 volt GFI outlet. The NEC requires the disconnect to be located in sight of the mobile home and not more than 30 feet away. The electrical meter and disconnect cannot be attached to the mobile home (can be fastened to a permanent foundation or basement). The wiring from this external service entrance equipment into the mobile home must be four conductor (two hots, a neutral, and an equipment ground (green or bare)). The NEC requires this conductor to be in conduit where exposed under the mobile home.

   The only way around the external disconnect is if the mobile home is mounted on a permanent basement. In this case you are actually feeding electricity to the basement with a sub feed to the mobile home. Crawl spaces do not work for this because of the head room requirement of 6.5 feet as per NEC 110.26. Also note that NEC 230.70(A)(1) requires the main disconnect to be located "nearest the point of entrance of the service conductors." Yet another issue is that the electrical panel in many mobile homes is not rated as "Service Entrance" equipment.

Multiple Metering

Code allows multiple service entrances as long as there is only one service drop or service lateral per voltage class (generally the utility's system). This allows multiple sites for main disconnects, but all of the metering must be at one location. The Company requires a single termination point unless multiple termination points are mutually beneficial. Note that code defines it as one service drop as long as it starts at a common bus, follows the same route, and terminates beside each other. (NEC 230.2 & 230.40). Consult your local inspector on any of these installations. (See also subsection 3.8).

Conduit Policy for Underground Services

Because of settling problems, it is necessary to provide adequate compaction under the normal UG service conductor depth (30") for disturbed soils. This needs to be done with sand or gravel. Frozen material and un-compacted clay are not acceptable.

The conduit shall be limited to a maximum of 270 degrees of total bends. This means 3-90 degree bends or 2-90 degree and 2-45 degree bends. The maximum length of the conduit run shall be 75 feet (shorter for very large entrances such as

1600 amps and up). Anything with more bends or longer lengths needs Regional Engineer involvement. Note that large entrances are limited to less than 75 feet to avoid voltage problems or damage when pulling the cables.

Conduit shall be buried at least 24 inches deep. If problems are encountered, consult NEC Table 300.5. Note that NEC 300.5(D) requires exposed PVC conduit to be Sch. 80 from 18 inches below ground to 8 feet above ground.

Fire Protection Systems Codes

Codes (some of the codes that may apply):

NEC 230.1(A)(1)	Allows an additional service for a fire pump.
NEC 230.72(A)Excep.	Allows the fire pump disconnect to be remote from the other disconnects.
NEC 230.82(5)	Allows a tap to the Supply Side of the service disconnect for fire pump equipment and fire alarms and sprinkler alarms.
NEC 230.94 Excep. #4	Allows for separate overcurrent protection device tapped supply side of the service overcurrent device for fire pumps and fire alarm systems.
NEC 695.3(A)	Source must be capable of supplying locked rotor current plus associated equipment. This is not normally an issue with the utility source (primary system capacity).
NEC 695.3(A)(1)	Does not allow the fire pump system to be tapped inside of the service entrance disconnecting enclosure. This means that the fire pump tap cannot be made inside of the building or in a weatherproof, main disconnect, service entrance enclosure located outside. The only options are a separate CT cabinet on the outside. This CT cabinet can also not be located right next to an outdoor rated disconnect, for the rest of the building. The only other option is a tap at the transformer or a totally separate feed. This is new in 2005. Look at the actual wording of the NEC for specific details.
NEC 695.4(B)(1)	Requires the overcurrent protection for the fire pump system to handle full locked rotor current continuously. It does not require the conductor or other devices such as the utility transformer to be rated for full locked rotor current. This means that the conductor may be rather small for most pumps.
NEC 695.4(B)(2)	Requires the fire pump disconnect not to be located within enclosures that feed other loads. It must also be located remote from other disconnecting means to reduce the chance of accidental operation. The next couple sections further define this and labeling requirements. This section requires the fire pump disconnect to be lockable in the closed position.
NEC 695.5(A)	This section deals with customer-owned transformers feeding the fire pump system. This transformer must be able to supply 125% of the normal load current of the pump plus 100% of associated equipment.
NEC 695.6(A)	Requires the service entrance conductors for fire pumps to be located outside of the building with only a few, very special exceptions.
NEC 695.7	Motor voltage shall not drop more than 15% on starting on the output of the controller (reduced voltage starter or SCR drive). The maximum voltage drop at 115% of load is 5%. These stipulations may be a problem with large 120/208 motors, without reduced voltage starter or SCR drives.