N.C Department of Labor
OSH Division

- ***Sampling and Analysis***

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NCDOL
N.C. Department of Labor
Cherie Berry, Commissioner

OSH Division
Internal Training

Resources

- FOM Chapter XV – Industrial Hygiene Compliance
  - OneStopShop
- OSHA Technical Manual
  - https://www.osha.gov/dts/osta/otm/otm_toc.html
- Chemical Sampling Information – OSHA website
  - https://www.osha.gov/dts/chemicalsampling/toc/toc_chemsamp.html
- NIOSH – Occupational Exposure Sampling Strategy Manual
  - http://www.cdc.gov/niosh/docs/77-173/
- Patty's Industrial Hygiene and Toxicology

Objectives

- Discuss Sampling Equipment
- Describe Analytical Techniques
- Reasons for Sampling
- Develop Sampling Strategy
- Evaluation of Sampling Results
- Carbon Monoxide – Coburn Equation
- Common Citations

Brief Review

Hazard Categories for IHs

Contaminant

- Chemical
  - CO
- Biological
  - Mold
- Radiation
  - Ionizing
  - Non-ionizing
- Reactive (explosive)
  - Combustible dust

Condition

- Thermal
  - Hot
  - Cold
- Ergonomic
  - Vibration
  - Repetitive tasks
- Noise
  - Continuous

Classification of Airborne Contaminants

Physical State

- Solids
  - Fumes
    - » Particles formed by condensation of vapor, generally after volatilization from the molten state and can be accompanied by a chemical reaction.
      - Size range: 0.01µm – 10.0µm
  - Dusts
    - » Particles generated by mechanical action.
      - Size range: 1µm – 100µm
  - Fibers
    - » Particulate with an aspect ratio (length to width) of 3:1

Classification of Airborne Contaminants

Physical State

- Liquids
  - Mists
    - » Suspended liquid droplets generated by condensation (from gas to liquid).
      - Size range: 0.01µm – 10µm
- Gases
  - Vapors
    - » A gaseous form of a substance that is normally a solid or liquid at room temperature

Classification of Airborne Contaminant

Multiple Physical States

- Aerosol
  - Liquid droplets or solid particles dispersed in air.
    - Size range: 0.001µm – 50µm
- Particulate matter
  - Fine solid or liquid particles dispersed in air.
- Smoke
  - Contains liquid droplets, solid particles, and gases originating from incomplete combustion.
    - Size range: 0.01µm – 1.0µm

Routes of Entry

- Inhalation
  - Material enters the body by breathing.
- Ingestion
  - Material enters the body by swallowing.
- Absorption
  - Material enters the body by diffusing across tissue/membranes.
- Injection
  - Material enters the body when tissue/membranes are punctured or broken.

Toxicological Classification

Different criteria used throughout the world

- Examples:
  - Acute Toxicity
  - Asphyxiants
  - Carcinogens
  - Chronic Toxicity
  - Corrosive
  - Irritation
  - Mutagens
  - Reproductive Toxicity
  - Sensitization
  - Systemic Poisons
  - Teratogens

Physiological Effects

- Acute Toxicity
  - Refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.
    - » e.g., phenol – [C_6H_6O]; nickel carbonyl – [$Ni(CO)_4$]
- Chronic Toxicity
  - Refers to the ability of a chemical to do systemic damage as a result of many repeated exposures, during a prolonged period of time, to relatively low levels of the chemical.
    - » e.g., phenol – [C_6H_6O]; nickel carbonyl – [$Ni(CO)_4$]

Physiological Effects

- Systemic Poisons
  - Toxic substance whose effect is not localized in one spot but spreads to all body organs and systems in varying degrees, the major effects being manifested in one or two organs.
    - » e.g., tetraethyl lead – [$(CH_3CH_2)_4Pb$]

Physiological Effects

- Asphyxiants
  - A vapor or gas that can cause unconsciousness or death by suffocation due to lack or depletion of oxygen.
    - » Simple asphyxiants
      - Are inert gases or vapors which are harmful to the body when they become so concentrated that they reduce oxygen in the air to dangerous levels
        - e.g., carbon dioxide – [CO_2]; nitrogen – [N]; methane – [CH_4]; hydrogen – [H]
    - » Chemical asphyxiants
      - Cause suffocation by either preventing the uptake of oxygen in the blood or by preventing the normal oxygen transfer from the blood to the tissues or within the cell itself.
        - e.g., carbon monoxide – [CO]; hydrogen cyanide – [HCN]; hydrogen sulfide – [H_2S]

Physiological Effects

- Corrosive
  - Chemical at the site of contact that causes visible destruction or irreversible alterations of the skin, eyes, lining of the respiratory tract, or gastrointestinal tract.
    - » e.g., hydrochloric acid – [HCl]; sulfuric acid – [H_2SO_4]
- Irritation
  - Chemical at the site of contact may cause inflammation of the skin, eyes, lining of the respiratory tract, or gastrointestinal tract.
    - » e.g., ammonia – [NH_3]; nitrogen dioxide – [NO_2]

Physiological Effects

- Mutagens
  - Chemicals to modify the genetic material in the nucleus of cells in ways that allow the changes to be transmitted during cell division and potentially causing heritable effects.
    - » e.g., bromine – [Br]; benzene – [C_6H_6]
- Carcinogens
  - A substance or a mixture of substances which induces cancer or increases its incidence.
    - » e.g., Beta-naphthylamine – [$C_{10}H_9N$]; Bis-chloromethyl either (BCME) – [$C_2H_4Cl_2O$]

Physiological Effects

- Reproductive Toxicity
  - Adverse effects induced by a chemical on any aspect of mammalian reproduction.
    - » Reproductive Toxicity
      - Adverse effects that interfere with the ability of males or females to reproduce.
        - e.g., lead – [Pb]; ethylene oxide – [C_2H_4O]; 1,2-dibromo-3-chloropropane (DBCP) – [$C_3H_5Br_2Cl$]
    - » Developmental Toxicity
      - Adverse effects manifested in the embryonic or fetal periods or postnatally, associated with exposure during pregnancy.
        - e.g., ethylene oxide – [C_2H_4O]; thalidomide – [$C_{13}H_{10}N_2O_4$]

Physiological Effects

- Teratogens
  - Agents that cause irreversible deleterious structural malformations in an embryo as a consequence of exposure of the mother during pregnancy.
    - » e.g., ethylene oxide – [C_2H_4O]; thalidomide – [$C_{13}H_{10}N_2O_4$]

- Sensitization
  - Agent that can cause an allergic response in susceptible individuals.
    - » e.g., methylene bisphenyl isocyanate (MDI) – [$C_{15}H_{10}N_2O_2$]; trichloroethylene – [C_2HCl_3]

Hazard Classification

1910.1200

Hazard Communication Standard (HCS) 2012

Figure C.1 – Hazard Symbols and Classes

Flame	Flame Over Circle	Exclamation Mark	Exploding Bomb
			
Flammables Self Reactives Pyrophorics Self-heating Emits Flammable Gas Organic Peroxides	Oxidizers	Irritant Dermal Sensitizer Acute Toxicity (harmful) Narcotic Effects Respiratory Tract Irritation	Explosives Self Reactives Organic Peroxides
Corrosion	**Gas Cylinder**	**Health Hazard**	**Skull and Crossbones**
			
Corrosives	Gases Under Pressure	Carcinogen Respiratory Sensitizer Reproductive Toxicity Target Organ Toxicity Mutagenicity Aspiration Toxicity	Acute Toxicity (severe)

Reasons for Sampling

Sampling Reasons

- Characterization of contaminant(s) and/or condition(s) present in the work environment through identification and quantification.
- Estimation of employee exposure
- Assess compliance
- Evaluation of the effectiveness of work place controls (i.e., engineering controls, PPE)

Types of Sampling

Types of Sampling

- Grab / Spot
  - Environmental concentrations at a specific point in time
    - » Can analysis multiple contaminants
  - Sampling collected over a short period of time
    - » Usually less than 5 minutes
  - Can be used to estimate time-weighted average (TWA)
- Integrated
  - Averages concentration over long periods of time
    - » Can consist of one sample or multiple samples
  - Known volume of air passed through a collection device to remove a specific contaminant(s)
  - Used to determine TWA
    - » Typically, 15 minutes – 8 hours

Types of Sampling

- Area
  - Specific area / fixed locations
    - » TWA
      - Full-shift
      - Partial-shift
    - » Ceiling / Excursion / Short Term Exposure Limit (STEL)
      - Typically 15 minutes
    - » Variations
      - Equipment
      - Processes
- Personal
  - Breathing Zone
    - » TWA
      - Full-shift
      - Partial-shift
    - » Ceiling / Excursion / STEL
      - Typically 15 minutes
    - » Variations
      - Tasks performed
  - Biological
    - » Biological exposure indices (BEIs)
      - Full-shift

Types of Sampling

- Passive
  - Passive diffusion
    - Fick's first law of diffusion
  - TWA
    - Area
    - Personal
  - Ceiling / Excursion / STEL
    - Area
    - Personal
- Active
  - Physically/forcibly moving air.
    - through media
    - Into a collection device
    - Across membranes
  - TWA
    - Area
    - Personal
  - Ceiling / Excursion / STEL
    - Area
    - Personal

Types of Sampling

- Screenings (Grab / Spot)
  - Provide proof of the existence of the contaminant
    - » Wipe samples
      - Establish presence of contaminant
      - Can determine concentration within a defined area
        - Difficult to interpret results
    - » Bulk samples
      - Establish and identify contaminant
      - Sometimes necessary to support analysis
    - » Direct read instruments
      - Instantaneous
      - Can provide quantification
      - Can be used to determine TWA

Full-shift Sampling

- Defined to be a minimum of the total time of the shift minus 1 hour.
  - e.g., 7 hours of an 8-hour work shift or 9 hours of a 10-hour work shift.
- Make every attempt to sample as much of the work shift as possible, including segments of the greatest exposure.

Full-shift Sampling

- Monitoring may be accomplished with a full shift **single sample** or **continuous multiple samples** taken to determine any 8 hours of exposure for comparison with the permissible exposure level (PEL).
- A separate sample should be used to determine any additional exposure beyond 8 hours.

Partial-shift Sampling

- Less than 7 hours of an 8-hour shift
  - Professional judgment is necessary for making any conclusions or assumptions regarding the un-sampled period
    - » i.e. the set-up and/or take-down time which is not to exceed 1 hour.
  - The CSHO **should carefully document** the rationale for any professional judgment regarding un-sampled exposure periods.
  - A determination that any employer is in compliance will not be made in any case unless the sampled period is **representative** of the employee's normal exposure.

Ceiling Sampling

- Typically a 15 minute sample
- Monitoring may be accomplished with a **single sample** to determine the exposure for comparison with the ceiling limits.
- Select time period of greatest concern and potential for exposure.

Biological Monitoring

- Indirectly reflects the dose to a worker from exposure to the chemical of interest.
  - Sampling time
    - Prior to shift
    - During shift
    - End of shift
    - End of the workweek
    - Discretionary
  - Examples
    - Urine Analysis
    - Blood Analysis
    - Expired Breath Analysis

Sampling Equipment

Sampling for Gases and Vapors

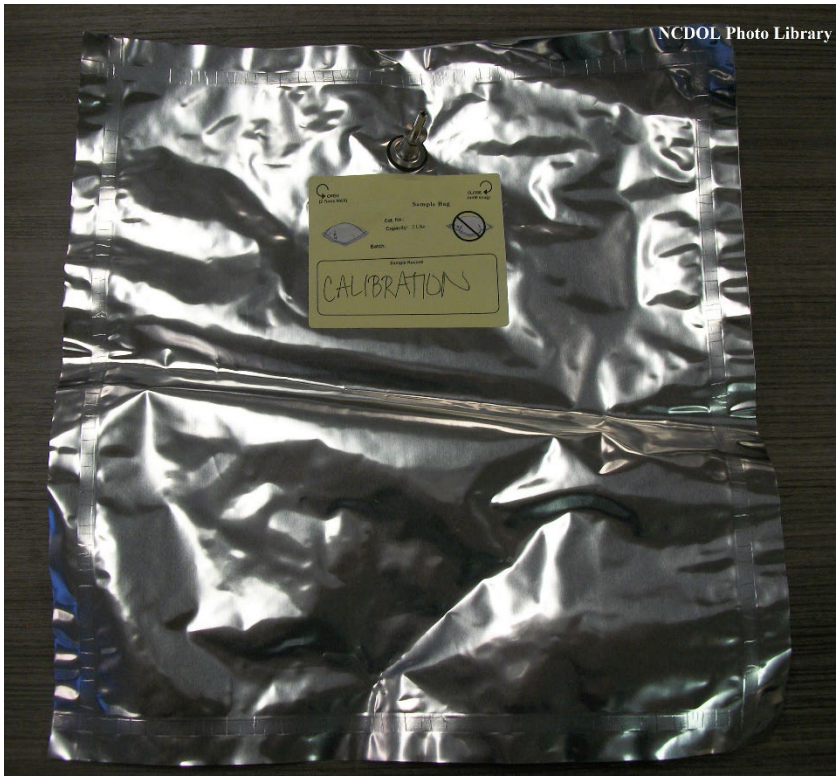
- Grab / Spot Sampling
  - Evacuated Containers
  - Displacement Collectors
  - Flexible Plastic Bags
- Integrated Sampling
  - Absorbers
  - Adsorption Media
  - Flexible Plastic Bags

Grab Sampling for Gases/Vapors

- Evacuated Containers
  - Flasks are heavy-walled containers of glass or other suitable material, where air has been removed, created a vacuum.
    - » Usually 200-1000ml in volume
    - » Open container
      - Air is drawn in
    - » Seal flask
    - » Ship for analysis

Sampling for Gases/Vapors

- Flexible Plastic Bags
  - Variety of sizes
  - Common materials used for bags;
    - » Polyester
    - » Polyvinylidene chloride
    - » Teflon
    - » Fluorocarbons
  - Air drawn into bag by hand pump or battery operated pump
  - Can be used for either grab or integrated sampling



Commonly used to collect

- Evacuated containers
  - e.g., oxygen – [O]; carbon dioxide – [CO_2]; carbon monoxide – [CO]; nitrogen – [N]; methane – [CH_4]
- Flexible Plastic Bags
  - e.g., organic and inorganic vapors and gases

Integrated Sampling for Gas/Vapors

- Absorbers
  - Impinger
    - » Air is passed through liquid, the contaminant is captured by the liquid.
    - » Types
      - Gas-wash
      - Spiral absorbers
      - Fritted bubblers

Integrated Sampling for Gas/Vapors

- Adsorption Media
  - Solid-sorbent tubes
    - » Air is passed through the tube and binds to the media
    - » Types
      - Activated charcoal based
        - Most common
        - Organic vapors
      - Silica gel based
        - Polar molecules
      - Impregnated solid sorbent
        - Specific contaminant

Integrated Sampling for Gas/Vapors

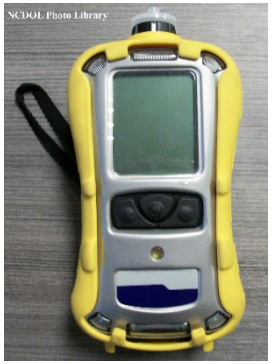
- Passive monitors
  - Utilize Brownian motion to control the sampling process into a collection medium
    - » Follows Fick's Law
  - Very easy to use

Commonly used to collect

- Absorbers
  - Impingers
    - » e.g., formaldehyde – [CH_2O]; iodine – [I]
- Adsorption Media
  - Solid-sorbent tubes
    - » Activated charcoal based
      - e.g., aliphatic, aromatic, halogenated hydrocarbons, alcohols, ethers, acetates, carbon disulfide – [CS_2]
    - » Silica gel based
      - e.g., Amines, acids, methanol – [CH_3OH]
    - » Impregnated solid sorbent
      - e.g., 1,3-Butadiene – [C_4H_6], ethylene oxide – [C_2H_4O]
  - Passive monitors
    - » e.g., formaldehyde – [CH_2O], mercury – [Hg],

Sampling for Gases and Vapors

- Direct-Reading Instruments
  - Typically used to rapidly detect
    - » flammable or explosive atmospheres
    - » oxygen deficiency
    - » specific gases and vapors
      - Typically Not designed to measure or detect below 1 ppm
      - Only for specific classes of chemicals; or
      - Only for one particular substance or chemical



Sampling for Particulates

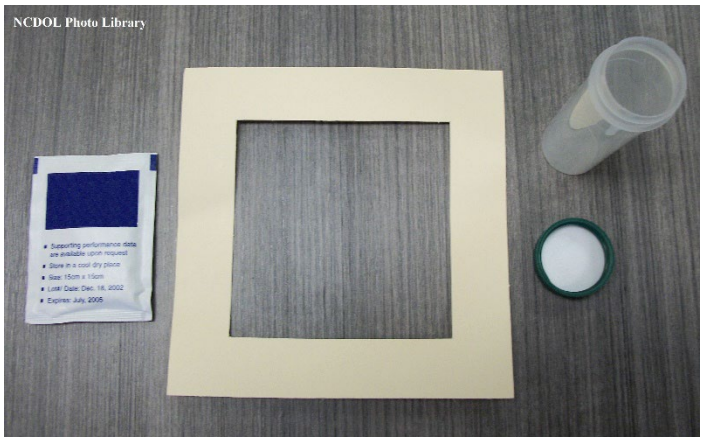
- Grab / Spot Sampling
  - Bulk
  - Wipe
- Integrated Sampling
  - Filtration
  - Impaction and Impingement
  - Elutriation
  - Centrifugal Collection
  - Electrostatic Precipitation

Sampling for Particulates

- Bulk
  - Physical collection of suspect material
    - » Necessary to support analysis of air samples and presence of hazard
  - Collected in plastic bad, glass container, or plastic container.
  - Commonly used to collect
    - » e.g., asbestos; combustible dust; silica – [SiO_2]

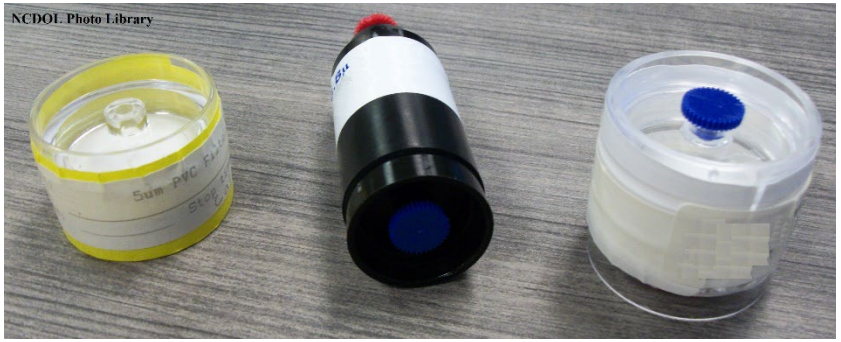
Sampling for Particulates

- Wipe
  - Wiping a predetermined area
    - » Establish presence of contaminant
      - Can determine concentration within a defined area
        - Difficult to interpret results
    - » Used to support effectiveness of PPE, housekeeping, and personal hygiene
  - Commonly used to collect
    - » e.g., Lead – [Pb]; chromium (VI) – [Cr]; isocyanates



Sampling for Particulates

- Filtration
  - Most common method
  - Air passes through the filter, particles impact onto the filter
  - Types
    - » Glass fiber
      - e.g., oil mist
    - » Mixed Cellulose ester
      - e.g., asbestos
    - » PVC
      - e.g., chromium (VI) – [Cr]
    - » PTFE (Teflon) with XAD-2 tube
      - e.g., coal tar pitch



Sampling for Particulates

- Impaction Impingement
  - Cascade impactors
    - » Constructed with several stages to separate dust by size fractions
      - Causing a sudden change in direction in airflow
        - Particle's momentum causes it to impact on the stage
    - » Collects viable or non-viable samples
    - » Commonly used to collect
      - e.g., mold

Sampling for Particulates

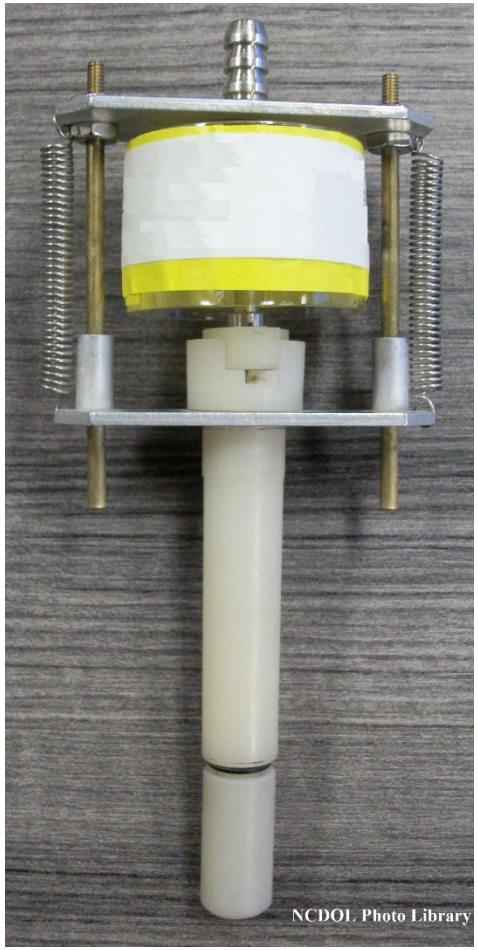
- Impingement
  - Impinger
    - » Air is passed through liquid, the contaminant is captured by the liquid.
    - » Commonly used to collect
      - e.g., dust
    - » Not really used much anymore for collecting particulates

Sampling for Particulates

- Elutriation
  - Used to remove unwanted materials and/or to remove larger size particles
  - Types
    - » Vertical elutriator
      - e.g., cotton dust
    - » Horizontal elutriator
      - e.g., mineral dust

Sampling for Particulates

- Centrifugal Collection
  - Used to determine the respirable fraction
  - Air stream enters the device and through centripetal force, eliminates particles larger than 10 microns.
    - » Types
      - Aluminum
      - Nylon
    - » Commonly used to collect
      - e.g., silica – [SiO_2]



Sampling for Particulates

- Electrostatic Precipitation
  - High airflow, where particulates pass through a high-voltage electrical field
    - » Particulates are attracted to the cylinder wall where they are collected
  - Commonly used to collect
    - » e.g., nanoparticles, metal fumes

Sampling for Particulates

- Direct-Reading Instruments
  - Typically used to rapidly detect
    - » Particulate size distribution
      - Respirable dust
      - Total dust
    - » Results are non-specific

Sampling for Noise

- Grab / Spot Sampling
  - Sound level meters (SLMs)
  - Octave Band Analyzer (OBA)
- Integrated Sampling
  - Noise Dosimeters

Sampling for Noise

- Sound level meters (SLM)
  - Microphones change energy from sound waves to mechanical energy
    - » Types of Microphones
      - Dynamic: mylar; vibrates with sound
      - Ceramic: crystals; distorted by sound; sends out piezoelectric signal.
      - Condenser: capacitor; measures voltage difference across gap (best type)
        - Type II
          - Intended for general field use
          - Typically ± 2 dB

Sampling for Noise

- Sound level meters
  - Measures
    - » Slow
      - Averages the response out so the SLM can be read more easily
    - » Fast
      - Used for intermittent noise (i.e., allows you to measure peaks)
    - » Impact
      - Transient acoustical event less than half second in duration separated by greater than one second between peaks

Sampling for Noise

- Octave Band Analyzer
  - Provides frequency analysis
    - » Useful to select the proper controls to reduce dB

Sampling for Noise

- Noise Dosimeters
  - Measures noise levels and compares them to the 8-hour PEL and AL
  - Read-out expressed as dose percentage.
  - Settings used to determine dose percentage
    - Criterion level – compared level (90 dB and 80 dB), read-out will be expressed as a percentage
    - Threshold level – level below which noise will not be registered by the meter
    - Exchange rate – amount of increase in sound pressure level that reduces the exposure time in half (e.g., OSHA uses 5 dB)

Sampling for Heat

- Grab / Spot Sampling
  - Thermometers (temperature)
  - Anemometers (air flow)
  - Psychrometry (humidity)
  - Wet-bulb, Globe, Thermometer (WBGT)

Sampling for Ergo

- Grab / Spot Sampling
  - Camera
    - Photographs
    - Movies
  - Spot watch
  - Scale

Sampling for Ergo - Vibration

- Grab / Spot Sampling
  - Accelerometers
    - » Common systems use a vibration transducer which transforms the mechanical motion into an electrical signal.

Radiation

- Ionizing vs non-ionizing
  - Ionizing
    - Alpha
    - Beta
    - Gamma
    - Neutrons
  - Non-ionizing
    - Light
      - Lasers
    - Ultraviolet radiation
    - Radiofrequency

Sampling for Radiation

- Ionizing
  - Grab / Spot Sampling
    - » Geiger Counter
  - Integrated Sampling
    - » Dosimeters
- Non-Ionizing
  - Grab / Spot Sampling
    - » Light Meter
    - » RF Meter

Analytical Techniques

Analysis Techniques

- Gravimetric Techniques
  - Most frequently used
  - Calculate based on weight gain
- Titrimetric Methods
  - Using a known concentration to determine an unknown concentration volumetrically
    - Acid-base
    - Oxidation-reduction
- Optical Methods
  - Use of a microscope to count particles and fibers
- Colorimetric Procedures
  - Change of color intensity or tone

Analysis Techniques

- Spectrophotometric Methods
  - Use infrared radiation spectra to the ultraviolet, measuring fractions transmitted or scattered
- Spectrographic Techniques
  - Vaporize sample, disperse it and photograph resulting spectrum for analysis
- Chromatographic Methods
  - Quantified by run times, when sample is passed through columns
- Atomic Absorption Spectrophotometry
  - Measures adsorption of radiation to determine concentration

Sampling Strategy

Methods of sampling

- There are multiple types of sampling methods and the method(s) selected comes from professional judgement and evaluation being conducted.
  - Time-weighted average (TWA)
    - » Determining exposure during the entire shift
      - Typically 8 hours
  - Ceiling/excursion limits/shot term exposure limits
    - » Determining short term exposures
      - Typically 15 minutes
  - Screenings
    - » Provide the existence of the contaminant
      - Can provide quantification

Sampling Strategy

- General Considerations
  - Preliminary Survey
  - Worst case vs Typical day
  - Whom/where/when to sample
  - Analytical Method
  - Sampling Equipment
  - Sampling Necessary?

General Considerations

- Preliminary Survey
  - Materials used/present
  - Employee complaints or symptoms
  - Process operations
  - Workplace observations

Materials/Products

- Identify the raw material/products being used in production
  - Review SDS/MSDS
  - Review purchasing records
  - Determine the chemical composition of the product(s)
    - » Do chemicals pose or potentially pose a hazard?
  - Determination amount of raw material/products
  - Identify any by-products produced during the production
    - » e.g., dust, carbon monoxide – [CO]

Symptoms/Complaints

- Interviews
  - Management
    - » Employee complaints
    - » Sick employees
  - Employees
    - » Experience any symptoms
      - Co-workers
    - » Illnesses
    - » Concerns/Issues
- Documentation
  - OSHA 300 logs
  - Form 19s
  - Medical Records
  - Workers Compensation Claims
    - » Form WC-14

Process/Operation

- Become familiar with the entire process operation.
  - Start to finish
  - Describe how raw materials/products are transformed into the sales/final product.
- Identify equipment used
  - Identify engineering controls in place.
- Identify specific tasks/operational procedures
  - Identify any task/operational hazards
    - » Noise
    - » Repetitive tasks
    - » Air contaminants

Process/Operation

- There are many processes and operations within the working environment that could expose employees to concentrations above the action level or permissible exposure limit.
  - Examples

Welding	Dipping
Soldering	Plating
Painting	Mixing
Etching	Milling
Spraying	Drilling

Workplace observation

- Workplace Conditions
  - Temperature
    - Hot / cold
  - Water damage
    - Mold
  - Visible contamination
    - Dust clouds
    - Fumes
    - Dust piles
    - Fog
- PPE
  - Respirators
    - Dust Masks vs Full Face
- Ventilation
  - Mechanical vs Natural
- Habits

Worst Case vs Typical Day

- Worst case
  - Representative of the highest potential exposures during process operations
- Typical Day
  - Representative of normal process operations

- Goal for compliance is to sample worst case.

Whom/Where/When

- Where
  - Sample location
    - » Operation
    - » Department
  - Sampling
    - » Area
      - Workplace
      - Specific operation
    - » Personal
      - Breathing zone

Whom/Where/When

- Whom
  - Select the maximum risk employee(s)
  - Employee(s) location to operation/area
  - Employees who perform similar tasks
- When
  - Differences between shifts
  - Ventilation changes
  - Weather conditions
  - Process change(s)
  - Unusual situation(s)
  - Worst case scenario(s)
  - Specific task(s)

Sample Analysis

- Sample Analysis
  - Accreditation
    - » Analytics
    - » OSHA's Salt Lake Technical Center (SLTC)
- Analytical Methods
  - Validation
    - » OSHA method or NIOSH method
      - Few exceptions
  - Interferences
    - » Positive
      - Gravimetric analysis
    - » Negative
      - Depletion of contaminant
    - » Combustible Dust
      - Moisture

Sampling Strategy

- 8-hours TWA
  - Full period single sample
  - Full period consecutive samples
  - Partial period consecutive samples
  - Grab samples measurement(s)
- Ceiling
  - Full period single sample
  - Grab samples measurement(s)

Considerations

- Sample Duration
  - TWA vs Ceiling
    - » Check Method for minimum/maximum sample volume and flow rates
  - Calculate minimum sample time

$$Minimum\ sample\ time = \frac{minimum\ sample\ volume}{flow\ rate}$$

  - Example
    - » NIOSH 7300 – Lead
      - Minimum sample volume = 50 L
      - Maximum sample volume = 2000 L
      - Flow rate 1 to 4 L/min
        - Minimum sample time = **50 to 12.5 minutes**

Considerations

- Media
  - Availability
  - Overnight shipping
- Number of Samples
  - Includes field blanks
- Cost
  - Method
  - Media

Analytics - Book

Analyte CAS #	Recommeded Media	Suggested Volume, L	Sampling Rate, LPM	LOQ, µg	Method Technique	Lab Code	Unit Cost USD	General Comment
Vinyl Toluene 25013-15-4	T-01 Charcoal, 226-01	10 - 24	0.01 - 0.2	100	NIOSH 1501 GC/FID	A	$53.00	
	M-3500 3M POVM 3500	Up to 8 hours	0.0251	150	NIOSH 1501M GC/FID	A	$53.00	
Vinylidene Chloride 75-35-4							$-	See 1,1-Dichloroethylene.
VM & P Naphtha 8032-32-4							$-	See Naphtha, VM&P.
[illegible]							$-	See Hydrocarbons, Total as n-Hexane
Welding Fumes Profile - Air N/A	C-04 MCEF, 37mm, 0.8um, 3PC, Matched-weight, C-04	200 Liters, 480 Liters needed to allow detection of Cadmium at OSHA action level	1.0 - 2.0	Varies by element	OSHA ID-125 ICP	EE	$187.00	Profile includes Aluminum, Antimony, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Titanium, Vanadium, Zinc & Total Particulates.
	[illegible] C-04	[illegible] um at OSHA action level						
Welding Fumes Profile - Bulk N/A	Vial or Bag	NA	NA	Varies by element	OSHA ID-125 ICP	EE	$215.00	Profile includes Aluminum, Antimony, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Titanium, Vanadium, Zinc
Welding Fumes Profile - Wipe N/A	K-07 Ghost Wipe Kit	100 sq cm	NA	Varies by element	OSHA ID-125 ICP	EE	$215.00	Profile includes Aluminum, Antimony, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Titanium, Vanadium, Zinc. Use "Ghost" wipe.
Wood Dust N/A	C-11 PVC, Preweighed, 37mm, 5um, 2PC, C-11	100 - 500	1.5 - 2.0	50	NIOSH 0500 Gravimetric		$20.00	Includes total airborne particulates. No speciation possible as to wood dust type.

Sampling Equipment

- Good working order
- Availability
  - Plus additional back ups
- Charged

Sampling Necessary?

- Potential exposure?
- Related symptoms present?
- Contaminant / Condition present?
- Employer's exposure assessment?
- Previous sampling conducted by NCDOL?

Sampling Necessary?

- Employer's exposure assessment
  - Who conducted the sampling?
    - » Credentials?
    - » Third-party?
  - Sampling Method Used?
  - Sample Time?
  - Employee(s) Sampled?
    - » Representative?
  - Operation(s)
  - Number of samples?
  - Meets requirements of standard where applicable?
    - » e.g., ethylene oxide – [C_2H_4O]

Sampling Necessary?

- OSHA's additional monitoring requirement
  - Whenever there has been a change in the **production**, **process**, **control equipment**, **personal** or **work practices** that may result in new or additional exposures or when the employer has **any reason to suspect that a change** may result in new or additional exposures.

Includes Personal

- Asbestos
  - 1910.1001(d)(5)
  - 1926.1101(f)(4)(ii)
- Inorganic Arsenic
  - 1910.1018(e)(4)
  - **1926.1118**
- Beryllium
  - 1910.1024(d)(4)
  - **1926.1124(d)(4)**
- Lead
  - 1910.1025(d)(7)
  - 1926.62(d)(7)
- Chromium (VI)
  - 1910.1026(d)(2)(vi)
  - 1910.1126(d)(2)(vi)
- Cadmium
  - 1910.1027(d)(4)
  - 1910.1126(d)(4)
- DBCP
  - 1910.1044(f)(4)
  - **1926.1144**
- Acrylonitrile
  - 1910.1045(e)(4)
  - **1910.1145**
- Ethylene Oxide
  - 1910.1047(d)(5)
  - **19126.147**
- MDA
  - 1910.1050(e)(5)
  - 1926.60(f)(5)
- 1,3-Butadiene
  - 1910.1051(d)(5)(i)
- Silica
  - 1910.1053(d)(4)
  - 1926.1153(d)(2)(iv)

Differences

- Doesn't include personal
  - Vinyl Chloride
    - » 1910.1017(d)(3)
    - » **1926.1117**
  - Coke Oven Emissions
    - » 1910.1029(e)(2)
    - » **1926.1129**
  - Cotton Dust
    - » 1910.1043(d)(3)(iii)
  - Methylene Chloride
    - » 1910.1052(d)(4)(i)
    - » **1926.1152**
- Unique
  - Formaldehyde
    - » 1910.1048
    - » **1926.1148**
  - 13 Carcinogens
    - » 1910.1003 – 1910.1016
    - » **1926.1103 – 1926.1116**

NCDOL Sampling

North Carolina Department of Labor
Occupational Safety & Health Division

Workplace Measurement Summary

Date: [redacted] *2015*

Company: [redacted]

Site Address: [redacted]

Sampling Date(s): [redacted]

Industrial Hygienist(s): John Jaskolka

Inspection Number: [redacted]

During a recent North Carolina Occupational Safety and Health Compliance inspection, employee exposure monitoring was performed for potential workplace hazards. All personal and/or area sampling data were obtained with pre- and post-calibrated equipment used in accordance with professional industrial hygiene practice. The exposure measurements are summarized below.

The scope of the sampling episode was limited to the activity in the work environment on the day of sampling. Although an effort was made to ensure sampling was conducted on a typical workday, the sampling data may not be representative of exposures on subsequent workdays due to changes in production, work practices, equipment, or other factors. **The data should not be used to predict exposures in the future in lieu of collection of additional monitoring data to determine compliance after changes are made to the work environment.**

Employee/ Operation Sampled (PPE Utilized)	Analyte (Method)	Sample Time (min.)	Exposure Level	Permissible Exposure Limit (PEL)	Notes - see table below
* [redacted]	Silica	221 minutes	ND	$\frac{10\ mg/m^3}{\%SiO_2 + 2}$	1
	Noise	221 minutes	88.8 dB(A)	85 dB(A)	1 & 2
			87.8 dB(A)	90 dB(A)	

NOTE: Exposure levels in **BOLD** exceed the OSHA Permissible Exposure Limit (PEL).

min = minutes
mg/m^3 = milligrams of contaminant per cubic meter of air
ND = none detected
TWA = time weighted average (8-hour)
AL = action level
A = A-scale weighted

Number	Notes (including environmental conditions or other variables that could have affected the results)
1	Unable to sample for 8 hours. (result will differ if work is increased)
2	The results show here are the average sound level. The exposure level for the action level is below the allowable dose.

It is the responsibility of the employer to inform affected employees of their rights to access their exposure records, including these results. This record must be maintained in accordance with 29 CFR 1910.1020, Access to Employee Exposure & Medical Records.

Sample results for employees with an asterisk (*) next to their name are representative of other employees who do the same type of work or work in the same area.

Regards,

CSHO Signature _____ Date _____

NCDOL Sampling

- The scope of the sampling episode was limited to the activity in the work environment on the day of sampling. Although an effort was made to ensure sampling was conducted on a typical workday, the sampling data may **not** be representative of exposures on subsequent workdays due to changes in production, work practices, equipment, or other factors.
- The **data should not be used to predict exposures in the future** in lieu of collection of additional monitoring data to determine compliance after changes are made to the work environment.

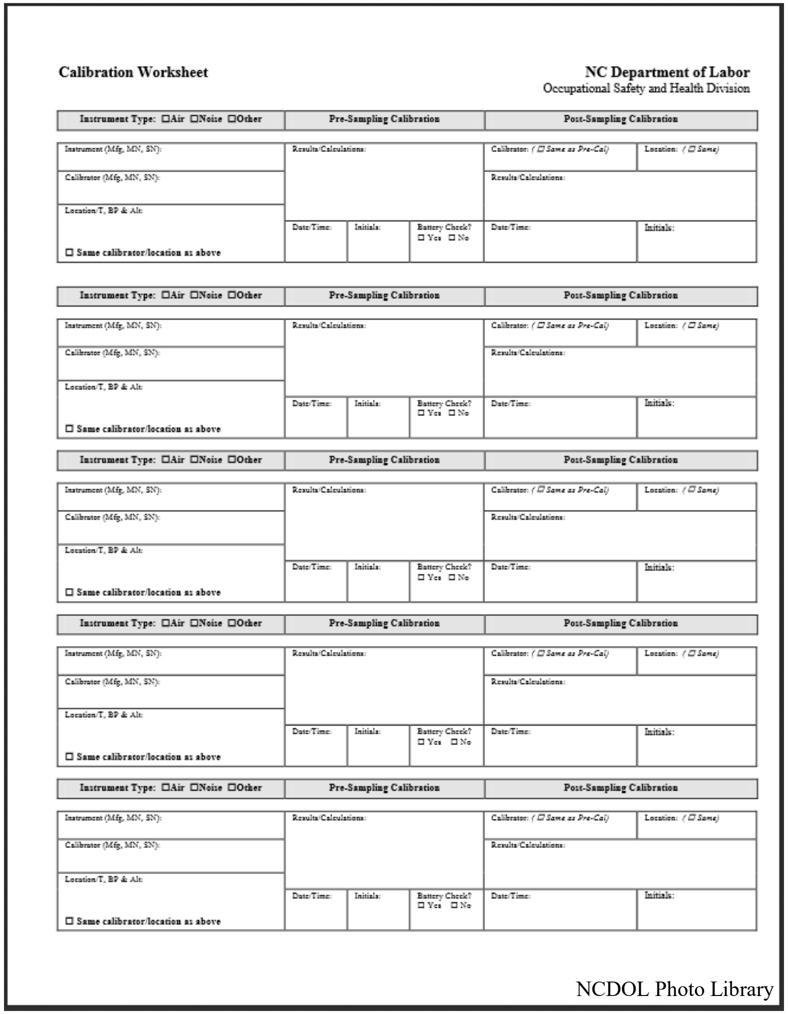
Sampling Necessary?

- FOM Chapter – XV.C.2.
  - Sampling procedures **should** be conducted for all complaints and referrals alleging exposure to substances.
  - If the CSHO determines that sampling is not necessary, the CSHO **will** discuss this with their supervisor.
  - If sampling is not conducted, the CSHO **will** document the reasons in the case file.

Sample Collection

- Air and Noise Samples

Calibration Worksheet



Calibration Worksheet

NC Department of Labor
Occupational Safety and Health Division

Instrument Type: ☐Air ☐Noise ☐Other	Pre-Sampling Calibration			Post-Sampling Calibration	
Instrument (Mfg, MN, SN):	Results/Calculations:			Calibrator: *(☐ Same as Pre-Cal)*	Location: *(☐ Same)*
Calibrator (Mfg, MN, SN):				Results/Calculations:	
Location/T, BP & Alt:	Date/Time:	Initials:	Battery Check? ☐ Yes ☐ No	Date/Time:	Initials:
☐ Same calibrator/location as above					

Instrument Type: ☐Air ☐Noise ☐Other	Pre-Sampling Calibration			Post-Sampling Calibration	
Instrument (Mfg, MN, SN):	Results/Calculations:			Calibrator: *(☐ Same as Pre-Cal)*	Location: *(☐ Same)*
Calibrator (Mfg, MN, SN):				Results/Calculations:	
Location/T, BP & Alt:	Date/Time:	Initials:	Battery Check? ☐ Yes ☐ No	Date/Time:	Initials:
☐ Same calibrator/location as above					

Instrument Type: ☐Air ☐Noise ☐Other	Pre-Sampling Calibration			Post-Sampling Calibration	
Instrument (Mfg, MN, SN):	Results/Calculations:			Calibrator: *(☐ Same as Pre-Cal)*	Location: *(☐ Same)*
Calibrator (Mfg, MN, SN):				Results/Calculations:	
Location/T, BP & Alt:	Date/Time:	Initials:	Battery Check? ☐ Yes ☐ No	Date/Time:	Initials:
☐ Same calibrator/location as above					

Instrument Type: ☐Air ☐Noise ☐Other	Pre-Sampling Calibration			Post-Sampling Calibration	
Instrument (Mfg, MN, SN):	Results/Calculations:			Calibrator: *(☐ Same as Pre-Cal)*	Location: *(☐ Same)*
Calibrator (Mfg, MN, SN):				Results/Calculations:	
Location/T, BP & Alt:	Date/Time:	Initials:	Battery Check? ☐ Yes ☐ No	Date/Time:	Initials:
☐ Same calibrator/location as above					

Instrument Type: ☐Air ☐Noise ☐Other	Pre-Sampling Calibration			Post-Sampling Calibration	
Instrument (Mfg, MN, SN):	Results/Calculations:			Calibrator: *(☐ Same as Pre-Cal)*	Location: *(☐ Same)*
Calibrator (Mfg, MN, SN):				Results/Calculations:	
Location/T, BP & Alt:	Date/Time:	Initials:	Battery Check? ☐ Yes ☐ No	Date/Time:	Initials:
☐ Same calibrator/location as above					

NCDOL Photo Library

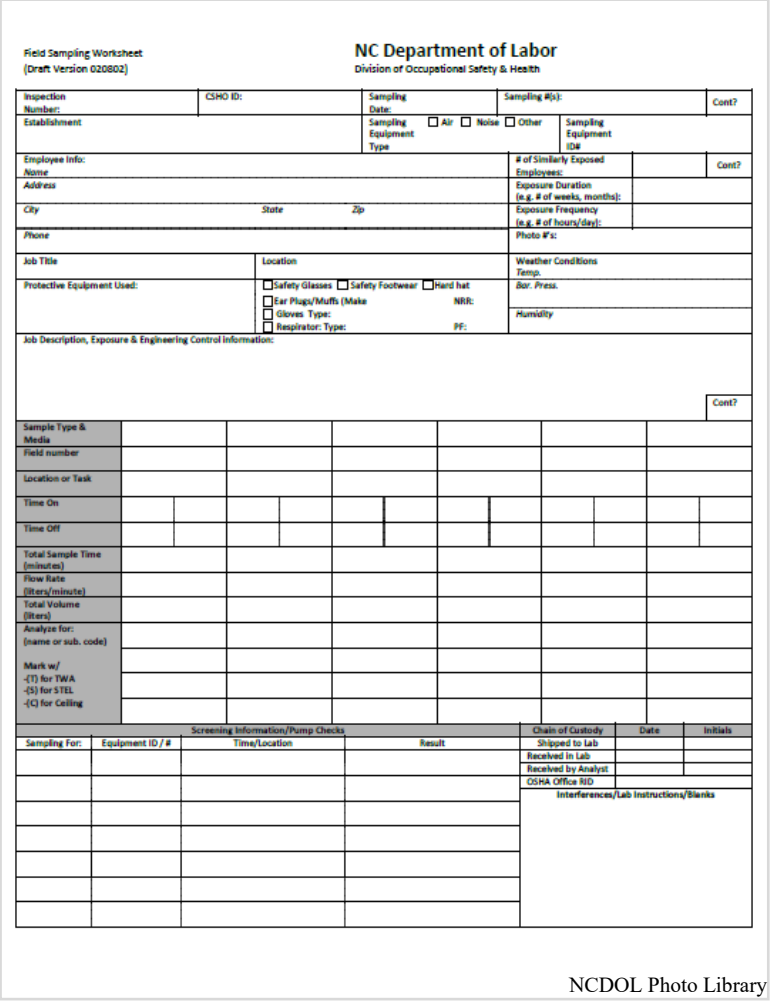
Calibration

- Sampling equipment checked out, inspected and calibrated before use (on-site if possible).
  - Pre and Post calibration must be recorded on the Calibration Worksheet for each piece of sampling equipment.

<table>
<tr><th>Instrument Type: ☐Air ☐Noise ☐Other</th><th colspan="3">Pre-Sampling Calibration</th><th colspan="2">Post-Sampling Calibration</th></tr>
<tr><td>Instrument (Mfg, MN, SN):</td><td colspan="3" rowspan="2">Results/Calculations:</td><td>Calibrator: (☐ Same as Pre-Cal)</td><td>Location: (☐ Same)</td></tr>
<tr><td>Calibrator (Mfg, MN, SN):</td><td colspan="2">Results/Calculations:</td></tr>
<tr><td rowspan="2">Location/T, BP & Alt:

☐ Same calibrator/location as above</td><td>Date/Time:</td><td>Initials:</td><td>Battery Check?
☐ Yes ☐ No</td><td>Date/Time:</td><td>Initials:</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Field Sampling Worksheet



Field Sampling Worksheet
(Draft Version 020802)

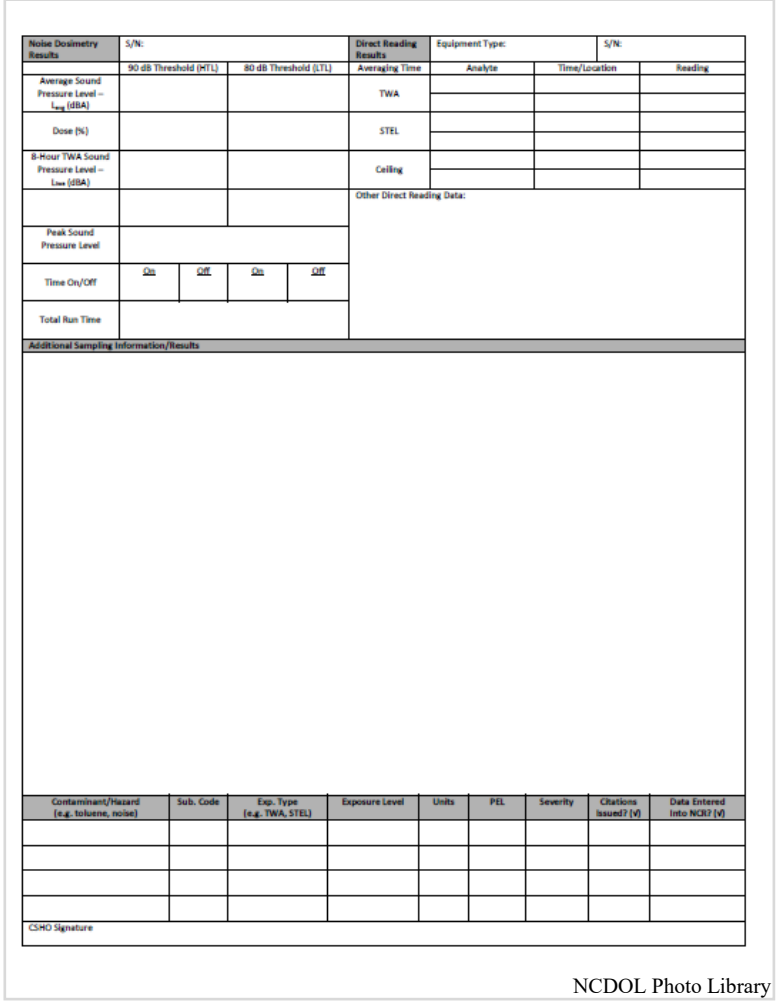
NC Department of Labor
Division of Occupational Safety & Health

Inspection Number:	CSHO ID:	Sampling Date:	Sampling #(s):	Cont?
Establishment		Sampling Equipment Type ☐ Air ☐ Noise ☐ Other	Sampling Equipment ID#	
Employee Info: Name			# of Similarly Exposed Employees:	Cont?
Address			Exposure Duration (e.g. # of weeks, months):	
City	State	Zip	Exposure Frequency (e.g. # of hours/day):	
Phone			Photo #'s:	
Job Title	Location		Weather Conditions Temp.	
Protective Equipment Used:	☐Safety Glasses ☐Safety Footwear ☐Hard hat ☐Ear Plugs/Muffs (Make NRR: ☐Gloves Type: ☐Respirator: Type: PF:		Bar. Press. Humidity	
Job Description, Exposure & Engineering Control Information:				Cont?

Sample Type & Media											
Field number											
Location or Task											
Time On											
Time Off											
Total Sample Time (minutes)											
Flow Rate (liters/minute)											
Total Volume (liters)											
Analyze for: (name or sub. code)											
Mark w/ -(T) for TWA -(S) for STEL -(C) for Ceiling											

Screening Information/Pump Checks				Chain of Custody	Date	Initials
Sampling For:	Equipment ID / #	Time/Location	Result	Shipped to Lab		
				Received In Lab		
				Received by Analyst		
				OSHA Office RID		
				Interferences/Lab Instructions/Blanks		

NCDOL Photo Library



Noise Dosimetry Results	S/N:		Direct Reading Results	Equipment Type:	S/N:	
	90 dB Threshold (MTL)	80 dB Threshold (LTL)	Averaging Time	Analyte	Time/Location	Reading
Average Sound Pressure Level – L_{avg} (dBA)			TWA			
Dose (%)			STEL			
8-Hour TWA Sound Pressure Level – L_{twa} (dBA)			Ceiling			
			Other Direct Reading Data:			
Peak Sound Pressure Level						
Time On/Off	On / Off	On / Off				
Total Run Time						

Additional Sampling Information/Results

Contaminant/Hazard (e.g. toluene, noise)	Sub. Code	Exp. Type (e.g. TWA, STEL)	Exposure Level	Units	PEL	Severity	Citations Issued? (Y)	Data Entered into NCR? (Y)

CSHO Signature

NCDOL Photo Library

NCDOL
N.C. Department of Labor
Cherie Berry, Commissioner

OSH Division
Internal Training

For Public Officials' Use Only

Day of Sampling

- Field Sampling Worksheet

Inspection Number:	CSHO ID:	Sampling Date:	Sampling #(s):	Cont?
Establishment		Sampling Equipment Type ☐ Air ☐ Noise ☐ Other	Sampling Equipment ID#	
Employee Info: *Name*			# of Similarly Exposed Employees:	Cont?
Address			Exposure Duration (e.g. # of weeks, months):	
City *State* *Zip*			Exposure Frequency (e.g. # of hours/day):	
Phone			Photo #'s:	
Job Title	Location		Weather Conditions *Temp.*	
Protective Equipment Used:	☐ Safety Glasses ☐ Safety Footwear ☐ Hard hat ☐ Ear Plugs/Muffs (Make NRR: ☐ Gloves Type: ☐ Respirator: Type: PF:		*Bar. Press.* *Humidity*	
Job Description, Exposure & Engineering Control information:				Cont?

Day of Sampling

- Field Sampling Worksheet

Sample Type & Media						
Field number						
Location or Task						
Time On						
Time Off						
Total Sample Time (minutes)						
Flow Rate (liters/minute)						
Total Volume (liters)						
Analyze for: (name or sub. code)						
Mark w/ -(T) for TWA -(S) for STEL -(C) for Ceiling						

Day of Sampling

- Field Sampling Worksheet

Direct Reading Results	Equipment Type:		S/N:
Averaging Time	Analyte	Time/Location	Reading
TWA			
STEL			
Ceiling			
Other Direct Reading Data:			

Day of Sampling

- Field Sampling Worksheet

Noise Dosimetry Results	S/N:			
	90 dB Threshold (HTL)		80 dB Threshold (LTL)	
Average Sound Pressure Level – L_{avg} (dBA)				
Dose (%)				
8-Hour TWA Sound Pressure Level – L_{twa} (dBA)				
Peak Sound Pressure Level				
Time On/Off	On	Off	On	Off
Total Run Time				

Breaks and Sampling

- Lunch breaks
  - Not advisable to sample during lunch breaks
    - » Employee may leave the company premises
    - » Unless employees eat in areas where potential exposure exists.
- Bathroom breaks
  - Not advisable to sample during bathroom breaks.
    - » Depends on the sampling equipment (e.g., Edge 5s)
- Regular breaks
  - Continue to sample during regular breaks.
    - » Unless employees leave the company premises
    - » Unless employees go for a smoke break

Breaks and Sampling

- Removal of equipment
  - Turn off device prior to break and turn on again after returning from break.
  - Care taken to assure that contamination of collection medium does not occur.
    - » Ensure sample media and equipment go back on the same person.
  - The time it is off should not be counted as sample time for calculation of TWA.

Day of Sampling – Equipment Checks

- Field Sampling Worksheet

Screening Information/Pump Checks				Chain of Custody	Date	Initials
Sampling For:	Equipment ID / #	Time/Location	Result	Shipped to Lab		
				Received in Lab		
				Received by Analyst		
				OSHA Office RID		
				Interferences/Lab Instructions/Blanks		

Equipment Checks

FOM XV.C.2.c

- Once sampling equipment is placed on employee or area
  - Check on sampling equipment
    - First 30 minutes
    - 1-hour after the 30 minutes
    - 2 hours after the first hour
- CSHO must remain at workplace while samples are being collected.

Observation

- Observe employee(s) during sampling
  - Note any deviation(s) from procedure
    - » Non-routine tasks
    - » Additional protections
      - New engineering controls
      - Rotation
      - PPE usage
    - » Shorten duration
  - Anything else of importance

Day of Sampling - Observation

- Field Sampling Worksheet

Additional Sampling Information/Results
Record any and all observations here

After Sample Collection

- Post Calibrate sampling equipment, immediately after sampling.
  - Document on Calibration Worksheet for each piece of sampling equipment.
- Difference between pre and post flow rates as a general rule should not be greater than 5%

Instrument Type: ☐Air ☐Noise ☐Other	Pre-Sampling Calibration			Post-Sampling Calibration	
Instrument (Mfg, MN, SN):	Results/Calculations:			Calibrator: *(☐ Same as Pre-Cal)*	Location: *(☐ Same)*
Calibrator (Mfg, MN, SN):				Results/Calculations:	
Location/T, BP & Alt:	Date/Time:	Initials:	Battery Check? ☐ Yes ☐ No	Date/Time:	Initials:
☐ Same calibrator/location as above					

Example 1

Pre-Sampling Calibration			Post-Sampling Calibration	
Results/Calculations: **1.690 L/min** **1.710 L/min** **+ 1.683 L/min** **5.083** **5.083 / 3 = 1.694 L/min**			Calibrator: *(☑ Same as Pre-Cal)*	Location: *(☑ Same)*
			Results/Calculations: **1.769 L/min** **1.799 L/min** **+ 1.772 L/min** **5.34**	**5.34 / 3 =1.780 L/min**
Date/Time: **6-5-13** **4:49pm**	Initials: **JEJ**	Battery Check? ☑ Yes ☐ No	Date/Time: **6-7-13** **9:12am**	Initials: **JEJ**

Example 2

Pre-Sampling Calibration			Post-Sampling Calibration	
Results/Calculations: 51.281 mL/min 49.761 mL/min + 50.672 mL/min 151.714 3 = 50.571 mL/min			Calibrator: (☑ Same as Pre-Cal)	Location: (☑ Same)
			Results/Calculations: 48.418 mL/min 48.552 mL//min + 48.534 mL/min 145.504 $\frac{145.504}{3}$ = 48.501 mL/min	
Date/Time: 9-1-15 5:30am	Initials: JEJ	Battery Check? ☑ Yes ☐ No	Date/Time: 9-1-15 6:00pm	Initials: JEJ

Analytics Lab Test Request Form

Photo Source: NCDOL Photo Library

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
N C DEPT OF LABOR
O S H SECTION
1101 MAIL SERVICE CENTER
RALEIGH, NC 27699-1101
Phone: 919-779-8570
Fax: 1-919-662-4709
PROJ#: 32409015

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
PURCHASE ORDER NO.		CONTACT	TELEPHONE NUMBER
TURN AROUND TIME • ☐ SAMEDAY • ☐ 2 DAY		SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS:	☐ FAX RESULTS FAX NUMBER: ( )

SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE

FOLEY COMPANY - P.O. BOX 442, RICHMOND, VA 23218

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

CARRIER

IF "ANALYTICS COURIER" SIGN HERE

SIGN HERE TO INITIATE CHAIN OF CUSTODY

DATE

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
		SIGNATURE(SAMPLE RECEIVING)	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Calculating Sample Volume

- Sample Volume = Flow rate x time
  - Example
    - »Sampled at a flow rate of 1.7 L/min
    - »Sample for 7 hours (420 minutes)
    - »Sample Volume $= 1.7 \frac{L}{min}\ x\ 420\ min$
    - »Sample Volume $= 714\ L$

Calculating Sample Volume

- What is the sampling flow rate and sample volume for Example 2?

Pre-Calibration	Post-Calibration
50.571 mL/min	48.501 mL/min

1. Pre-cal = 50.571 mL/min
2. Post-cal = 48.501 mL/min
3. Average of pre and post = 49.536 mL/min

Answer

- Pre-cal = 50.571 mL/min
- Post-cal = 48.501 mL/min
- Average = 49.536 mL/min

Reason

- Example – PEL 1ppm
  - 43µg was detected on one sample collected over 480 minutes.

    - Typical reports
      - mg/m^3 and/or ppm
      - 43µg = 0.043mg

1. Pre-cal = 50.571 mL/min
2. Post-cal = 48.501 mL/min
3. Average of pre and post = 49.536 mL/min

Conversions

Pre-cal

- 50.571 mL/min x 480 min = 24274.08 mL
- 24274.08 ml = 24.27408 L = 0.02427408 m^3

Post-cal

- 48.501 mL/min x 480 min = 23280.48 mL
- 23280.48 mL = 23.28048 L = 0.02328048 m^3

Average

- 49.536 mL/min x 480 min = 23777.28 mL
- 23777.28 mL = 23.77728 L = 0.02377728 m^3

Concentrations

Pre-Cal

- 0.043mg / 0.02427408 m^3 = 1.77 mg/m^3
- 1.77 mg/m^3 = 0.98 ppm

Post-Cal

- 0.043mg / 0.02328078 m^3 = 1.85 mg/m^3
- 1.85 mg/m^3 = 1.03 ppm

Average

- 0.043mg / 0.02377728 m^3 = 1.81 mg/m^3
- 1.81 mg/m^3 = 1.00 ppm

Form 21 Tape


OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

SAMPLE SEAL

Form OSHA-21 DEC. 1971

SAMPLE NO. _____ DATE _____

COLLECTED BY _____ (SIGNATURE)

ANALYST _____

Form 21 Tape


ADMINISTRATION


OCCUPATIONAL SAFETY AND HEALTH
ADMINISTRATION
SAMPLE SEAL
Form OSHA-21 DEC. 1971


HEALTH

Form 21 Tape


Diffusion
SAMPLE NO.
COLLECTED
ANALYST
HEALTH
3M
3520


SAMPLE NO.
AFETY AND HEALTH

Sample Collection

- Wipe Samples

Wipe Sampling

- Wipe Sampling Procedures
  - FOM Chapter XV
    - » Refer to the OSHA Technical Manual
- Prior determination of wipe sample locations
  - Surfaces
    - » e.g., Floor, desks, tables, door knobs, etc.
  - Employees' skin
    - » e.g., hands, face.
- Each wipe sample
  - A new set of clean, disposable, powder-free gloves must be used for each sample.
    - » prevents false positives

Day of Sampling

- Record each location with a unique identifier.
  - Photograph each location and specify each location within the facility.
    - » If photographs cannot be taken, sketches, diagrams, and other means of identifying locations are acceptable.
- Don gloves
- Remove media (e.g., filter) from packaging / cassette / vial with tweezers or fingers.
  - If a damp wipe sample is desired, moisten the filter with distilled water or other solvent as recommended.
    - » Note: For skin sampling use only distilled water.

Day of Sampling

- Place single-use 10cm x 10cm templates at desired location
- Using the media, wipe an area about 100 cm^2, rubbing the entire area side to side, then up and down.
  - When wiping, apply firm pressure
  - In many cases (such as knobs and levers) it may not be possible to wipe 100 cm^2.
    - » Sample cannot be quantified
- Place media in a sample vial, cap and label it with the same unique identifier as the location.

Day of Sampling

- Remove and dispose gloves.
- Include additional relevant details regarding the nature of the sample
  - e.g., inside Fred's respirator, "x" distance from contaminant generating process
- At least one blank media treated in the same fashion, but without wiping, should be submitted for each sampled area.

Day of Sampling

- Some substances (e.g., benzidine, hexavalent chromium, and 4,4’-methylenedianiline) are unstable and may require a solution to be added to the vial as soon as the wipe sample is placed in the vial or may require other special sample handling.

After Sampling Collection

- Submit the samples, each sealed with a Form OSHA-21, and in accordance with any special procedures located in OTM Section II Chapter 4 (Sample Shipping and Handling).

Sample Collection

- Bulk Samples

Bulk Sampling

- Bulk Sampling Procedures
  - FOM Chapter XV
    - » Refer to the OSHA Technical Manual
- Locations
  - Prior determination after walk-around
  - Immediate during walk-around
- Equipment
  - Plastic container, natural bristle brush and non-sparking dust pans
    - » e.g., combustible dust
  - Plastic bag and gloves
    - » e.g., paint chips

Dust – Day of Sampling

- Each type of dust must be collected as a separate sample
  - Collect at least 1 liter of dust per sample
  - If grain dust collect two samples
- Suggested locations
  - "High spaces" such as roof beams, open web beams, and other ceiling supports; tops of pipes, railing, ductwork, conduit, electrical boxes/panels and other horizontal surfaces located as high in the overhead as possible.
    - » Samples from floor level present a significantly reduced potential for dust cloud generation

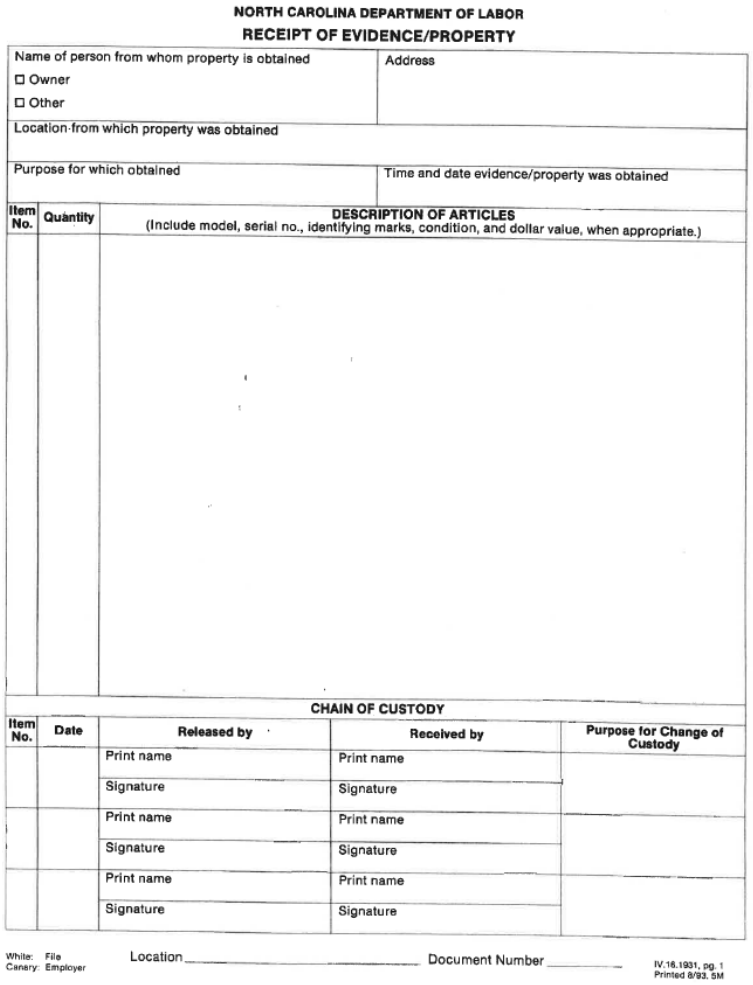
Dust – Day of Sampling

- Record each location where sample was collected.
  - Document each location within the facility.
    - » Do not take photographs
    - » Use sketches, diagrams, and other means of identifying locations were samples were taken from.
  - Document where, when, and how dust is used and/or generated.
- Don gloves
- Use natural bristle hand brush to sweep accumulated dust into non-sparking dust pans.

Dust – Day of Sampling

- Transfer dust from dust pans to plastic container.
- Upon completion
  - Affix an OSHA-21 sample identification seal to the container.
    - » To seal the container, apply one end of the seal to the center of the lid, and run the seal down the edge of the lid and as far down the side of the container as it will reach
  - Complete the Receipt of Evidence or Property Form
  - If available collect MSDS/SDS of dust or raw materials

Receipt of Evidence/Property Form



NORTH CAROLINA DEPARTMENT OF LABOR

RECEIPT OF EVIDENCE/PROPERTY

Name of person from whom property is obtained ☐ Owner ☐ Other	Address
Location from which property was obtained	
Purpose for which obtained	Time and date evidence/property was obtained

Item No.	Quantity	DESCRIPTION OF ARTICLES (Include model, serial no., identifying marks, condition, and dollar value, when appropriate.)

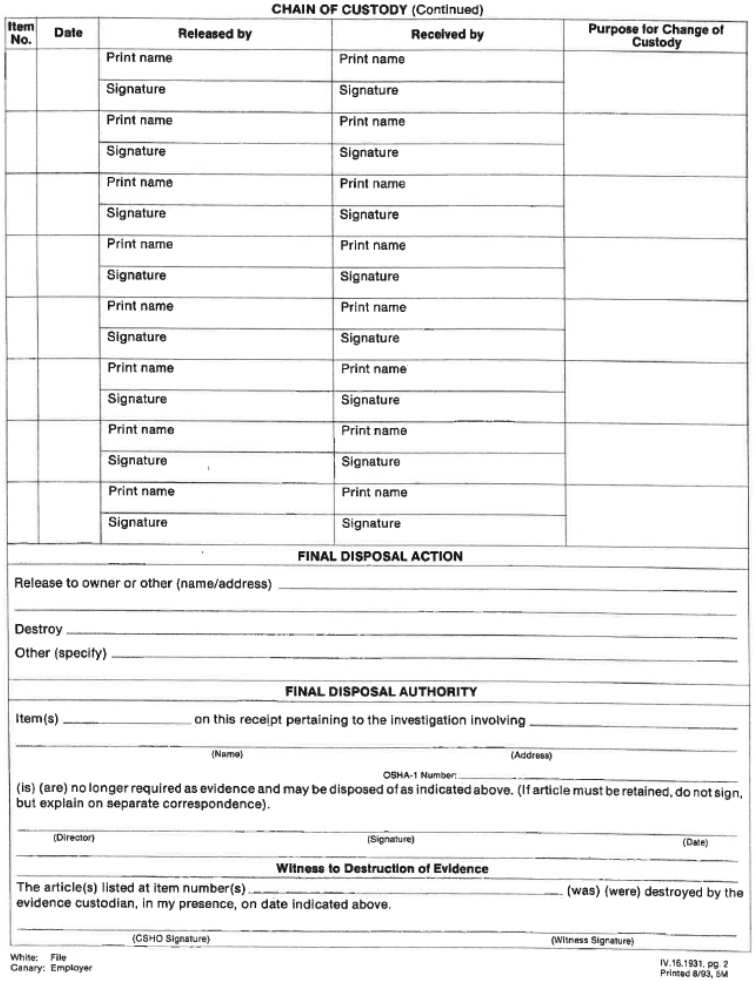
CHAIN OF CUSTODY

Item No.	Date	Released by	Received by	Purpose for Change of Custody
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	

White: File
Canary: Employer

Location _____ Document Number _____

IV.16.1931, pg. 1
Printed 8/93, 5M



CHAIN OF CUSTODY (Continued)

Item No.	Date	Released by	Received by	Purpose for Change of Custody
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	
		Print name	Print name	
		Signature	Signature	

FINAL DISPOSAL ACTION

Release to owner or other (name/address) _____

Destroy _____

Other (specify) _____

FINAL DISPOSAL AUTHORITY

Item(s) _____ on this receipt pertaining to the investigation involving _____

(Name) (Address)

OSHA-1 Number: _____

(is) (are) no longer required as evidence and may be disposed of as indicated above. (If article must be retained, do not sign, but explain on separate correspondence).

(Director) (Signature) (Date)

Witness to Destruction of Evidence

The article(s) listed at item number(s) _____ (was) (were) destroyed by the evidence custodian, in my presence, on date indicated above.

(CSHO Signature) (Witness Signature)

White: File
Canary: Employer

IV.16.1931, pg. 2
Printed 8/93, 5M

NCDOL
N.C. Department of Labor
Cherie Berry, Commissioner

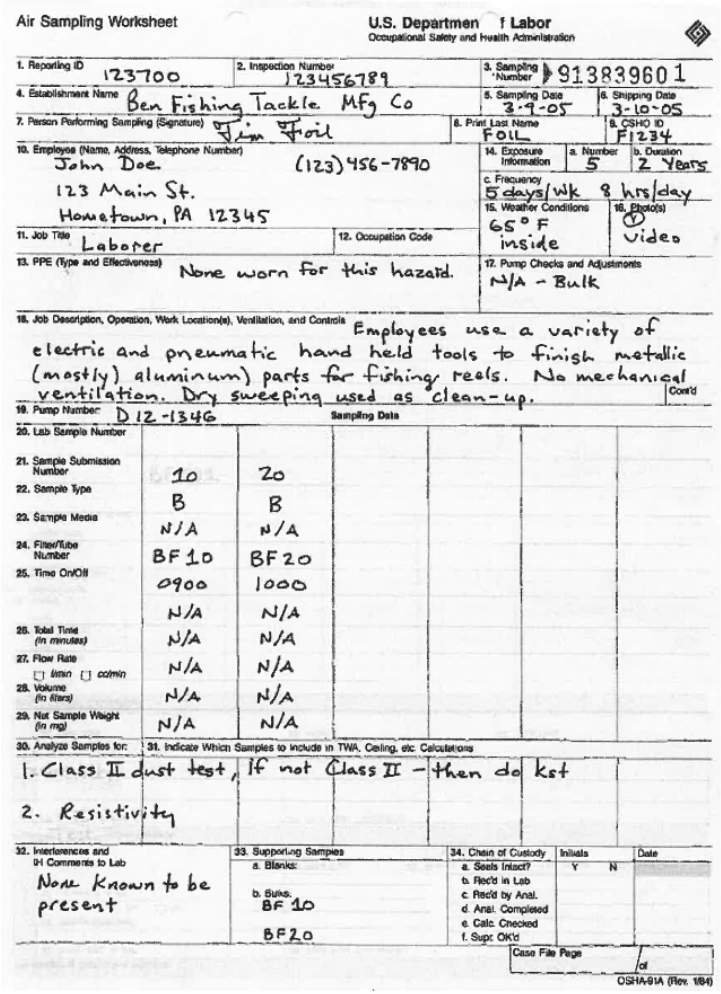
OSH Division
Internal Training

For Public Officials' Use Only

Dust – Day of Sampling

- Storage
  - Secure sample(s)
- Approval must be received prior to sending sample for analysis
  - Typically after file is contested
- Fill out form 91 to submit to SLTC
  - Must specify test to be done
    - » Request “Potential Class II Dust” to support electrical violations
      - e.g., 29 CFR 1910.307
    - » Request “Kst” to support fire or explosion hazards that may result from housekeeping or 95-129(1).

Dust - Submission



Air Sampling Worksheet

U.S. Department of Labor
Occupational Safety and Health Administration

1. Reporting ID	123700
2. Inspection Number	123456789
3. Sampling Number	913839601
4. Establishment Name	Ben Fishing Tackle Mfg Co
5. Sampling Date	3-9-05
6. Shipping Date	3-10-05
7. Person Performing Sampling (Signature)	Jim Foil
8. Print Last Name	FOIL
9. OSHO ID	F1234
10. Employee (Name, Address, Telephone Number)	John Doe. (123) 456-7890 123 Main St. Hometown, PA 12345
14. Exposure Information	a. Number 5 b. Duration 2 Years
c. Frequency	5 days/wk 8 hrs/day
15. Weather Conditions	65° F inside
16. Photo(s)	(Y) Video
11. Job Title	Laborer
12. Occupation Code	
13. PPE (Type and Effectiveness)	None worn for this hazard.
17. Pump Checks and Adjustments	N/A - Bulk

18. Job Description, Operation, Work Location(s), Ventilation, and Controls: Employees use a variety of electric and pneumatic hand held tools to finish metallic (mostly) aluminum) parts for fishing reels. No mechanical ventilation. Dry sweeping used as clean-up. Con'd

19. Pump Number: D12-1346

Sampling Data

20. Lab Sample Number						
21. Sample Submission Number	10	20				
22. Sample Type	B	B				
23. Sample Media	N/A	N/A				
24. Filter/Tube Number	BF10	BF20				
25. Time On/Off	0900	1000				
	N/A	N/A				
26. Total Time (in minutes)	N/A	N/A				
27. Flow Rate ☐ l/min ☐ cc/min	N/A	N/A				
28. Volume (in liters)	N/A	N/A				
29. Net Sample Weight (in mg)	N/A	N/A				

30. Analyze Samples for: 31. Indicate Which Samples to Include in TWA, Ceiling, etc. Calculations

1. Class II dust test, if not Class II - then do ksf
2. Resistivity

32. Interferences and (H Comments to Lab	33. Supporting Samples	34. Chain of Custody	Initials	Date
None known to be present	a. Blanks:	a. Seals Intact?	Y N	
	b. Bulks: BF10	b. Rec'd in Lab		
	BF20	c. Rec'd by Anal.		
		d. Anal. Completed		
		e. Calc. Checked		
		f. Supv. OK'd		

Case File Page / of

OSHA-91A (Rev. 1/84)

Evaluation of Sampling Results

- Air and Noise Samples

Understanding Results

- Direct Reading Results
  - Directly displayed on screen
  - Print outs
- In-House Results
  - Equipment software
    - Print outs
- Laboratory Results
  - Mailed results
    - Amount detected

Direct Print Out – Sound Results: Edge 5s

Session Report [redacted]

Description	Meter	Value	Description	Meter	Value
PKtime	1	[redacted] 8:52:03 AM	Lavg	1	95.9 dB
TWA	1	95.7 dB	ProjectedTWA (8:00)	1	95.9 dB
Dose	1	220.7 %	Pdose (8:00)	1	228.8 %
Exchange Rate	1	5 dB	Criterion Level	1	90 dB
Projection Time	1	480 mins.	Integrating Threshold	1	80 dB
Int Threshold Enable	1	True	Weighting	1	A
Peak Weighting	1	Z	Response	1	SLOW

Comments [redacted]
Location
User Name
Start Time [redacted] 8:17:26 AM
Stop Time [redacted] 4:00:19 PM
Run Time 07:42:53

Logged Data Table

Date/Time	Lavg-1	Lavg-2

Page 1

3M

Direct Print Out – Sound Results: Edge 5s

Description	Meter	Value	Description	Meter	Value
PKtime	2	[redacted] 8:52:03 AM	Lavg	2	95.6 dB
TWA	2	95.4 dB	ProjectedTWA (8:00)	2	95.6 dB
Dose	2	212.4 %	Pdose (8:00)	2	220.2 %
Exchange Rate	2	5 dB	Criterion Level	2	90 dB
Projection Time	2	480 mins.	Integrating Threshold	2	90 dB
Int Threshold Enable	2	True	Weighting	2	A
Peak Weighting	2	Z			

Information Panel

Name	Study 3
Comments	[redacted]
Location	
User Name	
Start Time	[redacted] 8:17:26 AM
Stop Time	[redacted] 4:00:19 PM
Run Time	07:42:53

Logged Data Table

Date/Time	Lavg-1	Lavg-2

Page 1

3M

Direct Print Out – Sound Results: Edge 5s

- Threshold – 80 dB(A)
  - AL 85 dB(A)
    - » TWA – 95.7 dB
      - Projected – 95.9 dB
    - » Dose – 220.7%
      - Projected – 228.8%
    - » Lavg – 95.9 dB
    - » Peak – 104.8 dB
- Threshold – 90 dB(A)
  - PEL 90 dB(A)
    - » TWA – 95.4 dB
      - Projected – 95.6 dB
    - » Dose – 212.4%
      - Projected – 220.2%
    - » Lavg – 95.6 dB
    - » Peak – 104.8 dB

Noise Equations

- Dose
  - $\%D = 100\left[\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots \frac{C_n}{T_n}\right]$
    - C is the total time of exposure at specific noise level
    - T is reference duration for noise exposure
    - %D is percentage dose

Dose Example

- Calculate the dose for an employee who is exposed to the follow noise levels:
  - 95 dB(A) for 1 hour
  - 90 dB(A) for 3 hours
  - 105 dB(A) for 10 minutes
  - 93 dB(A) for 2 hours
  - 86 dB(A) for 1 hour
  - Answer:

Noise Equations

- TWA
  - $TWA = 16.61 \log\left(\frac{\%D}{100}\right) + 90\ dBA$
  - %D is percentage dose

TWA Noise Example

- Calculate the TWA in dB(A) for an employee was exposed to noise at a dose of 140.7%
  - Answer:

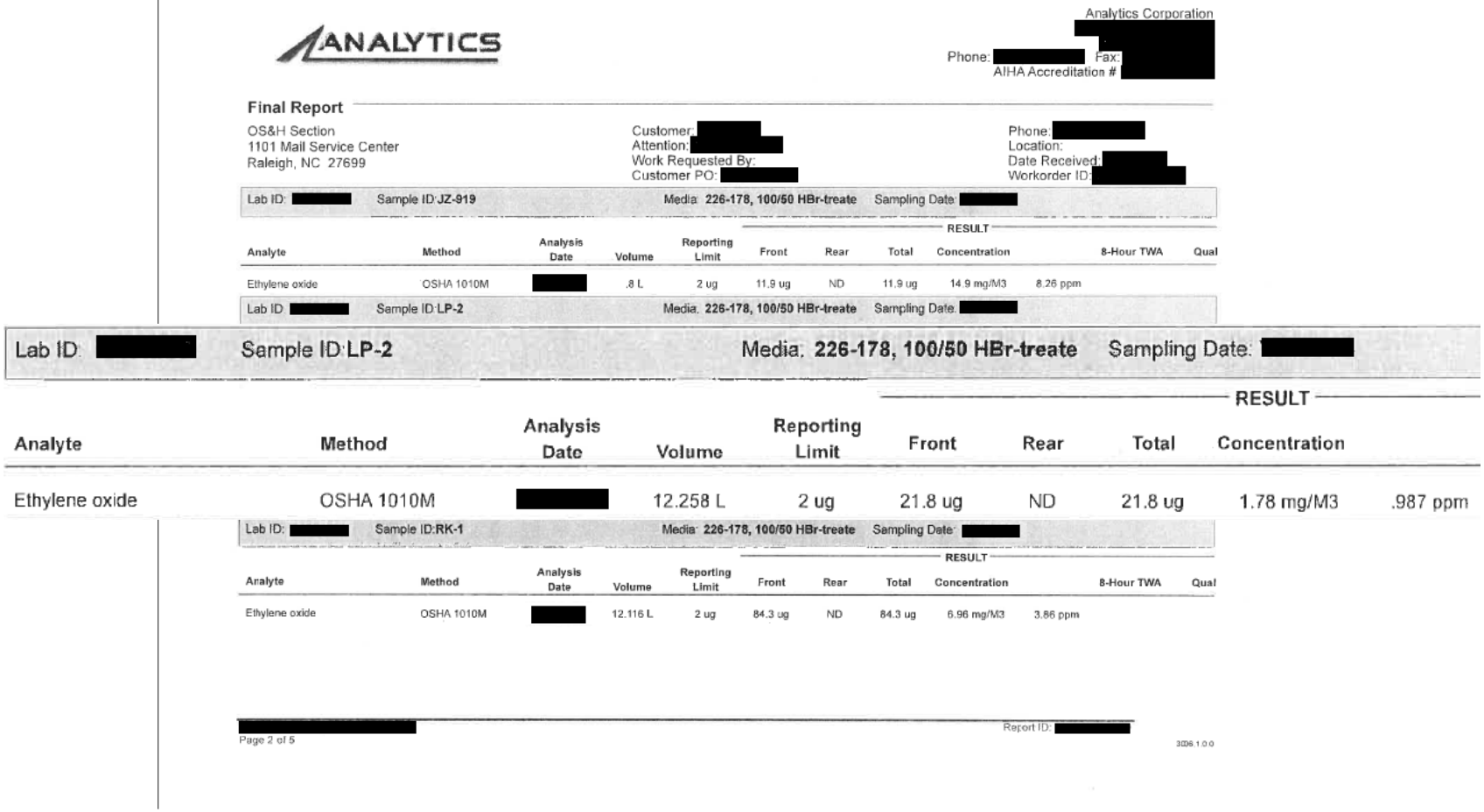
Noise Equations

- Distance
  - $SPL_2 = SPL_1 + 20 \log\left(\frac{d_1}{d_2}\right)$
  - SPL is sound pressure level in dB(A)
  - d is distance in feet or meters

Distance Noise Example

- You measure the sound pressure level of 95 dB(A) from 5 feet away from the noise source, what is the sound pressure level the employee is exposed to at 1 foot away?
  - Answer:

Laboratory Results



ANALYTICS

Analytics Corporation
[redacted]
Phone: [redacted] Fax: [redacted]
AIHA Accreditation # [redacted]

Final Report

OS&H Section
1101 Mail Service Center
Raleigh, NC 27699

Customer: [redacted]
Attention: [redacted]
Work Requested By:
Customer PO: [redacted]

Phone: [redacted]
Location:
Date Received: [redacted]
Workorder ID: [redacted]

Lab ID: [redacted] Sample ID: **JZ-919** Media: **226-178, 100/50 HBr-treate** Sampling Date: [redacted]

Analyte	Method	Analysis Date	Volume	Reporting Limit	RESULT Front	Rear	Total	Concentration	8-Hour TWA	Qual
Ethylene oxide	OSHA 1010M	[redacted]	.8 L	2 ug	11.9 ug	ND	11.9 ug	14.9 mg/M3	8.26 ppm	

Lab ID: [redacted] Sample ID: **LP-2** Media: **226-178, 100/50 HBr-treate** Sampling Date: [redacted]

Analyte	Method	Analysis Date	Volume	Reporting Limit	RESULT Front	Rear	Total	Concentration	
Ethylene oxide	OSHA 1010M	[redacted]	12.258 L	2 ug	21.8 ug	ND	21.8 ug	1.78 mg/M3	.987 ppm

Lab ID: [redacted] Sample ID: **RK-1** Media: **226-178, 100/50 HBr-treate** Sampling Date: [redacted]

Analyte	Method	Analysis Date	Volume	Reporting Limit	RESULT Front	Rear	Total	Concentration	8-Hour TWA	Qual
Ethylene oxide	OSHA 1010M	[redacted]	12.116 L	2 ug	84.3 ug	ND	84.3 ug	6.96 mg/M3	3.86 ppm	

[redacted] Report ID: [redacted]

Page 2 of 5

3D8.1.0.0

Sample Break-Through

- Sample break-through
  - If the back-up section of the sampling media contains >25% of the contaminant then the sample should be considered invalid.

Front	Rear
77.2 ug	ND

Equations

- Calculation of **potential exposure** concentrations

- However, no more than eight hours of sampling can be used in the 8-hour TWA calculation

Equations

- A zero exposure will be assumed unless the CSHO can defend a professional judgment on the magnitude of the exposure for the unsampled period. Thus, a TWA should generally be calculated by dividing the sample results by 8 hours (or 480 minutes) rather than the actual time sampled

TWA Equations

- Actual
  - $TWA = \frac{C_1T_1+C_2T_2+C_3T_3+....C_nT_n}{T_1+T_2+T_3+....T_n}$
- 8-hour
  - $TWA = \frac{C_1T_1+C_2T_2+C_3T_3+....C_nT_n}{480\ minutes\ or\ 8\ hours}$

  - C is concentration
  - T is actual duration of time sampled

TWA Example 1

- Sampling for Sulfuric Acid.
  - **PEL** is **1 mg/m^3**
  - Take one sample
    - The sampling pump ran for **7 hours** or **420 minutes**.
  - The laboratory reported a concentration of **1.1 mg/m^3**.
    - 8-hour TWA

TWA Example 2

- Sampling for Sulfuric Acid.
  - ***Take two samples***
    - » ***Sample 1***
      - The sampling pump ran for **4 hours** or **240 minutes.**
      - The laboratory reported a concentration of ***1.12 mg/m^3 .***
    - » ***Sample 2***
      - The sampling pump ran for **4 hours** or **240 minutes**.
      - The laboratory reported a concentration of **1.13 mg/m^3**
        - Actual & 8-hour TWA

Sulfuric Acid Sampling

- Example 1
  - 1 sample taken
    - » 7 hours sampled
    - » **8-hour TWA**
      - 0.9625 mg/m^3
    - » **Actual TWA**
      - 1.1 mg/m^3

- Example 2
  - 2 samples taken
    - » 8 hours sampled
    - » **Actual & 8-hour TWA**
      - 1.125 mg/m^3

Equations

- Severity / hazard ratio
  - $Y = \frac{C}{OEL}$
  - Y is the severity or hazard ratio
  - C is the concentration or employee exposure
  - OEL is the Occupational Exposure Limit

Severity / Hazard Ratio

- Example 1
  - 8-hour TWA
    - » 0.9625 mg/m^3
    - » $Y = \frac{0.9625}{1}$
    - » $Y = 0.9625$
    - » 96.25% of the PEL
- Example 2
  - 8-hour TWA
    - » 1.125 mg/m^3
    - » $Y = \frac{1.125}{1}$
    - » $Y = 1.125$
    - » 112.5% of the PEL

TWA Mixture Equation

- For substances with occupational exposure limits (OELs) established for similar toxicological pathways and target organs.
  - Compare results to unity (1)
    - » < 1 – below combined OEL
    - » > 1 – exceeds combined OEL
  - $= \frac{C_1}{OEL_1} + \frac{C_2}{OEL_2} + \ldots \frac{C_n}{OEL_n}$
  - C is 8-hour TWA concentration
  - OEL is Occupational Exposure Limit

Mixture Example

- Sampling conducted
  - carbon tetrachloride
    - » ***Sample 1*** reported **2.9 ppm** collected over **4 hours**
    - » ***Sample 2*** reported **3.5 ppm** collected over **4 hours**
      - **PEL** is **10 ppm**
  - trichloroethylene
    - » ***Sample 1*** reported **30 ppm** collected over **4 hours**
    - » ***Sample 2*** reported **60 ppm** collected over **4 hours**
      - **PEL** is **100 ppm**
  - vinyl chloride
    - » ***Sample 1*** reported **0.39 ppm** collected over **4 hours**
    - » ***Sample 2*** reported **0.23 ppm** collected over **4 hours**
      - **PEL** is **1 ppm**

Mixture Example

- carbon tetrachloride
  - TWA is 3.2 ppm
- trichloroethylene
  - TWA is 45 ppm
- vinyl chloride
  - TWA is 0.31 ppm
- Now we can do the mixture equation (E_m)
  - $E_m = \frac{3.2}{10} + \frac{45}{100} + \frac{0.31}{1}$
  - $E_m = 1.08$
  - E_m > 1, exceeds

Statistical Analysis

Accuracy of air sampling

- Air sampling accuracy is ± 25% of the true value (given the errors during calibration, sampling, and analytical methods).

Statistical Equations

- Sampling and Analytical Error (SAE)
  - $SAE = 1.645\ x\ S_{rT}$
    - » 1.645 is a statistical constant
    - » S_{rT} is the Overall Precision
- OSHA Methods: SAE can be read directly
- NIOSH Methods: Must be calculated
- Not listed: Contact the laboratory to get the SAE

Statistical Equations

- Confidence Limits: **Full-Period, Single Sample**
  - Upper Confidence Limit (UCL)
    - $UCL = Y + SAE$
  - Lower Confidence Limit (LCL)
    - $LCL = Y - SAE$
  - Y is severity / hazard ratio.
  - SAE is sampling and analytical error.
- If LCL is ≥ 1, then a violation exists with a 95% confidence

TWA Examples

- Sampling for Sulfuric Acid.
  - NIOSH Method 7903
    - » The **SrT** is **0.087**
- Sampling and Analytical Error
  - $SAE = 1.645\ x\ 0.087$
  - $SAE = 0.143115$

TWA Example 1

- **Example 1**
  - Lower Confidence Limit (LCL)
    - » $LCL = 0.8194$
  - Upper Confidence Limit (UCL)
    - » $UCL = 1.1056$
  - $LCL_{95\%} < 1$ & $UCL_{95\%} > 1$
    - » the results are in the possible overexposure region.

- **Example 2**
  - Lower Confidence Limit (LCL)
    - » $LCL = 0.981885$
  - Upper Confidence Limit (UCL)
    - » $UCL = 1.268115$
  - $LCL_{95\%} < 1$ & $UCL_{95\%} > 1$
    - » the results are in the possible overexposure region.

Statistical Equations

- Confidence Limits: **Full-Period, Consecutive Sampling**
  - Upper Confidence Limit (UCL)

$$UCL = Y + \frac{\left\{SAE\sqrt{[(T_1X_1)^2+(T_2X_2)^2+\ldots(T_nX_n)^2]}\right\}}{[PEL(T_1+T_2+\ldots T_n)]}$$

  - Lower Confidence Limit (LCL)

$$LCL = Y - \frac{\left\{SAE\sqrt{[(T_1X_1)^2+(T_2X_2)^2+\ldots(T_nX_n)^2]}\right\}}{[PEL(T_1+T_2+\ldots T_n)]}$$

  - Y is severity / hazard ratio
  - SAE is sampling and analytical error
  - T is actual duration of time sampled
  - X is concentration

TWA Example 2

- Calculated
  - TWA = 1.125 mg/m3
  - Severity / hazard ratio = 1.125
- Lower Confidence Limit (LCL)
  - $LCL = 1.125 - \frac{\left\{0.143115\sqrt{[(4\ hours\ x\ 1.13\ mg/m^3)^2+(4\ hours\ x\ 1.12\ mg/m^3)^2]}\right\}}{[1\ mg/m^3(4\ hours\ +4\ hours)]}$
  - $LCL = 1.011152$

Statistical Equation

- Confidence Limits: **Mixtures**
  - $CL = 1 + R_{St}$
    - » $R_{St} = [(R_1 SAE_1)^2 + (R_2 SAE_2)^2 + \ldots (R_n SAE_n)^2]^{0.5}$
      - $R_1 = \frac{Y_1}{E_m}$
  - CL is mixture control limit
  - E_m is the equivalent exposure for the mixture
  - Y is the exposure ratio
  - R is the ratio to total exposure
  - SAE is the sampling and analytical error
- If $E_m > 1$ and $E_m > CL$ = an overexposure

Mixture Example

- TWA
  - carbon tetrachloride
    - » $TWA = 3.2\ ppm$
  - trichloroethylene
    - » $TWA = 45\ ppm$
  - vinyl chloride
    - » $TWA = 0.31\ ppm$

- $E_m = 1.08$

Mixture Example

- $E_m = 1.08$
  - carbon tetrachloride
    - $TWA = 3.2\ ppm$
    - $Y = 0.32$
    - $SAE = 0.15134$
  - trichloroethylene
    - $TWA = 45\ ppm$
    - $Y = 0.45$
    - $SAE = 0.13489$
  - vinyl chloride
    - $TWA = 0.31\ ppm$
    - $Y = 0.31$
    - $SAE = 0.0987$

Mixture Example

- Ratio to total exposure
  - carbon tetrachloride
    - » $R_C = \frac{0.32}{1.08}$
    - » $R_C = 0.2963$
  - trichloroethylene
    - » $R_T = \frac{0.45}{1.08}$
    - » $R_T = 0.4167$
  - vinyl chloride
    - » $R_V = \frac{0.3}{1.08}$
    - » $R_V = 0.2870$

Mixture Example

- $E_m = 1.08$
  - carbon tetrachloride
    - » $TWA = 3.2\ ppm$
    - » $Y = 0.32$
    - » $SAE = 0.15134$
    - » $R_C = 0.2963$
  - trichloroethylene
    - » $TWA = 45\ ppm$
    - » $Y = 0.45$
    - » $SAE = 0.13489$
    - » $R_T = 0.4167$
  - vinyl chloride
    - » $TWA = 0.31\ ppm$
    - » $Y = 0.31$
    - » $SAE = 0.0987$
    - » $R_V = 0.2870$

Mixture Example

- Total Ratio
  - $R_{St} = [(0.2963\ x\ 0.15134)^2 + (0.4167\ x\ 0.13489)^2 + (0.287\ x\ 0.0987)^2]^{0.5}$
  - $R_{St} = 0.07728057$
- Mixture Control limit
  - $CL = 1 + 0.07728057$
  - $CL = 1.07728057$
- Em = 1.08
- CL = 1.077
- $E_m > 1$ & $E_m > CL$.
  - Therefore, an violation has been established.

Equations

- Field Sampling Worksheet

Additional Sampling Information/Results

Recorded observations

Recommended to include your calculations in this area as well

TWA

$$TWA = \frac{(2.9\ ppm\ x\ 4\ hours) + (3.5\ ppm\ x\ 4\ hours}{8\ hours}$$

$$TWA = 3.2\ ppm$$

Severity

$$Y = \frac{3.2}{10}$$

$$Y = 0.32$$

Evaluation of Sampling Results

- Wipe Samples

Wipe Results

- OSHA does not have standards setting limits for surface contamination.
  - Standard with housekeeping sections
    - » Inorganic arsenic – §1910.1018
    - » Beryllium – §1910.1024
    - » Lead – §1910.1025 & §1926.62
    - » Chromium (VI) – §1910.1026 & §1926.1126
    - » Cadmium – §1910.1027 & §1926.1127
    - » Etc.
      - All use that same language “as free as practicable”.

Wipe Results

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. [redacted]
Account No. [redacted]
Report Date: [redacted]

[redacted]
N C DEPT OF LABOR
O S H SECTION
1101 MAIL SERVICE CENTER
RALEIGH, NC 27699-1101

**** FINAL REPORT ****

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001 1	Samp Date: [redacted]		Wipe Sample			
-	Lead	NAG L	2.73 ug	2 ug	-- --	[redacted]
-001 1	Samp Date: [redacted]		Wipe Sample			
-	Lead	NAG L	2.73 ug	2 ug	-- --	[redacted]
-002 2	Samp Date: [redacted]		Wipe Sample			
-	Lead	NAG L	< 2.0 ug	2 ug	-- --	[redacted]
-003 3	Samp Date: [redacted]		Wipe Sample			
-	Lead	NAG L	2.76 ug	2 ug	-- --	[redacted]
-004 4	Samp Date: [redacted]		Wipe Sample			
-	Lead	NAG L	< 2.0 ug	2 ug	-- --	[redacted]
-005 5	Samp Date: [redacted]		Wipe Sample			
-	Lead	NAG L	< 2.0 ug	2 ug	-- --	[redacted]

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, NTG = No Time Given, LOQ = Limit of Quantitation.

Understanding Wipe Results

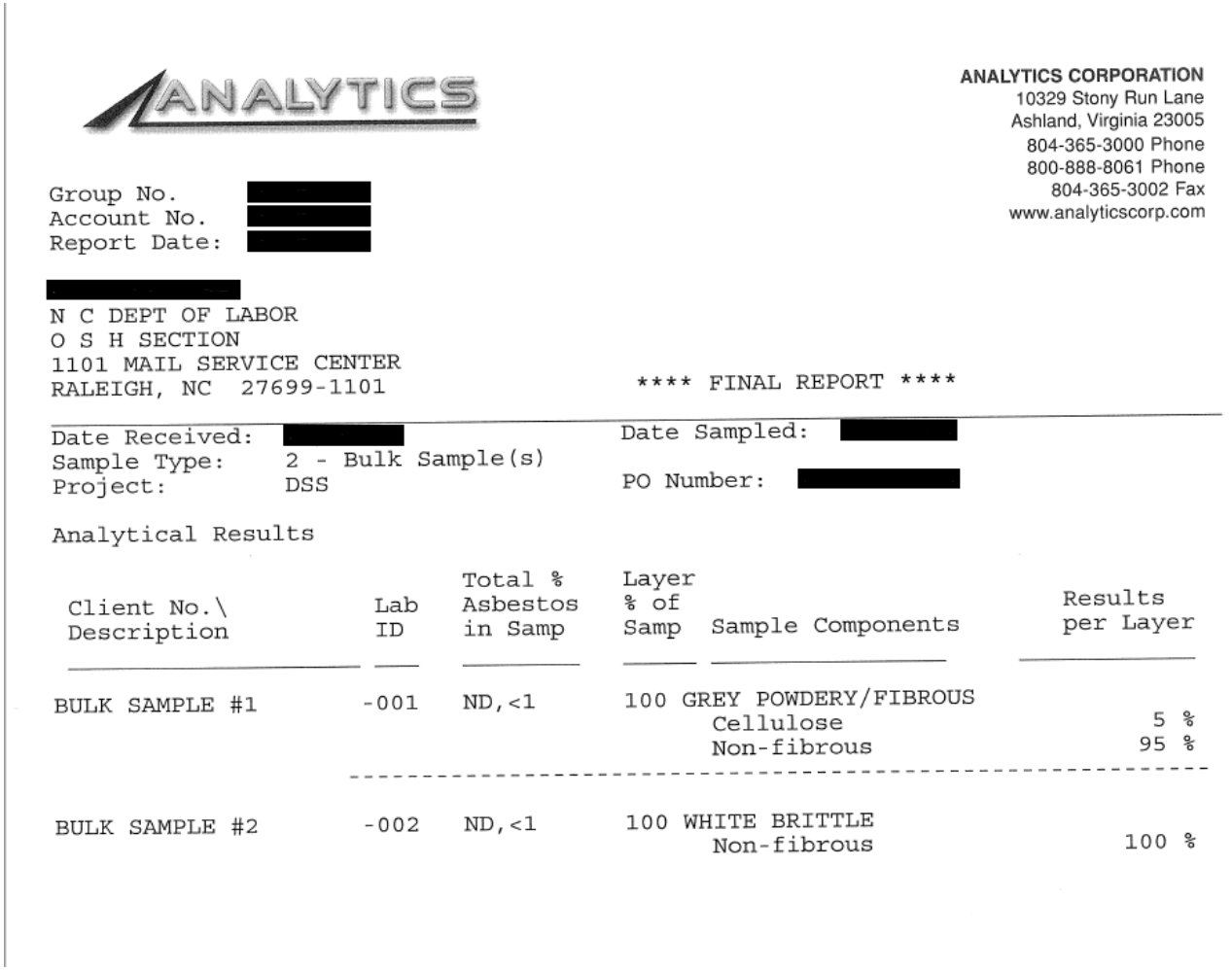
- Lead Wipe
  - Concentration
    - » 0.0273 µg/cm^2

- Does this concentration constitute a violation of the standard?

Evaluation of Sampling Results

- Bulk Samples

Bulk Sample - Identification



ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. [redacted]
Account No. [redacted]
Report Date: [redacted]

[redacted]
N C DEPT OF LABOR
O S H SECTION
1101 MAIL SERVICE CENTER
RALEIGH, NC 27699-1101

**** FINAL REPORT ****

Date Received: [redacted]
Sample Type: 2 - Bulk Sample(s)
Project: DSS

Date Sampled: [redacted]
PO Number: [redacted]

Analytical Results

Client No.\ Description	Lab ID	Total % Asbestos in Samp	Layer % of Samp	Sample Components	Results per Layer
BULK SAMPLE #1	-001	ND,<1	100	GREY POWDERY/FIBROUS	
				Cellulose	5 %
				Non-fibrous	95 %
BULK SAMPLE #2	-002	ND,<1	100	WHITE BRITTLE	
				Non-fibrous	100 %

Bulk Sample - Dust Results

Air Sampling Report U.S. Department of Labor Occupational Safety and Health Administration

Page 1 of 2

1. Reporting ID: 315555 | 2. Inspection Number: 123456789 | 3. Sampling Number: 142956555

4. Establishment Name: BEN FISHING TACKLE MFG CO

5. OSHO ID: S6762 | 6. Sampling Date: 25 June 2006 | 7. Shipping Date: 26 June 2006 | 8. Date Result Received

9. Job Title: Not applicable | 10. Occupational Code | 11. Number Exposed

12. Frequency of Exposure

Exposure Summary

14. Substance Code	15. Rqstd	16. Smpl Type	17. Exp Type	18. Exp Level	19. Units	20. PEL	21. Adj	22. Severity	23. Citation Information: No Cit	FTA	Over Exp	Rng	PPE	Trng	Med	OTH

TWA calculated on actual time sampled
The I. H. is free to make changes on the Form 91B and submit them directly to IMIS

26. Analyst's Comments (Analytical Method): NMAM 353-3

Both sample materials are class II dusts. This means that both are explosive.

Resistivity results are reported with the units of Kohm-cm. The resistivity results place both materials as group E. conductive.

P65727 - material less than 20 mesh is 100%, less than 200 mesh is 46%.

P65728 - material less than 20 mesh is 99%, less than 200 mesh is 85%.

If you have any questions, please call Jon Rima at the OSHA Salt Lake Technical Center (801) 233-4966.

27. Chain of Custody

a. Seals Intact	Init.	Data Y
b. Rec'd In Lab	LLD	11 MAR 2005
c. Rec'd by Anal.	JR	25 MAR 2005
d. Anal. Completed	JR	31 MAR 2005
e. Calc. Checked	SRJ	31 MAR 2005
f. Supr. OK'd	RD	31 MAR 2005

28 Submission number: 10 | 20

29 Lab Sample No. (Minutes/Type): P65727 B | P65728 B

30. Analyte	31. Analysis Results/	32. Sample Included in calculations of
8430 Resistivity	1.2000	16.8000
R101 Explosion Severity	0.8163	4.0000

Because the results for air samples are used in further calculations, the number of figures reported in section 31 may not reflect the actual precision of the analysis. Calculated confidence limits (UCL & LCL) should be rounded to no more than three significant figures.
The precision of analysis for wipe samples and for bulk material samples justify rounding results to no more than two significant figures.

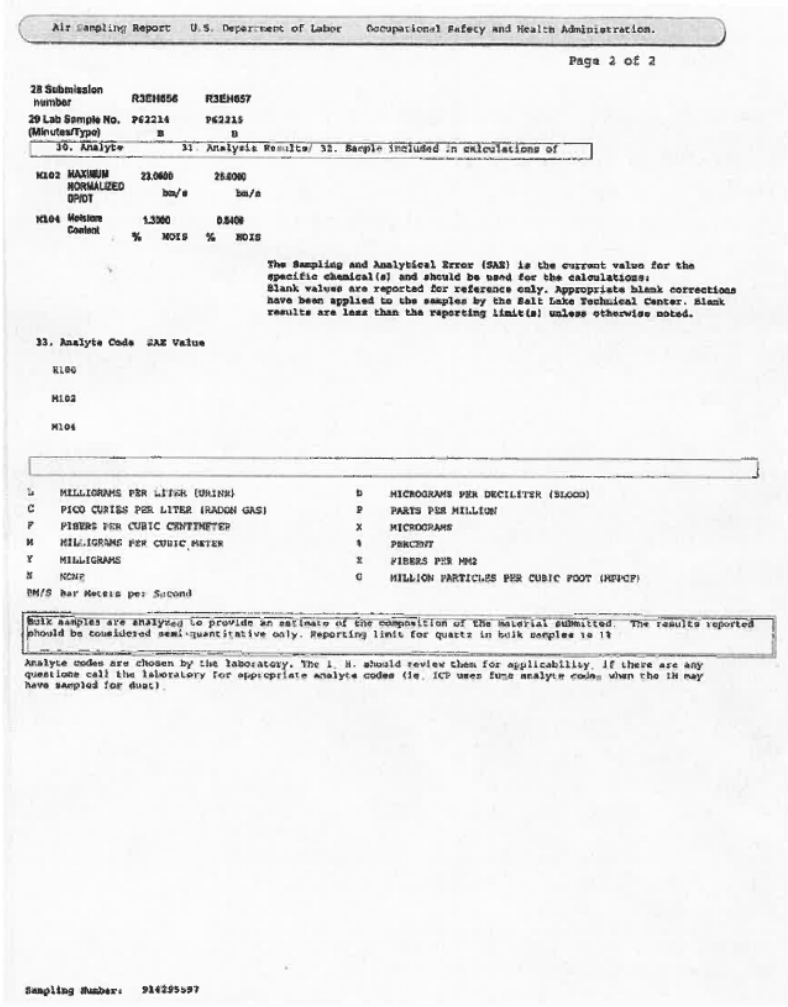
The Sampling and Analytical Error (SAE) is the current value for the specific chemical(s) and should be used for the calculations.
Blank values are reported for reference only. Appropriate blank corrections have been applied to the samples by the Salt Lake Technical Center. Blank results are less than the reporting limit(s) unless otherwise noted.

33. Analyte Code SAE Value

8430

R101

Sampling Number:



Air Sampling Report U.S. Department of Labor Occupational Safety and Health Administration.

Page 2 of 2

28 Submission number: R3EH656 | R3EH657

29 Lab Sample No. (Minutes/Type): P62214 B | P62215 B

30. Analyte	31. Analysis Results/	32. Sample Included in calculations of
R102 MAXIMUM NORMALIZED DPIDT	23.0600 lbs/s	25.6000 lbs/s
R104 Moisture Content	1.3300 % MOIS	0.5400 % MOIS

The Sampling and Analytical Error (SAE) is the current value for the specific chemical(s) and should be used for the calculations.
Blank values are reported for reference only. Appropriate blank corrections have been applied to the samples by the Salt Lake Technical Center. Blank results are less than the reporting limit(s) unless otherwise noted.

33. Analyte Code SAE Value

R100

R102

R104

L	MILLIGRAMS PER LITER (URINE)	D	MICROGRAMS PER DECILITER (BLOOD)
C	PICO CURIES PER LITER (RADON GAS)	P	PARTS PER MILLION
F	FIBERS PER CUBIC CENTIMETER	X	MICROGRAMS
M	MILLIGRAMS PER CUBIC METER	%	PERCENT
Y	MILLIGRAMS	Z	FIBERS PER MM2
N	NONE	G	MILLION PARTICLES PER CUBIC FOOT (MPPCF)

RM/S Bar Meters per Second

Bulk samples are analyzed to provide an estimate of the composition of the material submitted. The results reported should be considered semi-quantitative only. Reporting limit for quartz in bulk samples is 1%

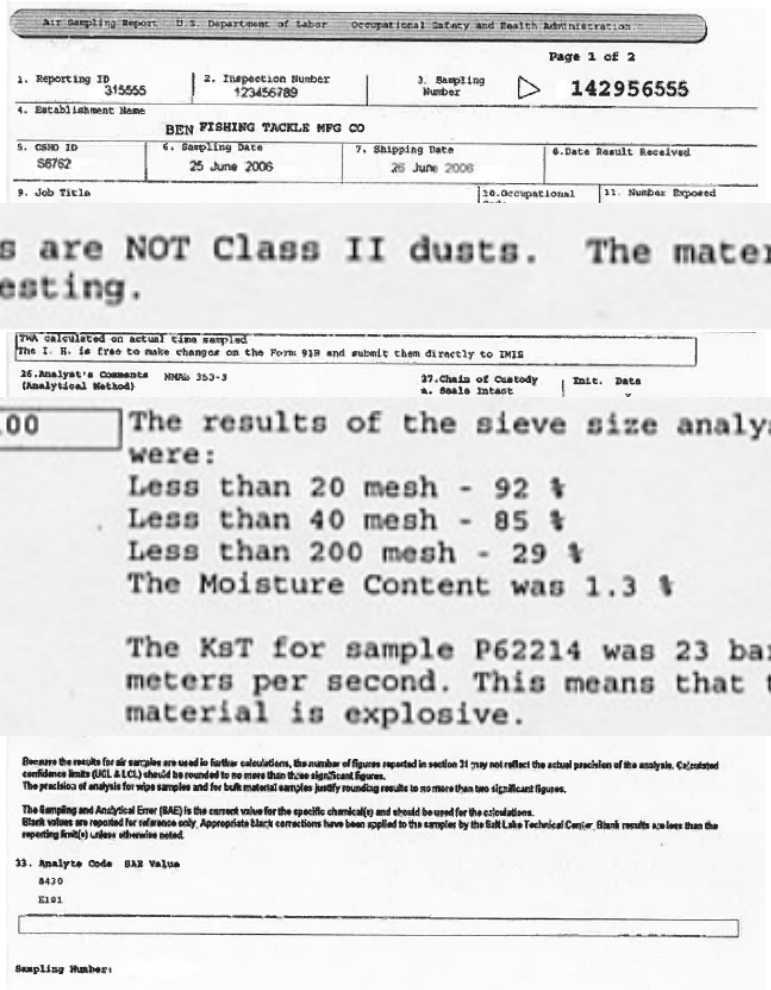
Analyte codes are chosen by the laboratory. The I. H. should review them for applicability. If there are any questions call the laboratory for appropriate analyte codes (ie. ICP uses fume analyte codes when the IH may have sampled for dust).

Sampling Number: 9142955597

Understanding Results

- Reports may contain the following:
  - Percent through 40 mesh
  - Percent moisture content
  - Percent combustible material
  - Percent combustible dust
  - Metal dusts will include resistivity
  - Minimum explosive concentration (MEC)
  - Minimum ignition energy (MIE)
  - Class II test
  - Sample weight
  - Maximum normalized rate of pressure rise (dP/dt) – Kst Test
  - Minimum ignition temperature

Understanding Results



Air Sampling Report U.S. Department of Labor Occupational Safety and Health Administration

Page 1 of 2

1. Reporting ID: 315555 | 2. Inspection Number: 123456789 | 3. Sampling Number: 142956555

4. Establishment Name: BEN FISHING TACKLE MFG CO

5. OSHO ID: S6762 | 6. Sampling Date: 25 June 2006 | 7. Shipping Date: 26 June 2006 | 8. Date Result Received

9. Job Title | 10. Occupational | 11. Number Exposed

These materials are NOT Class II dusts. The material did not react during testing.

TWA calculated on actual time sampled
The I. H. is free to make changes on the Form 91B and submit them directly to IMIS

26. Analyst's Comments (Analytical Method) NMAM 353-3

27. Chain of Custody a. Seals Intact | Init. | Date

P62214 E100 The results of the sieve size analysis were:
Less than 20 mesh - 92 %
Less than 40 mesh - 85 %
Less than 200 mesh - 29 %
The Moisture Content was 1.3 %

The KsT for sample P62214 was 23 bar meters per second. This means that the material is explosive.

Because the results for air samples are used in further calculations, the number of figures reported in section 31 may not reflect the actual precision of the analysis. Calculated confidence limits (UCL & LCL) should be rounded to no more than three significant figures.
The precision of analysis for wipe samples and for bulk material samples justify rounding results to no more than two significant figures.

The Sampling and Analytical Error (SAE) is the current value for the specific chemical(s) and should be used for the calculations.
Blank values are reported for reference only. Appropriate blank corrections have been applied to the samples by the Salt Lake Technical Center. Blank results are less than the reporting limit(s) unless otherwise noted.

33. Analyte Code SAE Value
8430
E101

Sampling Number:

Understanding Results

- Kst
  - The maximum rate of pressure rise generated when dust is tested in a confined enclosure.

Dust Explosion Class	Kst (bar.m/s)	Characteristic
St 0	0	No Explosion
St 1	>0 and ≤200	Weak explosion
St 2	>200 and ≤300	Strong explosion
St 3	>300	Very strong explosion

Understanding Results

- Moisture
  - Moisture in dust particles raises the ignition temperature of the dust because of the heat absorbed during heating and vaporization of the moisture.
    - » Ignition temperature of cornstarch may increase as must as 122F, with an increase of moisture content from 1.6% to 12.5%.
  - The moisture in the air surrounding a dust particle has no significant effect on the course of deflagration once ignition has occurred.
    - » In order for moisture to prevent ignition of dust by common source, the dust would have to be so damp that a cloud could not be formed

Recording Sampling Data

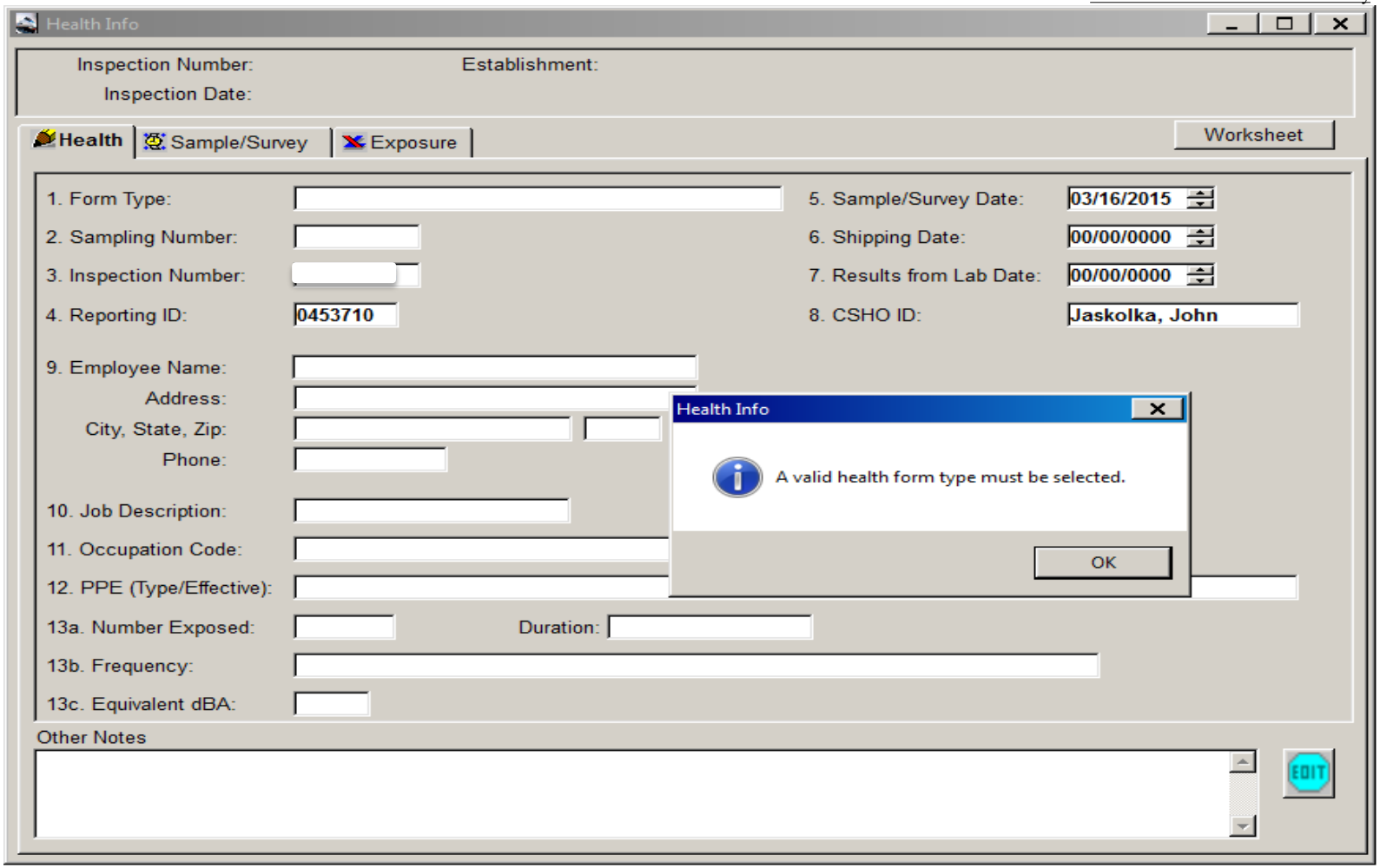
- Air and Noise Samples

Recording Sampling Data

- All sampling data must be recorded
  - OE
  - Field Sampling Worksheet

Entering Sampling Data in OE

Photo Source: NCDOL Photo Library



Entering Sampling Data in OE

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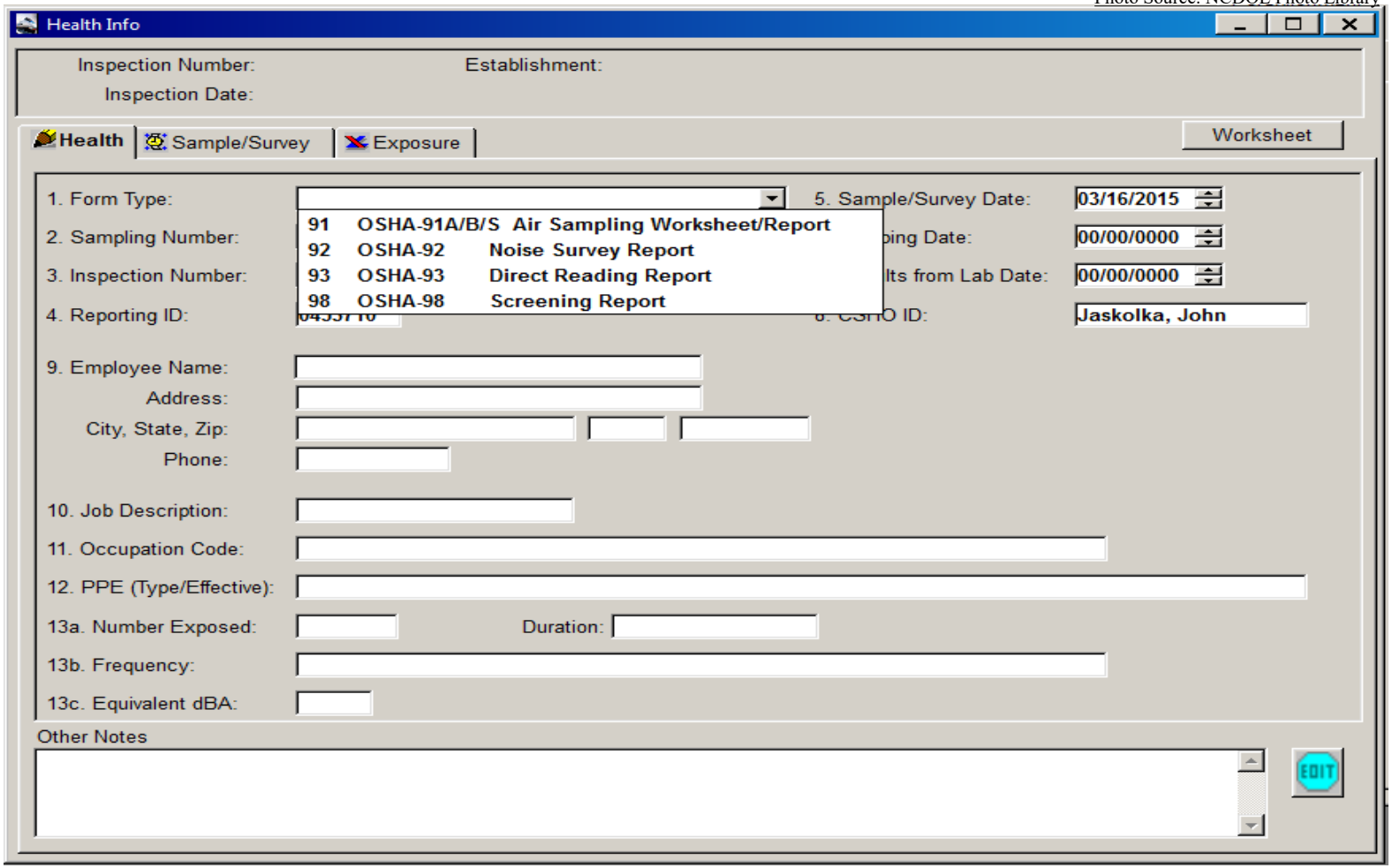

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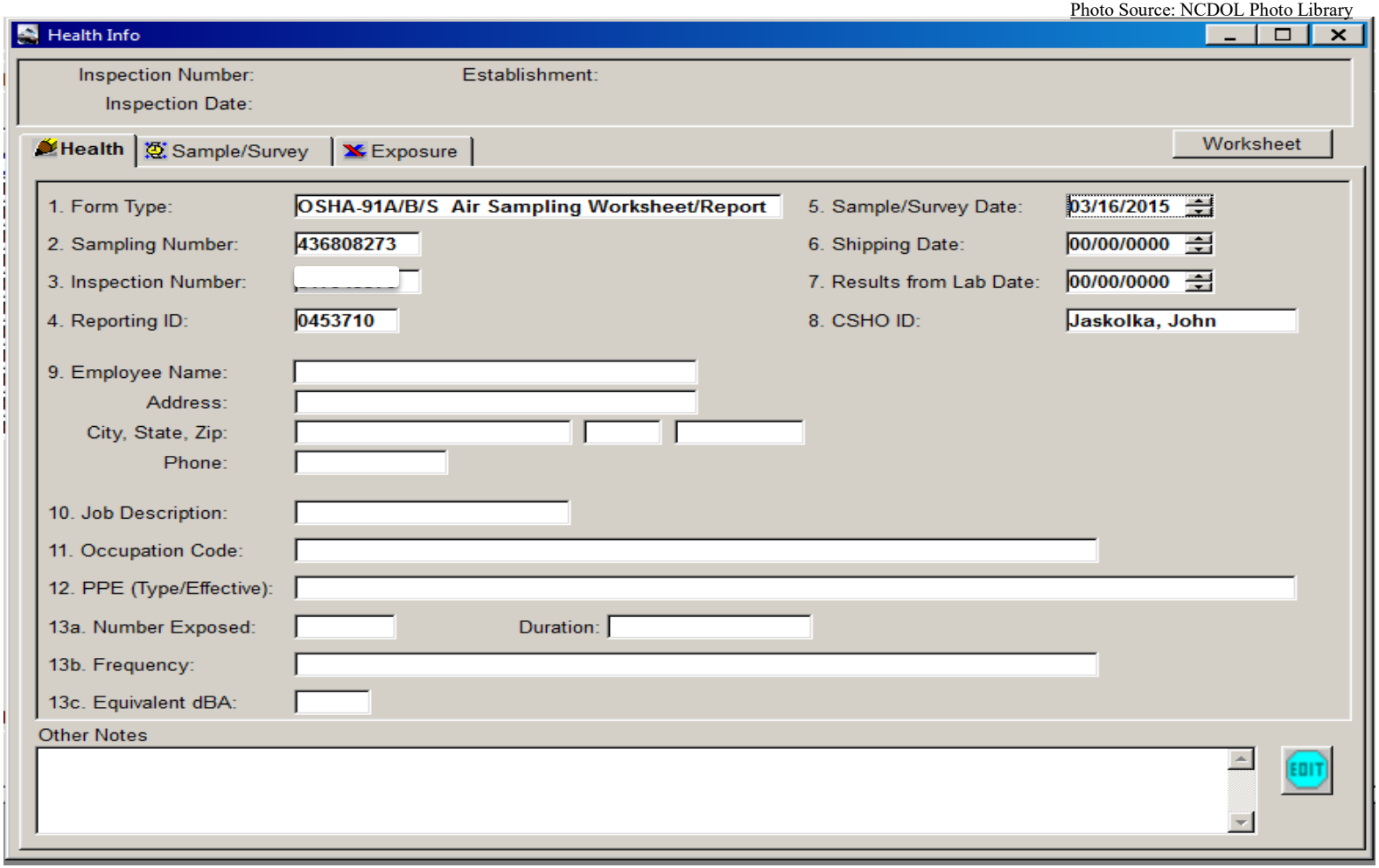

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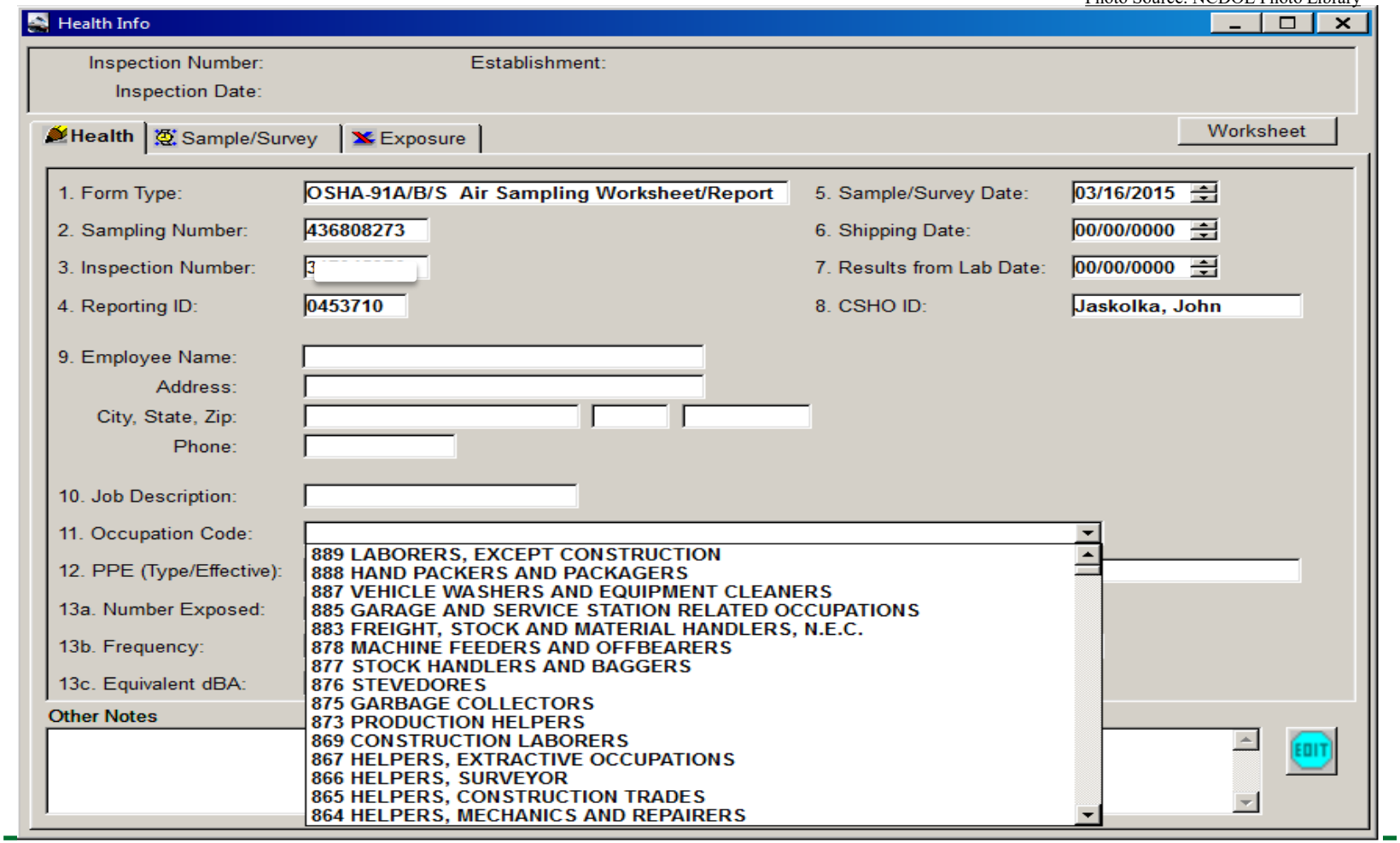

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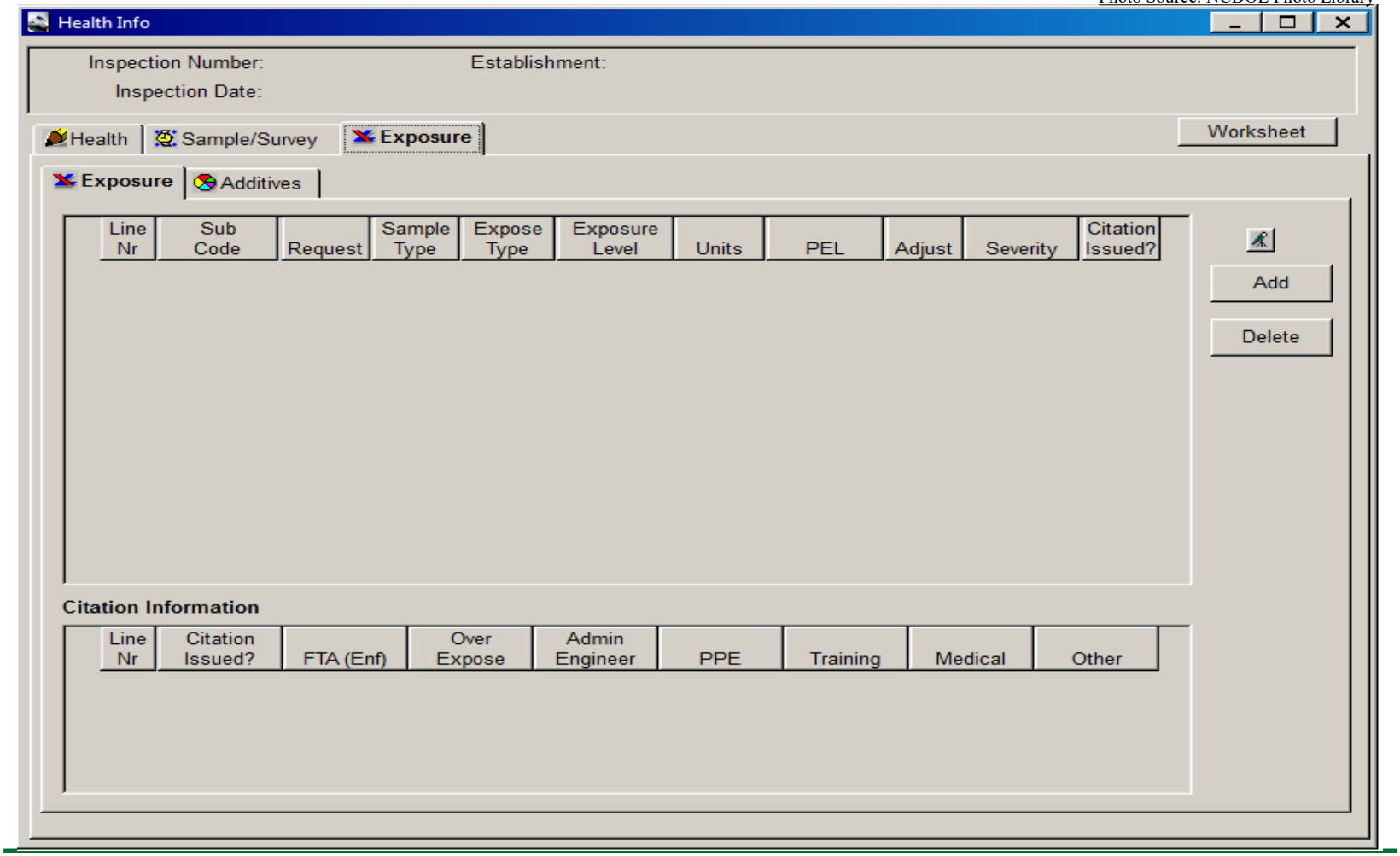

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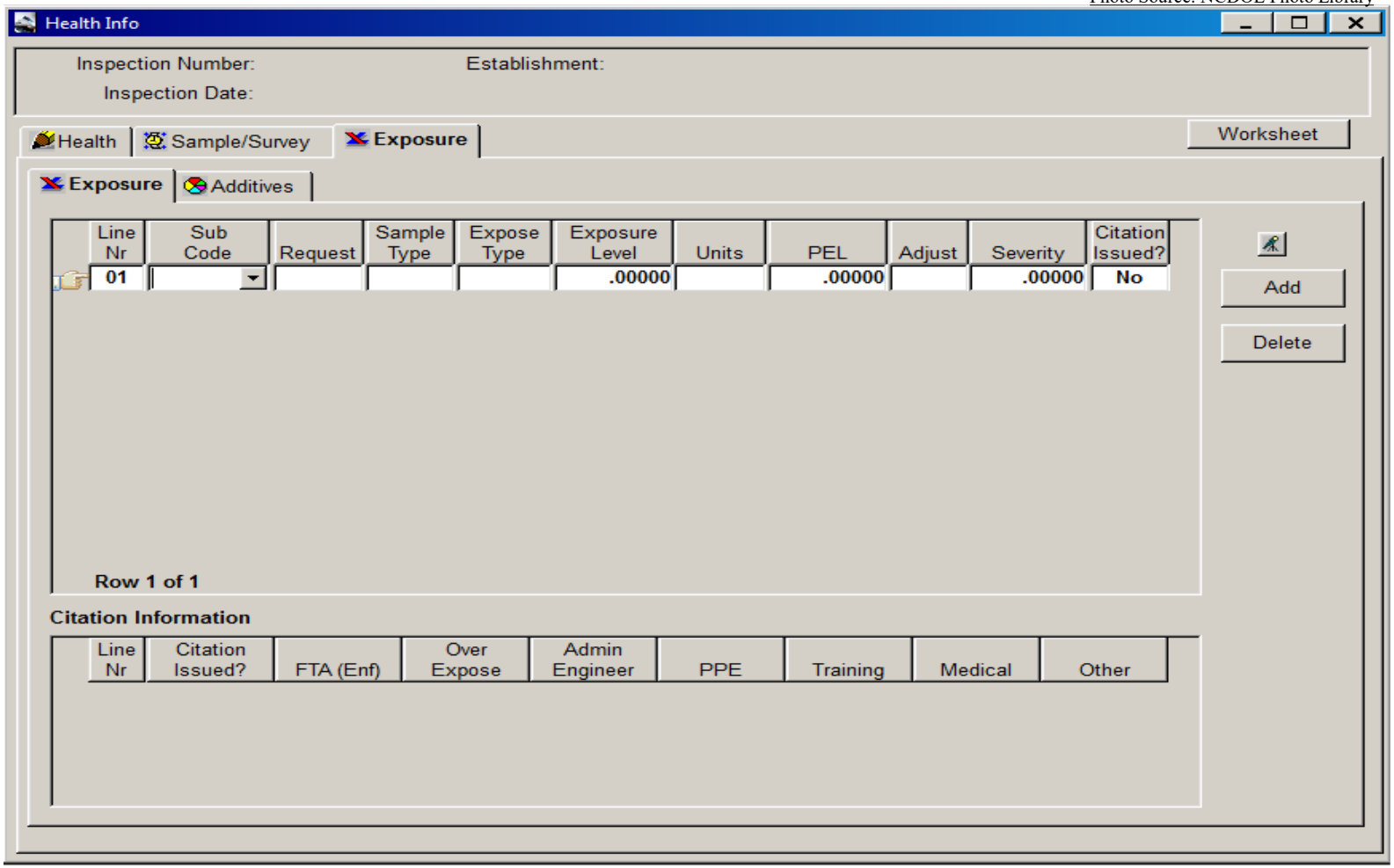

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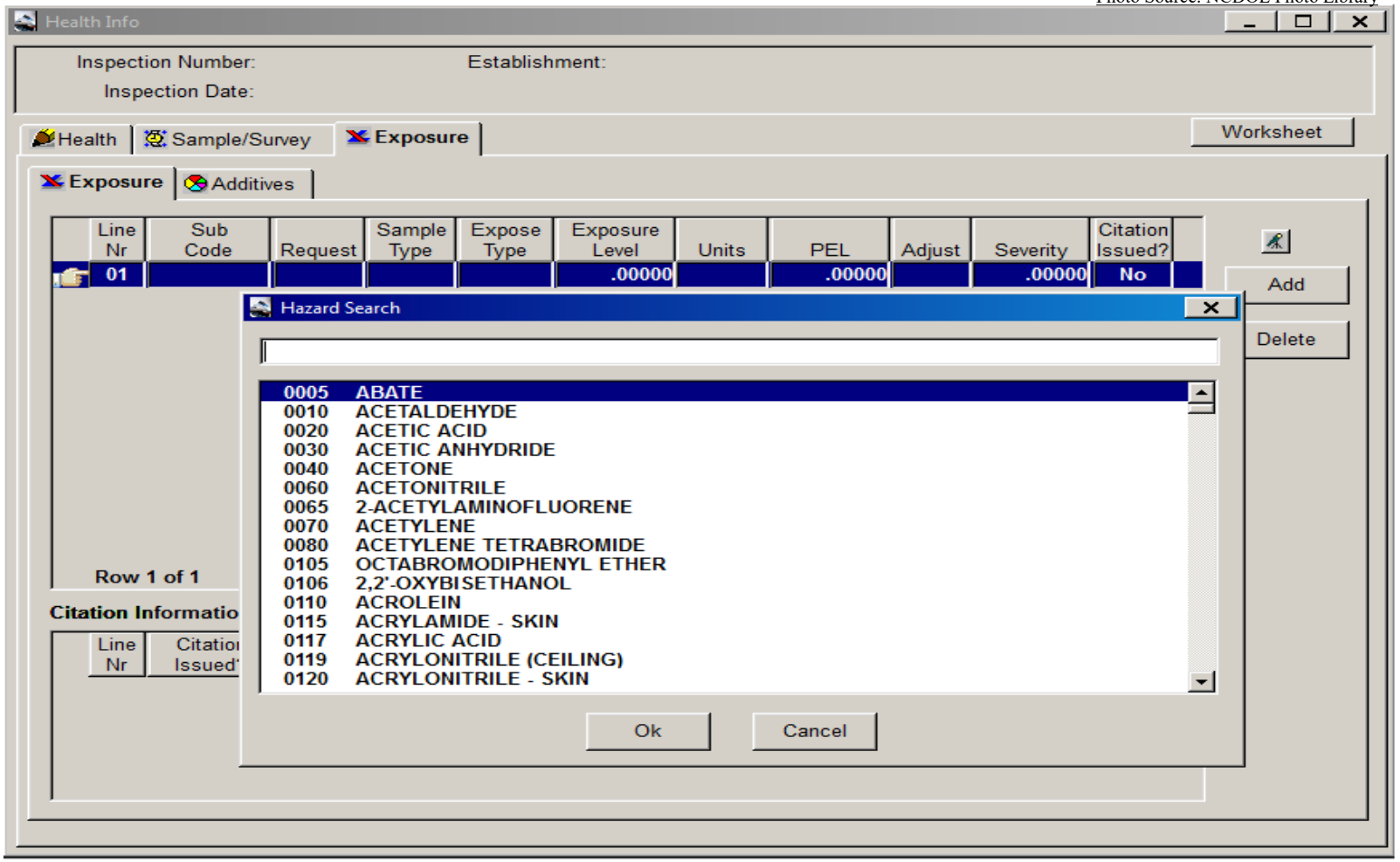

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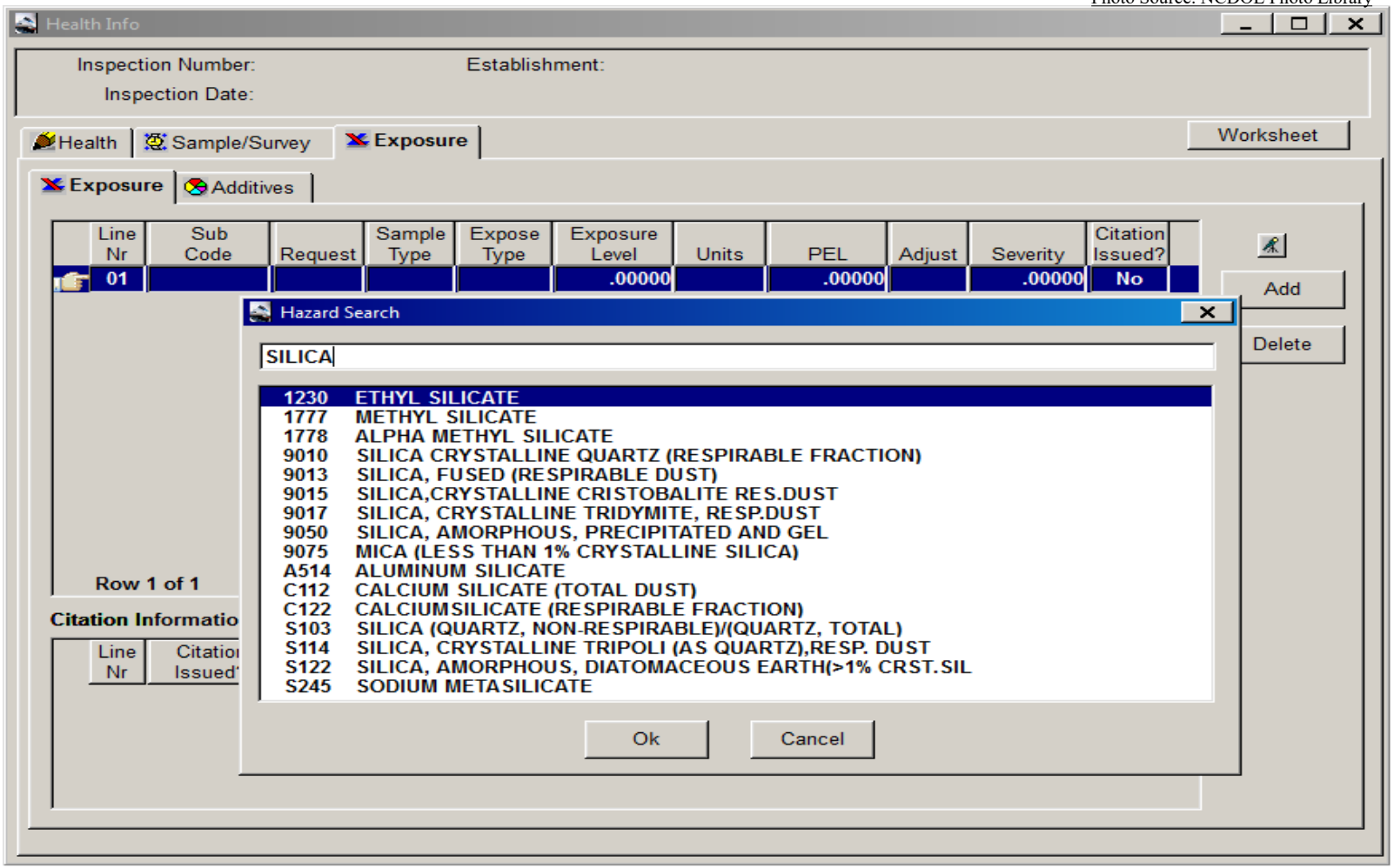

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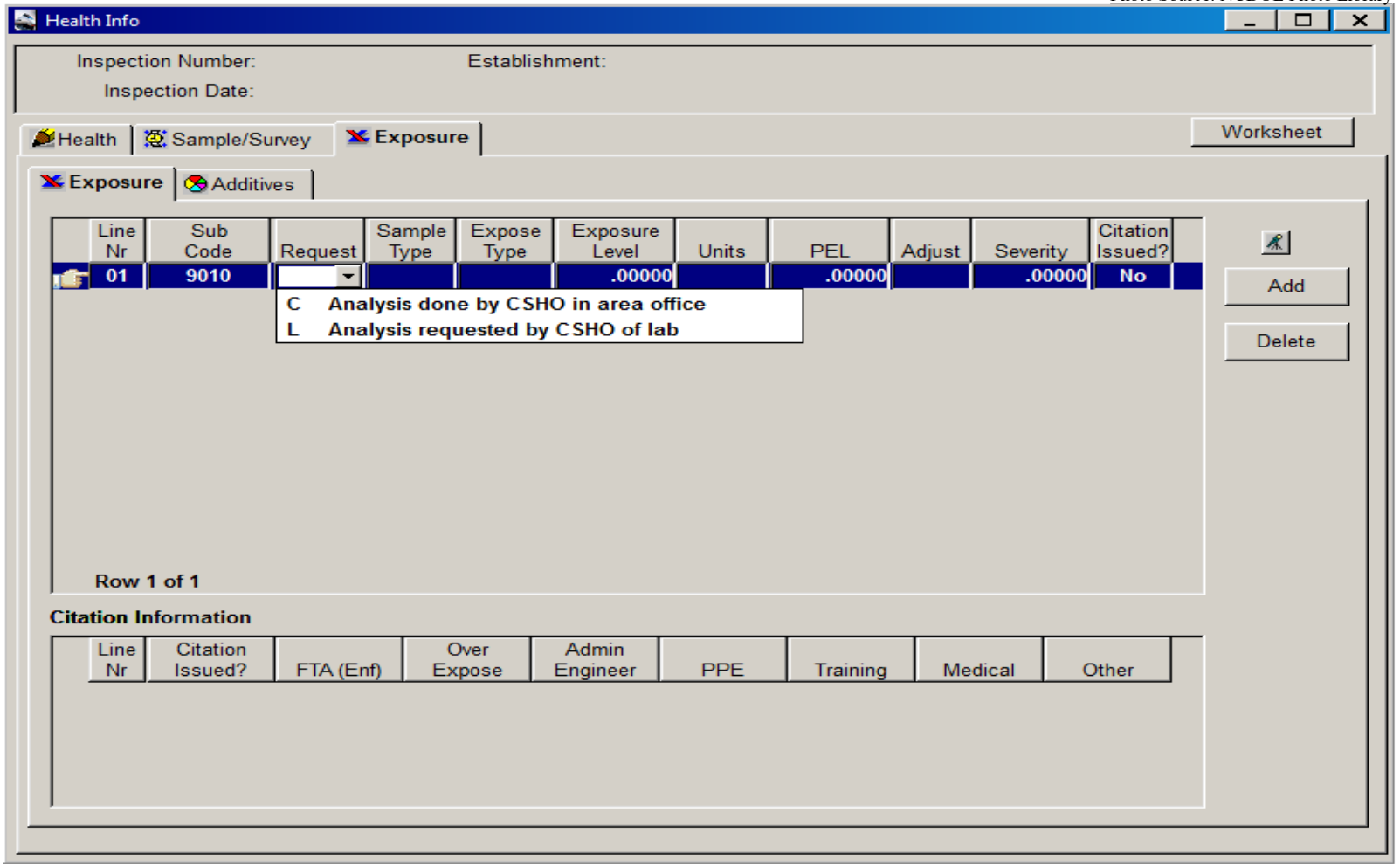

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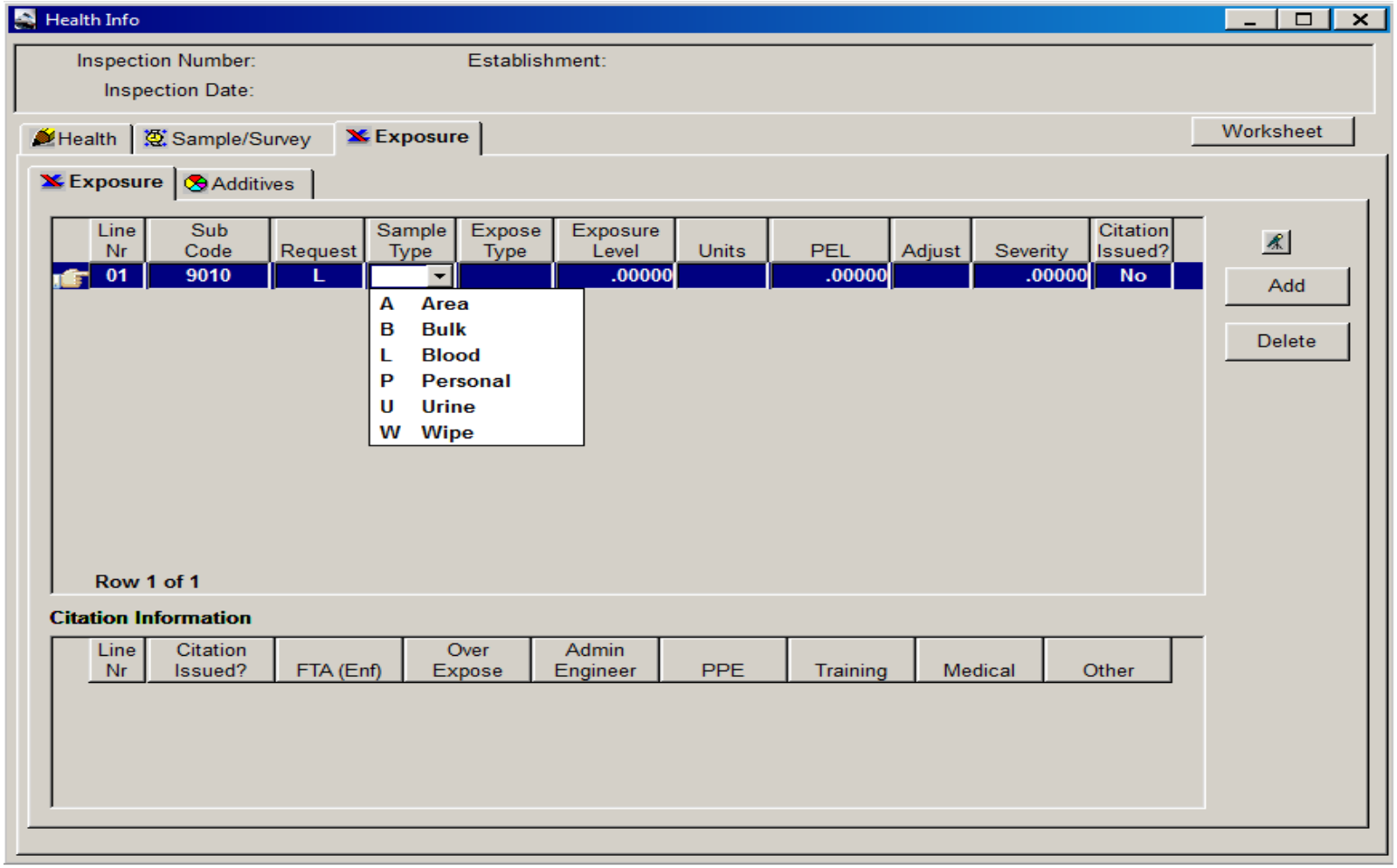

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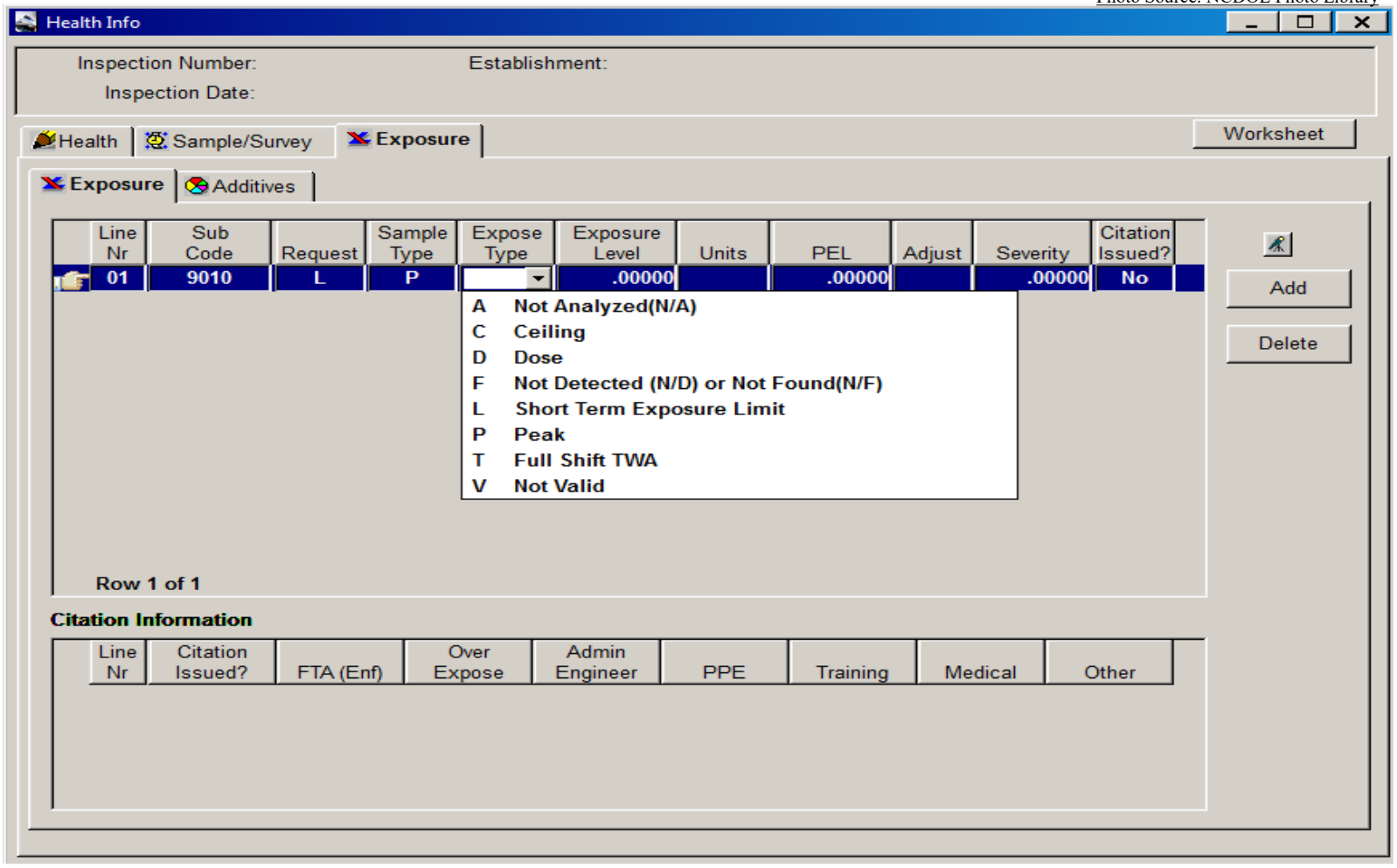

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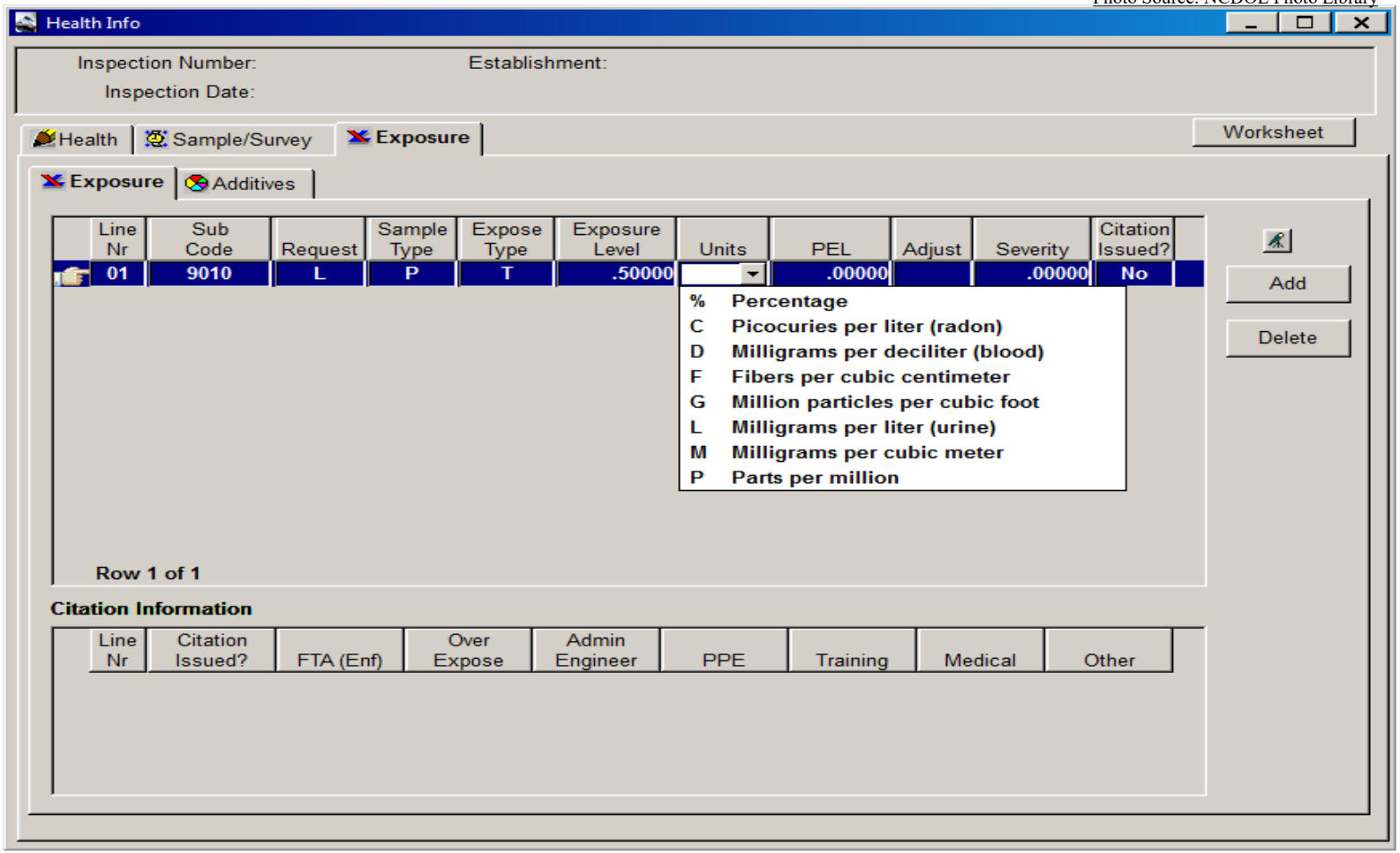

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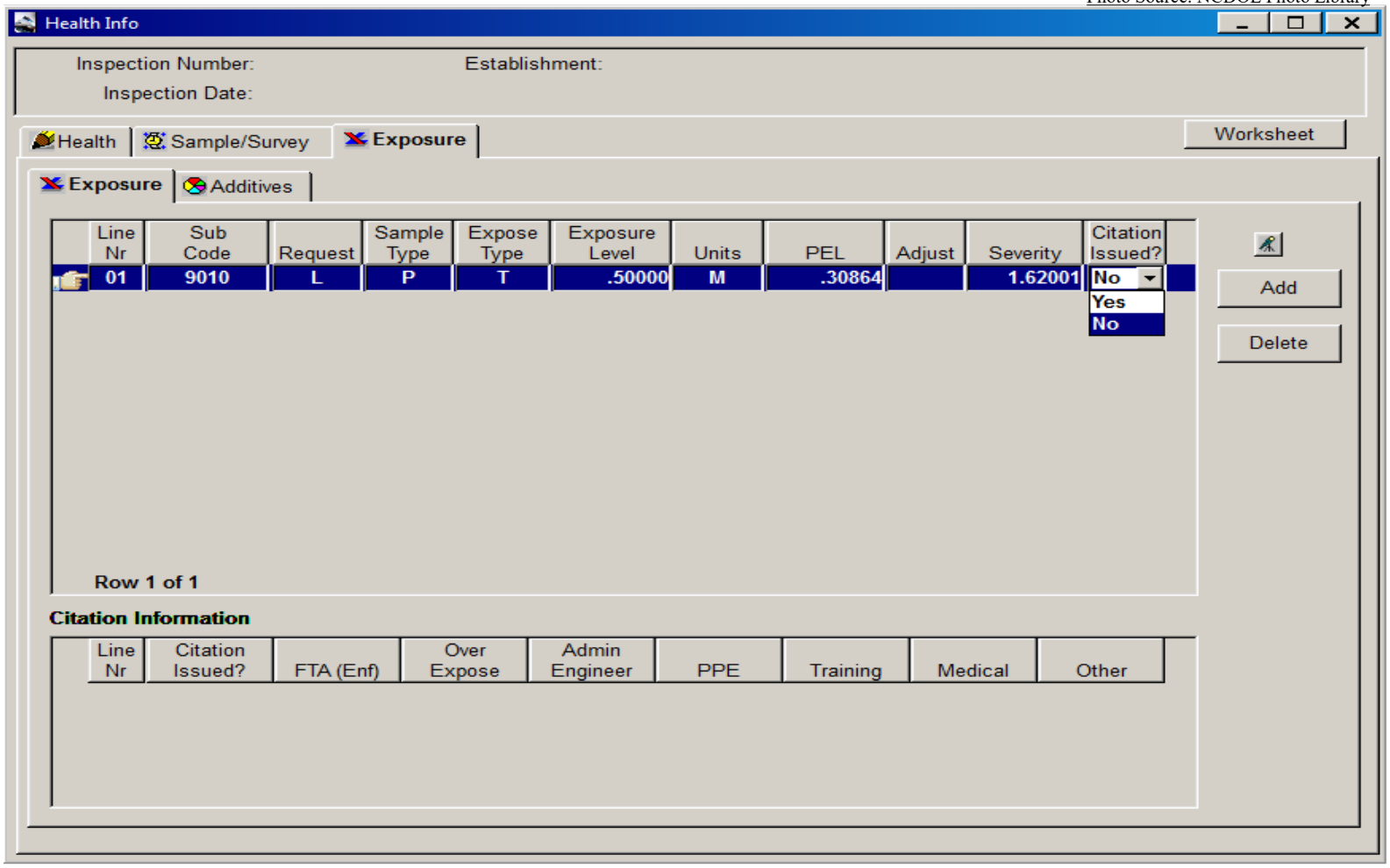

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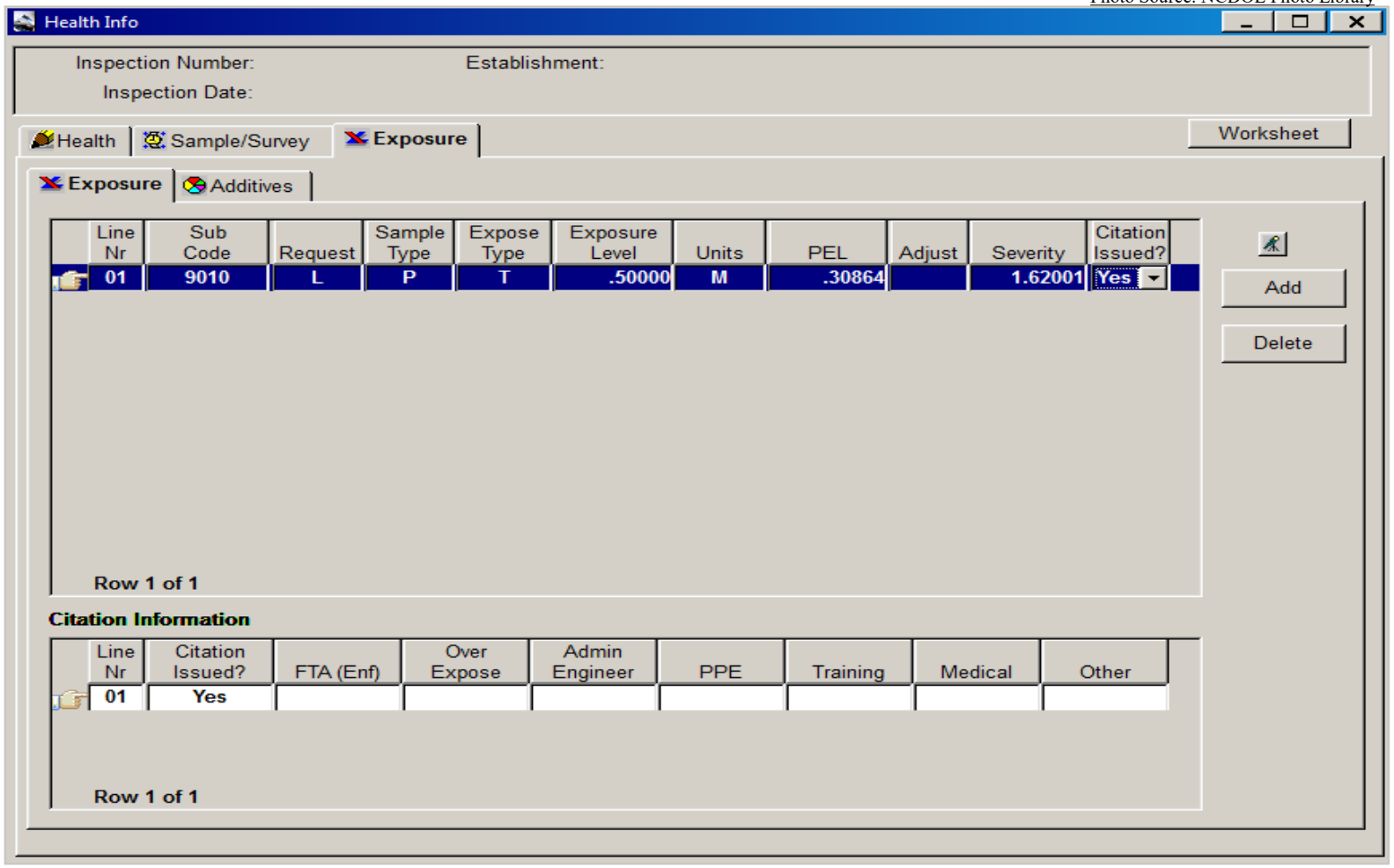

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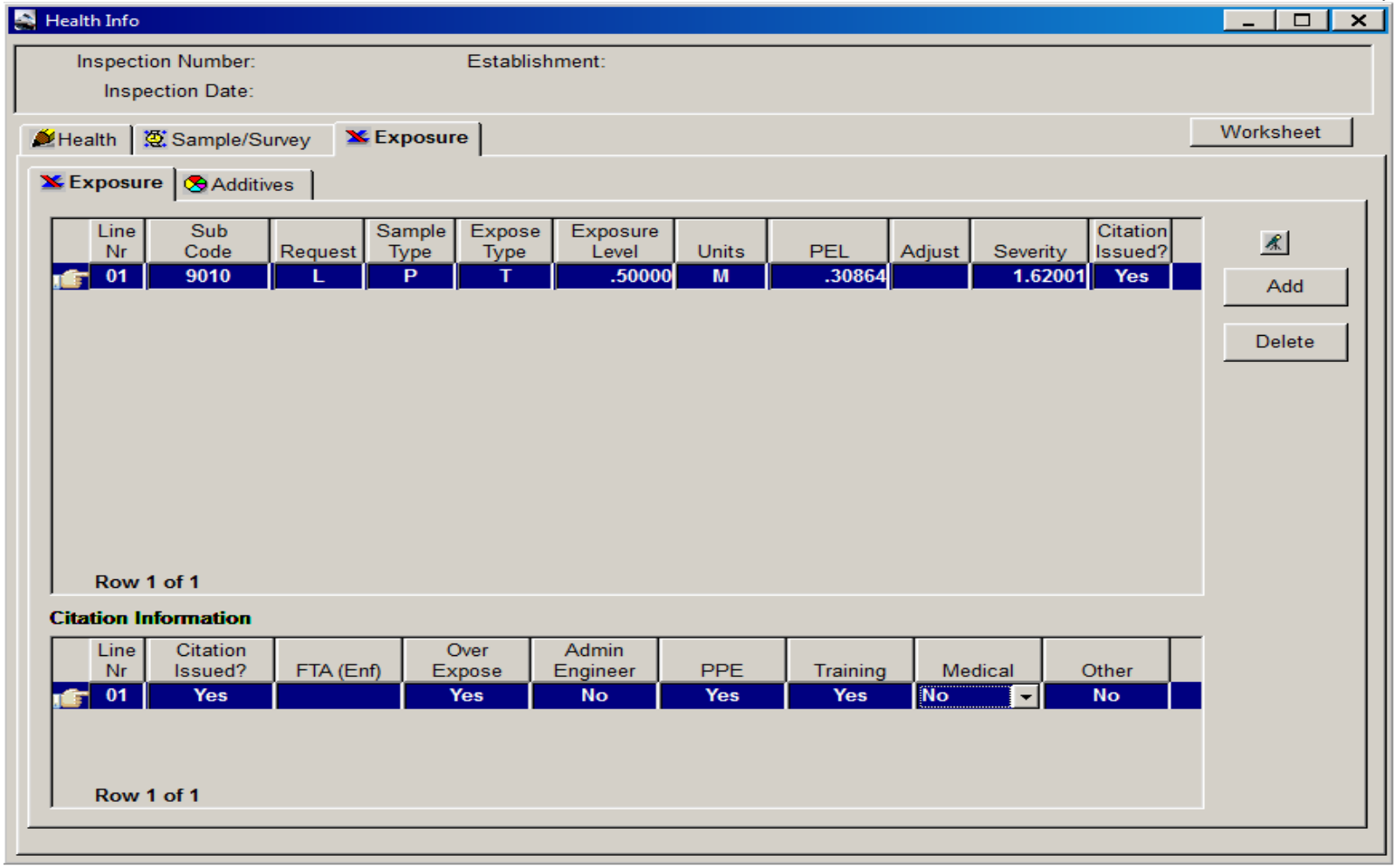

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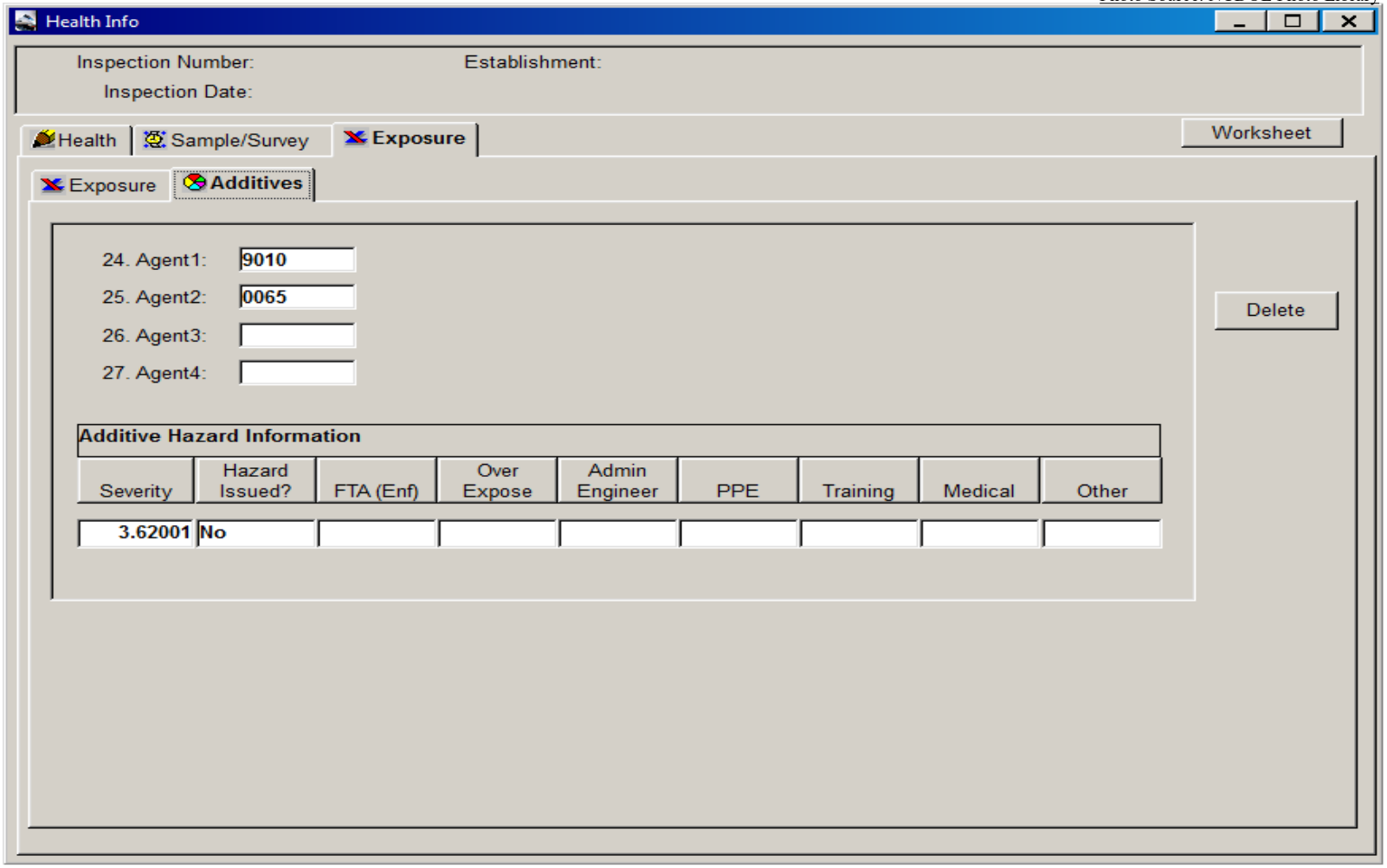

Entering Noise Results

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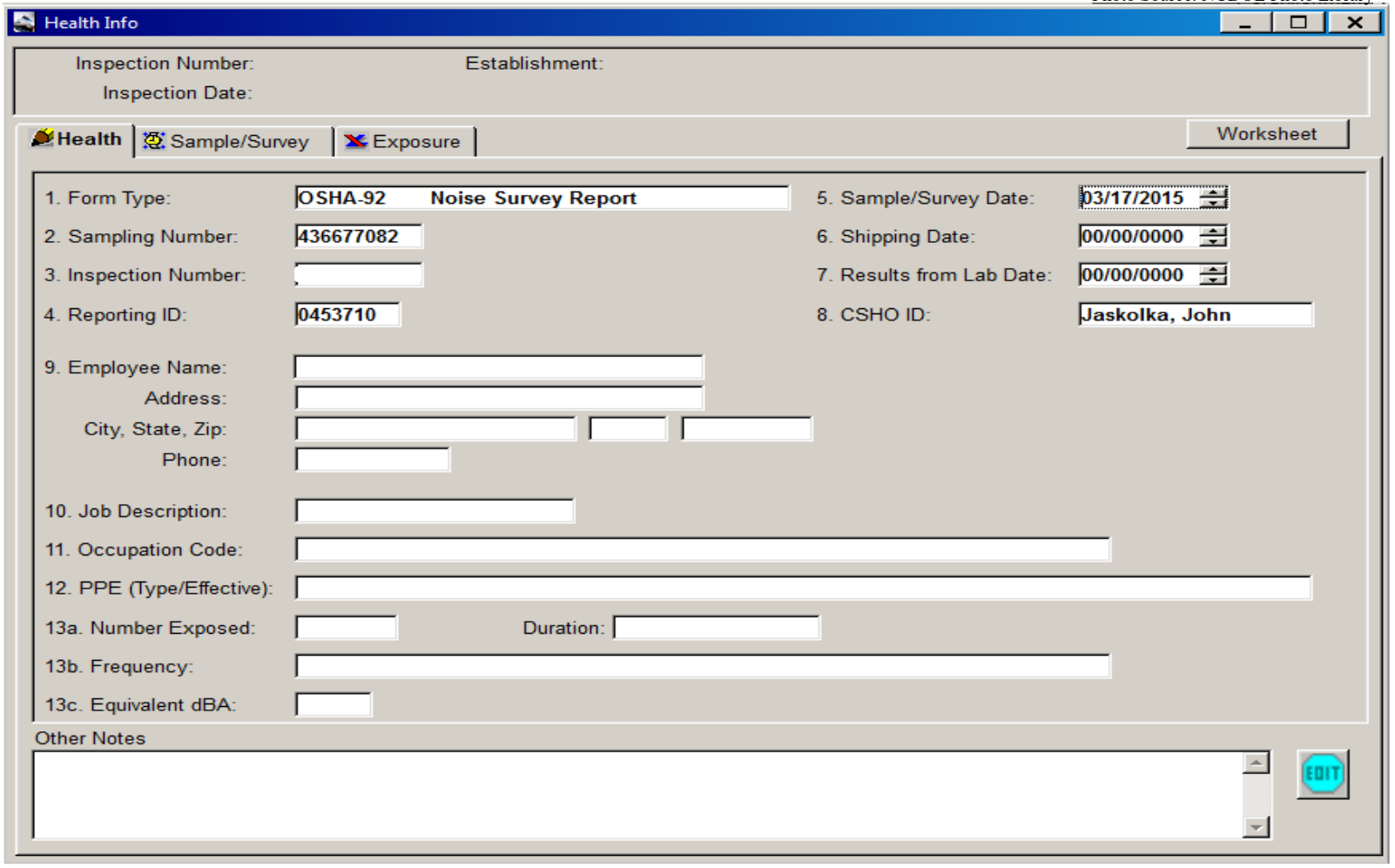

Entering Noise Results

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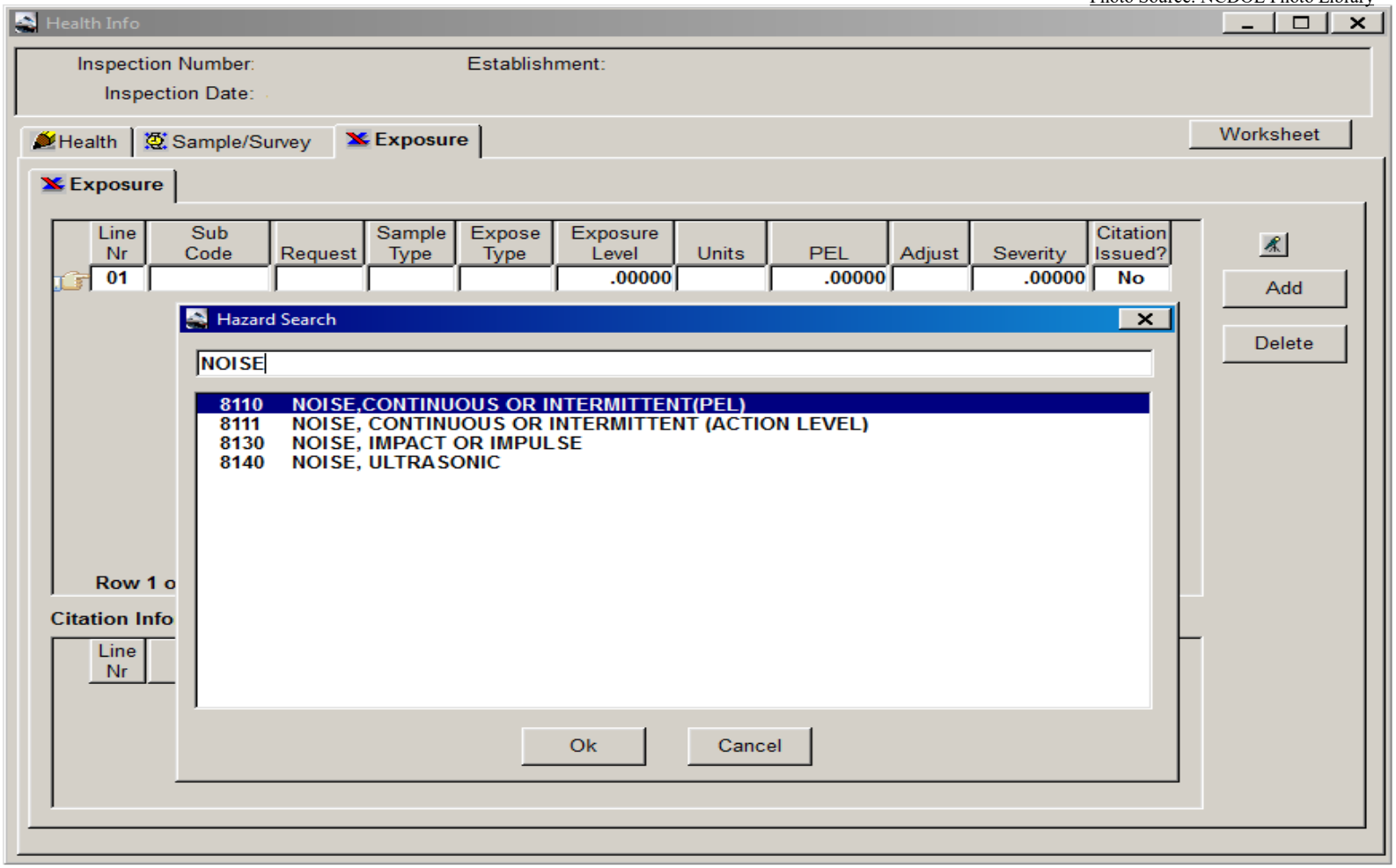

Entering Noise Results

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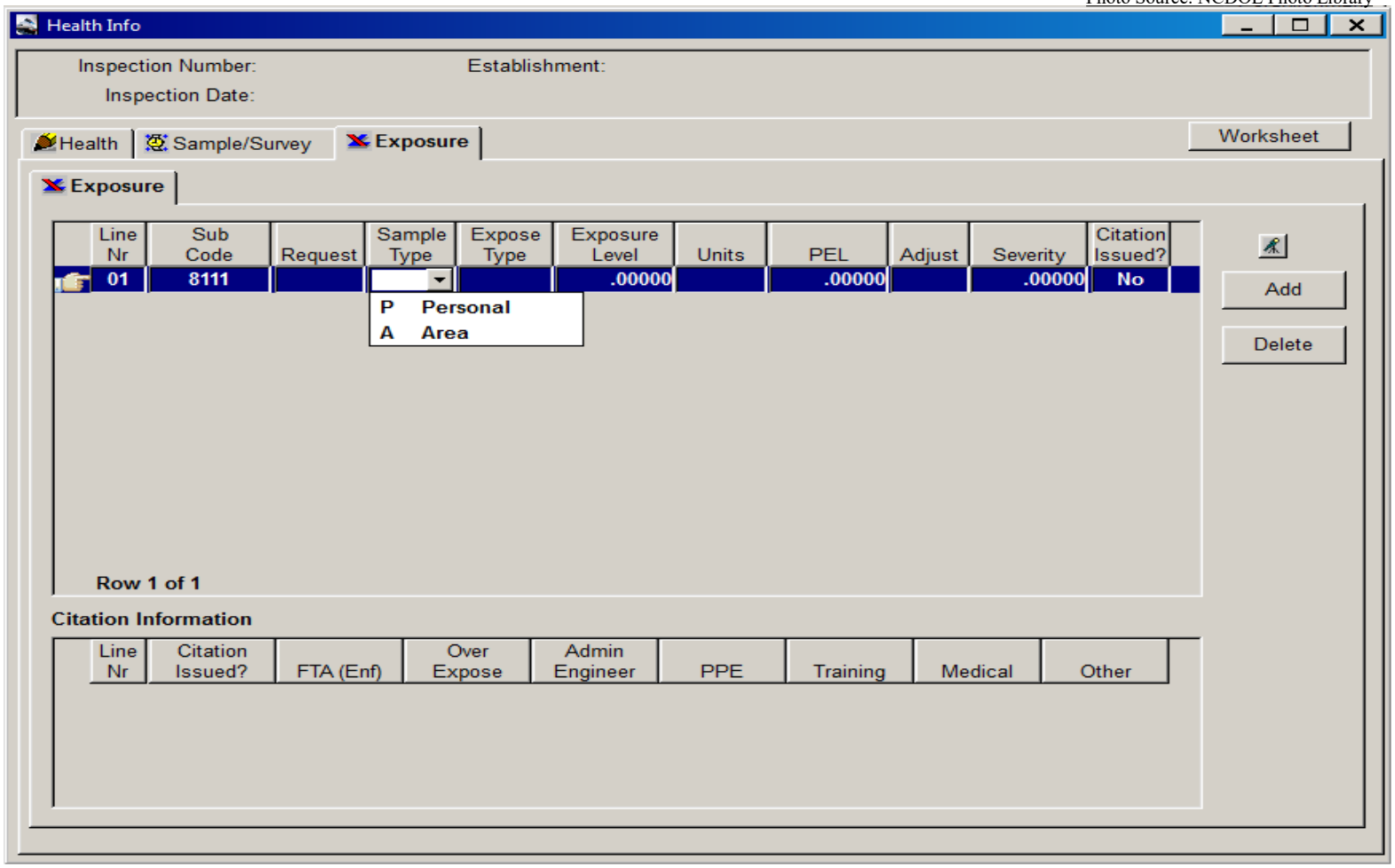

Entering Noise Results

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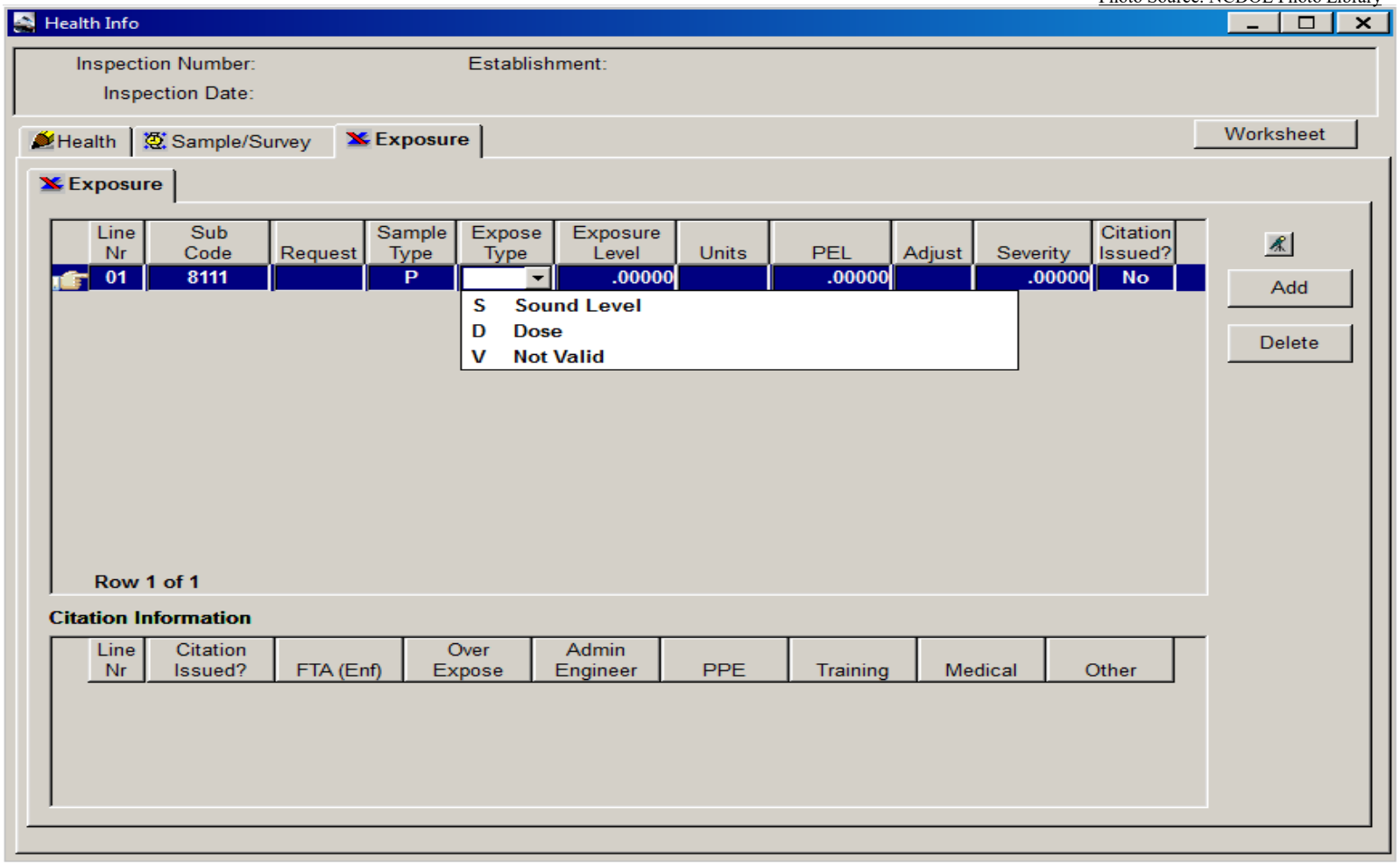

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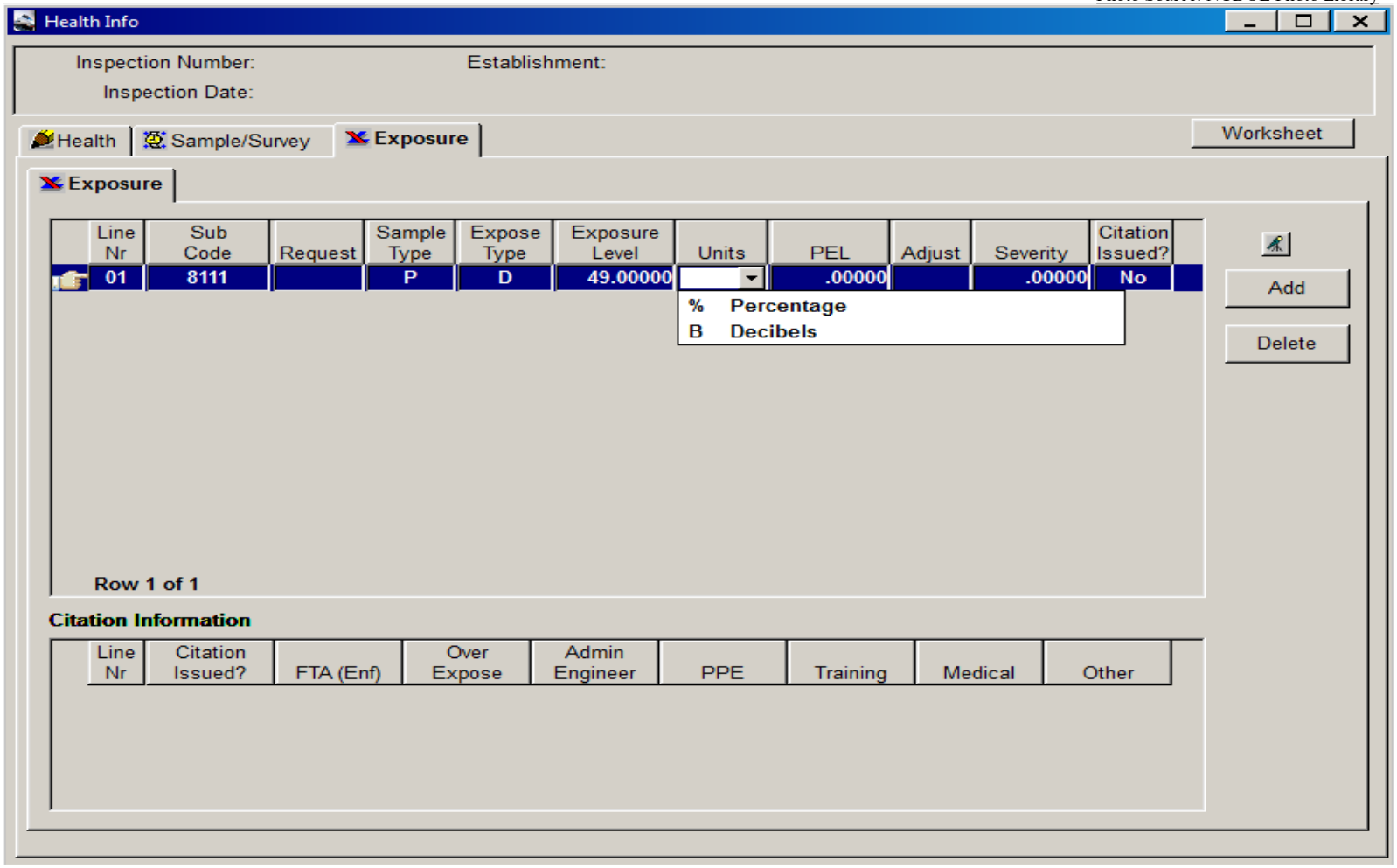

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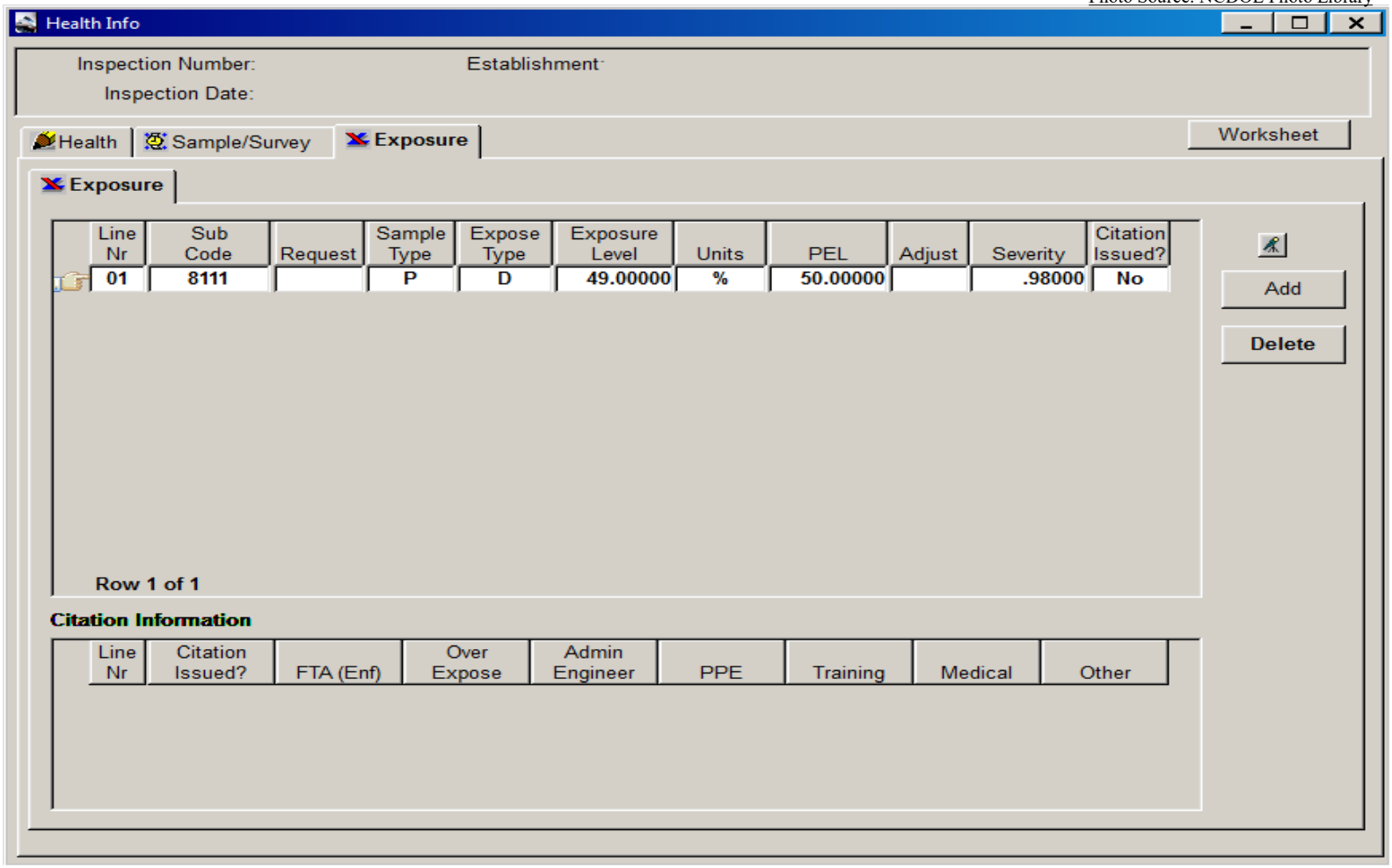

Entering Noise Results

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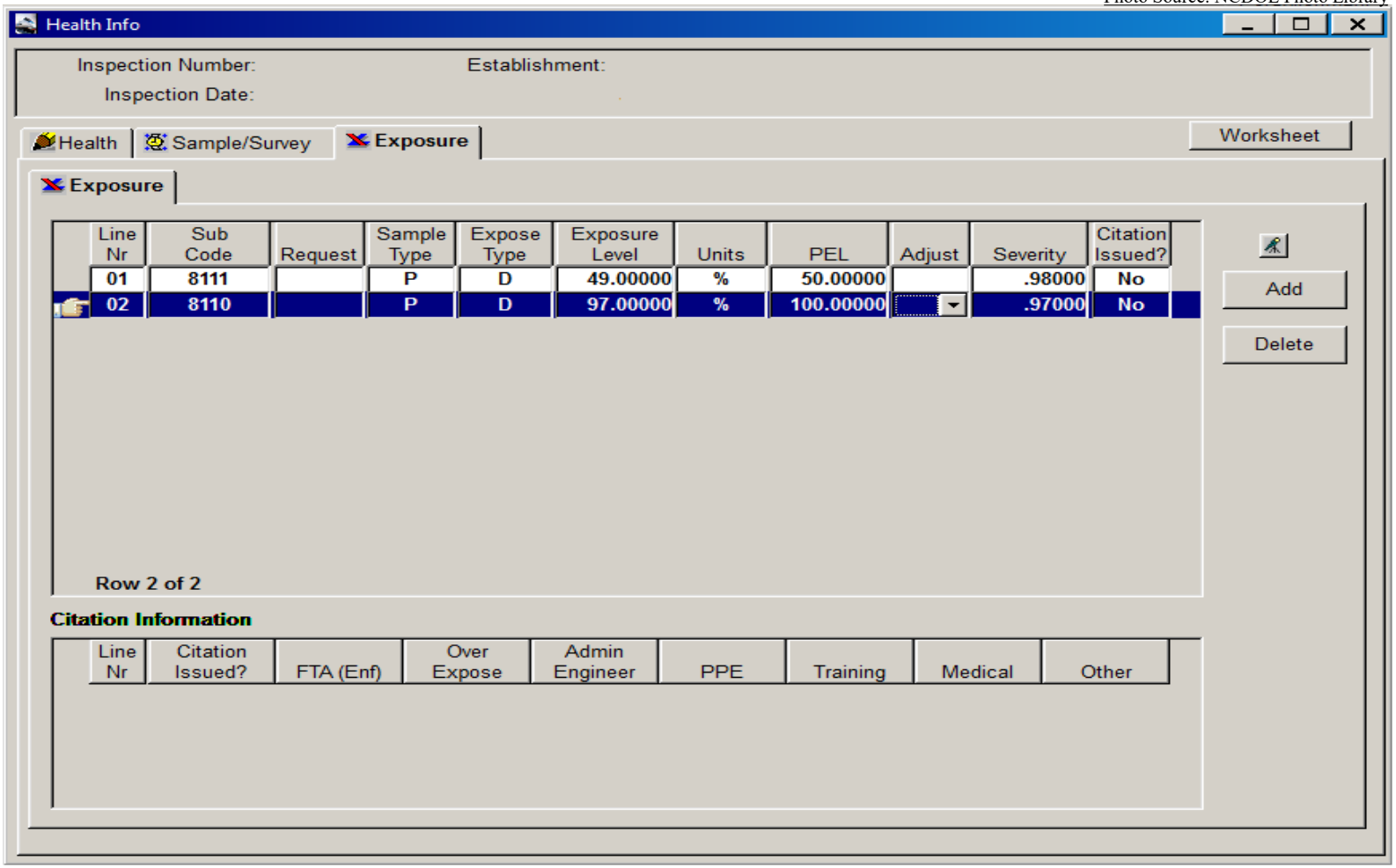


Entering Results

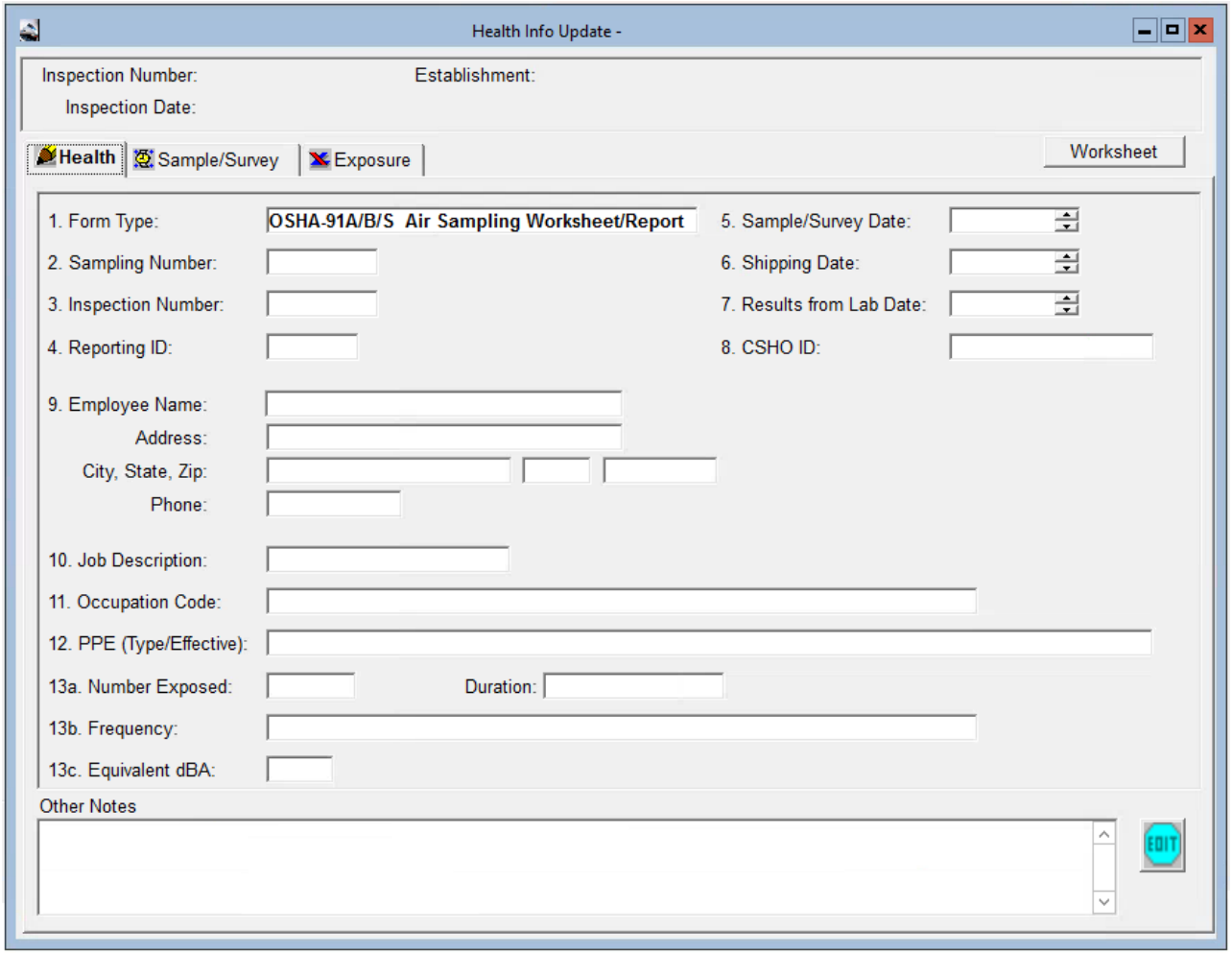
- Field Sampling Worksheet
  - All sampling data must be record

Contaminant/Hazard (e.g. toluene, noise)	Sub. Code	Exp. Type (e.g. TWA, STEL)	Exposure Level	Units	PEL	Severity	Citations Issued? (√)	Data Entered Into NCR? (√)
Noise AL	8111	TWA	49	%	50	0.98	No	Yes
Noise PEL	8110	TWA	97	%	100	0.97	No	Yes
Carbon Monoxide	0560	TWA	5	PPM	50	0.10	No	Yes
CSHO Signature *Your Signature*								

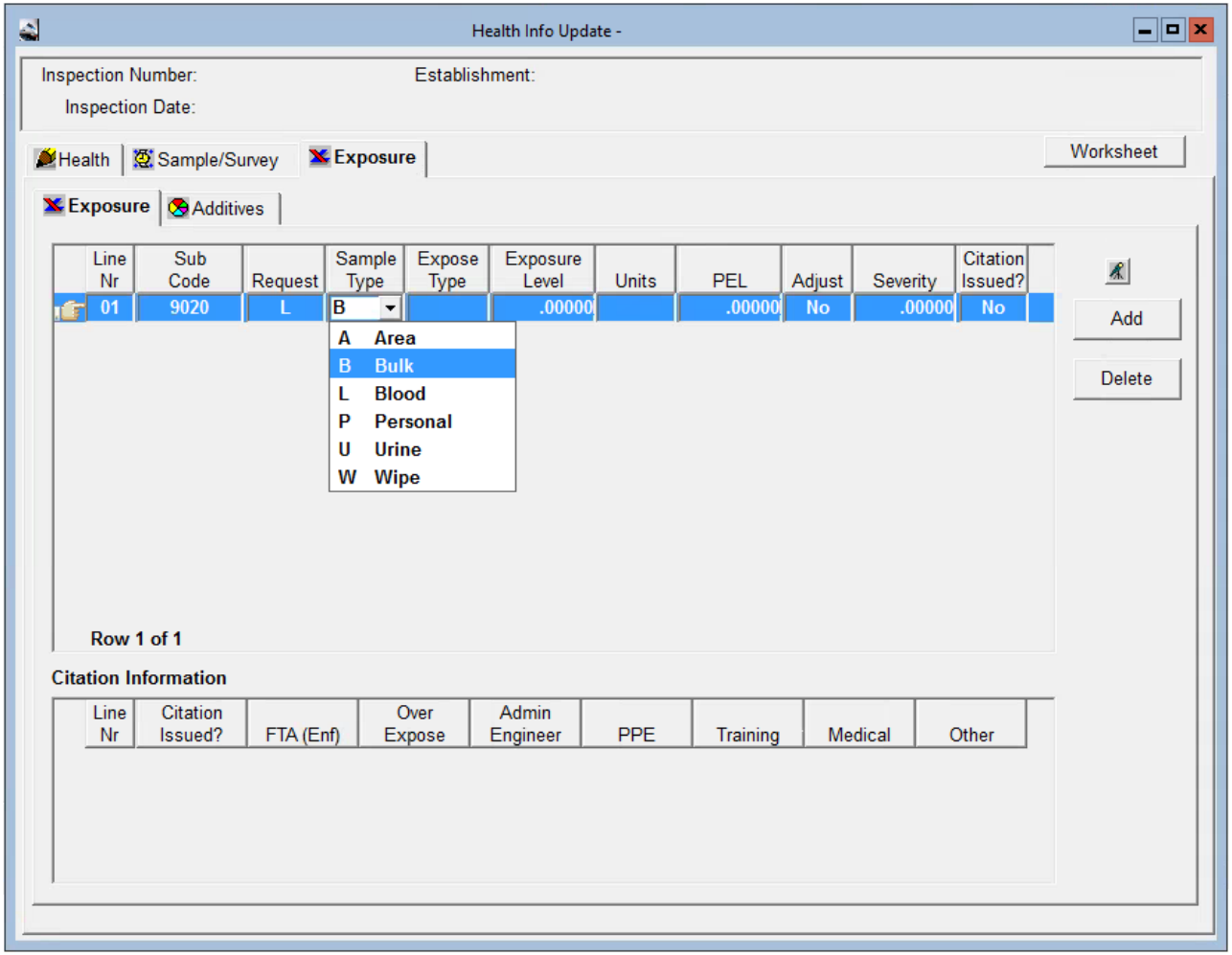
Recording Sampling Data

- Bulk and Wipe Samples

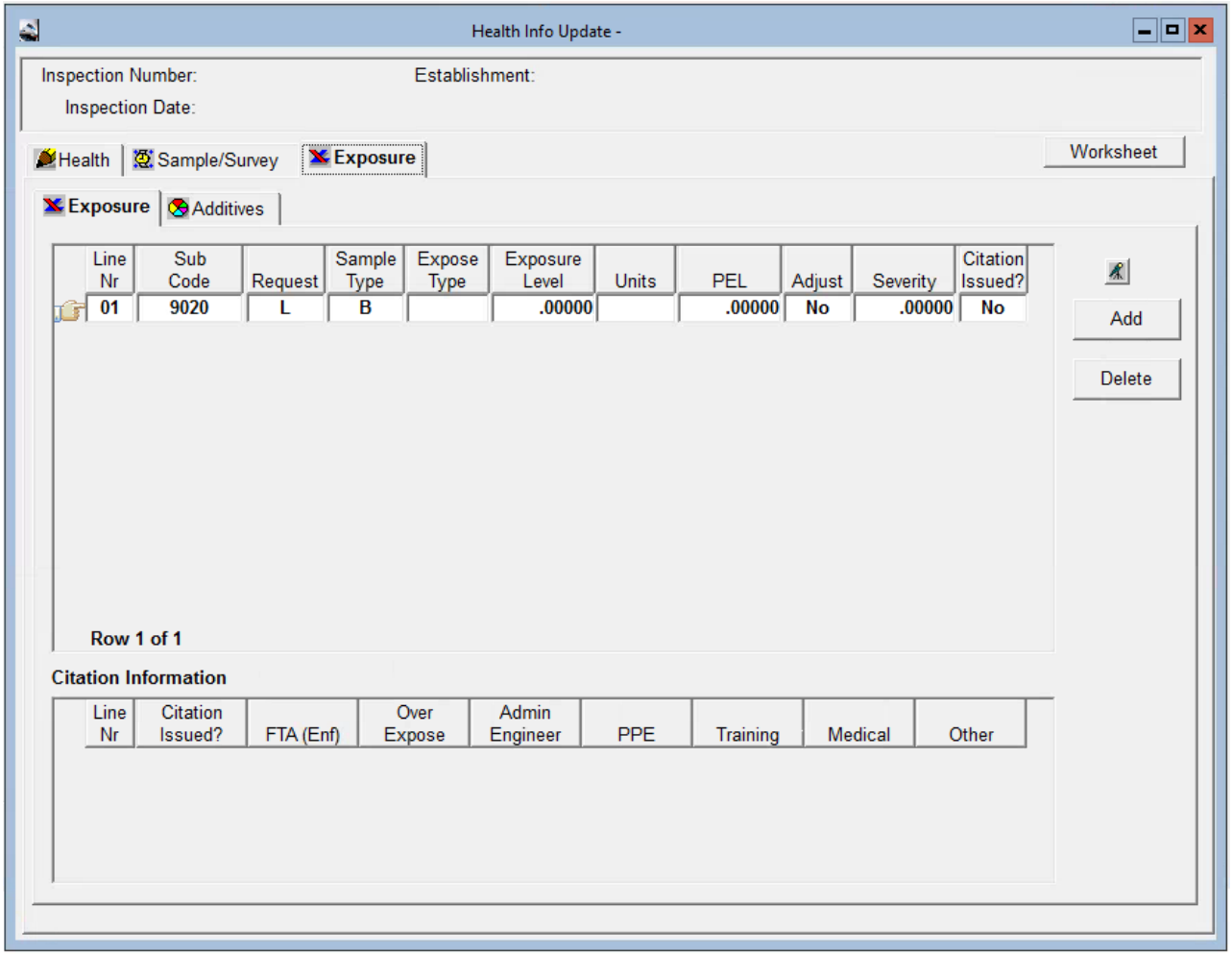
Entering Bulk & Wipe Data



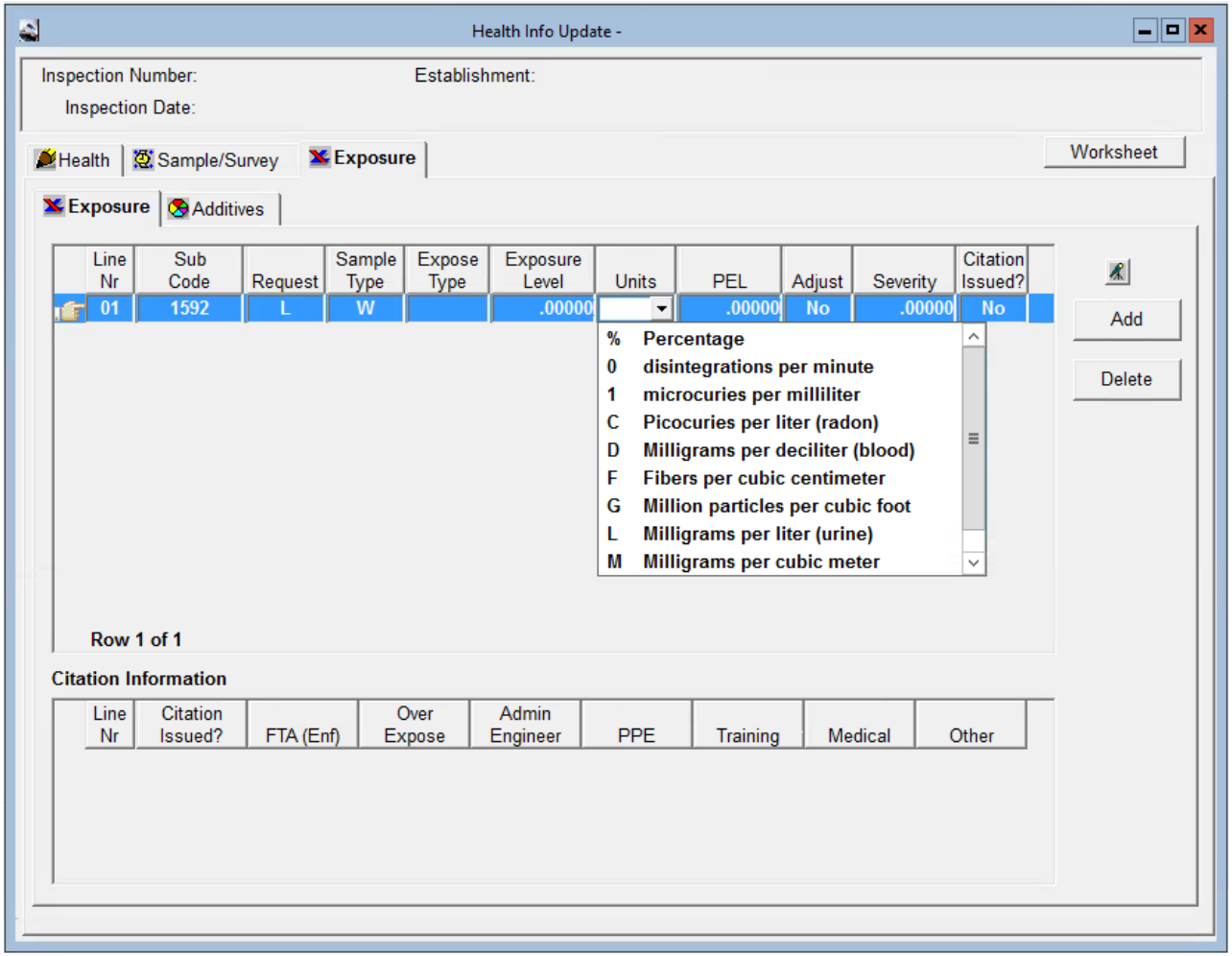
Entering Bulk Data



Entering Bulk Data



Enter Wipe Data



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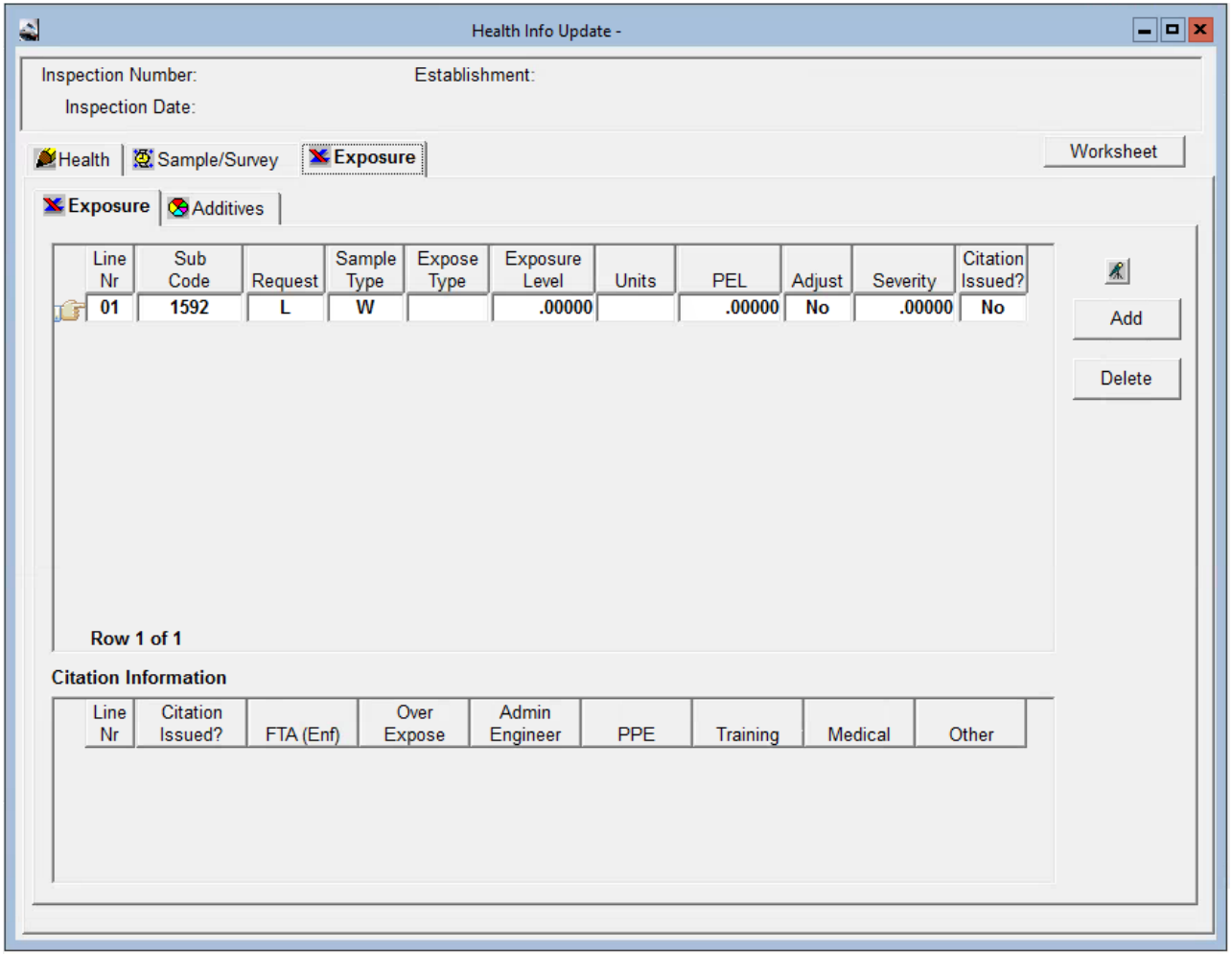
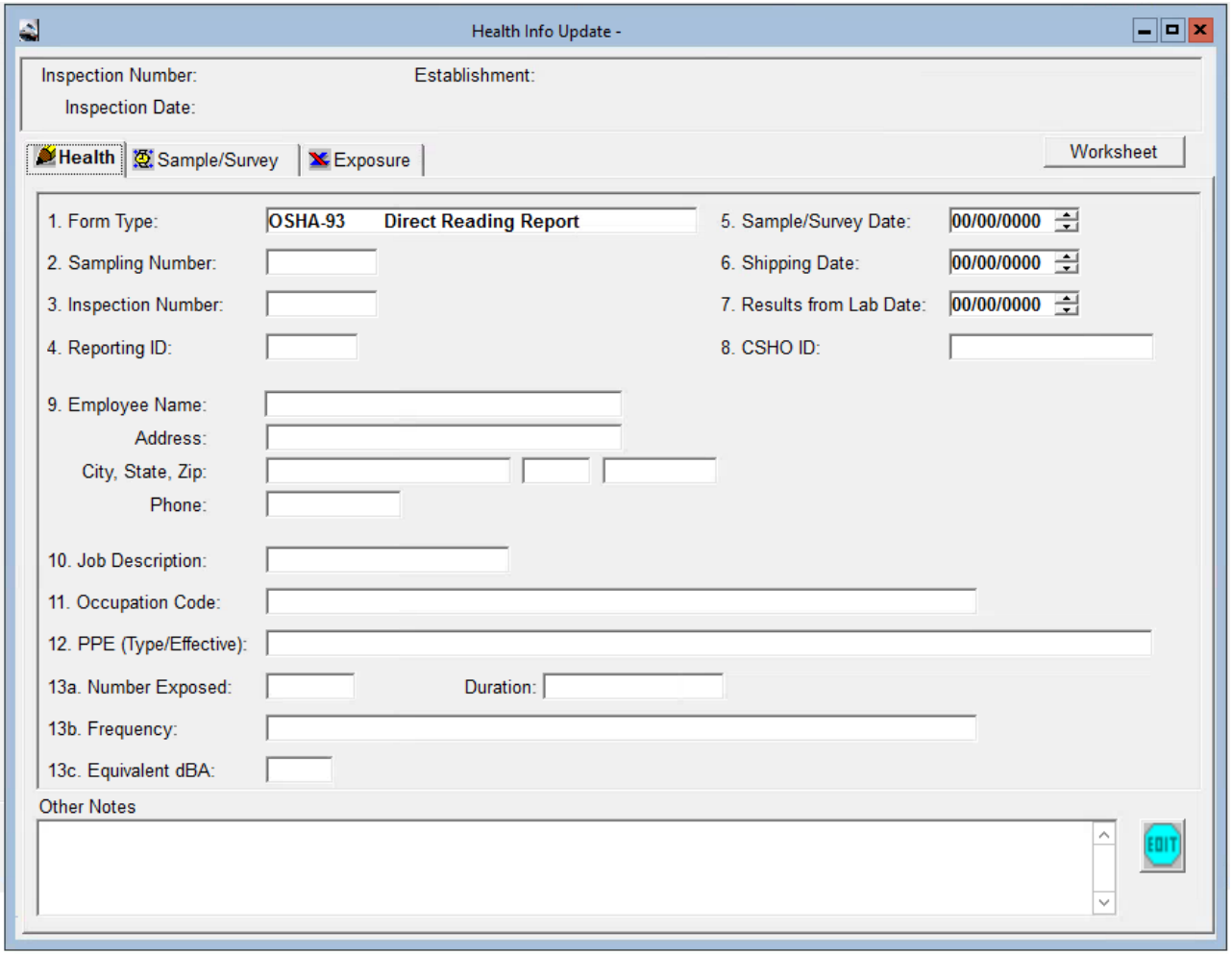


Recording Sampling Data

- Direct Read Samples

Entering Direct Read Data



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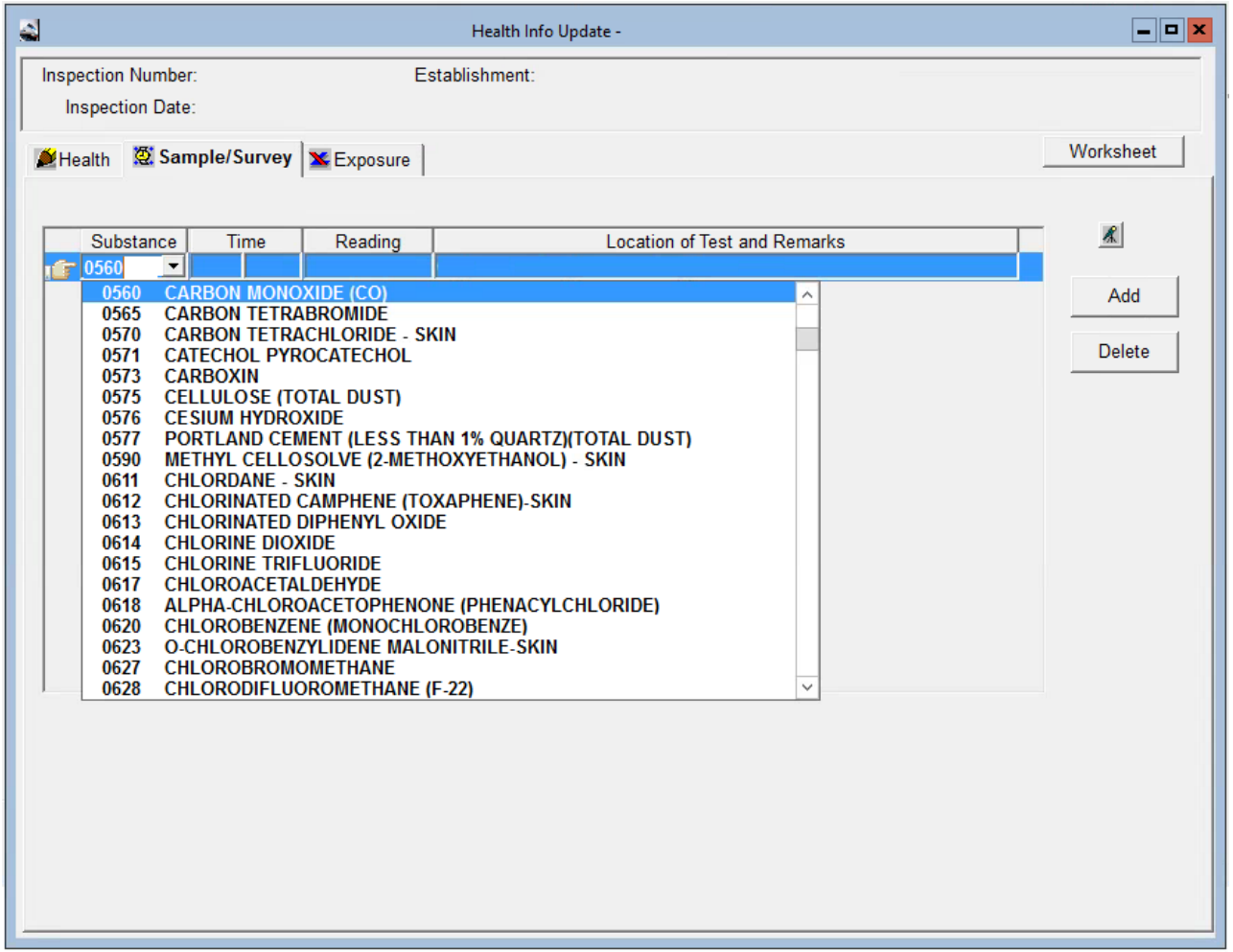

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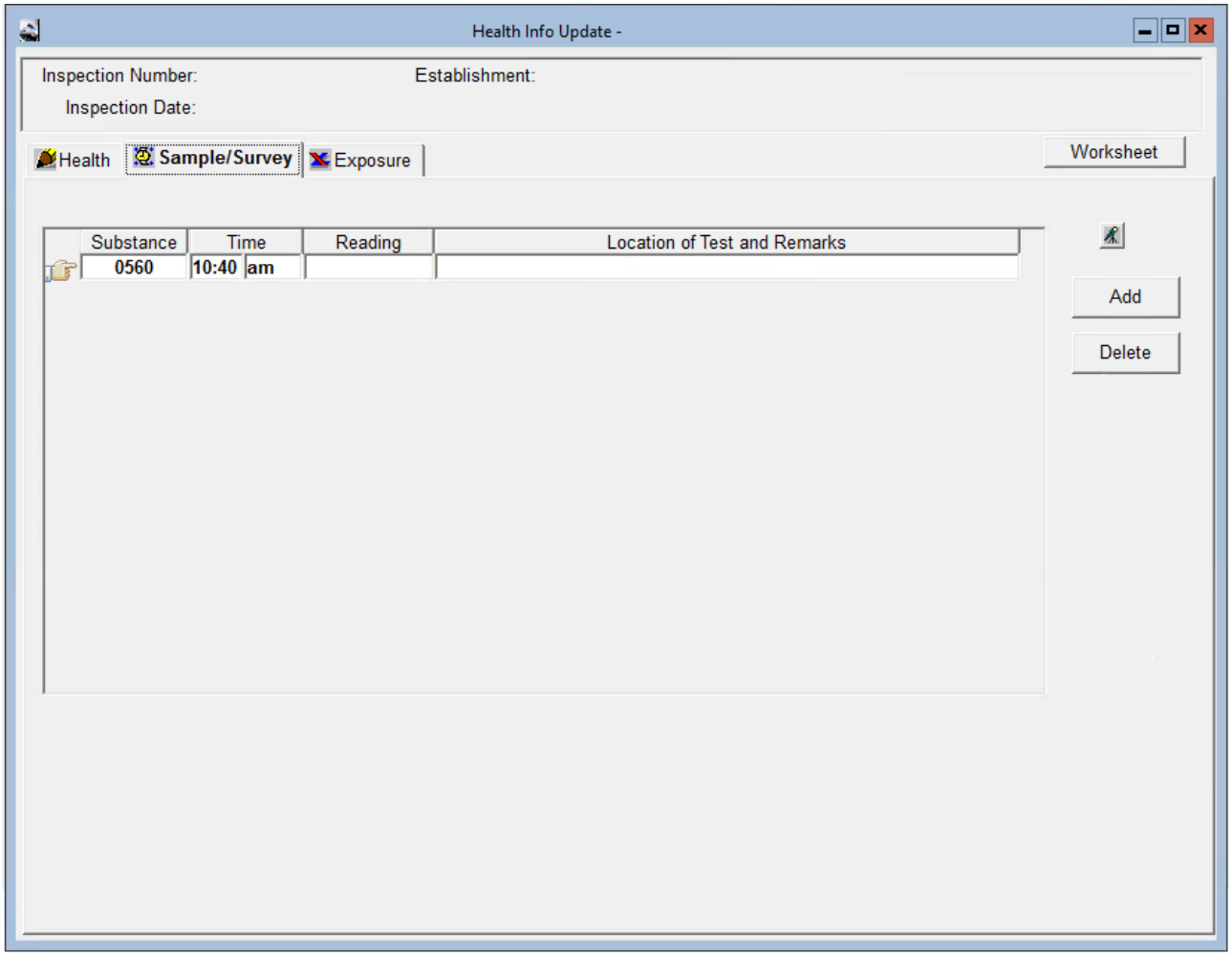

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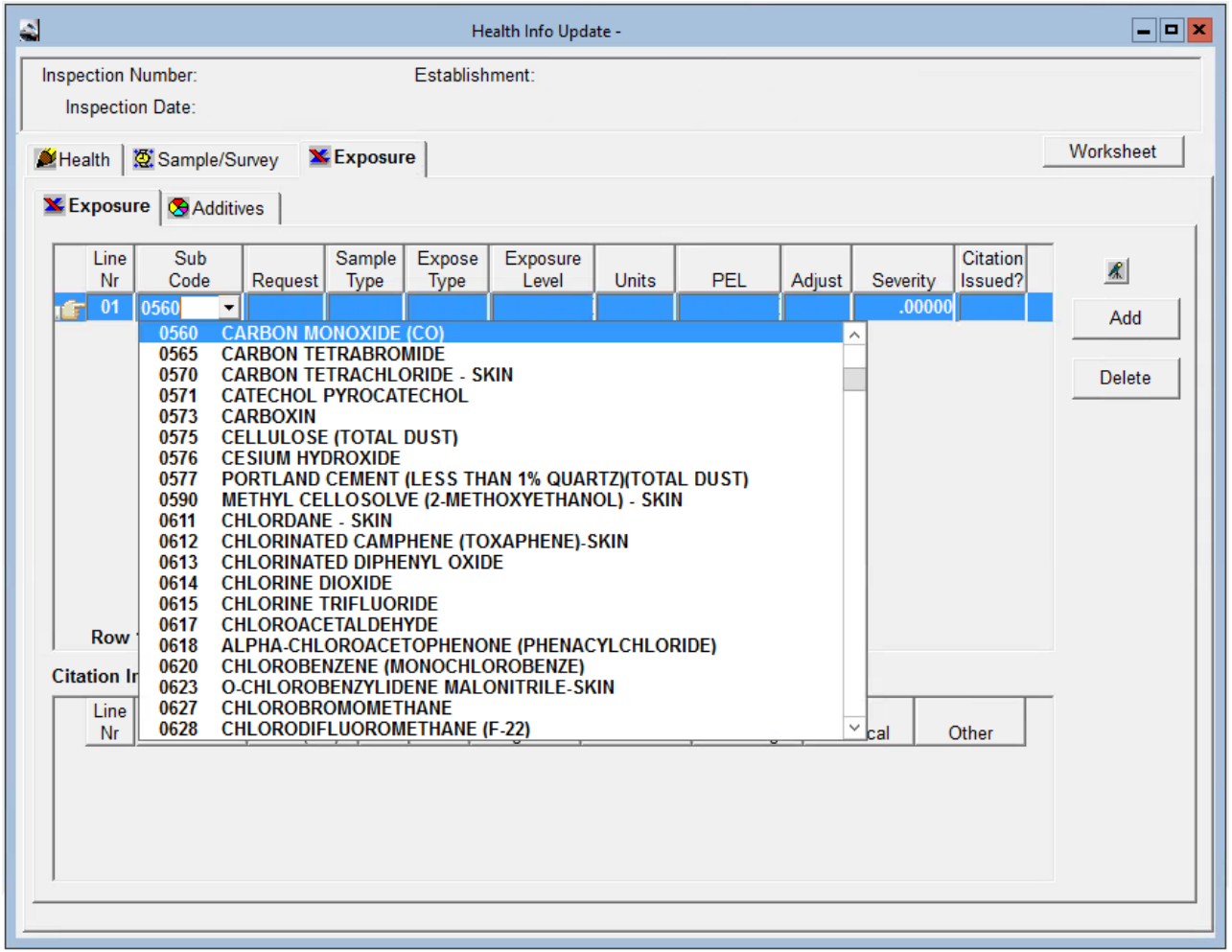

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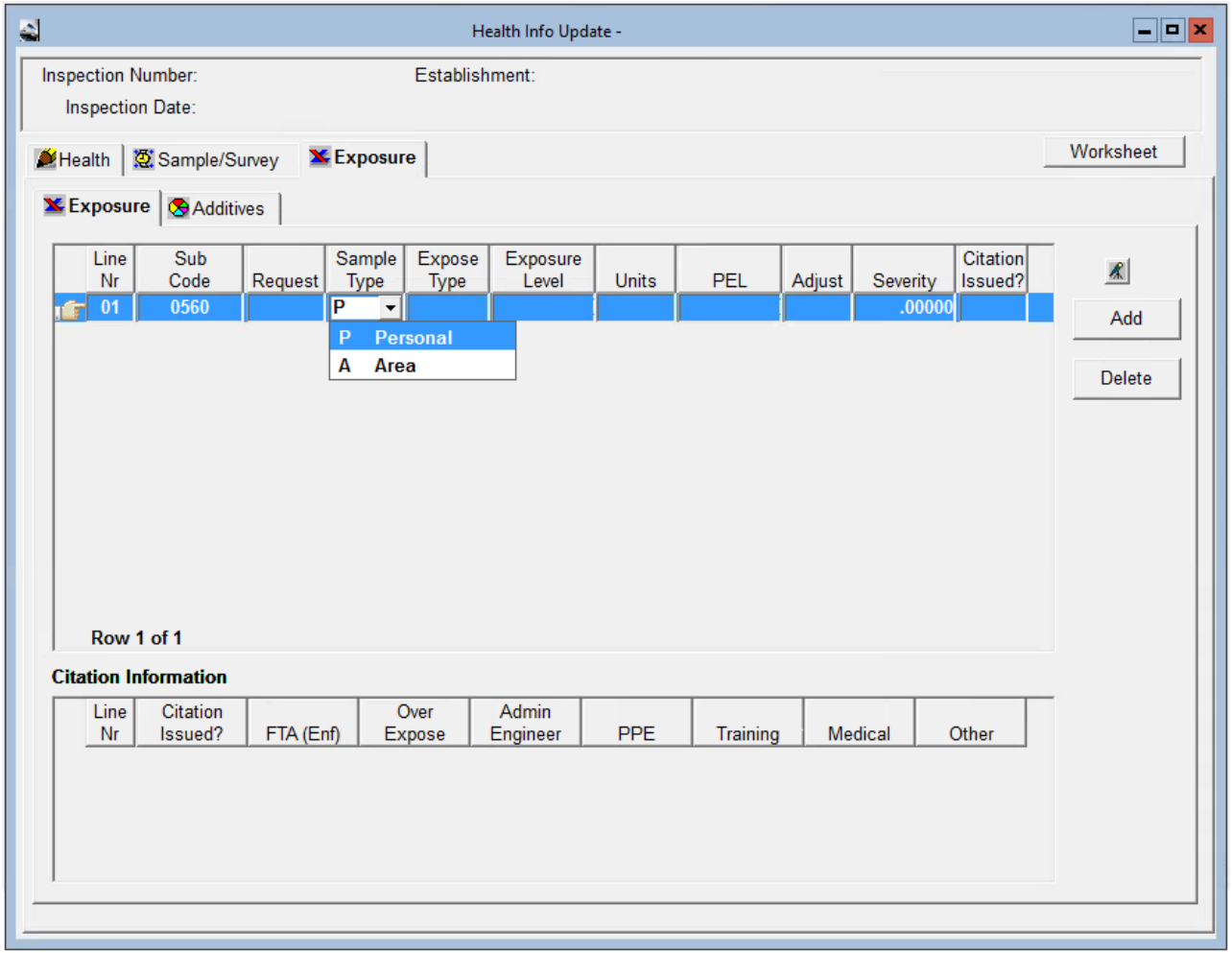
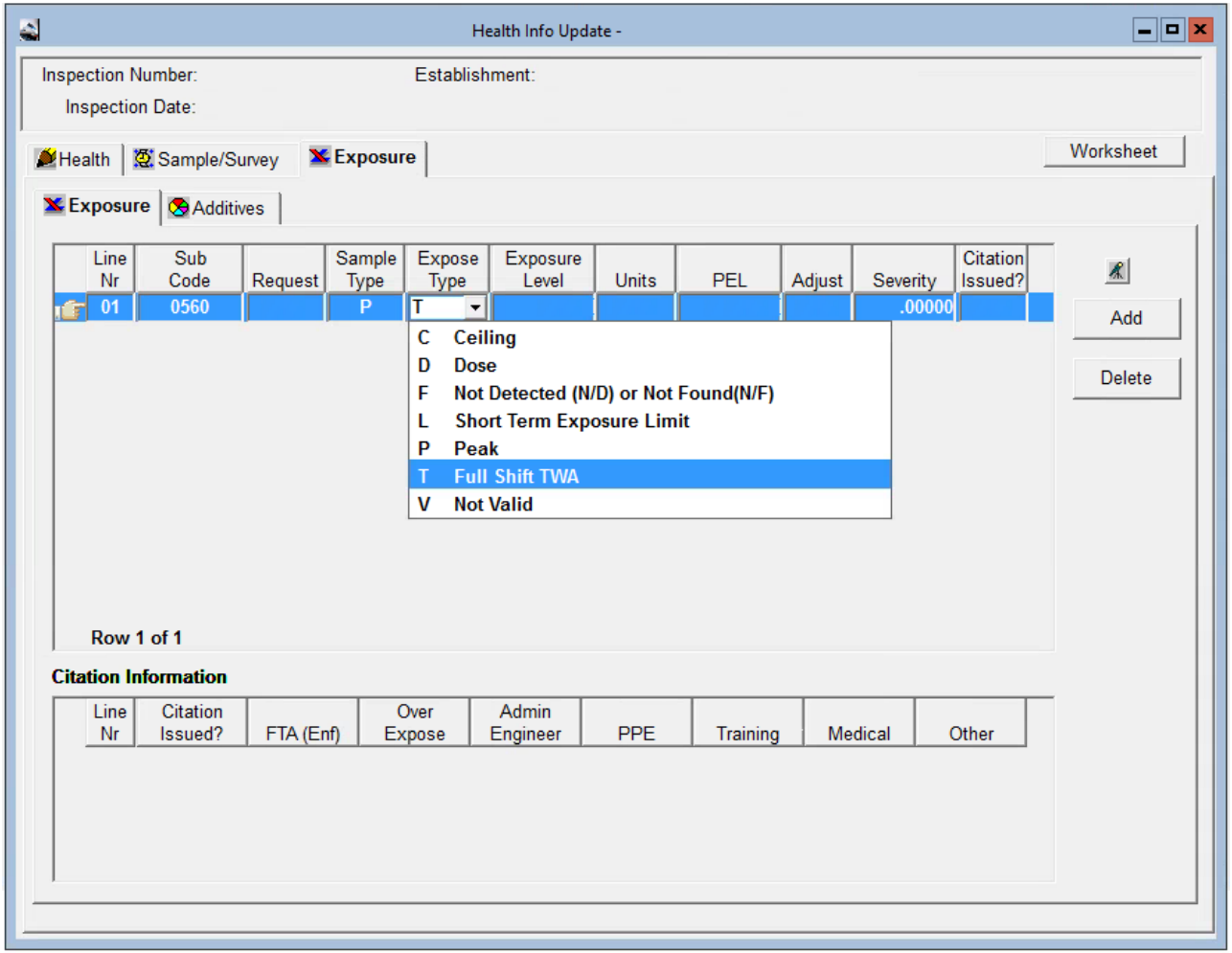
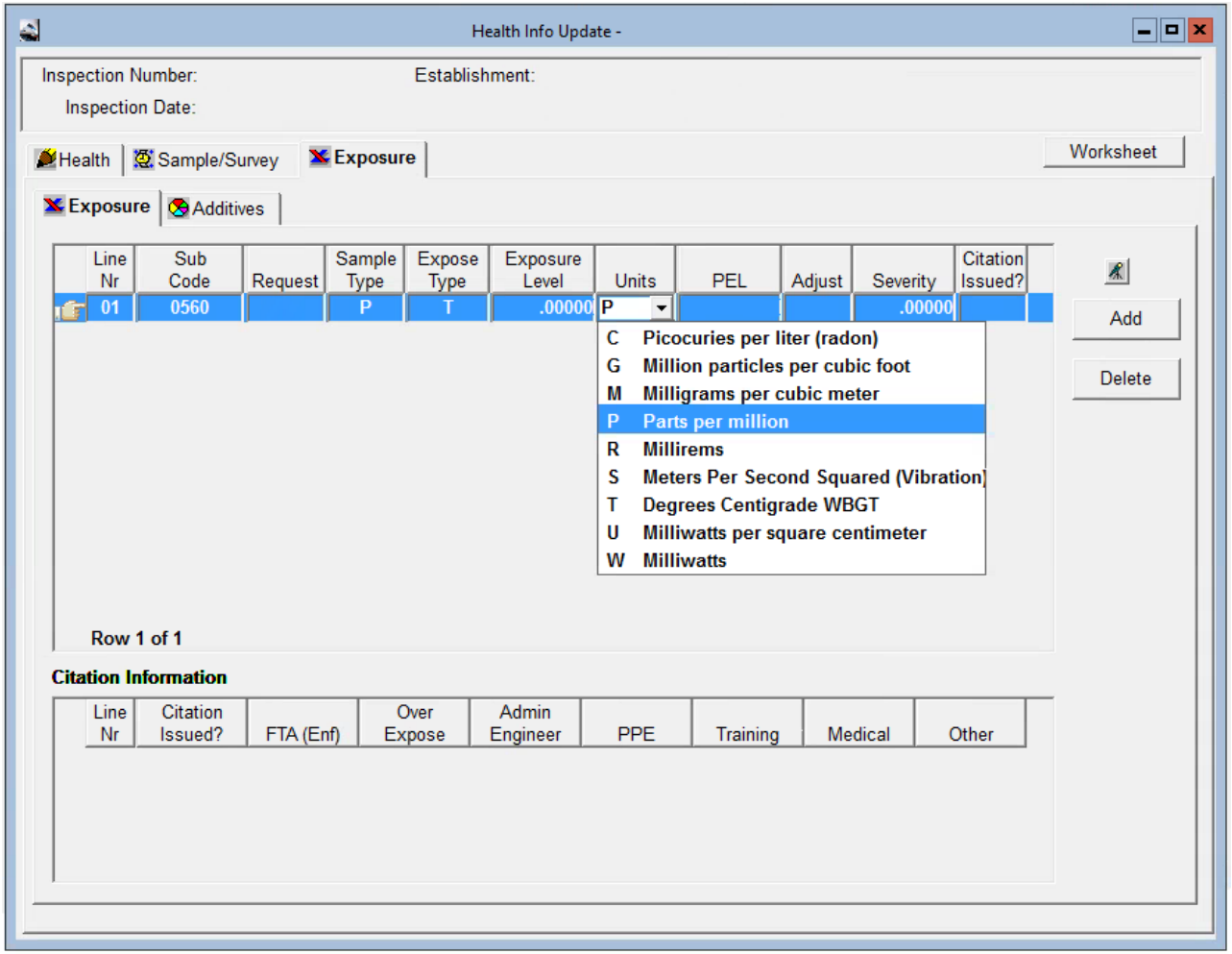


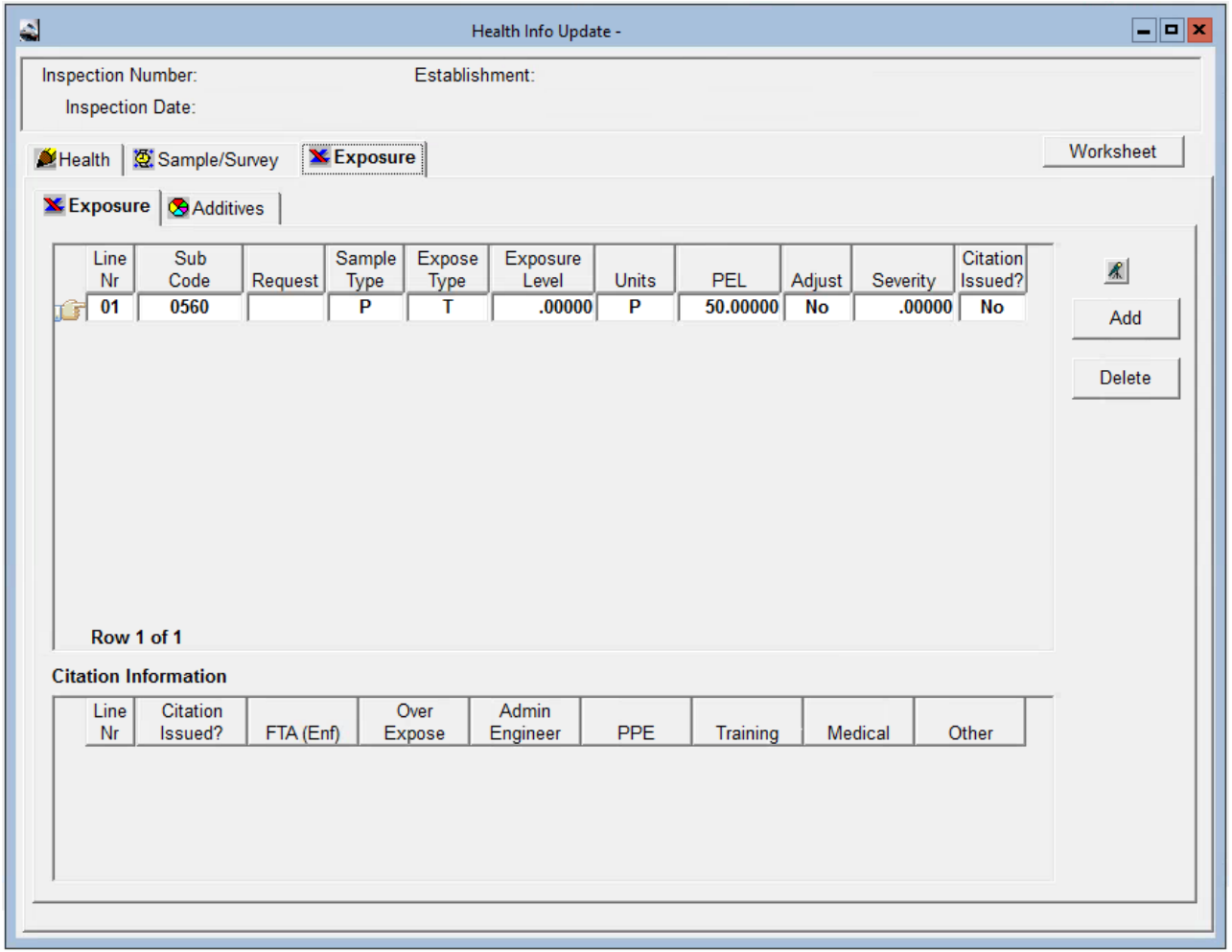
Entering Direct Read Data



Entering Direct Read Data



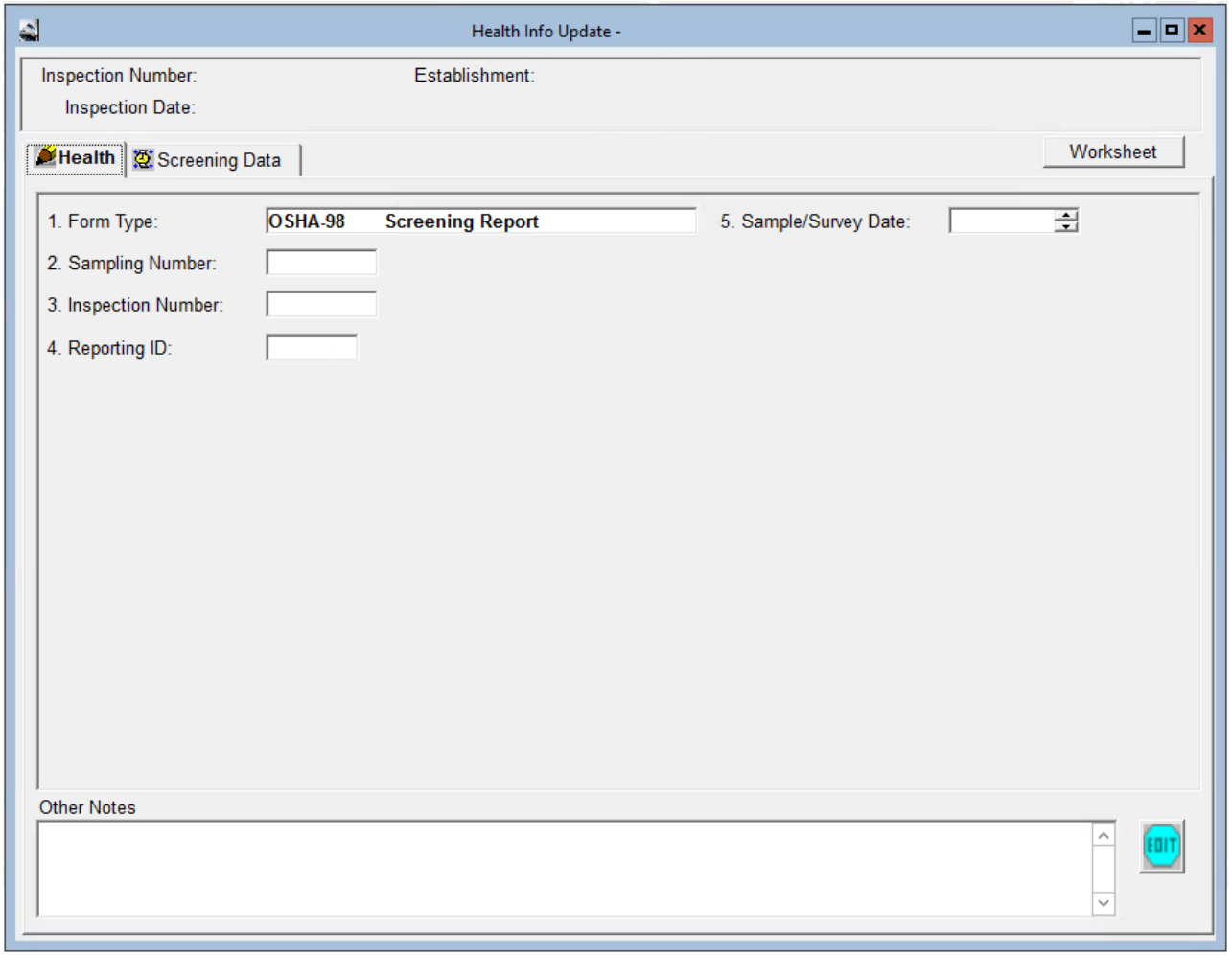
Entering Direct Read Data



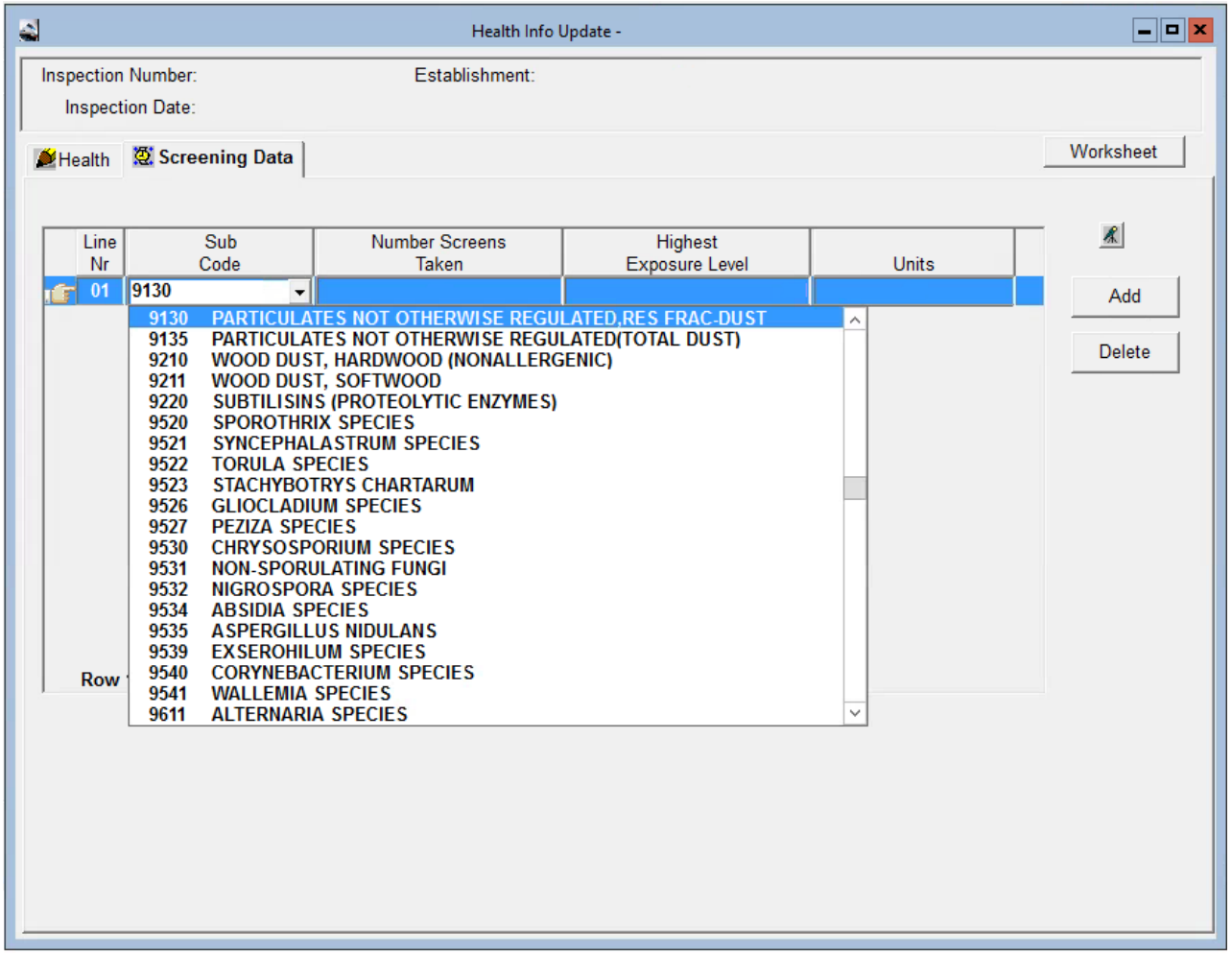
Recording Sampling Data

- Screening Samples

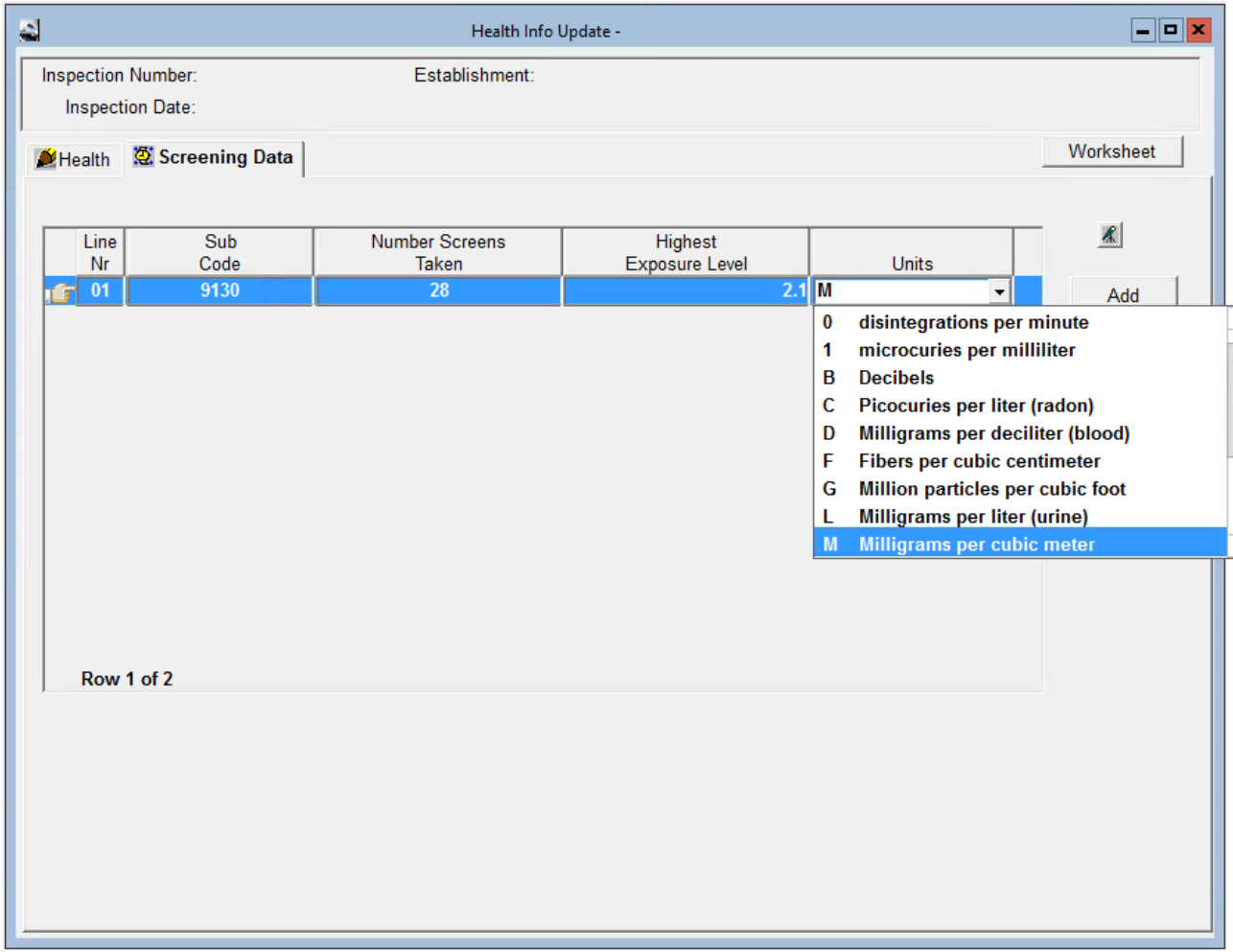
Entering Screening Data



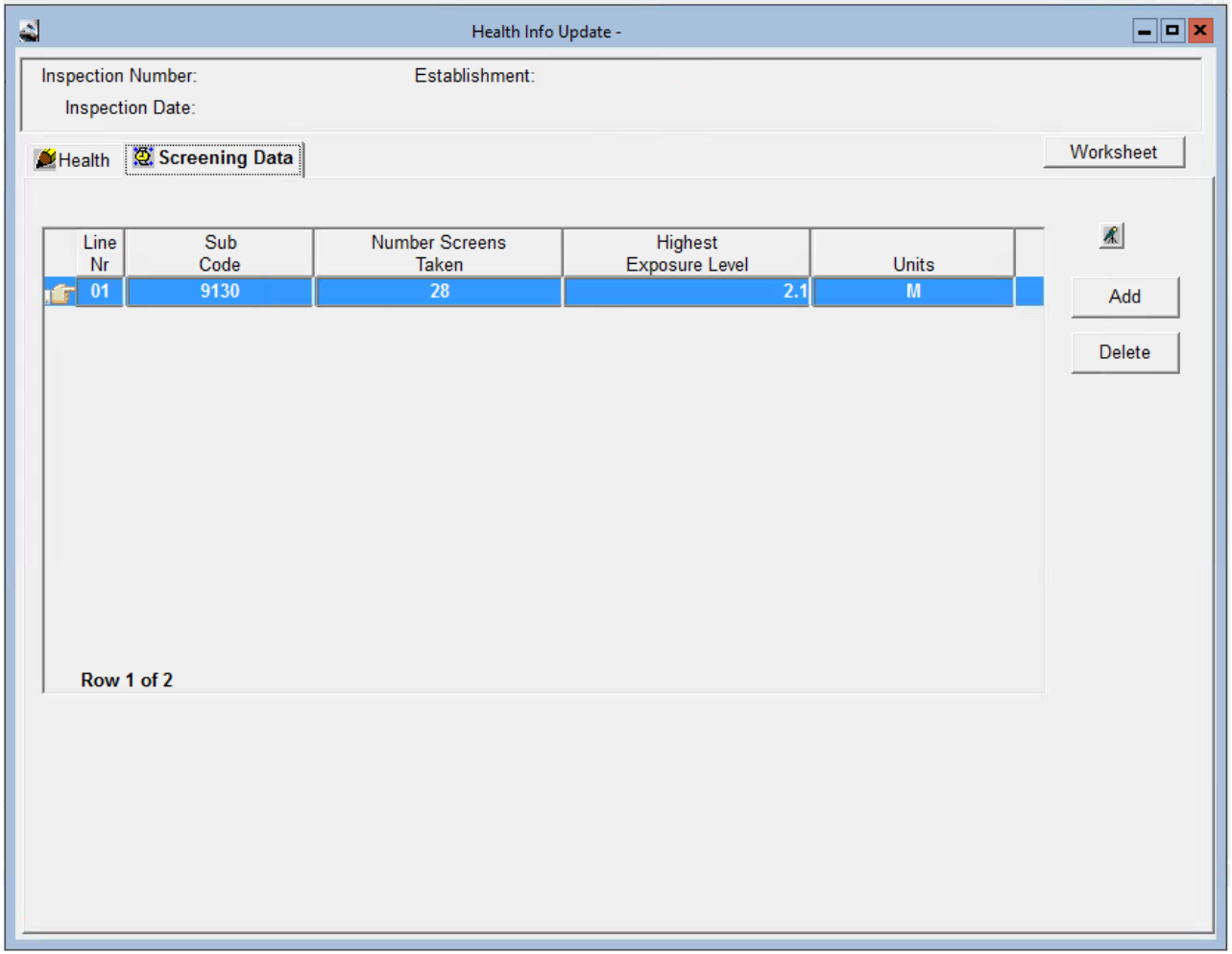
Entering Screening Data



Entering Screening Data



Entering Screening Data



Carbon Monoxide

- OPN 148

OPN-148

- For situations where significant exposure(s) to CO occurred, resulting in medical intervention and/or hospitalization.

- Theoretically derive an employee's exposure to CO
  - Coburn Equation
  - Coburn-Forster-Kane Model

OPN-148

- Must request medical records of suspected employees.
  - % carboxyhemoglobin (COHb or HbCO)
- Smoker or non-smoker
- Assess individual's physical activity level for assigned job task(s).
- Description of work activity for assigned job task(s).
- Determine the entire time period (in minutes) to which the individual(s) were occupational exposed to CO.

Con't

- Determine time period between the end of CO exposure and blood sample taken (in minutes).

- Recovery Time (air, oxygen, hyperbaric or mixture)
  - Mixture
    - » Include time for each type of treatment

Coburn Equation

- $$CO = \frac{1316\{[(0.0046)(2^{\theta/T})(C)]-[(0.007)(B)]+[(0.007*B)-2.3(D)(e^{-2.3(t)/5500(b)})]\}}{1-(e^{-2.3(t)/5500(b)})}$$

- CO = theoretical concentration of CO in air (ppm)
- C = Blood COHb in % at the time of blood sample
- B = Activity Factor (sedentary = 0.152, light work = 0.065, heavy work = 0.040)
- D = background COHb level (non-smoker = 0.0015, smoker = 0.0100)
- t = time of exposure to CO (in minutes)
- θ = time between end of CO exposure and blood sampling (in minutes)
- T = half-life recovery factor of CO removal from blood (in minutes)

Coburn Equation

- FIS
  - Forms
    - » 10 Forms COB 1: Coburn Equation CO Calculator

Reference

- OSHA
  - CO PEL = 50 ppm
- NIOSH
  - CO REL = 35 ppm
  - Ceiling = 200 ppm
- ACGIH (2014)
  - CO TLV = 25 ppm
  - CO BEI
    - Blood (end of shift) = 3.5% of hemoglobin
    - Exhaled air (end of shift) = 20 ppm

Example 1

- Employee #1
  - COHb % at time of blood sample = **4.5%**
  - Activity Factor = **Sedentary**
  - Background COHb = **non-smoker**
  - Exposure time to CO = **8 hours**
  - Time between end of CO exposure and collection of blood sample = **1 hour**
  - Recovery method = **Air**

Example 2

- Employee #1
  - COHb % at time of blood sample = **6.5%**
  - Activity Factor = **Heavy Work**
  - Background COHb = **Smoker**
  - Exposure time to CO = **30 minutes**
  - Time between end of CO exposure and collection of blood sample = **45 minutes**
  - Recovery method = **Mixture**
    - Air recovery time = **15 minutes**
    - Oxygen recovery time = **30 minutes**

Carbon Monoxide

- OPN 148
  - If Coburn Equation results in > 50 ppm
    - » Get supervisor's approval to initiate the Coburn-Forster-Kane Model.
      - Done by Salt Lake Technical Center (SLTC)
      - Model has been extensively tested for reliability.
  - Download SLTC Application
    - » Directions in Appendix C
    - » Requires a OSHA Extranet account

SLTC Application

Sample Submission Number:_____

OSHA Occupational Safety and Health Administration — SLTC Application

Submitting Data for the Carbon Monoxide Calculation at the OSHA Salt Lake Technical Center (SLTC).

The Limited Access CSHO Inspection Preparation page has the most recent version of this worksheet.

Special instructions for using OSHA Form 91 when submitting data to SLTC for the Carbon Monoxide Calculation (effective November 2007).

You MUST accompany your data submission with a statement from your Area Director indicating concurrence with your strategy. The statement of concurrence may be on the cover letter, the FAX cover sheet, or in an e-mailing. Please contact SLTC prior to submitting data if the incident involved more than 4 individuals -or- an affected individual had a measured %COHb of less than 7% -or- if you wish to discuss any critical elements of data collection strategy.

Jon Rima:	Scott Jones:	Dan Crane:
Voice phone: 801-233-4966	Voice phone: 801-233-4962	Voice phone: 801-233-4964

No physical sample is shipped to SLTC for chemical analysis. ***However, a Form 91A or Form 91S MUST be completed*** **and should be included with this multiple-page worksheet to establish the chain of custody for the data and to provide tracking through the SLTC laboratory database. Each Carbon Monoxide Calculation requested requires a separate Form 91 to evaluate each exposure requiring certain information on each Form 91. These items are listed below.** Item descriptions listed on the State Plan Forms 91S may differ somewhat from the item descriptions listed on the Form 91A and in the table that follows. If you have questions regarding what to enter, please call SLTC. If the individuals are away from their phones, a message can be left on their voice mail -or- you may have them paged at 801-233-4900 during office hours. The completed Form 91 and COHb worksheet may be either faxed or mailed to SLTC. To help keep faxed sheets in groups, please be sure to clearly print the optional Sample Submission Number you assign for this calculation at the top of the page. When mailed, the worksheet pages should be stapled to the back of the Form 91.

Reporting ID	**Person Performing Sampling** (signature & printed name)	**Sample Type** (Enter "P" or "Personal" here because the calculation uses clinical results based on a personal sample.)
Inspection Number	**Print Last Name**	**Sample Media** (Enter "COHb" here.)
Sampling Number	**CSHO ID**	**Analyze Sample for:** (Enter the IMIS code "C730" for CO Calculation here.)
Establishment Name	**Job Title**	
SIC Code	**Sample Submission Number** (If you do not provide a Sample Submission Number for the COHb data, we will use the Sampling Number.)	
Sampling Date		
Shipping Date (Date you Mail or FAX paperwork to SLTC)		

By default, the reported results of this calculation are in terms of the current 50 ppm TWA Federal OSHA PEL. If you are in a State OSHA program and use a different occupational exposure limit, such as the 1989 "Final Rule," the ACGIH TLV, or the EPA EGL, please specify the ppm value and the occupational exposure limit you wish us to use in the report.	_____

You are also encouraged to complete any additional data fields on the Form 91A that may be useful to you, may be of use in the future to help track exposure trends, or may help OSHA track its effectiveness in protecting the

SLTC Application

- Detailed questions
  - 25 numbered questions
  - Any sampling information taking during event (e.g., emergency responders)
  - Symptoms or signs employees exhibited.
  - Refer to the catalog of activity levels

- Recommendation
  - Download this form prior to conducting inspection to ensure the gathering of all necessary information.

Common Citations

Noise Citations

- When the 8-hour TWA is ≥ 92 dB(A) (a dose of 132%)
  - Exceeds the permissible noise exposure
    - » Cite 29 CFR 1910.95(b)(1) or 29 CFR 1926.52(b)
      - Serious
        - Hearing protection not provided or properly utilized; and/or
        - Hearing conservation program is deficient or nonexistent
      - Non-Serious
        - Effective hearing protection provided and utilized; and
        - Hearing conservation program is effective
        - Employer has an effective training program.

Noise Citations

- When the 8-hour TWA is ≥ 87 dB(A) (a dose of 66%)
  - Cite for Hearing Conservation Program if non-existent
    - » 29 CFR 1910.95(c)(1) or 29 CFR 1926.52(d)(1)
      - Serious
        - 8-hour TWA ≥ 92 dB(A) (a dose of 132%)
      - Non-Serious
        - 8-hours TWA ≥ 87 dB(A) but < 92 dB(A)

Air Contaminant Citations FOM ch XV F.4.d-e

- Limits for air contaminants are exceeded
  - Air contaminant concentration ≥ acceptable levels
    - » Table Z-1
      - Cite 29 CFR 1910.1000(a)(1) or (2)
    - » Table Z-2
      - Cite 29 CFR 1910.1000(b)(1) or (2)
    - » Table Z-3
      - Cite 29 CFR 1910.1000(c)
    - » Threshold Limit Values of Airborne Contaminants for Construction
      - Cite 29 CFR 1926.55(a)
    - » Lack of engineering controls and/or administrative and work practice controls
      - Cite 29 CFR 1910.1000(e) or 29 CFR 1926.55(b)

General Duty Clause §95-129(1)

- Substance with no OSHA PEL
  - If the substance's dose (exposure) and toxicity could result in a serious illness or injury; and
  - The substance has an OEL set by other entities
    - » TLV published by ACGIH
    - » REL recommendation by NIOSH
      - 10 hour TWA
  - Exceptions (further discussion needed with supervisor and bureau chief)
    - » Substance concentration below established PEL, but in excess of a TLV or REL
    - » Substance has a PEL with no established ceiling limit, but a ceiling from either ACGIH or NIOSH

General Duty Clause §95-129(1)

- Heat Stress
  - OPN 141 – Enforcement Guidance for Conducting Heat-Related Illness Inspections and Issuing Citations
- Ergonomics
  - FOM Chapter 17 – Ergonomics Inspection Procedures
- Combustible Dust
  - NEP: Combustible Dust Explosion Prevention Program

Air Contaminant Citations

- Grouping
  - Situations where an overexposure is documented, feasible engineering and/or administrative controls have not been implemented, and respiratory protection has not been provided or is insufficient or ineffective
    - » Overexposure for regulated contaminants
      - 29 CFR 1910.1000(a), (b), (c), (d) or 29 CFR 1926.55(a)
    - » Engineering/administrative controls
      - 29 CFR 1910.1000(e) or 29 CFR 1926.55(b)
    - » Respirator
      - 29 CFR 1910.134(a)(2)

Citation Classification

- Guidance
  - Based on Health Codes from the Chemical Sampling Information page on the OSHA website
    - » Substances with a health code of 13 or less
      - Serious
    - » Substances with a health code of 6, 8, and 12
      - Non-serious
        - mild to temporary effects
    - » Substances with a health code of 14 and 15
      - Non-serious
        - Mild to moderate irritation
    - » Multiple health codes
      - Non-serious
        - Until the concentration reaches a level which a serious effect could occur

Air Contaminant Citations

- Documented overexposure
  - No violation or citation
    - » Engineering and/or administrative controls are in place, utilized and effective; and
    - » Personal protective equipment is provided, utilized and maintained properly
  - Example;
    - » Process evaluated by Professional Engineer (PE) and/or Certified Industrial Hygienist (CIH), documented that engineering controls reduce the contaminant level to lowest possible levels (not below the PEL), and with proper PPE eliminated the hazard to employees.

Related Citations

- General Industry
  - 29 CFR 1910.94 – Ventilation
  - 29 CFR 1910.106 – Flammable Liquids
  - 29 CFR 1910.119 – Process Safety Management of Highly Hazardous Chemicals
  - 29 CFR 1910.120 – Hazardous Waste Operations and Emergency Response
  - 29 CFR 1910.123 – 126 – Dipping and Coating Operations
  - Subpart I – Personal Protective Equipment
  - 29 CFR 1910.151 – Medical Services and First Aid
  - Subpart Q – Welding, Cutting and Brazing
  - Subpart Z – Toxic and Hazardous Substances

Related Citations

- Construction
  - 29 CFR 1926.20 – General Safety and Health Provisions
  - Subpart D – Occupational Health and Environmental Controls
  - Subpart E – Personal Protective and Life Saving Equipment
  - Subpart J – Welding and Cutting
  - Subpart Z – Toxic and Hazardous Substances
  - Subpart AA – Confined Spaces in Construction

Summary

In this course, we discussed

- Sampling Equipment
- Analytical Techniques
- Reasons for Sampling
- Sampling Strategies
- Evaluation of Sampling Results
- The Coburn Equation
- Common Citations

Thank You For Attending!

Final Questions?

1-800-NC-LABOR

(1-800-625-2267)

www.nclabor.com