***Purpose:***

The purpose of this program is to specify the maximum allowable levels of exposure to Radio Frequency (RF) fields with ranges between 10 MHz and 100 GHz. It further establishes guidelines for individual activities while working in the presence of RF Energy.

***Maximum Exposure Limits:***

Basic exposure levels are based upon the specific absorption rate, (SAR). This is defined as the rate at which the human body absorbs RF energy expressed per unit mass of the body. RF energy absorption can be through either direct induction of an electromagnetic field or through contact with energized metallic objects. The Occupational Safety and Health Administration (OSHA) in the standard on nonionizing radiation 29 CFR 1910.97 have determined maximum limits for both “partial body irradiation” and “whole body irradiation”. “Partial body irradiation” pertains to a portion of the body being exposed to incident electromagnetic energy, and “whole body irradiation” pertains to the whole body being exposed to incident electromagnetic energy.

OSHA has determined that for both partial and whole body exposures relative to electromagnetic fields of 10 MHz through 100 GHz under normal environmental conditions, the maximum level to be: 10 mW/cm2 (milliwatt per square centimeter) over a 0.1-hour period.

***Exposure Monitoring:***

An RF survey to determine potential employee exposures shall be performed on the site by a competent person. This survey should be done as frequently as possible to document areas of potential employee exposure. Any individual working on any site whose duties bring them within 10 feet of an antenna shall wear a personal monitoring device to determine potential exposure. If the maximum exposure level is approached, they are to leave the area immediately until a determination is made that they can work safely in the area.

***General Requirements:***

Every Companyindividual working on a site will have RF awareness training and understand the use of personal monitoring systems. Training will occur upon initial assignment and annually.

Only Company authorized individuals will be allowed on work sites.

Signage that meets the requirements of ANSI Z53.1 as referenced in OSHA 29 CFR 1910.97 will be posted prominently at controlled environment sites.

Assume all antennas to be active and emitting RF energy. Only specially trained individuals shall install or repair any component parts. All locations will be fenced off to prevent the general public from potential RF exposures. Any protective devices such as shields must be installed prior to testing any new or repaired equipment that may emit RF energy.

Additional metallic objects not necessary for the operation of the site should be removed to prevent inadvertent contact with energized metals.

***Electro-explosive Devices:***

Care shall be taken to ensure that electro-explosive devices are not placed in FR fields of a level sufficient to cause serious risks. Firing circuitry along with the wires of electric blasting caps may, under certain circumstances, pick up sufficient energy from RF fields to cause caps to explode. The susceptibility of the blasting caps to RF fields depends on the frequency, polarization and the strength of the field and various factors in the design of the detonator – including to what extent it is electrically screened from radio interference. The level of field intensity that may prove hazardous depends on its frequency: the lower the frequency, the more susceptible are the detonators.

***Safety Procedures for Operators and Maintenance Personnel of RF Devices (RF Workers):***

1. All affected employees and RF workers will wear RF monitors to notify any personnel in a given area that RF levels are approaching or exceeding FCC limits.

2. Maintenance personnel and operators of RF devices shall be aware of the potential hazards of RF fields and adhere to the procedures outlined in this program.

3. Particular care shall be taken to ensure that all people are clear of any direct beam of a

RF device before it is switched on for test or maintenance purposes.

4. Instructions and procedures for repair, maintenance and operation of a device, as specified by the manufacturer or a competent person, shall be readily available to, and be followed by, operators and maintenance personnel.

5. Replacement components shall be equivalent to original components. Transmission lines, waveguides, gaskets, flanges and similar components shall have the same operating characteristics as the original components or be approved by the manufacturer of the original equipment, or a person trained in the safe use of this equipment.

6. Testing of a device either before or after completion of any repair work shall be carried out after protective shields, waveguides and other components have been replaced in their designated locations.

7. The correct operation of electronic test equipment and power meters shall be checked in advance, i.e., prior to using them at the repair station or test site.

8. Adjustment of voltages, replacement of RF energy generating components, dismantling components or refitting transmission lines shall be undertaken by persons specially trained for such assignments. The services of a qualified repair person shall be sought when any malfunction is suspected.

9. The correct operation of all safety interlocks shall be tested and operators shall not defeat any safety interlock.

10. A RF generating component shall be tested with an appropriate load connected to its output or with the radiated energy absorbed by anechoic material. The energy generated shall not be allowed to radiate freely into occupied areas.

***RF Surveys:***

**RF Survey Procedures** – The objective of a survey is to determine whether the device or installation complies with recommended standards of performance and personnel exposure, and to assess the effect of the location of the device with respect to controlled and uncontrolled areas in the environment. The following recommendations are made with respect to RF surveys:

1. Company Competent persons shall carry out RF surveys

2. Before routine operations begin, a RF survey shall be conducted for all new installations capable of producing levels exceeding those specified.

3. A survey shall be made following any repairs, increases in radiated power or changes in working conditions, protective shielding and barriers that may increase the levels, to ensure that the levels do not exceed the limits specified. This refers both to RF and microwave exposed workers and the general public.

4. A survey shall be conducted when any malfunction that may increase the field levels, induced body currents or contact currents is suspected.

5. A survey shall be conducted as frequently as practically possible around devices and at installations which are capable of producing fields, induced body currents or contact currents in excess of specified limits.

6. Survey instruments shall be selected to match the RF source & exposure conditions such as frequency, level of field strength or power density, near- or far- field. Survey instruments shall be fully calibrated at least once every three years. Their performance shall be checked against another calibrated instrument before carrying out a survey.

7. During a survey, a complete record of the field parameters (electric field strength, magnetic field strength or power density and induced body and contact currents) at each work site shall be kept to assist in making a realistic evaluation of compliance.

8. During the inspection of any RF device or installation, all safety interlocks and "ON- OFF" control switches shall be examined and placed in working order. The required warning signs, labels & tags must be readable and properly affixed to the device.

9. Medical surveillance will be addressed as necessary for reporting RF injuries and follow-up medical examinations to determine the extent of exposure.

***Records and Recommendations:***

(a) Records shall be kept of all RF survey measurements and their evaluation. The records shall include the date the measurements were made, number and type of devices in the area surveyed, the locations of measurement with respect to the RF emitting device, names and organization of who conducted the survey, survey results, as well as the model, serial number and calibration date of the measuring instrument(s) used. Other information that may prove useful would be photographs, floor plans, etc.

(b) Recommendations on appropriate changes in shielding, location and operation of the device, based on the evaluation of the survey measurements, shall be made to the person(s) responsible

for the device. When a remedial action based on these recommendations has been taken, another survey shall be made to verify the effectiveness of the actions.

***Warning Signs:***

**Recommended Warning Signs**- There are three warning signs suggested for RF Field awareness. These signs or reasonable alternatives shall be used. The suggested signs are designed to indicate the nature and degree of hazard associated with a given device or location. The nature of the hazard is indicated by the symbol, and degree of hazard is indicated by the shape and color of the sign. The warning signs and their meaning should be posted as required. The size of the sign shall be appropriate to the conditions of use, such that it is clearly distinguishable, being either illuminated or employing reflective materials as necessary.

Signage that meets the requirements of ANSI Z53.1 as referenced in OSHA 29 CFR 1910.97 will be posted prominently at controlled environment sites.

***Definitions:***

**Antenna** - A device for radiating or receiving radio frequency (RF) energy.

**Antenna Gain** - The increase in power transmitted or received by a directional antenna when

compared to a standard antenna, which is usually an ideal isotropic antenna. Gain is a ratio of powers and may be expressed in decibels (dB) or as a pure number.

**Auditory Effect** - Human perception to individual pulses from RF fields in the form of audible clicks, chirping or buzzing sounds, depending on the pulsing regime and intensity of the field.

**Cavity** - The interior of a metal structure that encloses or confines a radio frequency field.

**Computerized Tomography** - A diagnostic-imaging procedure in which anatomical

information is digitally reconstructed from x-radiation transmission data obtained by scanning an anatomical area from many directions.

**Competent Person** - An individual who because of his/her knowledge, training and experience is qualified to carry out RF and microwave surveys and/or repair and maintain RF and microwave devices.

**Contact Current** - Current flowing between an energized, isolated, conductive (metal) object and ground through an electrical circuit representing the equivalent impedance of the human body.

**Continuous Wave (CW)** - Successive oscillations that are identical under steady state conditions (an unmodulated electromagnetic wave).

**Denied Access Area** - An area not to be accessed by any person.

**Duty Factor** - The ratio of the pulse duration to the pulse period (i.e., time lapse between the

start of consecutive pulses) of a periodic pulse train. Mathematically, the duty factor is the product of the pulse duration multiplied by the pulse repetition frequency.

**Effective Isotropically Radiated Power (EIRP)** - This term applies to directional antennas. The power that would have to be transmitted by an isotropic antenna to produce the same power density at any given point along the directional antenna's axis. Mathematically, EIRP is the gain of a transmitting antenna multiplied by the net power delivered to the antenna from the connected transmitter.

**Electric Field** - The region surrounding an electric charge, in which the magnitude and direction of the force on a hypothetical test charge, is defined at any point.

**Electrical Ground** - The earth or a metal surface placed in contact with the earth, or connected to the earth with a conductor.

**Electromagnetic Interference** - Degradation of the performance of a device, a piece of equipment, or a system caused by an electromagnetic disturbance.

**Electromagnetic Radiation** - The propagation of time-varying electric and magnetic fields through space at the velocity of light.

**Extremities** - Limbs of the body, including upper arms and thighs.

**Far-Field Zone** - The space beyond an imaginary boundary around an antenna. The boundary marks the beginning where the angular field distribution is essentially independent of the distance from the antenna. In this zone, the field has a predominantly plane wave character.

**Field Strength** - The magnitude of the electric or magnetic field, normally a root-mean square value.

**Frequency** - The number of sinusoidal cycles made by electromagnetic waves in one second; usually expressed in units of hertz (Hz).

**General Public** - All persons not employed as RF and microwave exposed workers or those not working in controlled environments (areas). They include pregnant women, the aged, children, the chronically ill and disabled.

**Induced Current** - Current induced in a human body exposed to RF fields.

**Interlock** - A component or set of components that, when actuated, prevents the generation of

power from a RF and microwave source, such as the magnetron in a microwave oven or a RF transmitter.

**Leakage Radiation** - Any unintended or accidental radiation emitted by a device outside its external surface.

**Magnetic Field** - A region of space surrounding a moving charge (e.g., in a conductor) being defined at any point by the force that would be experienced by another hypothetical moving charge. A magnetic field exerts a force on charged particles only if they are in motion, and charged particles produce magnetic fields only when they are in motion.

**Magnetic Resonance Imaging** - A technique for obtaining images of the internal anatomy based on the use of nuclear magnetic resonance (NMR) signals. The NMR method is based on partially aligning the nuclear spins by use of strong, static magnetic field, stimulating these spins with an RF field oscillating at the precession frequency of nuclear magnetic moments, and detecting the signal that is induced at this frequency.

**Microwave** - A radio wave that has a frequency of between 1 GHz and 300 GHz or a wavelength of between 30 cm and 1 mm.

**Modulated Wave (radiation)** - An electromagnetic wave that is modified by pulsing, or by varying its amplitude, frequency or phase. Such a wave is called, respectively, pulse-, amplitude-frequency-, or phase-modulated.

**Near-Field Zone** - A volume of space generally close to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The near-field zone is further subdivided into the reactive near-field region and the radiating near-field region.

**Occupationally Exposed Persons** - Workers who are exposed to RF fields and microwaves in the course of their regular employment.

**Organ-averaged SAR for the eye** - Specific Absorption Rate (SAR) averaged throughout the whole eyeball.

**Owner** - A person, organization or institution having title to, or, an administrative control over a given RF emitting device.

**Plane Wave Character** - Nature of the angular field distribution in the far-field region of a source antenna, in which the electric field vector is perpendicular to the magnetic field vector, and they are both perpendicular to the direction of propagation.

**Power Density** - The rate of flow of electromagnetic energy per unit surface area usually expressed in W/m 2 or mW/cm 2 or µW/cm 2.

**Portable Transmitter** - A mobile device that radiates electromagnetic waves for the purpose of communication, examples of which are cellular telephones and walkie-talkies.

**Radio frequency** - The frequency in the portion of the electromagnetic spectrum that is between 3 kHz and 300 GHz.

**Radiation (electromagnetic)** - The emission or transfer of energy through space in the form of electromagnetic waves.

**Radiating Near-Field Region** - The region between the reactive near-field and the far-field wherein the radiation field dominates the reactive field, but lacks substantial plane-wave character.

**Reactive Near-Field Region** - The region that is closest to an antenna or other radiating structure and contains most or nearly all of the stored energy.

**Responsible User** - A person who is authorized to operate an RF device properly and safely with respect to RF radiation.

**Restricted Occupancy** - An area where access is restricted to RF and microwave exposed workers for a prescribed time duration.

**RF Device** - A device which generates and/or utilizes RF energy.

**RF Survey** - An evaluation of the actual or potential RF field levels in any area, specifically in the vicinity of RF devices, and an evaluation of induced and contact currents.

**RF Worker** - An employee or a person (including a pregnant woman) who because of his/her knowledge, training and experience with RF devices is qualified to work with these devices properly and safely with respect to RF exposure.

**RF and Microwave Exposed Workers** - Persons who are exposed to RF fields and microwaves in the course of their daily work (e.g., those who may work near an RF device but may not be RF workers).

**rms** - Root mean square. Mathematically, it is the square root of the average of the square of the instantaneous field or current taken throughout one period.

**Safety** - The absence of detrimental health effects from RF exposures.

**Safety Officer** - A person who is appointed to ensure safety of working within an RF environment.

**Specific Absorption Rate (SAR)** - The rate of radio frequency energy absorbed in tissue per unit mass. Quantitatively, it is the time derivative (rate) of the incremental energy (dW) absorbed by an incremental mass (dm) contained in a volume element (dV) of given mass density.

**Transceiver** - A combination of transmitter and receiver in a single housing, with some components being used by both parts.

**Uncontrolled Area** - Any area that is neither a Restricted Occupancy Area, nor a Denied Access Area.

**Visible Warning Indicator** - A display such as flashing lights and signs to warn people of the fact that the power of an RF device is on.

**Wavelength** - The distance traveled by a propagating wave in one cycle of oscillation.

**Radiation** - Electromagnetic radiation having a wavelength in the range of 0.0001 to less than 1 nm.