

A PRACTICAL GUIDE FOR USE OF REAL TIME DETECTION SYSTEMS FOR WORKER PROTECTION AND COMPLIANCE WITH OCCUPATIONAL EXPOSURE LIMITS

DOE and DOE Contractors Industrial Hygiene Meeting

In conjunction with the 2019 American Industrial Hygiene Conference
and Exposition

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Why this White Paper?

- ▶ Practical Guidance needed for use of Real Time Detection Systems (RTDS):
 - ▶ Worker protection
 - ▶ Compliance with Occupational Exposure Limits (OELs)

Focus of Paper

- ▶ Protection of worker health.
- ▶ Solid exposure decisions based on occupational exposure limits (OELs).
- ▶ Successfully managing compliance with applicable regulations.

Paper Includes Discussion of:

- ▶ occupational exposure assessment
- ▶ OELs
- ▶ traditional use of RTDS
- ▶ use and limitations of RTDS
- ▶ use of RTDS for compliance
- ▶ documentation and reporting of RTDS results
- ▶ practical matrices for real time monitoring decisions
- ▶ data collection and interpretation worksheet

What are RTDS?

- ▶ They are industrial hygiene instruments with sensors that can detect a hazard.
- ▶ They assist the industrial hygienist in establishing a hazard's presence or absence (i.e., a qualitative result) or provide a concentration (i.e., a quantitative result).
- ▶ They include configurable functions such as data logging, intervals, and alarm settings.

How are RTDS used?

- ▶ They are traditionally used as screening tools, or for emergency response.
- ▶ They can be used to examine within-shift variability of peak exposures for fast acting agents such as hydrogen sulfide.
- ▶ They can also be used to demonstrate compliance with OELs.

Occupational Exposure Assessment is:

- ▶ The degree and variability of workplace exposures to hazards.
 - ▶ $R=f$ (hazard magnitude) X (health consequence).
- ▶ Comparing results to an OEL with one or more sample results.
 - ▶ Straight comparison of OEL to a result
 - ▶ Use of an exposure control categories
 - ▶ Use of statistical analysis

Peak Exposures are of concern with:

- ▶ agents with rapidly occurring acute adverse health effects
 - ▶ Many have established STEL or ceiling value.
 - ▶ For those without a TLV-STEL or TLV-C, ACGIH uses the 3/5 rule.

The ACGIH 3/5 Rule

| | | |
|---|--|---|
| <p>The “3” Rule: a transient increase in workers’ exposure levels may exceed 3 times the value of the TLV-TWA for no more than 15 minutes at a time, on no more than 4 occasions spaced 1 hour apart during a workday.</p> | <p>The “5” Rule: under no circumstances should a transient peak exposure exceed 5 times the value of the TLV-TWA level.</p> | <p>8-Hour TWA: the 8-hour TWA is not to be exceeded for an 8-hour work period.</p> |
| <p>If a RTDS is used, each data point within a 15-minute period is averaged. If worker exposure levels exceed 3 times the value of the TLV-TWA for a 15-minute period, on more than 4 occasions during a workday, work should be paused, and an adjustment using the hierarchy of controls should be immediately implemented.</p> | <p>For any data point that exceeds 5 times the TLV-TWA, including instantaneous RTDS readings, work should be paused, and an adjustment using the hierarchy of controls should be immediately implemented.</p> | <p>If an RTDS is used, each data point within an 8-hour period is averaged. For any 8-hour TWA exceeded in an 8-hour work period, work should be paused, and an adjustment using the hierarchy of controls should be immediately implemented.</p> |

Why use an RTDS?

- ▶ Workers may vary their behavior from day to day, or may not follow process instructions in a consistent manner from day to day.
- ▶ With the addition of variations in process equipment and materials properties, exposure profile variations begin to appear.
- ▶ When excursions above an OEL are noted, it is important to address the risk associated with the excursions and determine appropriate actions in the future to avoid or minimize them.

Advantages of RTDS

- ▶ Immediate availability of the data.
- ▶ Better accuracy and precision than sampling pumps and laboratory analysis in some cases.
- ▶ Method performance specified in widely used laboratory methods is +/- 25%. Many RTDS claim best-case accuracy of better than 1%.
- ▶ Ability to data log and provide an exposure profile over the sample period.

Regulatory compliance

- ▶ Regulatory interpretations grounded in updated legal precedent are lacking.
- ▶ As a result, some practitioners believe that any data point recorded above the OEL is a de facto demonstration of non-compliance, regardless of
 - ▶ the time interval of the recorded data point, or
 - ▶ the linkage of that datum to the evidence of a health consequence.

Regulatory compliance

- ▶ These beliefs lead to real implications for industrial hygienists such as:
 - ▶ abandoning technical toxicological foundations for the interpretation of information;
 - ▶ application of the hierarchy of controls and the resources to implement them when they may not be needed; or
 - ▶ overprotection of the employee through assignment of personal protection equipment, resulting in significant costs in work productivity, efficiency, and finances.

OSHA Compliance and RTDS

- ▶ RTDS are specifically discussed in OSHA standards, e.g., General Industry Confined Space Standard.
- ▶ OSHA regulations in general neither require nor prohibit measurement of air contaminants using RTDS for an employer to determine compliance with exposure standards.
- ▶ To the degree that RTDS may be used for exposure assessment, they should be embraced and used to the extent of their capabilities, with full understanding of their limitations.

DOE compliance

- ▶ DOE sites are required to report exposures over an OEL in accordance with DOE Order 232.2a, Occurrence Reporting and Processing of Operations Information.

DOE compliance

- ▶ An exposure over the OEL is categorized under Group 2-Personnel Safety and Health 2A(6):
 - ▶ (High) Personnel exposure to chemical, biological, or physical hazards that exceed 10 times the limits established in 10 CFR Part 851, Worker Safety and Health Program (see 10 CFR Section 851.23 Safety and Health Standards) or exceed levels deemed Immediately Dangerous to Life and Health (IDLH).
 - ▶ (Low) Personnel exposure to chemical, biological or physical hazards above limits established in 10 CFR Part 851, Worker Safety and Health Program (see 10 CFR Section 851.23, Safety and Health Standards), but below levels deemed IDLH.

Occupational Exposure Limits

- ▶ Ceiling - A ceiling limit is generally accepted as a value which should not be exceeded at any time.
- ▶ Values related to ceiling limits are generally based upon a minimum sample volume.
- ▶ Minimum sample volumes are specified in OSHA Ceiling Limits.

Occupational Exposure Limits

- ▶ Excursion - OSHA defines an excursion limit as a 15-minute or a 30-minute TWA exposure that must not be exceeded at any time. In the asbestos expanded standards for construction and general industry, the excursion limit is a concentration that must not be exceeded over a 30-minute period. In the ethylene oxide general industry standard, the excursion limit is a concentration that must not be exceeded over a 15-minute period.

Occupational Exposure Limits

- ▶ Immediately Dangerous to Life or Health (IDLH) - an atmospheric concentration of any toxic, corrosive or asphyxiant substance that:
 - ▶ poses an immediate threat to life or
 - ▶ would cause irreversible or delayed adverse health effects or
 - ▶ would interfere with an individual's ability to escape from a dangerous atmosphere.

Occupational Exposure Limits

- ▶ Peak Exposure - typically considered the highest recorded data point within a defined set of data.
- ▶ OSHA (29 CFR 1910.1000, Table Z-2) also uses the term “acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift” in a unique regulatory sense for a select group of chemicals with regulatory OEL values derived from 1960s era American National Standards Institute (ANSI) standards.

Occupational Exposure Limits

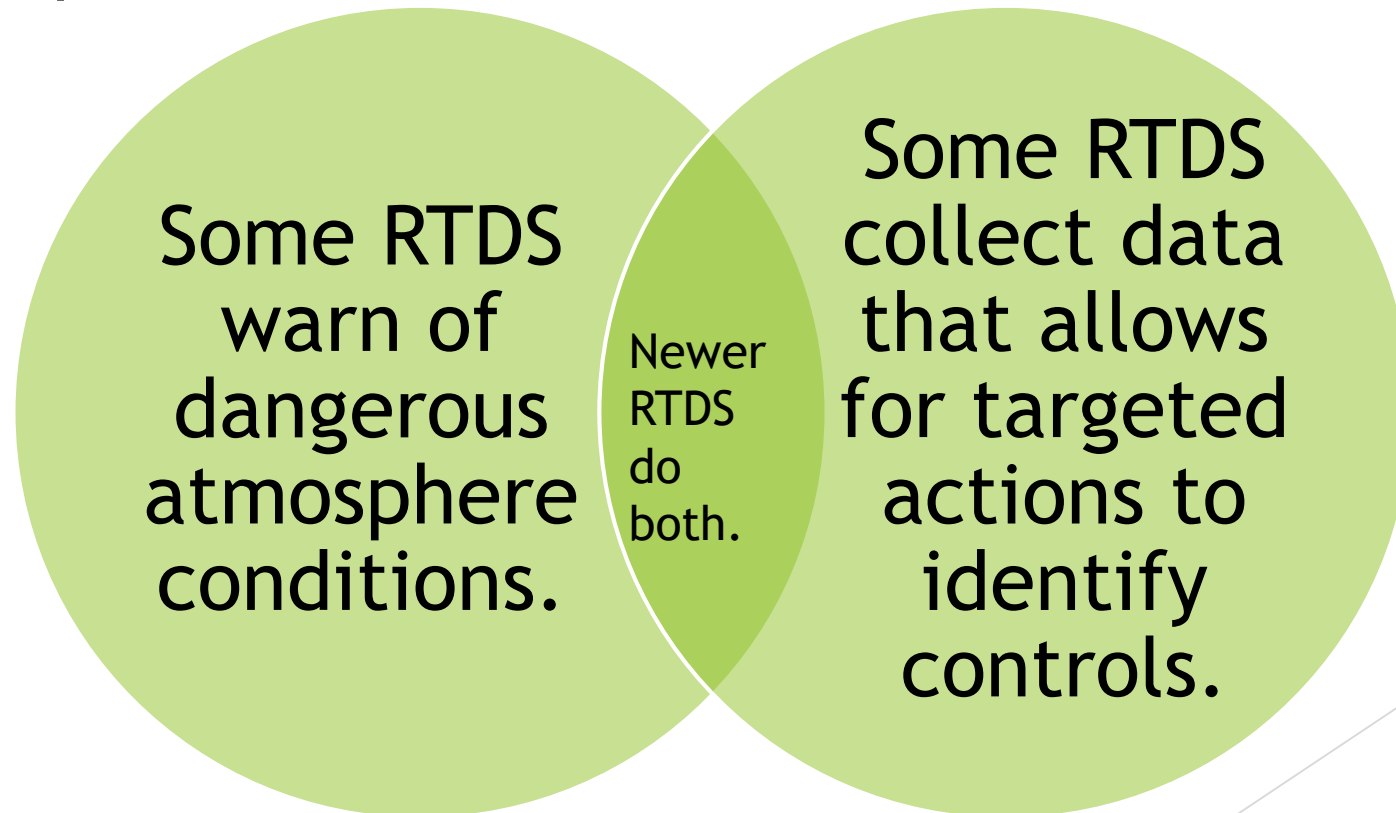
- ▶ STEL - used to address acute health effects such as irritation when chronic health effects may also be expected.
- ▶ For example, many organic vapors, which may be irritating at high levels, may also cause disease within a target organ with lower exposure levels over prolonged periods (e.g., months or years).

Occupational Exposure Limits

- ▶ TWA - Time-Weighted Average (TWA) exposures are used to assess risk of chronic ill health effect over prolonged periods of time, generally 8 hours.
- ▶ An averaged concentration obtained over any time period is actually a TWA value. For example, a 15-minute STEL sample collected using a sampling pump and sampling medium provides a 15-minute TWA exposure value.

Traditional Use of RTDS

- ▶ initially created based on market needs to manage occupational health consequence risks, not to support exposure assessment programs nor compliance demonstrations.



Traditional Use of RTDS

- ▶ Grab samples
- ▶ Screening samples
- ▶ Emergency response

Use and Limitations of RTDS

- ▶ Always review specifications¹ before use
 - ▶ information specifications
 - ▶ performance specifications
 - ▶ operation specifications
 - ▶ readings specifications
 - ▶ interference specifications
 - ▶ maintenance specifications
 - ▶ data management specifications
 - ▶ safety specifications

¹ Reporting Specification for Electronic Real Time Gas and Vapor Detection Equipment, Fact Sheet sponsored by the AIHA Real Time Detection Systems Committee, October 17, 2016.

Data Logging

- ▶ Document peak exposures.
- ▶ Demonstrate compliance with ceiling limits.
- ▶ Characterize tasks that have variable exposures.
- ▶ Useful in situations where the industrial hygienist is not able to be near the task (e.g., limited space, additional exposure risk) or when variable exposures are difficult to manually document in real time.

Data Logging

- ▶ Variables:
 - ▶ Where the data is stored
 - ▶ How often the data is recorded
 - ▶ Format of data
- ▶ Data collected during sampling would likely be considered an employee exposure record per 29 Code of Federal Regulations (CFR) 1910.1020 (Access to Employee Exposure and Medical Records) and would need to be preserved and maintained for the appropriate length of time.
- ▶ The DOE also requires that all RTDS readings used for evaluating personal exposures must be retained in accordance with the DOE Epidemiological Moratorium.

Sensors. Evaluate:

- ▶ Selectivity
- ▶ Accuracy, precision and repeatability
- ▶ Effect of environmental conditions on sensor performance
- ▶ Known inherent characteristics of the sensor

Alarm Set Point Considerations

- ▶ Duration of the exposure
- ▶ Type of monitor and its capabilities (integrating or instantaneous direct reading)
- ▶ Location and type of sampling (e.g., breathing zone (BZ) or area)
- ▶ Goal of the sampling (e.g., personal evaluation, confirmation of adequacy of controls)
- ▶ OEL
 - ▶ type of monitoring conducted, instantaneous or integrated
 - ▶ duration of the task
 - ▶ goal of the monitoring

Additional Alarm Set Point Considerations

- ▶ PELs, TLVs, STELs, and peaks have an integrated time-weighted aspect to them. These values can be exceeded if the value over the applicable time frame is not exceeded.
- ▶ The chosen alarm level should be set at a low enough level to ensure the protection of the workers yet high enough to avoid spurious alarms that can be caused by temporary fluctuations in air concentrations, or fluctuations due to environmental changes (humidity, temperature, or pressure).

Additional Alarm Set Point Considerations

- ▶ Multiple strategies may be employed when setting an alarm set point. For example, the low alarm may be set at a percentage of the 8-hour TWA while the high alarm is set at a percentage of the STEL.

Temporal Variability

- ▶ RTDS allow exposure excursions above a target value to be readily identified, whereas integrated sampling onto a medium (generally analyzed in a laboratory) provides information only about the average exposure across the full sample collection period.

Use of RTDS for Compliance

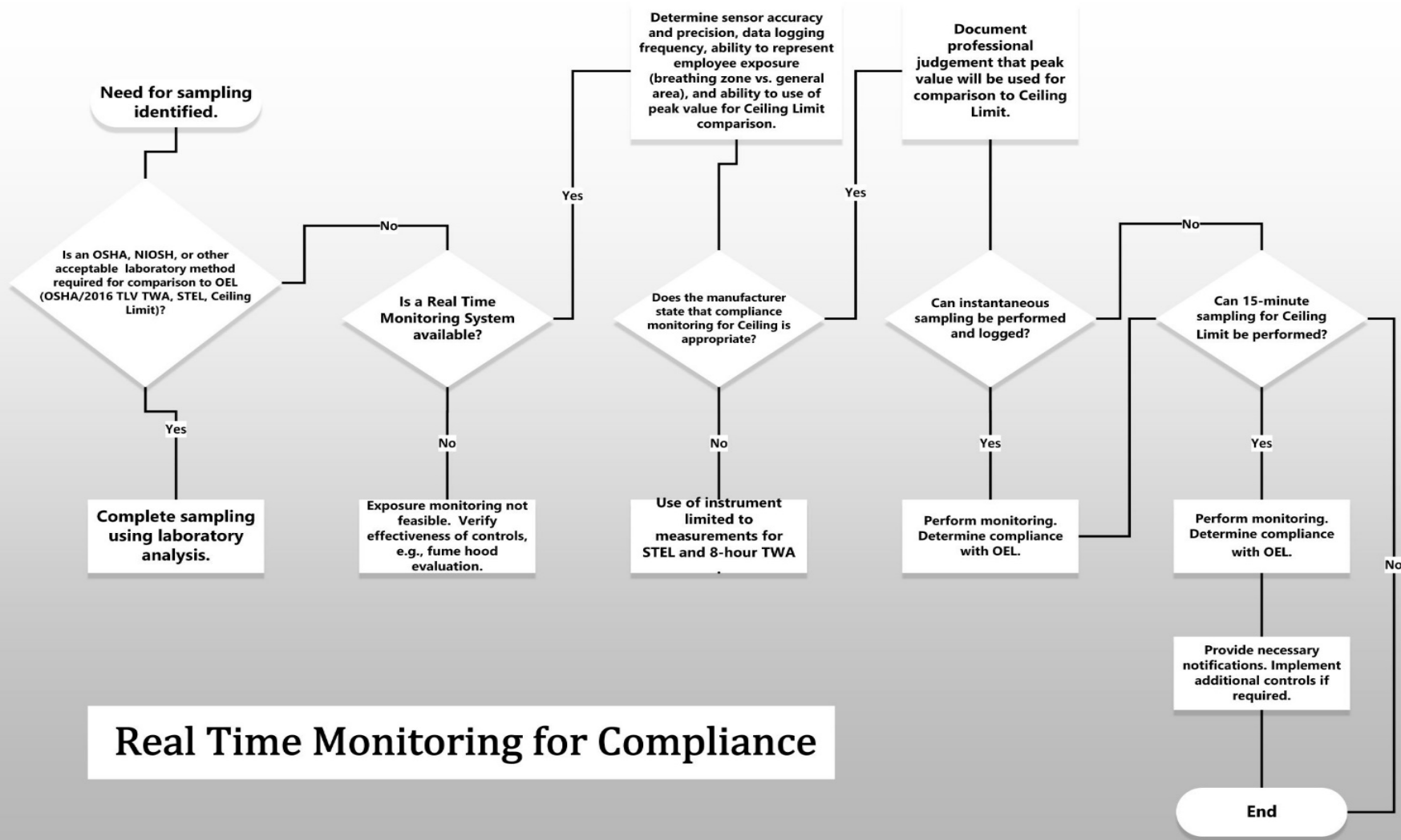
- ▶ It must be understood that the values are based on sample results in the worker's BZ and the monitoring capability of the instrumentation.

Documentation/Reporting

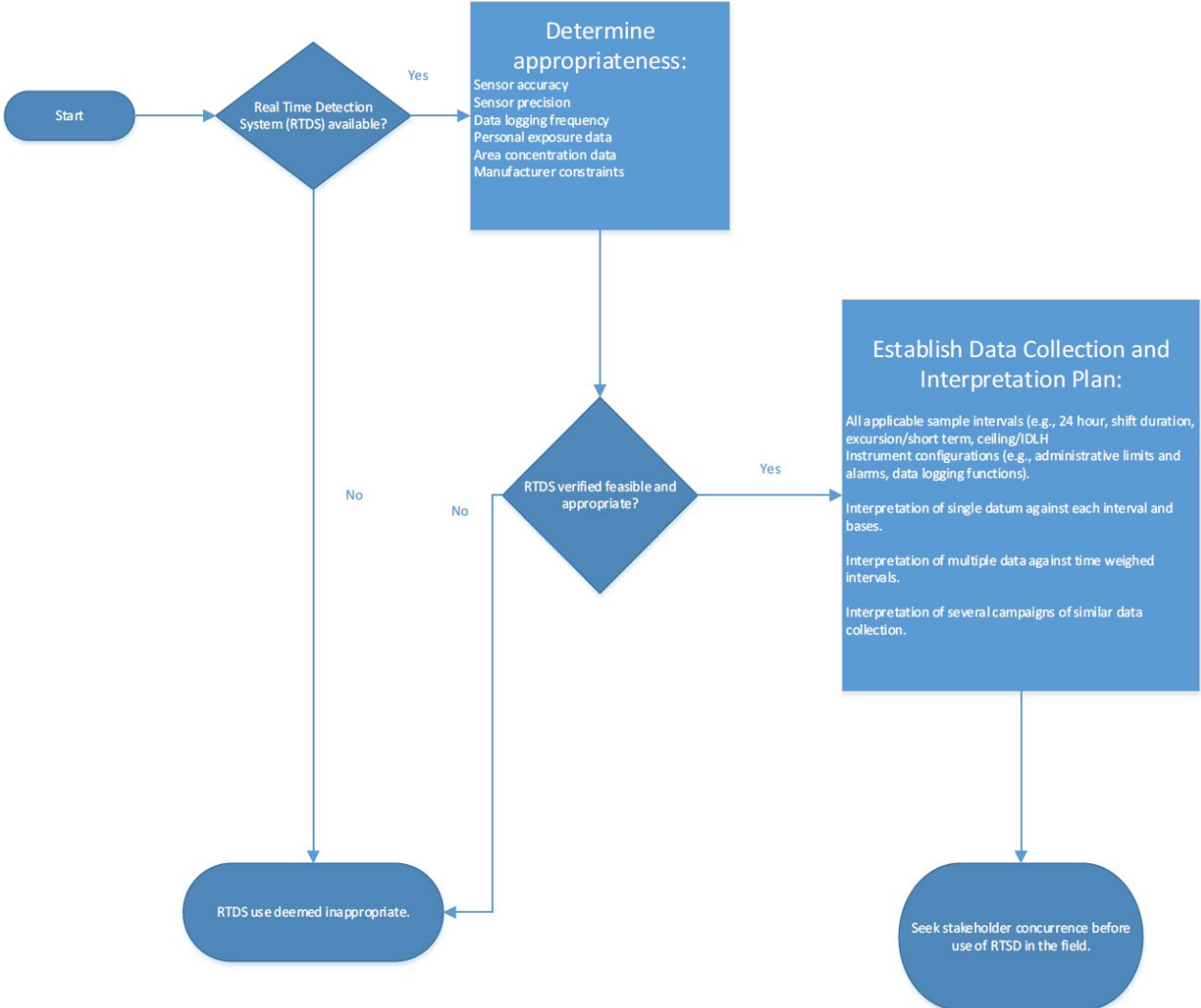
- ▶ Monitoring results should be documented and retained as part of the assessment of workplace hazards. The DOE, in the promulgation of the Worker Safety and Health Program, 10 CFR 851, mandates that contractors must:
- ▶ 1) 10 CFR 851.21(a)(2) Document assessment for chemical, physical, biological and safety workplace hazards using recognized exposure assessment and testing methodologies,
- ▶ 2) 10 CFR 851.21(a)(3) Record observations, testing and monitoring results, and
- ▶ 3) 10 CFR 851.26(a)(1) Establish and maintain complete and accurate records of all hazard inventory information, hazard assessments, exposure measurements, and exposure controls.

Peak Exposure Data Interpretations

- ▶ The interpretation of data against instrument configured alarms and data logging parameters should reflect all relevant limits addressing Immediately Dangerous to Life and Health (IDLH), Ceiling (TLV-C, Calculated TLV-C [from the “3/5” Rule] or PEL-C), or STEL (TLV-STEEL, Calculated TLV-STEEL [from the “3/5” Rule] or PEL-STEEL).
- ▶ Data interpretations should exist for single datum, grouped data, or SEG-linked data. These data interpretations are necessary to comply with 10 CFR 851.21 requirements for exposure assessment.
- ▶ The sum of all the determinations made by the industrial hygienist around instrument selection, data logging parameters, and data interpretation should be transparent to all stakeholders.



Decision Tree for Use of RTDS



Attachment 1

Real Time Monitoring Data Collection and Interpretation Worksheet

| | |
|---|--|
| Targeted Hazardous Agent | |
| Proposed Technology/Instrument | |
| Sensor Accuracy at 50% and 100% OEL Concentration | |
| Sensor Precision at 50% and 100% OEL Concentration | |
| Data Logging Frequency | |
| Personal Sample or Area Sample Collection | |
| Manufacturer Constraints or Prohibitions | |
| OEL Selection Basis and Source <ul style="list-style-type: none"> • 8-hour TWA: • STEL: • C: • IDLH: • Other: • ACGIH 3/5 Rule (i.e., peak exposures for hazards with rapidly occurring acute adverse health effects): | |
| Instrument Configuration Data logging interval duration Alarm Settings (i.e., names and values as displayed on instrument display and data logged report) | |
| Environmental/Other Factors (e.g., temperature, humidity, age of sensor) | |
| Logged Data Reporting and Analysis | |
| Data Interpretation | |
| Interpretation of any single exceedance of all applicable criteria (Shift TWA, STEL, Ceiling, IDLH) | |
| Interpretation of multiple exceedance of all appropriate criteria (e.g., number of STEL occurrences in Shift TWA, number of alarm points occurring during work) | |
| Interpretation of several campaigns of data collection (multiple random days of the month, or sequence of days in a week, or something else defined as an exposure campaign). | |
| Stakeholder Concurrence: Surveyed Workgroup Manager _____ ESH Management _____ | |

The Team:

- ▶ A PRACTICAL GUIDE FOR USE OF REAL TIME DETECTION SYSTEMS FOR WORKER PROTECTION AND COMPLIANCE WITH OCCUPATIONAL EXPOSURE LIMITS
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