INFRARED TRAINING INSTITUTE INC.
INFRARED THERMOGRAPHY TRAINING & CERTIFICATION

Level I Thermography Certification

Level 1 Thermography Overview

This course is an introduction to the laws of thermodynamics, temperature, the electromagnetic spectrum, and basic thermal camera use. This Level I Thermography Course fulfills the requirements for Level I Thermal/Infrared Certification as specified by the American Society for Nondestructive Testing (ASNT). Level 1, Level 2, and Level 3 Thermography courses follow the ASNT-recommended course curriculum. Our training meets or exceeds ASNT-TC1A and ASNT CP-189. Special consideration can be made to meet or exceed ISO 9712 with the required 2 weeks or 80 hours of training.
On conclusion of this course, every trainee must show their abilities, not only in operating their infrared device, but also in accurate temperature measurement, inspection, and data finding. Students can receive the certification only after passing the written exams. 32 hours of training is required for certification.
We limit class size to ensure all students receive the necessary personal attention required to make their training experience a complete success. Each student learns to operate their thermal imaging camera, making use of all features and functions available for their specific application. We cover a wide range of inspection applications including electrical, mechanical, petrochemical, building envelopes, etc.

Section 1: Introduction

- **Infrared Thermography:**
  - **Introduction to Thermography:** Infrared thermography is one of the fastest growing forms of non-destructive testing in the world today. The ways in which we can use this technology are only limited by our imagination.
  - **Level I Certification Course Outline:** This course meets or exceeds the recommended training requirements of ASNT-TC-1A for Level I Thermal/Infrared Certification. Review of the course outline.
  - **Certification Procedure and Requirements:** ASNT – TC – 1A recommends that the required classroom instruction for a Level 1 thermographer is 32 hours. In keeping with these requirements, the candidate must attend the Level 1 Thermographer Training course as administered by Infrared Training Institute and pass the written examination with a grade of 70% or more.
  - **Thermography Course Schedule:** Each student will receive course materials at these ASNT compliant courses including but not limited to: a comprehensive manual, course handouts, administration and grading of examination as well as Certification to those who meet the written requirements.

Section 2: The Foundation - Basic Thermal Physics

- **Basic Thermal Physics:**
  - **The Basic Physics of Matter:** Physics is the study of nature or natural things. The word in today's world speaks of a branch of science that is the study of nature at its

fundamental level. It deals with the behavior of atoms, gravity, electromagnetism etc.
    - **Thermal Analysis and Infrared Thermography:** Infrared thermography is one of the newest Industrial/Commercial Research and development testing techniques. Unlike X-ray which has been in use for over 100 years or Doble Testing which has been conducted... or in transit from one place to another as a consequence of temperature differences only.
    - **Thermodynamics:** The science of heat transfer has evolved from three fundamental concepts “laws” of thermodynamics, the first and second law being the most important.
    - **Change of State:** While change of state is not considered a true mode of heat transfer, the principles of latent heat do have a number of practical applications in infrared thermography and are worth considering.
    - **Conduction:** The transfer of energy from areas of higher temperature to areas of lower temperature by the intimate contact of the molecules.
    - **Convection:** The transfer of energy from areas of higher temperature to areas of lower temperature by the movement of a fluid.
    - **Wind Chill:** The weatherman tells you that the temperature is going to be cold but bundle up because the wind chill factor is going to make it feel really cold out there. What does that mean and why would the wind make it feel even colder than it really is.
    - **Heat transfer by Radiation:** Heat transfer by radiation takes place primarily in the area of the electromagnetic spectrum known as the infrared band.
    - **Radiation:** The transfer of energy, through a gas or a vacuum, from objects at higher temperatures to objects at a lower temperature by means of alternating electromagnetic waves.

Section 4: Electromagnetic Radiation

- **Overview: Electromagnetic Radiation:**
    - **Electromagnetic Radiation Basics:** You may not realize it, but every moment of your life, from birth to death, you are being constantly bombarded by electromagnetic radiation.
    - **The Electromagnetic Spectrum:** The electromagnetic spectrum is a chart of energy, which describes the full range of known electromagnetic radiation types.
    - **Radio Waves:** All objects in the universe give off radio waves, as all objects are above absolute zero.
    - **Microwaves:** In 1924 Marconi developed “The Beam System” which was the beginnings of microwaves.
    - **Infrared:** The infrared portion of the spectrum is from 1 – 1000 microns. All objects above absolute zero emit radiation in the form of infrared rays.
    - **Night Vision:** In general most night vision devices are electro-optical devices, which amplify available light in low light scenes such as night time conditions.
    - **Infrared Thermography:** Infrared thermographic instruments are non-contact, non-intrusive systems that see only radiated energy from the 1/1000” of most objects.
    - **Infrared Film:** In the daylight, infrared film will pick-up reflections off objects and not

the heat emission from these objects.
    - **Visible Light:** The visible area occupies the band width from .38 - .72 microns. Wavelengths are associated with temperatures of 525 degrees Celsius or higher.
    - **Ultraviolet:** Ultraviolet radiation as the name suggests is electromagnetic radiation that is just off the violet end of the visible spectrum.
    - **X-Rays:** Discovered in 1895, X-rays are much shorter than ultraviolet rays and can penetrate many solids.

Section 5: Radiation Laws and Emissivity

- **Overview: Infrared Radiation and Emissivity:**
    - **Infrared Radiation Physics – Introduction:** For a complete understanding of the infrared image one must have a background into some of the basic physics behind infrared radiation.
    - **Blackbody: Definition:** A blackbody is a theoretical object that emits a maximum amount of energy at all temperatures in all wavelengths.
    - **Stephan–Boltzmann Law:** Determined that the amount of energy radiated by an object is proportional to the object's temperature in Kelvin raised to the 4th power.
    - **Wien's Law:** Most objects emit energy at many wavelengths. However there is one specific wavelength at which there is a maximum amount of energy emitted.
    - **Variable Integration Time:** Unlike single element systems, the ability to look at higher temperatures cannot be achieved using apertures with FPA systems.

Section 6: The Infrared Image

- **Overview: The Infrared Image:**
    - **The Infrared Image: Introduction:** The infrared image that appears on your camera screen is a representation of the radiated energy that is given off of the surface (1/1000") of objects in the field of view above approximately –35° C.
    - **Thermographic Camera Operation:** Infrared thermography can be broken down into two basic categories: qualitative and quantitative inspections.
    - **Atmospheric Attenuation:** Most infrared systems work in the shortwave range of 3 – 5 microns, or the longwave range of 7 – 14 microns.
    - **Angle:** The Angle from which you view an object at, as well as the atmosphere, can also make a difference to the amount of energy your thermal imaging camera sees.
    - **Infrared Image Analysis:** The thermographer must have the ability to examine the thermal patterns and identify the various thermal signatures to determine first if there is a true anomaly and then determine the cause of that anomaly.
    - **The Infrared Image and Camera Resolution:** The infrared image that you view on your screen or in your eyepiece is an image that is made up of a large number of picture elements or pixels. Each of these pixels represents a small spot of the scene, which we are viewing with our camera.
    - **Field Of View (FOV):** The total area that our camera sees is defined by the FOV angle given by the manufacturer for each specific lens.
    - **The Instantaneous Field of View (IFOV):** The IFOV value describes the smallest spot that your system can geometrically resolve or see the size and shape of. It is given by an angle defined in milliradians.

- **Infrared Lenses:** Infrared lenses are made from expensive specialty materials. The most common lens materials are germanium, sapphire, and silicon.
- **Infrared Windows:** There are a number of transparent infrared window materials. Some examples are sapphire, Irtran, Germanium, (thin) Polyethylene film, and some new fluoride materials.

Section 7: Application Notes

- **Application Notes:**
  - **Introduction:** Infrared thermography is employed on a wide range of applications. While many of these applications are based on temperature, many others use object characteristics such as emissivity/reflection, or transmittance differences, while there is no variation in temperature. In general there are two types of thermographic applications, these are passive applications and active applications.
  - **Report Formats:** There is no one “perfect” report format for infrared inspections. The format is usually dictated by the environment in which you work.
  - **Electrical Inspections:** The inspection of electrical components was the first big commercial use of infrared thermography back in the mid 1960’s.
  - **Mechanical Inspections:** As with electrical inspections, mechanical inspections are also based on the first law of thermal dynamics. The energy that is applied to a system must be exactly accounted for.
  - **Mechanical Reports:** The mechanical report should have all temperature and associated pertinent information included.
  - **Equipment List:** Review of equipment suitable to be included in a mechanical inspection program.
  - **Process Inspections:** Process inspections with infrared thermography cover a wide variety of situations.
  - **Building Inspections:** In some climates, building inspections are seen as a valuable role for infrared thermography.
  - **Specific Heat:** The specific heat of a body is defined as the amount of thermal energy Q required to raise the temperature of a unit mass of the material 1° C.
  - **Conventional Built-up Flat Roofs:** Although the roof is a part of a building, it should be treated as a separate item. The hardest part of dealing with a roof leak is often locating it.

Section 8: Appendix

- **Appendix:**
  - **Getting A Good Image Workshop:** The object behind this workshop is to get a good infrared image by using the manual adjustments on the camera.
  - **Ambient Reflection Workshop:** The ambient reflected quantity that you must enter into your system is not necessarily a true temperature value.
  - **Performing Inspections Workshop:** Qualitative Inspection and Quantitative Measurement.
  - **Hot Spot or Not:** We will often see hot spots in our infrared image that are not really hot at all. Our infrared cameras do not see temperature, they see radiated energy!