Biological Systems Engineering

BSE Announcements—Winter 2005

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Virginia Tech

In this issue...

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Engineering Update – Biological Systems Engineering

December 2005

To: Extension Unit Directors, Extension District Directors, Extension Program Directors, and ANR Agents

Dear Co-Workers: Engineering Update is a joint effort of Biological Systems Engineering and other interested agents. Subject matter areas include timely information on water quality, natural resource management, TMDL, air emissions, animal waste management, machinery management, precision farming, application technology, farm safety, engineering education, and technology. Please use this information in your on-going Extension programs and circulate to all Extension staff. Engineering Update is electronically accessible via the VCE Intranet World Wide Web site (*at http://www.ext.vt.edu/vce/anr/bse/index.html*).

BSE In-service Training at VESA - TENTATIVE

BSE In-service session at VESA Conference (8-10 am Friday, 1/20/06) will provide 5 educational topics from Biological Systems Engineering in 20 minute blocks and a 20 minute listening session. Here are some topics:

"***Virginia's TMDL Program: Restoring Water Quality Successes and Challenges***" by Brian Benham. Objectives: a) Review status of Virginia's TMDL program (development and implementation), b) Discuss characteristics of successful TMDL implementation efforts, and c) Illustrate how being engaged in TMDL implementation process can steer future activities.

"***Value Added Bioproduct and Bioenergy from Agricultural Residues***" by Zhiyou Wen. Objectives: a) Byproducts utilization concept, b) Case I – Omega-3 rich algae biodiesel waste for use as animal feed additives, c) Case II – Bioenergy (hydrocarbon) production from animal manure, and d) Prospective and Challenge

"***Introduction to Agricultural Ammonia Emissions***" by Susan Gay. Objectives: a) Discuss recent concerns regarding ammonia emissions from animal feeding operations; and b) describe current research efforts in the field.

(Continued on page 5)

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Issued in furtherance of Cooperative Extension work, Virginia Polytechnic Institute and State University, Virginia State University, and the U.S. Department of Agriculture cooperating. Patricia Sobrero, Director, Virginia Cooperative Extension, Virginia Tech, Blacksburg; Lorenza W. Lyons, Administrator, 1890 Extension Program, Virginia State, Petersburg.

VIRGINIA STATE UNIVERSITY

Sizing and Safety Tips for Standby Power Generators

An emergency source of power is essential for any farm with mechanically ventilated facilities, bulk milk handling equipment, automated feeding systems, or buildings requiring constant and consistent heat. A standby power generator is an excellent investment to prevent costly production losses during power failures.

Standby generators are either engine- or tractor-driven. Engine-driven generators are often sold with an engine as a single package or "genset". Engines are either automatic- or manual-start and are available in gasoline- and diesel-fueled models. Advantages of engine-driven generators include high fuel-efficiency and easy starting after power outages.

Tractor-driven generators are powered from the tractor's power-take-off (PTO) shaft. These generators have a low initial cost and reduced maintenance because an engine is eliminated. Tractor-powered generators can be trailer-mounted and towed to locations where electrical service is not available.

Generators are rated by the amount of power they generate in terms of kilowatts (kW). One kW equals 1,000 watts (W). Generators must provide the same type of power at the same voltage and frequency as that supplied by the power lines. This is usually 120/240 volt, single-phase, 60-cycle alternating current (AC).

Generators are selected for either full- or part-load systems. A full-load system provides the electric load for the entire farmstead. Automatic-start, engine-driven generators are recommended for full-load systems. These generators can furnish power immediately or up to 30 seconds after a power outage.

A part-load system is used only for critical electrical loads such as milking equipment and ventilation fans. The generator capacity for a part-load system is much smaller than that for a full-load system. Part-load systems are usually designed for tractor-driven generators.

Electric motors require about four times more power at starting than when running; thus, generators must be sized for both power requirements. To size an automatic-start unit, add the running-wattage of all motors connected to the generator and multiply 4. Manual-start units are sized by adding the maximum starting- and running-wattage demand on the generator. For example, a 20-kW generator is required if the largest connected motor has a 15-kW starting-load and a 5-kW running-load.

Tractor-driven units require tractors with horsepower (hp) ratings at least twice the generator power rating. For example, a 15-kW generator requires a minimum 30-hp tractor to drive the generator.

Improperly connected generators are shock hazards to users and power utility personnel. Generators must be connected to a wiring system through a transfer device that prevents power from feeding back in the supply line. Installation of a double-pole transfer switch prevents such feed back. A licensed electrician is recommended to make all electrical connections.

Generators should be anchored to a 6-inch concrete pad and sheltered from the weather. For generators housed inside, provide a half of a square foot of inlet and outlet air opening for each 1 kW of generator rating to allow excess heat to escape. Combustion fumes must be carried outdoors safely and away from building inlets. Exhaust pipes should be at least 6 inches from combustible material.

Automatic-start generators should start automatically when power fails and stop when power is restored. The procedure for using manual-start engine-driven or tractor-driven generators follows:

- Call power supplier and advise them of power outage.
- Turn off or disconnect all electrical equipment.
- Position the tractor or engine for belt of PTO drive.
- Start the unit and bring the generator up to proper speed (1800 or 3600 rpms).
- Check voltage to indicate when the generator is ready to carry the load.
- Put the transfer switch in the generator position.
- Start the largest electrical motor first, adding other loads when each is up to operating speed.
- Put the transfer switch in normal power position when commercial power is restored.
- Stop the standby unit.

Generators should be kept clean and in good running condition, so they will be ready for immediate use. Dust and dirt accumulations on the motor can cause it to overheat when running. Short operation at set intervals will keep the engine in good operating condition.

(Susan W. Gay, Assistant Professor and Extension Engineer, Department of Biological Systems Engineering)

Winter Ventilation Management for Freestall Barns

During the coldest days of winter, dairy producers are often concerned that naturally ventilated freestall barns are too cold and drafty for cows. Some producers are tempted to keep barns warm by closing sidewall curtains. However, fresh outside air is required even on the coldest winter night to replace warm, humid air inside the barn.

At 30°F, a 1,300 lb dairy cow produces about 30 lbs of water vapor through respiration and losses through skin. This moisture must be removed through ventilation, at a rate of 100 cubic feet per minute per cow, to maintain a healthy environment inside the barn. Closing sidewall curtains restricts this ventilation rate and allows moisture to accumulate in the barn.

Naturally ventilated barns are designed to be cold. Barn temperature should be within 10° F of the outside air temperature. Closing sidewall curtains will create humid conditions inside the barn that may lead to respiratory health problems in cows and decrease the lifespan of the structure. Evidence of humid conditions includes fog, condensation, and frost on building surfaces.

During severe cold weather or winter storm conditions, sidewall curtains can be partially closed to reduce airflow and the amount of sleet or snow blowing into the barn. Provide a minimum opening at the top of both sidewalls that is one-half inch for each 10 feet of building width. For example, a 100 foot wide barn requires a 5-inch opening at the top of each sidewall. Sidewall curtains should be reopened to the standard one inch per 20 feet of barn width when normal winter weather conditions return.

Drafts should be minimized to maintain cow comfort in winter. Patching curtain holes, minimizing the space between the ends of curtains, and sealing around doors or other openings will help eliminate gaps through which wind blows.

Dairy producers should avoid the temptation to keep naturally ventilated freestall barns too warm in winter. Cows are still productive at temperatures below 20°F, if they are kept dry and protected from the wind. The key is providing proper ventilation to maintain a healthy environment for cows.

(Susan W. Gay, Assistant Professor and Extension Engineer, Department of Biological Systems Engineering)

PLANS

In response to numerous requests, building and facility plans are now available for download from the Virginia Cooperative Extension (VCE) Intranet. Plans are categorized under five main categories: Forage Storage and Feeding, Grain Handling and Feeding, Beef, Horse, and Sheep. You will need Adobe Acrobat to download these files. For the building and facility plans, as well as additional resources, please visit:

http://www.ext.vt.edu/vce/anr/bse/index.html

(Susan W. Gay, Assistant Professor and Extension Engineer)

Tractors Require Extra Safety in Winter

Operating a tractor at any time can be hazardous; winter snow, ice and cold make it even more so. A tractor's braking ability is affected significantly by snow and ice because most two-wheel-drive machines have brakes only on their rear wheels. Braking is even more limited when front-end loaders are carrying heavy loads of snow or hay.

FWA (front-wheel assist) or MFWD (mechanical front-wheel drive) tractors should be operated with the front-wheel drive engaged at all times for winter operations.

Using front-end loaders requires considerably more caution in winter than summer. Slippery conditions increase the hazards of maneuvering elevated loads. Operators should keep both the load and machine speed low when traction is poor.

Front-end loaders should have bale clamps for use when moving large round bales of hay, fodder or straw to prevent the load from shifting. Clamps will prevent bales from rolling back onto the tractor and crushing the operator. Even a ROPS (rollover protective structure) can't provide full protection against this situation.

Safe and proper tractor ballasting is always needed when using a front-end loader, but it is vital in winter. Calcium chloride solution in the rear tires or solid weights are reliable options. Water shouldn't be used because it will freeze.

Operator reaction time also may be affected by cold temperatures and poor visibility. Plan ahead. Winter projects need additional time to be completed safely. *(Robert Grisso)*

Chain Saw Safety

Chain saws can be great labor saving tools. But if not operated properly and with respect, they can quickly cause severe injury and death. This note cannot address every potential hazard you may encounter while using a chain saw. If you are not familiar with techniques of sawing, saw operation, or maintenance, read your owner's manual, consult a more detailed publication, or ask a dealer for more information.

Owner's Manual Read the owner's manual before operating a chain saw for the first time. Note the safety practices. Note how to check and adjust the chain tension. It's important for safe operation.

Personal Protective Equipment One of the best safeguards against injury is wearing the proper protective equipment. This includes: safety glasses or goggles heavy-duty, non-slip gloves sturdy non-slip shoes hearing protection trim fitting clothes (not loose or ragged) long-sleeve shirt and pants (chaps if you have them) hardhat

Transporting the Saw Put the chain guard on the saw when not in use. Always carry the saw at your side with the cutting bar and chain to the rear and to the outside. Never carry a chain saw in the passenger area of a vehicle.

Fueling a Chain Saw Use the fuel mix recommended by the manufacturer. Never fuel a hot chain saw; let it cool first. Always fuel in a clear area away from debris. If your fuel can has no spout, use a funnel. Wipe the saw clean of any spilled fuel after fueling. Never smoke while fueling.

Starting the Chain Saw There is only one safe way to start a chain saw: Move 10 feet or more away from the fueling area. Place the saw in a clear, debris-free area. Hold the saw firmly on the ground by putting your foot through the rear handle (if possible) and by holding it down with one hand on the top handle. Pull the starter cord with the other hand. The chain should not be moving while the saw is idling. Never start the saw while holding it off the ground, or by "drop starting" it.

Preparing to Cut
Clear away anything that has a chance of interfering with the operation. Remove debris that could cause you to slip or lose your balance or accidentally contact the chain. Keep both hands firmly on the saw when cutting.

Avoiding Kickback Kickback occurs when the saw rotates back, or "kicks back" at the operator, due to the nose of the saw contacting an object or obstruction. To prevent kickback:

- Use a saw equipped with **chain brake** or **kickback guard**.
- **Hold** the saw firmly with both hands. **Grip** the top handle by putting the thumb around it.
- **Watch** for twigs that can snag the chain.
- **Don't pinch** the chain while cutting the log.
- Saw with the lower part of the bar close to the bumper, not on the top near the nose.
- Maintain **high saw speed** when entering or leaving a cut.
- Keep the chain **sharp**.
- **Do not reach** above your shoulder to cut. The chain is too close to your face in this position.

Felling, Limbing, and Bucking Cutting down large trees is not simple and should be left to experienced operators who have felled trees before. Limbing requires proper position and consideration of kickback potential, the springing back of branches, and the chance the log will roll. Bucking (cutting a log into lengths) requires knowing how to block the log to prevent binding, kickback, and rolling. If you are not familiar with these operations, get more information from your owner's manual, a saw dealer, a book or video, or from an experienced operator.

(Chris Mariger)

Safety Videos, Slide Sets, and Films

BSE has a loan library of safety presentation materials available on a short-term loan basis for educational programs. Users are required to pay return postage fees.

Following is a categorical listing of safety presentations currently available:

- ATV Safety
- Automobile Safety
- Bicycle Safety
- Chain Saw Safety
- Chemical & Pesticide Safety
- Electrical Safety
- Falls
- Fire Safety
- General Farm Safety
- Gun Safety
- Home Safety
- Garden, & Landscaping
- Spraying Systems
- Tool & Shop Safety
- Tractors & Machinery
- Water & Recreation
- Wood Stoves
- Miscellaneous

Descriptions are found at:
http://www.ext.vt.edu/vce/anr/bse/farmsafety/videos.html

To request: Phone (540) 231-6809, Fax (540) 231-3199 or E-mail: tlcox@vt.edu

BSE In-service Training

(Continued from page 1)

"***Fundamentals of animal waste treatment technologies***" by Jactone Arogo. Objectives: a) Describe the basic operation principles of waste treatment technologies, b) Outline factors to consider when selecting a waste treatment technology.

"***AgrAbility Project: How to get Involved***" by Bobby Grisso. Objectives: a) Discuss the USDA AgrAbility project and the Virginia partnership b) Who qualifies for serves and what can be expected, and c) Describe available resources and case studies,

Listening Session - agent feedback concerning engineering programs. Look forward to the interaction!

Keeping Cool in the Mud Saves Injury

Getting farm equipment stuck in the mud can be dangerous if frustrations lead to carelessness in attempting to get the equipment out.

Remember, stuck equipment isn't going anywhere; take the time to make safe decisions.

Without taking time to keep cool when equipment is stuck, a rope or chain may break. Fast-moving parts can become unguided missiles, striking or injuring operators or bystanders.

Never work alone. Two operators are needed if the stuck vehicle requires a driver. With two people, one can go to find help if the other is hurt or ill.

Check tow ropes, chains, cables, hooks and clevises for damage, rust or weak spots. Use only hardware rated at or above the weight to be towed. Nylon ropes or straps should be rated at least twice the weight to be towed.

Attach the tow chain or rope to the towing tractor's drawbar. Towing from higher attachment points can cause the tractor to overturn. Wrap underneath axles so that any encourage breaking chains, tow ropes or straps will fly down and not up.

Don't jerk -- apply power from the towing vehicle gradually. Change directions deliberately.

When using two tractors to pull out another, use two independent ropes, chains, or straps and coordinate pulling carefully.

Try not to get stuck in the first place.

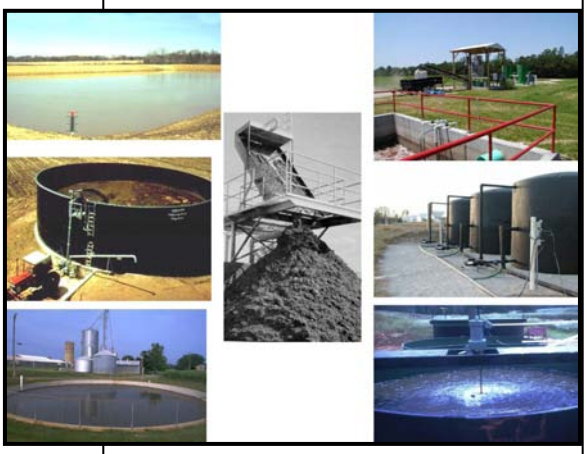
Walk the fields checking for muddy areas before bringing in equipment.

(Robert Grisso)

Visit our website:
http://www.bse.vt.edu

Choosing a Manure Treatment System

Historically, animal manure treatment systems have been selected to protect the soil, air and water quality and/or recover nutrients (nitrogen (N), phosphorus (P), potassium (K)) to use as fertilizer for crops. Over time, the protection of soil, air, and water quality has evolved to include the management of pathogens, heavy metals (such as copper (Cu) and zinc (Zn)), and other potentially toxic materials such as antibiotics and hormones. Specifically, concerns about nutrient management and increased emphasis on air quality (emissions of odor, ammonia (NH_3), hydrogen sulfide (H_2S), particulates, volatile organic compounds (VOCs), and green house gases) have become a major public concern.



In recent years, government agencies, private corporations, and farmers have been investigating alternative manure treatment systems or technologies to reduce odors and manage nutrients from animal feeding operations. In some cases, the technologies have reduced odor and nutrients associated with water pollution from individual farms. However, long-term successes of these treatment systems are still in question. There are concerns about affordability, effectiveness, and long term environmental and social impacts associated with some of these technologies.

There are numerous manure treatment systems or technologies being promoted to livestock and poultry producers by different vendors. The technologies include one or a combination of the following processes: solid separation, aerobic, and anaerobic based processes. The question is, how does one select a manure treatment technology. The first step in selecting a manure treatment system is to learn how the different treatment systems work and then base your selection on the ability of the technology to provide the required protection to soil, water, and air quality. Some manure treatment systems address several concerns, while others are so specialized, addressing only individual manure constituents.

Here are some questions to ask when selecting a manure treatment system:

- What happens to the nutrients and pollutants of interest in the manure? Where do the nutrients go? If phosphorus is removed, where does it go and how much is left? If nitrogen (N) removal is proposed, what form of N will result? What effects do the products of the manure treatment system have on the environment? Are there any federal laws regulating the products from the treatment system? How will the regulations impact your farm or operation? Some technologies convert nutrients into forms which are more available to plants (soluble P; nitrate; ammonium). Soluble nutrients can be lost to the environment more easily.
- Find out the concentration of the nutrients in any material to be applied to crop land. Will there be enough cropland to spread the treated manure? How does the treated manure impact your nutrient management plan?
- Are pathogens reduced by the treatment system?
- Is energy generated by the system? If yes, how can it be used on the farm?
- Will the treatment system require energy to operate? If so, how much?
- Is it necessary to pre treat manure before passing it through the treatment system?
- Are any materials added to manure to enhance the treatment process? What is the fate of the se materials?
- Will the treatment process be continuous? What happens when the system shuts down? Is there enough storage for the manure?
- How much time per day is required to operate the system?
- What are the operation and maintenance requirements?
- What is the life expectancy of the equipment?
- How much will the system cost?
- Are there any projected by products that can generate revenue?
- Has the treatment system been installed on any other farm? What was there experience?

(Jactone Arogo Ogejo)

Omega-3 Fatty Acids --- Benefits, Sources, and Production Techniques

If you ask people what food group they should avoid, most will probably answer “fats.” While it is true that, in large amounts, some types of fat are bad for your health (not to mention your waistline), there are some we simply cannot live without. Among them are the omega-3 fatty acids, including eicosapentaenic acid (EPA) and docosahexanoic acid (DHA).

Omega-3s can help reduce various heart diseases such as heart attack, arrhythmias, atherosclerosis, and thrombosis. Other benefits include reducing joint pain, rheumatoid arthritis, and symptoms of schizophrenia such as hypertension and depression. A recent study by UCLA neuroscientists has even shown that DHA can protect the brain against Alzheimer’s disease.

How do omega-3s perform so many health "miracles" in people? One way is by balancing the ratio of omega-3s with another group of essential fatty acids known as the omega-6s, and thus, reducing the negative impact caused by an over-balance of omega-6s. Omega-6s are commonly found in eggs, poultry, cereals, vegetable oils, baked goods, and margarine, and are in part responsible for skin health, lower cholesterol, and blood clotting. But when omega-6s are not balanced with sufficient amounts of omega-3s, problems arise. For example, when blood is too proficient at clotting, clots form; increasing the risk of heart attack and stroke. Once omega-3s are added to the mix, the risk of heart problems goes down.

Examples of Omega-3 Products

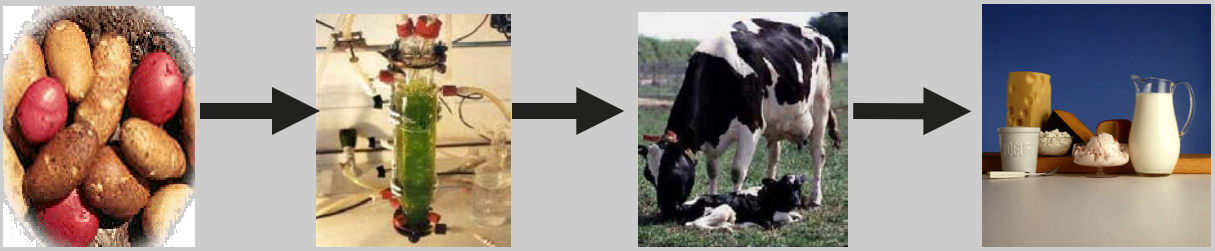
The latest research shows that the most desired ratio of omega-3s to omega-6s is roughly 4 to 1. However, the typical American diet has this ratio drastically reversed with a ratio of around 20 omega-6s to every omega-3! While reducing the intake of omega-6s can help, getting more omega-3s from food is an even better way to go.

Omega-3 fatty acids are commonly found in wild coldwater fish such as cod, salmon, herring, mackerel, sturgeon, anchovies, and tuna with about 1.5 ounces of fish containing 1 gram of omega-3s. However, as ocean fish catch decreases and concerns of contamination over freshwater wild fish arises, as well as a general absence of fish in the preferred diet of many Americans, the typical American diet is often deficient in seafood and consequently even more deficient and disproportionately lacking in omega-3s.

An alternative to eating fish is to purchase and take fish oil capsules that are widely available on grocery shelves. However, most people do not like the peculiar taste and fishy flavor of the fish oil. In addition to the omega-3s, though, fish oil also contains some unwanted saturated fatty acids which will offset the beneficial effects of omega-3s when people eat the fish oil capsules.

(Continued on page 8)

Converting cull potatoes (A) into Omega-3 fatty acids containing algae (B) and feed the algal biomass to cows (C) to convert the Omega-3 fatty acids into milk (D)



(A) **(B)** **(C)** **(D)**

Omega-3 Fatty Acids --- Benefits, Sources, and Production Techniques

(Continued from page 7)

Another, new and intriguing alternative exists in the fact that fish, like humans, are not capable of synthesizing omega-3 fatty acids. Much of their omega-3s are derived by eating the algae in the oceanic environment that are the primary producers of the omega-3 fatty acids. Thus, the new alternative approach to supplying people with a sufficient amount and proportion of omega-3s is to culture and introduce this algae source into the American diet.

When algae culturing is mentioned, the most common perception is the growth of algae in a large open-air pond where the algae is exposed to the necessary photosynthetic light source it needs to grow. This culture mode is called photoautotrophy. The photoautotrophic culture mode, however, cannot grow very much algae because the growing conditions are difficult to control.

Plus, the algae growing in the bottom of the pond cannot get enough light because of light penetration problems. All of these factors lead to a very low algae concentration in the pond and thus, a very low level of omega-3s produced.

Instead of being cultured in ponds, algae can be grown in a well controlled fermentor without the requirement of light. This heterotrophic culture mode can significantly increase the algal concentration and the omega-3 production. However, this process requires sugar sources (such as glucose) as a feedstock for the algal growth and because of the high cost of pure sugar used the process is usually considered uneconomical. In addition, the commercialization of algal omega-3 fatty acids production is also limited by the high cost of purification of these omega-3s from the complex algae biomass.

Reducing the cost of producing heterotrophic algae-derived omega-3 fatty acids is a challenge for both the scientific and industrial communities. As some algae can utilize potato starch as their sugar source, the high cost of pure glucose used in algal culture can be reduced significantly, by replacing it with an inexpensive source of starch from under-valued culls. Also, the limit imposed by the high cost of purification is being resolved by directly feeding the omega 3-rich algae to dairy cows to make omega-3 fatty acids in the form of milk. By using cows as “omega-3s extractors” to isolate the fatty acids from the complex algal biomass into milk, the purification cost is avoided.

Preliminary research findings reported elsewhere have shown that: (1) the cows will tolerate a fraction of their diet being comprised of algae biomass; (2) there is no subsequent loss to milk yield; and (3) upon digestion a considerable fraction of the omega 3 fatty acids survive intact from the rumen process due to their enclosure within the algae cell walls.

(Zhiyou Wen)

Keep Your Natural Christmas Tree Safe

To many Virginians, the holidays smell like a fresh cut Christmas tree. But if you are going to have a fresh tree, there are a few things consumers should keep in mind. First and foremost, freshness is a key when selecting your tree. The needles should be resilient, and not brittle. Run your finger down a branch--the needles should stay attached. Feel the bottom of the trunk. On fresh trees it will feel moist.

When you bring your tree home, take measures to keep it fresh. If you decide not to set it up immediately, the tree will keep better if its base is placed in a bucket of water in a cool, shaded area, sheltered from the wind. Sprinkling the branches with water will help maintain freshness. Just before putting the tree in its stand, cut about an inch or two of the trunk off. The resins that have sealed the end of the stump will be removed and the tree can take up water easier. A tree that has become dry by improper storage will not take up new moisture.

Be sure to put the tree in a stand that will hold water. Keep the water level above the base of the tree at all times. Most trees will consume a pint of water or more each day. Water uptake is still the best single means of keeping your tree safe and fresh. Be sure that the base of the tree is well supported and the tree is placed away from fireplaces, radiators, electric heaters, televisions or any other sources of heat.

For safety the tree should not be decorated with cotton, paper, or other materials that burn readily. Lights and wiring should be checked for worn spots and cracks. When you leave your home or retire for the night turn off the tree lights. And remember, trees should be properly disposed of and the needles never burned in a fireplace.

(Robert Grisso)

Jump A Dead Vehicle Battery

The battery converts chemical energy to electrical energy. For a battery to operate properly, it must have the plates and electrolytes in proper proportions and the elements must be clean both inside and outside the battery case.

Temperature can influence a battery and that is the reason most batteries fail during winter conditions. In cold temperatures, the battery capacity for cranking is smaller and the engine has more friction to overcome. For example, a battery has only 65 percent of its cranking power at 32 degrees F as it does at 80 degrees F; and only 40 percent at zero degrees F. At the same time the engine is 165% harder to turn over and start at 32 degrees than at 80 degrees F.

Follow manufacturer's directions for "jump" starting of engines with the aid of an extra battery. Operators must be in the operator's seat when jump-starting an engine so that the tractor will be under control when the engine starts. Jump-starting should be a two-person operation.

Be careful when jumping a dead vehicle battery. It is a big deal so take your time and think before 'jumping'. Make sure all electrical connections, switches and accessories are turned off and make sure the last connection and the last disconnection is at some point away from the battery. Use this order for connecting jumper cables:

Identify the POSITIVE (red) end of one of the jumper cable clamps - attach it to the POSITIVE (+) terminal of the dead battery.

Attach the other POSITIVE cable clamp on the other end of the jumper cable to the good battery's POSITIVE post or terminal. Attach the NEGATIVE (black) jumper cable clamp nearest the good battery to the good battery's NEGATIVE (-) post or terminal. Attach the remaining NEGATIVE jumper cable clamp to a good engine ground point on the dead battery's vehicle away from the dead battery.

Never reverse the connections and never charge or jump a frozen battery; it can explode!

Allow a period for the battery to recharge and now with the dead vehicle in park and transmission disengaged, turn the switch and start the dead engine.

After the dead vehicle has started remove the jumper cables in reverse order. Allow the vehicle to charge the battery before operating under a load.

Never jump-start a tractor by touching the cables to the starter motor. The tractor can suddenly lurch forward and crush you.

Lead-acid batteries produce flammable explosive gases. Keep arcs, sparks, flames and lighted tobacco away. The sulfuric acid within a battery can damage eyes and skin on contact. Always wear a face shield to avoid acid in your eyes.

If further work is needed on the electrical system, disconnect the battery by removing the ground terminal first. Never work on the electrical system of any equipment unless you are thoroughly familiar with the system details.

If using a battery charger to recharge a dead battery, ALWAYS hook the charger leads to the battery BEFORE plugging the charger into the AC current - with the charger unplugged, there is little chance of a spark if you hook the leads to the proper polarity.

Then, ALWAYS unplug the charger from the AC wall socket BEFORE removing the leads from the charged battery - again avoid a spark while removing the leads - and please, wear eye protection when using the battery charger!

QUESTIONS AND ANSWERS:

1. T or F Safety glasses should be used whenever handling, charging, or jump starting batteries.
False: A full-face shield should be employed in addition to safety glasses to protect eyes, face, and head from potential chemical burns and flying debris in the event the battery explodes while being charged.

2. T or F The main hazard with charging and jumping batteries comes from the production of hydrogen gas by the battery, which can explode violently if exposed to a spark, flame, or other ignition source.
True: Always make sure that charging areas are well ventilated, prohibit smoking while working on or around batteries, and avoid creating sparks while connecting charging or booster cables.

3. T or F It is okay to smoke cigarettes while working around batteries.
False: In handling storage batteries, keep sparks, flames, burning cigarettes, and other ignition sources away from batteries at all times.

(Robert Grisso)