ELECTRICAL SAFETY

1. INTRODUCTION

Electricity is a safe and efficient form of energy and its benefits in providing a convenient source of lighting, heating and power are widely used and necessary at Vision Painting Inc.. However, if the human body becomes part of the electrical circuit, severe injuries and fatalities can occur. Therefore, extreme caution should be used around all electrical equipment and the potential for electric shock should never be underestimated.
Electrical hazards can exist in a variety of ways, most notably, from exposed wiring, improper use of electrical equipment or the presence of underground electrical lines when digging or excavating. In addition, lightning is a hazard during outdoor operations, particularly for workers handling metal containers or equipment. To eliminate this hazard, weather conditions should be monitored and recommendations given to suspend work during electrical storms.

Vision Painting Inc. workers are considered as *not qualified* under the OSHA definition. As such, they will not perform any work where a *qualified* worker is required.

2. HAZARDS

2.1. PERSONAL INJURIES
Injuries associated with electric shock include:

a. Contraction of the chest muscles which may interfere with breathing.
b. Nerve paralysis causing respiratory failure.
c. Interference with normal rhythm of the heart causing ventricular fibrillation.
d. Suspension of heart action by muscular contraction.
e. Hemorrhages, burns and destruction of tissues, nerves and muscles from heat due to heavy current along the path of the electric circuit through the body.
f. Broken bones or lacerations caused by falls and/or severe muscular contraction due to electric shock.

The difference between a minor shock, a burn or a fatality depends on the current that flows through your body. Skin resistance directly affects the magnitude of the current forced through the body. Dry skin typically has from 100,000 to 600,000 ohms resistance, while wet skin resistance may be less than 1,000 ohms. At 15-20 milliamps muscle control is lost, with possible ventricular fibrillation of the heart at 50-100 milliamps and certain ventricular fibrillation at 100-200 milliamps.
Burns are the most serious side effect of electrical accidents and are the principal danger with direct currents or very low voltage alternating currents (below about 80 volts). While there may be severe burns from low and medium voltage alternating currents, burns from extra high voltages tend to be very severe, and may cover a large area of the body. These burns may be of several types:

g. Contact burns may be very small but reach to the bone

Arc burns may be very extensive with resultant scarring or amputation

h. Radiation burns are similar to a severe form of sunburn
i. Vaporized metal may burn into face and hands
j. Deep burns and necrosis can result from high voltage contact burns

While one reportable electrical accident in ten is fatal, damage to muscles may be serious and amputation may be necessary in very bad cases.

In the event of a life-threatening electrical shock, the first priority in rescue when dealing with electricity is to avoid becoming a victim. Before approaching a possible electrical shock victim, shut off all electricity in the immediate area. Shut off the main breakers for the area (check for more than one breaker box), and then remove the victim from the electrical hazard using a non-conductor (broom handle, rubber hose or plastic pipe). Move victim a good distance from the electrical hazard. Perform CPR immediately if needed.

2.2. ELECTRICAL FIRES

Electrical fires can result from arcing or overheating. The causes of electrical fires can be divided into four categories:

a. Deteriorated electrical insulation
b. Improper use (i.e., high current flow) of approved equipment (e.g., under-sized wires, too 'heavy' a load)
c. Accidental 'shorting' of circuit
d. Defective installations

Both grounding and overcurrent protection are used to minimize fire hazard. Common overcurrent protection devices are fuses, circuit breakers, and thermal overload units.

Depending on the short-circuit current being drawn, a circuit breaker may not trip. A shorted heat tape may arc to a vessel or tubing but not draw sufficient current to throw a 20-amp breaker.

Potential releases of flammable gases and/or vapors require installation of electrical equipment that is isolated or low energy. The classification of this equipment may require pressurization with inert gas or fresh air, intrinsic safety, or explosion-proof design. All are used at ESCI to prevent ignition of flammable gases or vapors.

3. WORK PRACTICES AND CONTROLS

Safety related work practices will be used to prevent electrical shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment that is or may be energized. Specific safety-related work practices will be consistent with the nature and extent of the hazard. Reference should be made to OSHA regulations (29 CFR 1910.331 through 1910.335) for both qualified persons (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and unqualified persons (those with little or no training in identification of or work on electrical hazards) working on, near or with premise wiring, wiring for connection to supply, other wiring (installations of other outside conductors on the premises), and optical fiber cable (if installed with electric conductors). The following personal practices can reduce the potential for shock:

a. Do not handle electrical equipment when wet or standing on a wet surface.
b. Check all cords and plugs for proper insulation and grounding.
c. Do not work on live circuits whenever it is possible to turn them off.
d. Ground out high voltage circuits before touching.
e. Be sure high voltage power supply is turned off before hooking up connectors.
f. Use appropriate meter to test electrical circuit before making physical contact with circuit.
g. Use rubber-soled shoes or stand on insulated surface.
h. Stay alert

Employees working in areas where there are potential electrical hazards will be provided with, and will use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

This paragraph applies to work on exposed deenergized parts or near enough to them to expose the employee to

any electrical hazard they present. Conductors and parts of electric equipment that have been deenergized but have not been locked out or tagged in accordance with 29 CFR 1910.333 paragraph (b) shall be treated as energized parts, and 29 CFR 1910.333 paragraph (c) applies to work on or near them.

4. CLASSIFICATION

4.1. APPLICABLE CODES & STANDARDS

Vision Painting Inc. complies with the National Electrical Code (NEC), which is an industry standard from the National
Fire Protection Association (NFPA 70), as the basis for design, installation and maintenance of electrical equipment.

4.2. HAZARDOUS AREA LOCATION

The NEC classifies hazardous areas by Class, Group and Division. In addition, if electrical equipment may have elevated surface temperatures, a temperature classification may also be specified. The Class description is used for the physical nature of the material:

a. Class 1 - Flammable gases/vapors and flammable and combustible liquids
b. Class 2 - Combustible dusts
c. Class 3 - Ignitable fibers

The Group description is used for the flammable and explosive properties of the material. There are 4 groups
(A-D) for Class 1 materials, 3 groups (E-G) for Class 2 materials and none for Class 3 materials. The following materials are examples of each Group and not a complete list:

a. Group A – Acetylene
b. Group B - Hydrogen, Butadiene, Propylene Oxide
c. Group C - Ethylene, Ethyl Ether
d. Group D - Acetone, Toluene, Methane, Propane, Ammonia
e. Group E - Metal dusts (e.g., Aluminum, Magnesium)
f. Group F - Carbonaceous dusts (e.g., Coal, Carbon Fiber)
g. Group G - Non-carbonaceous dusts (e.g., Flour, Grain)

The Division description defines the likelihood that the hazard will exist in the area:

h. Division 1 - Hazard exists during normal operations, including repair/maintenance
i. Division 2 - Hazard exists only during abnormal operations or upset conditions

In a Class 1, Division 2 area, equipment which sparks or arcs during normal operation must be explosion proof, purged/pressurized, or intrinsically safe. An ordinary light switch and a Variac are examples of devices that arc during normal use. Because the vapors from a large spill/release may not be readily diluted within close proximity to the liquid pool or in an enclosed location, electrical equipment within 20 feet and up to an elevation of 30 inches must be classified. All buildings in the pilot plant area, which are connected to storage tanks, drums, pipelines, etc. containing flammables, are at least Class 1, Division 2, Group D from the floor up to 30 inches. Other locations in the pilot plant area, particularly process equipment (e.g., motor valves, relief valves, flare pots) in unclassified areas, have the potential to release combustible vapors/gases during normal operation. These locations are classified electrically as “point sources”. Within 5 feet of a point source, any equipment must be Class 1, Division 2, Group D.

4.3. RESTRICTED ACCESS

Access to electrical equipment must be maintained for both operations and maintenance personnel. Maintenance personnel require access for both installation and routine maintenance activities. Electrical

equipment (e.g., switchgear) for high-voltage (13.8 kV) circuits must be installed with a minimum clearance of 4 feet for maintenance access. . Operations may require access during emergencies to circuit breaker panels. The area within 36 inches and directly in front of a circuit breaker panel must remain clear. (Refer to definitions for access and working space) Compressed gas cylinders should not be secured or waste chemical cans stored within the 36-inch area directly in front of the circuit breaker panel. Hanging a fire extinguisher or placing a desk or chair in this area is acceptable, if the panel is immediately accessible (i.e., panel opened and the switches activated without climbing on or moving furniture) during an emergency and can be removed for electrical maintenance work. Areas inside or on top of electrical panels and cabinets are not to be used for storage.

4.4. WORK ON ENERGIZED EQUIPMENT

This section applies to work performed on exposed live parts (involving either direct contact or by means of tools or materials) or near enough to them for employees to be exposed to any hazard they present. Only qualified persons will be allowed to work on electric parts or equipment that have not been de-energized. These persons shall have been trained and must be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

4.5. OVERHEAD LINES

If work is to be performed near overhead power lines, the lines shall be deenergized and grounded, or other protective measures shall be initiated before work is started. If the lines are to be de-energized, arrangements shall be made with the person or organization that operates or controls the electric circuits involved to deenergize and ground them. If protective measures, such as guarding, isolating, or insulating, are provided, these precautions shall prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment. If de-energizing is not feasible, then a distance of 10 feet, as a minimum, shall be maintained at all times, from the energized overhead power line. When an unqualified person is working in a position near overhead lines, he must remain far enough away so that the longest conductive object cannot come closer to any unguarded, energized overhead line than the following distances:

a. For voltages to ground 50kV or below - 10 feet;
b. For voltages to ground over 50kV - 10 feet plus 4 inches for every 10kV over 50kV.

When a qualified person is working in the vicinity of overhead lines, whether in an elevated position or on the ground, the person may not approach or take any conductive object without an approved insulating handle closer than 10 feet unless:

c. The person is insulated from the energized part (gloves, with sleeves if necessary, rated for the voltage involved are considered to be insulation of the person from the energized part on which work is performed), or
d. The energized part is insulated both from all other conductive objects at a different potential and from the person, or
e. The person is insulated from all conductive objects at a potential different from that of the energized part.

4.6. VEHICULAR AND MECHANICAL EQUIPMENT

Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 ft. (305 cm) is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10kV over that voltage. However, under any of the following conditions, the clearance may be reduced:

a. If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. (122 cm). If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10 kV over that voltage.
b. If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.
c. If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in Table S-5. Employees standing on the ground may not contact the vehicle or mechanical equipment or any of its attachments, unless:
d. The employee is using protective equipment rated for the voltage; or
e. The equipment is located so that no uninsulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in paragraph (c)(3)(iii) of this section.
f. If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

4.7. ILLUMINATION

Employees are not allowed to enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely.
Where illumination is insufficient, or an obstruction interferes with the observation of the work to be performed, employees may not perform tasks near the exposed energized parts. Employees may not reach blindly into areas that may contain energized parts.

5. GROUNDING

Grounding provides a low-resistance path for current to ground in the event of a short circuit. The ground wire is the round connection in three-prong plugs. A separate wire attached to the metal parts of equipment can also ground equipment. All process equipment must be grounded as part of the installation. Piping connections or supports cannot be assumed to provide such a ground.

5.1. CIRCUITS

Ground must be continuous and uninterrupted by switches, fuses or circuit breakers. Since threaded pipes use Teflon tape or joint compound, water pipes do not make good grounds.
Grounding should be provided on all exposed metallic, non-current carrying parts of electrical equipment. A good ground, one (1) ohm or less, should be provided when securing metal frames or chassis. Painted surfaces should be scraped to provide metal-to-metal connection with star washers and lock nuts. Power tools with "double insulation" should be checked after purchase by the electrical shop for adequate insulation. Also, these tools should be checked before reuse if they have been mishandled or dropped. Extension cords are designed for temporary use and will be avoided for permanent installations. Electrical extension cords must either be UL approved or made by electrical shop personnel. Depending on the classification of an area (Class 1, Division 1, etc.), properly recommended

explosion-proof plugs, receptacles and wire/cord are to be used as required to meet the code of that area. If an adapter type cord (from explosion-proof to grounded three-prong system) is needed, approval by a shift leader and Shift Superintendent is required with proper instructions given for use. Such a cord should not be used in Class 1, Division 1 and 2 areas.
Power strips must be UL approved and equipped with their own circuit breaker.

5.2. GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)
It is a Vision Painting Inc. policy that a GFCI be installed on all applications which are in wet locations for personnel protection against electrical shock hazards. Ground-fault protection.
All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, will have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

6. ASSURED EQUIPMENT GROUNDING CONDUCTOR PROGRAM
Vision Painting Inc. will establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. This program will comply with the following minimum requirements:

a. A written description of the program, including the specific procedures adopted by Vision Painting Inc., will be available at the jobsite for inspection.
b. Vision Painting Inc. will designate one or more competent persons (as defined in 1926.32(f)) to implement the program.
c. Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, will be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. Equipment found damaged or defective will not be used until repaired.

The following tests will be performed on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:

d. All equipment grounding conductors will be tested for continuity and will be electrically continuous.
e. Each receptacle and attachment cap or plug will be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor will be connected to its proper terminal.

All required tests will be performed:

f. Before first use;
g. Before equipment is returned to service following any repairs;
h. Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and
i. At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage will be tested at intervals not exceeding 6 months.

Tests performed as required in this section will be recorded. This test record will identify each receptacle, cord set, and cord and plug connected equipment that passed the test and will indicate the

last date it was tested or the interval for which it was tested. This record will be kept by means of logs, color coding, or other effective means and will be maintained until replaced by a more current record. Attachment 1 will be used for documentation.
The record will be made available on the jobsite for inspection by the Safety Manager and any affected employee.

7. LOCKOUT/TAGOUT

When working on electrical equipment that could become energized, the breaker or disconnect is to be locked out as specified in the Vision Painting Inc. *Lockout/Tagout program*.
While any employee is exposed to contact with parts of fixed electric equipment or circuits which have been deenergized, the circuits energizing the parts shall be locked out or tagged or both in accordance with the requirements of this paragraph. The requirements shall be followed in the order in which they are presented (i.e., 29 CFR 1910.333 paragraph (b)(2)(i) first, then paragraph (b)(2)(ii), etc.).
Note 1: As used in this section, fixed equipment refers to equipment fastened in place or connected by permanent wiring methods.
Note 2: Lockout and tagging procedures that comply with paragraphs (c) through (f) of 29 CFR 1910.147 will also be deemed to comply with paragraph 29 CFR 1910.333 (b)(2) of this section provided that:

a. The procedures address the electrical safety hazards covered by 29 CFR 1910.333; and
b. The procedures also incorporate the requirements of paragraphs 29 CFR 1910.333 and of this section.

Operations will insert their lock first and remove their lock last. Each craft should have a supply of locks, lockout devices and tags. The first craft to work on the equipment to be locked out will place a lockout device on the switch to be locked out, then tag with the craftsman's name and phone number on it. The Shift Superintendent can provide temporary lockouts for contract personnel. All subsequent individuals will place a lock and tag on the existing lockout device. On completion of work, each craftsman will remove his/her lock and tag until all locks have been removed. The last craft to remove a lock is responsible for checking out the equipment by notifying Operations that the equipment is ready for testing. Some electrical disconnects do not have lockout means. The following methods may be needed to safeguard these disconnects:

a. Most multi breaker panels do not have a way of locking individual breakers. A special set-screw lockout device may then be fastened to the toggle of the breaker. The breaker should also be tagged.
b. Some smaller switches do not have lockout options. On these, special lockable covers are used. They are also to be tagged.
c. An electrical disconnect that cannot be locked off should be turned off and tagged. If work will require only a short time, one employee will stay by the disconnect until the work is finished. If work will require more than 30 minutes, the wires from the disconnect secondary are to be removed and tagged.

8. OTHER

Other rules include:

a. "Confined or enclosed work spaces." When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized parts, the employer shall provide, and the employee shall use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

b. "Conductive materials and equipment." Conductive materials and equipment that are in contact with any part of an employee's body shall be handled in a manner that will prevent them from contacting exposed energized conductors or circuit parts. If an employee must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, the employer shall institute work practices (such as the use of insulation, guarding, and material handling techniques) which will minimize the hazard.
c. "Portable ladders." Portable ladders shall have nonconductive siderails if they are used where the employee or the ladder could contact exposed energized parts.
d. "Conductive apparel." Conductive articles of jewelry and clothing (such a watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear) may not be worn if they might contact exposed energized parts. However, such articles may be worn if they are rendered nonconductive by covering, wrapping, or other insulating means.
e. "Housekeeping duties." Where live parts present an electrical contact hazard, employees may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.
f. "Interlocks." Only a qualified person may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment. The interlock system shall be returned to its operable condition when this work is completed.

9. TRAINING

9.1. INTRODUCTION

Training requirements apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements. Other employees who also may reasonably be expected to face a comparable risk of injury due to electric shock or other electrical hazards will also be trained (including Control of Energized sources training).

9.2. CONTENT OF TRAINING

a. Practices addressed in this standard. Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments.

b. Additional requirements for unqualified persons. Employees who are covered by paragraph (a) of this section but who are not qualified persons shall also be trained in and familiar with any electrically related safety practices not specifically addressed by 1910.331 through 1910.335 but which are necessary for their safety.

c .Additional requirements for qualified persons. Qualified persons (i.e. those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:

d. The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.

e. the skills and techniques necessary to determine the nominal voltage of exposed live parts, and

f. The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.

9.3. TYPE OF TRAINING

The training required by this section shall be of the classroom or on-the-job type. The degree of training provided shall be determined by the risk to the employee.

10. DEFINITIONS

Access and Entrance to Working Space-At least one entrance of sufficient area will be provided to give access to the working space surrounding electrical equipment.

Clear Space-Working space required which may not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, will be suitably guarded.

Qualified Person-A Person familiar with the construction and operation of the equipment and the hazards involved. Whether an employee is considered to be qualified depends on the various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered qualified with regard to certain equipment in the workplace, but unqualified as to other equipment. An employee who is undergoing on the- job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties. Training requirements are found in 29 CFR 1910.332 (b)(3).

Working Space-The minimum clear working space directly in front of electric equipment (e.g., cabinets, control panels), will not less than 36 inches. In addition, the workspace may not be less than 30 inches wide directly in front of electric equipment.