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USACE / NAVFAC / AFCEC **UFGS-02 53 16.16 (February 2025)**

Preparing Activity: USACE **New Section**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2025
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02/25

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SECTION 02 53 16.16

IN-SITU THERMAL REMEDIATION
02/25

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NOTE: This guide specification covers the requirements for in-situ thermal remediation (ISTR) of materials contaminated by hazardous or toxic organic wastes and/or by petroleum, oil, or lubricants (POL). The ISTR can be achieved by electrical resistance heating, thermal conduction heating, or steam enhanced extraction. Site-specific criteria for temperature, mass removal, target treatment zone (TTZ), and treatment of extracted fluids would be determined and presented in this specification.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: This paragraph should be deleted if the work is in one single job price or there is a separate Measurement and Payment Section.

Any requirements for bid items need to be consistent with any bid sheet or list of contract line items. Payment for operations can be done as a single job price, especially for performance-based contracts, but if specifications are used, the work is usually bid on a unit-cost basis.

****

1.1.1 Preparation of Planning Documents, Permits[, and Community Relations Support] (Single Job Price)

The preparation of all required planning documents and obtaining permits [and providing community relations support] will be a single job price.

1.1.2 Site Preparation (Single Job Price)

The necessary actions to prepare the site for installation of the heating and treatment infrastructure, for installation of fencing, and for utility coordination will be a single job price.

1.1.3 Monitoring Point Installation and Baseline Sampling (Single Job Price)

The installation of new monitoring points, abandonment of existing monitoring points, and sampling of soil, soil vapor, and groundwater prior to heating will be a single job price.[Include costs for any additional characterization in this bid item.]

1.1.4 Installation (Single Job Price, Plus Unit Cost per Area or Volume)

****

NOTE: The language of this section allows payment for installation of subsurface and above-ground treatment infrastructure based on the identified TTZ as a single job amount. If treatment of additional volumes is necessary based on assessment of observed baseline concentrations or observations during installation of monitoring points or heater wells, contract options can be included to provide flexibility in expanding the TTZ without need for contract modification.

****

Installation of all components will be a single job price.[Bid options for installation of components to remediate additional treatment [area][volume] units on a [per square meter] [per square foot] [per cubic meter] [per cubic yard][_____] basis according to the bid sheet.]

1.1.5 Operations (Heating and Utilities)

****

NOTE: The language of this section allows payment for operations based on the actual effort required to meet the overall objectives. The operations bid costs may ideally be broken out into unit costs for operations per time and energy and power costs. Alternatively, the operations can be bid for an assumed amount of time at full target temperature and for the identified TTZ as a single job price

though this shifts risks to the contractor. If a single job price-approach is taken, and if additional treatment time or treatment of additional volumes is necessary based on assessment of observed concentrations or mass removal rates, contract options can be included to provide flexibility to continue operations for additional periods without need for contract modification. If the Government procures power or natural gas via separate contract directly with the utility provider, it can avoid contractor markup on those costs.

****

Bid prices for operations will be provided separately for operations and utility costs. Operations, other than utility costs,[for heating to target temperature] will be bid on a single job price[with contract options for additional operations time as per the bid sheet].

1.1.5.1 Operations During Heating to Target Temperature

Bid prices for operations necessary to bring the target treatment zone (TTZ) to target temperature will be bid on a single job price.

1.1.5.2 Operations at Target Temperature

Bid prices for operations will be per [week][day] spent at full temperatures.

1.1.5.3 Utilities Costs

****

NOTE: The contractor normally coordinates with local utility purveyors and pays for utility costs. There is often an administrative cost or mark-up associated with the contractor managing payment for the utilities. Some cost savings may be possible if the Government directly pays for the utilities. On active Department of Defense (DoD) installations, the Government may be better positioned to directly provide the utilities.

****

Include all utility costs, including but not limited to usage, distribution, and other fees associated with power, water, sewer, fuel, and other consumable materials to operate all equipment related to the in-situ thermal remediation (ISTR) system in the bid[except for the cost of [_____] to be provided by the Government].[Energy costs will be bid on a megawatt-hours of power delivered to the subsurface.][British thermal units (BTUs) delivered to the subsurface.] Non-energy utility costs will be bid as a single job price.

1.1.6 Site Restoration (Single Job Price, Plus Unit Cost per Well, Electrode, and Area)

Site restoration will be bid as a single job price. Additional [area][volume] requiring restoration will be bid on a [per square meter] [per square foot][per cubic meter][per cubic yard][_____] basis.

1.1.7 Treatability Study

NOTE: Treatability studies are generally not required for ISTR for typical contaminants, but may be necessary where complex mixes of contaminants or emerging contaminants with less history of treatment are present, or where design parameters would be refined by such a study.

Bid treatability study as a single job price. Include costs for collecting necessary samples of site media and any characterization necessary to identify the media for the treatability study.

1.2 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D5092	(2016) Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2026) National Electrical Code
NFPA 86	(2023) Standard for Ovens and Furnaces

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

1.3 DEFINITIONS

1.3.1 Target Treatment Zone (TTZ)

The TTZ encompasses the full three-dimensional limits of the subsurface requiring heating to meet the performance criteria. The heated volume will include subsurface media beyond the TTZ to allow for necessary contaminant mass removal and containment and to prevent redistribution of contamination due to condensation or migration.

1.3.2 Critical Infrastructure

Utilities, roadways, and structures whose function must be maintained during ISTR treatment are considered critical infrastructure.

1.3.3 Temperature Strings

Temperature strings are series of temperature sensors (e.g., thermocouples) arranged in a linear fashion in boreholes in and around the TTZ to assess the temperature response to energy input to the subsurface.

[1.4 ADMINISTRATIVE REQUIREMENTS

****
NOTE: These paragraphs should be omitted if the requirements are identified in other specifications, such as 01 30 00 Administrative Requirements.
****

1.4.1 Pre-Installation Meetings

A pre-installation meeting [and site walk-through] will be held to identify key logistical, safety, and community concerns. Prepare minutes of this meeting and submit these for review as part of the Pre-Installation Examination Report[and include them in the Remedial Action Work Plan].

1.4.2 Sequencing and Scheduling

If the treatment is to be conducted in discrete phases, the phasing of treatment, referred to herein as "stages" must occur in a manner that does not allow recontamination of a treated area or from upgradient. Similarly, the operation of each stage of treatment must not impact newly treated areas by maintaining hydraulic and pneumatic control.

]1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Remedial Action Work Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan; G, [_____]

Treatability Study Work Plan; G, [_____]

Permits

Pre-Installation Examination Report

Pre-Commissioning Checklist; G, [_____]

SD-02 Shop Drawings

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NOTE: Drawings may be submitted as part of the RAWP.
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SD-03 Product Data

****
NOTE: Product data may be required and submitted as part of the RAWP.
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SD-05 Design Data

Treatability Study Testing Results And Recommendations; G, [_____]

SD-06 Test Reports

Piping Coupon Testing

Baseline Sampling And Monitoring Point Installation Report

Commissioning Report

Daily Contractor Quality Control Reports; G, [_____]

Weekly And Monthly Reports

SD-07 Certificates

Qualifications; G, [_____]

SD-11 Closeout Submittals

Remedial Action Report; G, [_____]

Post Heating Sampling Results

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****
NOTE: Additional references from Federal, state, and local regulatory requirements; utility company regulations; and applicable codes and standards published by scientific and engineering institutions should be included where appropriate in the body of the specification. Some of the potentially applicable Federal regulations are listed as follows:

Recording and Reporting Occupational Injuries and Illnesses

Occupational Safety and Health Standards

Safety and Health Regulations for Construction

Permitting

National Primary and Secondary Ambient Air Quality Standards

National Emission Standards for Hazardous Air Quality Pollutants

State and Local Air Quality Standards

National Pollution Discharge Elimination System (NPDES) Discharge Limitations and Permit Procedures

Hazardous Waste Identification and Standards Applicable to Generators, Transporters, and Owners and Operators of Treatment, Storage and Disposal Facilities (TSDF)

Land Disposal Restrictions (LDRs)

Department of Transportation Hazardous Materials Program Procedures

Hazardous Materials Transportation Regulations

Standards for Protection Against Radiation

Land Disposal of Low-Level Radioactive Waste

Packaging and Transportation of Radioactive Materials

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air discharges, treated water discharge, well installation and abandonment, underground injection, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

****

Coordinate and obtain all[permits][, permit equivalents][, and meet the substantive regulatory requirements] necessary for the installation, operation and closure of the project prior to the initiation of the relevant activities. Submit documentation of the completed permitting or permit equivalent to the Contracting Officer [as part of the Remedial Action Work Plan (RAWP)]. Comply with all Federal, state, and local regulations. For any of the above-listed items requiring a longer time frame, copies of applications, and scheduled dates for receiving final approval, must be included.

1.6.2 Qualifications

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NOTE: Requirements for the Contractor's experience should be determined and specified based on the

experience, availability, and state of the ISTR industry and the site-specific requirements. If not provided in other portions of the contract documents, the requirements can be provided below.

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1.6.2.1 Contractor Experience

Submit evidence of successful completion of[at least [1][_____] ISTR project of comparable size and scope][at least [3][_____] ISTR pilot scale treatability studies, demonstration studies, and/or full scale remediation projects that required treatment of materials contaminated with[RCRA hazardous wastes][CERCLA hazardous material][_____]] using the proposed system or a similar system.

1.6.2.2 Key Personnel

Provide key personnel with a minimum of [3][_____] years of ISTR field experience, including project engineer, lead operator, site safety and health officer, quality control officer, project chemist and other lead technical staff involved with the ISTR system operation. Submit a list of these personnel with their qualifications.

1.6.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting thein accordance with[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 DELIVERY, STORAGE, AND HANDLING

Safely store, transport, and handle the equipment, materials, and any contaminated materials. Follow United States Department of Transportation (USDOT) requirements for packaging and shipping of these items. Store and handle these items onsite in accordance with the manufacturer's recommendations and in compliance with applicable regulatory requirements.

1.8 PROJECT/SITE CONDITIONS

****

NOTE: This section would provide necessary background information on conditions at the site that are relevant to the ISTR system construction and would affect the performance of the ISTR. Alternatively, reference can be made to other Government-furnished information. Important considerations would include site contaminants (location, depth, and concentrations); the TTZ; areas for material and equipment laydown and treatment and control system construction; soil types and groundwater flow conditions; surface topography; subsurface utilities, including potential for leaking water and sewer lines, potential subsurface obstructions or buried waste; and available utility connections.

****

The existing site conditions as currently understood are presented [in Appendix [_____]][and][on the drawings][and][in the specifications]. These include [physical configuration,][utilities,][topography,][land uses,][site access,][project limits,][geotechnical characteristics of the contaminated materials (including[grain size analysis,][total organic content,][moisture content,][density,] and[porosity])][hydrogeology,][treatability study results,][nature and extent of contamination,][mass estimate and approximate breakdown by constituent type within the TTZ,] and [_____]. The contaminants of concern are given in [Table 1][_____]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions may be anticipated. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within[48 hours][_____] if discrepancies between the data provided and actual field conditions or apparent data gaps are discovered.

1.9 WARRANTY

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NOTE: Vendors may offer warranties for attaining the cleanup goals. If the ISTR services are obtained under a performance-based contract, the full contract payment is based on the attainment of the goals, and therefore, a warranty does not provide additional value beyond the existing contract terms. A performance bond may be required.

****

Provide all warranties for the performance of the work[in the RAWP].

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Vendors normally provide their own equipment for the duration of the treatment and retain the equipment at the completion of the project. The requirements for the heating and treatment equipment can be specified here, but a performance-based approach will generally obviate the need for the specification of the products and materials.

To maximize the pool of potential bidders, recommend leaving the ISTR technology unspecified and focusing on the performance requirements. The bidders will identify what they believe to be the most cost-effective approach that may include one or more ISTR technologies. It is important to provide the necessary site information that will allow the bidders to assess the technology applicability, including contaminant type, concentration, and mass; groundwater depth and flow velocities; surface constraints, etc.

****

Provide and install an ISTR system that will introduce the energy into the subsurface necessary to attain all treatment requirements and to collect

and appropriately manage all recovered vapors and liquids to meet all discharge and disposal requirements.

2.1.1 Design Requirements

Design the ISTR system in accordance with all applicable building codes and licensing requirements with the following design requirements.

2.1.1.1 Remedial Action Work Plan

Prepare a Remedial Action Work Plan (RAWP) and submit for approval within [60][_____] calendar days of receiving the notice to proceed. If the work is to be conducted in stages, each stage of ISTR will require a work plan addendum detailing any changes to the approach outlined in the RAWP and stage-specific treatment details omitted from the RAWP. Address all items in the RAWP and associated addenda as discussed in this specification and other relevant specifications.

Address the following topics in the RAWP:

a. Contractor’s basis of design for its selected equipment and approach including targeted design temperature, heating element layout/spacing, materials of construction, and design approach/basis for vapor/liquid treatment equipment.[If the treatment of the TTZ is to be conducted in discrete phases, referred to herein as "stages," describe how the stages will be treated in a manner that does not allow recontamination of a treated area. In addition, explain how lessons learned from initial stages will be incorporated into operations for later stages.]

b. Modeled estimates of energy needs for optimal temperature increase and duration necessary to reduce subsurface mass and concentration to performance requirements and/or provide results from other field efforts substantiating the operational assumptions.

c. Equipment sizing, staging locations, and installed layout.

d. Well-field layout (number, spacing, depths of heating wells and elements, monitoring wells, extraction wells, all other wells, and temperature sensor strings).

e. Process piping and instrumentation diagrams.

f. Electrical one-line diagrams.

g. Vapor/liquid collection and treatment system layout plans.

h. Component process flow diagrams.

i. Estimated amount of energy, water, fuel, and other consumable materials (e.g., granular activated carbon) to operate the ISTR system and vapor/liquid treatment system during the duration of the treatment period.

j. Connections for electrical, water, sewer, natural gas, communications, and the layout of these utility connections.

k. System Commissioning Plan, including a pre-commissioning checklist.

l. Other information as required to describe the design, construction,

installation, and operations approach of the system to implement the remediation in accordance with the Contract Documents.

m. Contingency planning for operations in the event of various failure scenarios (i.e., develop a risk register with likely mitigation actions for the important risks).

n. Proposed decision logic for heating shutdown and logic/approach for confirmation sampling.

o. Security and fencing plans.

p. Traffic control plan.

q. Stormwater protection plan.

r. Waste management plan.

s. Contingent actions if downgradient groundwater concentration limits are exceeded.

t. Comprehensive schedule for mobilization, installation, operation, and close-out activities.

u. Surface cover materials, thickness, seaming details, and R-values (thermal resistance per unit area).

[Prepare [draft for Government review][, draft-final for [regulatory] [_____] review][, and] final versions of the RAWP. Allow [30][_____] calendar days for [Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.]
[
A review meeting to discuss and resolve Government comments and concerns on the draft RAWP will be held prior to the submittal of a final draft version of that plan.]

2.1.1.2 Uniform Federal Policy Quality Assurance Project Plan

****
NOTE: This section may reference a separate specification section requiring preparation of a quality assurance project plan or may be excluded entirely if the requirements are part of another specification section.
****

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with EPA 505-B-04-900A and UFP-QAPP WKSTS. Tailor the content to the requirements of the project and the site conditions and media of interest and address the collection of chemical and physical data necessary to make operational and shut-down decisions. Include the standard procedures for sampling hot media in the UFP-QAPP.[Prepare [draft for Government review] [draft-final for [regulatory] [_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.]

2.1.2 Performance Requirements

****

NOTE: As ISTR projects are typically done under a performance-based contracting approach, the performance standards provided in this section are critical to the project success. Multiple performance standards are recommended to assure the desired outcome, but not all of the requirements listed below need to be included.

****

Meet the following performance requirements. These are either primary or secondary requirements, where primary requirements are to be met upon shutdown of the ISTR treatment and secondary requirements are those that to be met during operation of the ISTR system.

2.1.2.1 Target Treatment Zone

****

NOTE: The appropriate delineation of the TTZ is the most critical performance requirement. If ISTR projects fail to meet other performance requirements, it is often due to an incomplete understanding of the actual extent of this zone. The zone is three-dimensional, and lateral and vertical dimensions are given. There is an opportunity to revise the zone based on observations during installation of ISTR subsurface system components, and the specification allows for adjustment of the TTZ. Depending on the contract approach, this can be accomplished through performance-based contract requirements or through the exercise of options for additional treatment volumes. If the top of the contaminated zone is below the water table, the TTZ needs to extend some distance above the water table to assure capture of contaminant vapors before they condense.

****

The TTZ is shown[on the drawings][Figure [_____] of the [_____] report]. Meet performance requirements throughout the entire TTZ as specified below. The basis for the TTZ is the [_____][ug/kg][mg/kg][ug/L][mg/L][soil concentration][groundwater concentration][soil vapor] contour [based on the maximum concentration observed at any depth][and the contact with the [_____] geologic unit]. During construction of the subsurface components of the remedy, inform the Contracting Officer of any unexpected contamination above the concentrations used as a basis for the TTZ but that exists outside the defined TTZ.

2.1.2.2 Soil Concentration Goals

Attain the target soil concentrations described in Table 1 below[on average][at each sampling interval][at [_____] percent of sampling points] [_____][with no point exceeding [_____] times the performance goal] within the TTZ based on the approved post-treatment verification sampling program described in the appropriate UFP QAPP. If measured soil concentration[s] exceed[s] the values shown in the table below, resume treatment as described in paragraph BASIS FOR SYSTEM RESTART.

2.1.2.3 Groundwater Concentrations Goals

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NOTE: The operation of the ISTR system may induce groundwater flow into the TTZ. If significantly contaminated groundwater exists outside the TTZ, this may affect the ability to attain a groundwater performance goal. Periodic sampling of groundwater during heating can be used to track progress toward goals.

****

Attain the target groundwater concentrations described in Table 1[on average][at each prescribed sampling point][at [_____] percent of the sampling points][with no sampling point exceeding [_____] times the groundwater performance requirements] [_____] based on the approved post-treatment verification sampling program described in the UFP QAPP. If measured groundwater concentration[s] exceed[s] the values shown in Table 1, resume treatment as described in paragraph BASIS FOR SYSTEM RESTART. Containment or treatment actions are required if exceedances of downgradient groundwater concentration limits are observed.

TABLE 1 - PERFORMANCE REQUIREMENTS

Contaminant	Soil concentration[1] [ug/kg] [mg/kg]	Groundwater concentration[1] [ug/L] [mg/L]	Treated air discharge limit[2] [ug/L] [ug/m^3] [ppmv] [ppbv] [lb/day] [kg/day]	Downgradient groundwater concen-trati limit[1,2] [ug/L] [mg/L]	Soil Vapor Concentrati[1,2] [ug/L] [ug/m^3]	Treated water discharge limit[2] [ug/L] [mg/L]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

[1] Primary requirement; [2] Secondary requirement

2.1.2.4 Temperature

****

NOTE: Time of heating and minimum temperature requirements should only be specified as a minimum and the other criteria should be the primary lines of evidence for true attainment of treatment goals. Although azeotropic boiling may occur at temperatures below100 degrees C 212 degrees F, progress is fastest and remediation more likely to be complete if temperatures of 100 degrees C 212 degrees F (or higher temperatures at depth below the water table) are targeted.

****

Achieve a temperature of[[100][_____] degrees C [212][_____] degrees F][equal to boiling accounting for hydrostatic pressure] at [95][_____] percent of the temperature monitoring points with no point in the TTZ below

[90][_____] degrees C [194][_____] degrees F. Continue full heating for a minimum of [_____] weeks following the attainment of a minimum temperature of [_____] degrees C degrees F at all temperature monitoring points and an average temperature of [_____] degrees C degrees F across the TTZ prior to proposing cessation of heating.

2.1.2.5 Mass Removal

Continue treatment until mass removal rates have[reached asymptotic conditions as defined in the RAWP][fallen below levels observed at start-up][fallen below [_____] percent of the peak weekly average mass removal][fallen below [_____] kg/day lbs/day for [_____] days [_____] based on measurements of the recovery of [all contaminants][contaminants listed in Table 1] in vapors, non-aqueous phase liquid (NAPL), and dissolved form][and no extraction point is continuing to recover mass at a considerable rate]. Compute mass removal rates for this purpose when all the intended heating and recovery wells are operating.

2.1.2.6 Vapor Control

Capture and manage all contaminants volatilized and mobilized by the thermal treatment via a vapor recovery system and convey them to a treatment system.[Facilitate capture through the installation of a surface cover as specified in paragraph SURFACE COVER.] Do not allow surface breakthrough of steam and contaminant vapors to occur.[Maintain an inward pneumatic gradient to the TTZ.][Monitor vapor concentrations in sampling points outside and above the TTZ to demonstrate vapor control as required by the UFP-QAPP and RAWP.] Prevent lateral migration of contaminant vapors outside the TTZ described in paragraph VAPOR RECOVERY of this specification and contaminant vapor migration into occupied buildings [at concentrations above [EPA Regional Screening Levels][_____]].

2.1.2.7 Off-gas Treatment Concentration Limits

Treat recovered vapors[to the standards specified in Table 1][to the level specified in the applicable permit equivalent] prior to discharge.

2.1.2.8 Liquid Treatment Concentration Limits

****

NOTE: The goal for treatment of water will depend on the discharge location (e.g., publicly owned treatment works [POTW], surface water, reinjection). If the disposal of the treated water is left to the Contractor to propose in the RAWP, direct the Contractor to determine and achieve the applicable treatment requirements based on applicable statutes, regulations, and rules for the selected discharge location, in accordance with paragraph PERMITS. Modify Table 1 to reflect the need for the Contractor to determine the appropriate treatment goals. Discharge to a local POTW offers advantages, and information on the local POTW and any pre-treatment requirements should be made available to the bidders.

****

Treat condensed and recovered liquids[to standards specified in Table 1][to the level specified in the applicable permit equivalent for the

selected discharge location] prior to discharge. Discharge treated water[to the sanitary sewer][to the storm sewer][to the surface water body][to injection wells][to [_____]][as indicated on the drawings].

2.1.2.9 Noise Limits and Operational Hours

****
NOTE: Noise limitations may also be addressed in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. If specified there, this paragraph can be omitted.
****

Provide noise mitigation measures to reduce sound levels at[the site boundary][nearby homes and businesses][_____] to [[_____] decibels (dB)][levels that comply with local noise ordinances]. Normal hours of operation during ISTR construction installation, and close-out activities must be between [7:00 am][_____] and [7:00 pm][_____] for all noise generating activities, [Monday through Friday][_____], excluding federal holidays. Do not conduct construction work outside these working hours without first obtaining written approval from the Government. These working hours may be further modified based on local ordinances, as applicable. ISTR operations will be on a 24-hour per day basis, from heating commencement through completion.

2.1.2.10 Permits

Obtain all necessary permits, including but not limited to air discharge permits, well drilling and abandonment permits, electrical permits, construction permits, water discharge permits, and underground injection permits, as required by Federal, state, and local agencies and in accordance with paragraph REGULATORY REQUIREMENTS.

2.1.3 Backup Power Supply

Provide a back-up power source capable of operating the ISTR vapor and liquid extraction and treatment equipment as well as monitoring and controls to maintain pneumatic and hydraulic control if the primary power source is lost. The backup power source will be capable of maintaining pneumatic and hydraulic control without refueling for at least [24][_____] hours[and will engage automatically upon loss of primary power (e.g., automatic transfer switch)]. Configure the back-up power supply to maintain continuity of control system function and to cause the operator to be notified of a loss of line power. Use EPA Tier 4 Final certified generators for on-site back-up and non-emergency purposes.

2.2 EQUIPMENT

2.2.1 Government-Furnished Equipment

****
NOTE: If there is no Government-furnished equipment, Table 2 should be omitted and other tables renumbered as necessary.
****

There [is][is not any] Government-furnished equipment available for this project.[The available equipment is described in Table 2.]

TABLE 2 - GOVERNMENT-FURNISHED EQUIPMENT		
Item	Location	Notes
Dedicated sampling pumps	Monitoring wells	[_____]
Transformer	[_____]	[_____]
[_____]	[_____]	[_____]

2.2.2 Contractor Equipment

Provide all equipment necessary to perform the work[except for the Government-furnished equipment noted in paragraph GOVERNMENT-FURNISHED EQUIPMENT]. Prepare the site for equipment installation prior to delivery and off-loading of equipment and system components. Decontaminate all equipment prior to entering or leaving the site. Include and describe in detail any additional equipment not specified below in the RAWP. Design, install, construct, operate, control, and monitor all equipment as one complete, compatible unit. Assure all components utilized at the site are constructed of materials that are thermally and chemically compatible with the contaminants and temperatures of the vapors and liquids recovered. Select all equipment to be properly rated for the environment and location where it will be operating, to include the potential for being in contact with hazardous, flammable, or explosive materials or explosive vapors, as well as extreme weather. Provide and install all equipment in conformance to pertinent local and national codes.

2.3 COMPONENTS

****

NOTE: As ISTR projects are typically done under a performance-based contracting approach, the individual above-ground equipment provided for extraction and treatment of site contaminants are not normally specified, but additional requirements for specific equipment can be added.
Delete requirements for secondary containment if these are addressed in Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS. If Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM is used, the Designer should review that section to remove specific requirements that may be excessive for a temporary secondary containment.

****

Provide and install an above-ground treatment system with appropriate heat exchangers and condensation capabilities; air-liquid separators, with adequate liquid storage and transfer capabilities to allow continuous operations; vacuum blowers suitable to capture all generated vapors; liquid treatment equipment appropriate for the liquid production rates and site contaminants and other extracted compounds that may be recovered in liquid form; and vapor treatment equipment appropriate for the non-condensable vapor extraction rates and vapor-phase contaminants. Provide secondary containment of all liquid storage and treatment equipment[in accordance with specification Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM.][with either double-walled containers or impermeable surfaces suitable to contain a spill or release of liquid.

Impermeable means having a maximum permeability for any hazardous substance that is being contained of 1x10-7 centimeters per second 3x10-9 feet per second at the maximum anticipated hydrostatic pressure.]

2.3.1 Instrumentation

Provide instrumentation and controls, including but not limited to indicators, sensors, transmitters, recorders, alarms, and auto-dialers, necessary to monitor and operate the equipment and heating infrastructure continuously,[remotely,] and safely. Provide such equipment that detect, monitor, record, and control key operating parameters such as liquid levels, equipment and air temperatures, gas and liquid flow rates, pressures, subsurface temperatures and pressures, etc. Select temperature, pressure, and flow sensors suitable for and tolerant of the expected range of conditions to be encountered.

Provide a system control panel that contains, at a minimum, all local control devices, circuit breakers, power control transformers, system disconnect switches, and alarm components, as necessary to operate the system effectively and safely. Provide the control system with all functions required for complete automatic and manual operation of the system, including but not limited to the following:

a. System shutdown and alarm on high-high liquid level conditions in moisture separator, other liquid handling equipment, and discharge locations,

b. Manual start and stop for blowers,

c. System shutdown if the secondary containment around critical process vessels indicates a spill,

d. System shutdown and alarm on low and no flow in system,

e. Automatic call-out and notification in the event of an alarm,

[

f. Automatic shutdown or opening of dilution valve if lower-explosive limit sensors indicate the influent concentrations to a thermal oxidizer will cause its operation outside of National Fire Protection Association guidelines, including those in NFPA 86.]

g. Automatic shutdown if an emergency stop is engaged.

The control system must also be furnished with a means to allow for remote, real-time access to monitoring data and data retrieval. Provide catalog information on the supervisory control and data acquisition (SCADA) system to be used during start-up and operations. Include this information in the RAWP.

2.3.2 Spare and Redundant Critical Components

Provide redundant or spare critical system components, including sensors [primary blowers,][transfer pumps,][and][_____]. Identify the redundant and spare components in the RAWP.

2.4 MATERIALS

2.4.1 Well and Piping Materials

Propose well and piping materials in the RAWP and select materials for well and piping construction that are compatible with site contaminants and other compounds that may be extracted in vapor or liquid form and can withstand the temperatures and pressures or vacuum levels encountered during operation without failure or excessive pressure drop. Provide insulation or other means of protection on piping that will conduct hot fluids that could be contacted by site personnel or trespassers.[Provide features, such as heat tracing, to winterize all parts of the system that will be exposed to cold weather.] Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) piping is prohibited for vapor transport under pressurized, above-ground service.

2.4.2 Electrical Supply and Equipment

****

NOTE: The designer should modify this section to provide site-specific details about electrical connection and coordination requirements. The designer should determine the following details about the electrical supply: 1) nearest suitable power, 2) infrastructure for the purveyor to bring power to the site, 3) the available voltages at the primary electrical feed, 4) requirements for secondary metering, 5) seasonal or daily restrictions on power availability and pricing policies, 6) necessary lead time for power drop to the site, 7) approximate costs for bringing service to the site.

****

[Necessary electrical service at the site will be provided by the Government.][Provide electrical service to the site of adequate capacity to support all planned remediation operations.] Coordinate with the local power utility company as necessary[and provide all engineering support to evaluate the adequacy of existing service lines]. All material, equipment, and incidentals in hazardous locations must meet local and state codes, and NFPA 70 National Electrical Code (NEC). Bury all primary service lines connecting the power drop to any transformer. Provide proper electrical grounding for all equipment. All cables and conductors must be rated for electrical loading specified in the RAWP and constructed with materials compatible with its designated environment.

2.4.3 Natural Gas Supply

Provide natural gas service in accordance with Section 33 11 23 NATURAL AND LIQUID PETROLEUM PIPING.

2.4.4 Surface Cover

****

NOTE: A surface cover is usually necessary to prevent the release of steam and contaminant vapors at the surface, inhibit infiltration of cold moisture, and to allow higher temperatures at shallow depths to facilitate vapor recovery and

prevent condensation of vapor-phase contaminants near the surface. Higher R values may be necessary for treatment of high-boiling-point compounds close to the surface. If the target ISTR treatment zone does not extend vertically to near the surface (e.g., is more than 3 meters 10 feet below the surface), a surface cover may not be necessary.

****

Install an insulating and vapor-controlling surface cover capable of achieving a minimum R value of [20][_____]. If thick concrete surface slabs are in place, the R value may be proportionally adjusted. Integrate a [seamed geomembrane][or equivalent] vapor barrier into the cover.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

2.5.1 Piping Coupon Testing

****

NOTE: Coupon testing would be warranted if there are concerns about potentially corrosive treatment streams generated during treatment. The coupon testing can be conducted during a pilot test or initial stage of treatment where multiple stages of treatment are necessary due to TTZ size or power limitations. Conducting such testing during design and providing results as part of Government-furnished information would reduce risk to the bidder and result in bids with lower risk premiums.

****

Conduct coupon testing for corrosion for proposed piping, well construction, and treatment equipment to demonstrate compatibility with site conditions and contaminants. Propose coupon testing procedures in the RAWP. Submit results of the coupon testing.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Site Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, site access constraints, and infrastructure. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-treatment conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on treatment and public safety. Examine location, condition, and construction of monitoring points in the treatment zone and surrounding area to assess the need to protect, abandon, or replace any monitoring point. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.1.2 Contractor-Supplied Equipment

The Government may examine equipment provided by the Contractor for the

project to identify any that is dilapidated, damaged, unsafe, or defective. Based on this examination, the Contracting Officer has the right to reject the entire system or any damaged, defective, unsafe, or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection will be borne by the Contractor. Properly and routinely inspect and maintain equipment to provide the operation of the system as required by the contract schedule. Any schedule delay and cost associated with improper functioning of equipment and controls, unavailability of labor and materials, etc., is the responsibility of the Contractor.

3.1.3 Treatability Study and Pre-Design Characterization

****

NOTE: The need for a treatability study may depend on the site contaminants and ISTR method to be used. Treatability studies are not normally needed for common contaminants such as trichloroethylene or benzene and would be more appropriate for complex mixtures of unusual contaminants. Treatability study testing to assess steam volumes needed to achieve cleanup goals, changes in NAPL density and viscosity with temperature, or treatment options may be specified.

If there are data gaps, additional characterization may be required. Optional text in this paragraph addresses the requirements for the additional investigations to refine the TTZ or assess groundwater flux.

****

Conduct treatability testing to determine the[response of site NAPL viscosity and density to temperature increases][design and operational parameters for treatment of influent streams][necessary steam pore-volume flushes][_____]. Propose treatability testing procedures, including sampling of site media, test instrumentation, chemical analysis, and data analysis[in the RAWP][in a Treatability Study Work Plan]. Submit the Treatability Study Testing Results and Recommendations.

[

Perform initial field-scale pilot test to verify design assumptions and treatment performance. Propose objectives, location, duration, methodology, monitoring, and data analysis for the pilot test in the Treatability Study Work Plan.]

[

Conduct additional characterization activities as necessary to address data gaps regarding[the definition of the TTZ][and][groundwater flux through the TTZ]. Include [groundwater,][soil,][and][soil vapor] sampling[and permeability testing] in the characterization effort. Provide the rationale, number, location, and methodology for the proposed characterization in the RAWP. Present the results in the Baseline Sampling and Monitoring Point Installation Report.]

3.2 SITE PREPARATION

3.2.1 Protection

3.2.1.1 Stormwater Management

Provide stormwater collection and conveyance systems to prevent interference of stormwater with the ISTR system.[Stormwater collection piping exists on the property including within the ISTR treatment area[as shown on the drawings][as indicated in the design report].] Identify the locations of stormwater infrastructure and impact of existing infrastructure on ISTR operations. Design the ISTR system and surface cover to account for possible infiltration of site surface water. The impact that the footprint of the thermal cover has on stormwater runoff must be considered within the construction and stormwater permits detailed in[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____]. If required, describe upgrades to stormwater drainage features in the RAWP.

3.2.1.2 Environmental and Infrastructure Protection

Protect site vegetation, wetlands and critical habitat, site features, and infrastructure in accordance with the approved Environmental Protection Plan prepared in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____]. Restore damaged areas and site infrastructure to at least its original condition upon completion of the project. Areas within the footprint of the TTZ, under conveyance systems and wiring, along site access roads, and within the area of the above-ground control and treatment systems are considered separate from these requirements and restoration of these areas is addressed in paragraph CLOSE-OUT ACTIVITIES.

3.2.2 Clearing and Grubbing

Conduct clearing, grubbing, and filling and grading necessary to prepare the site for placement of the surface cover, site access, and equipment in accordance with Section 31 11 00 CLEARING AND GRUBBING. Provide necessary filling, grading, compaction, and placement of aggregate necessary to provide stable conditions for site access and placement of equipment. Avoid disturbance to contaminated soils.

3.2.3 Infrastructure Removal, Rerouting, and Protection

****

NOTE: Critical infrastructure (e.g., communications lines, water supplies, sewer service) that cross or lie adjacent to the TTZ may need to be maintained and protected from the effects of heating or will need to be rerouted around the TTZ (e.g., non-watertight storm sewers). Other utilities may be heat-tolerant (e.g., ductile iron piping or pre-cast concrete sewer lines). If unneeded or if relocated, the abandoned utilities in the TTZ may need to be sealed to prevent undesirable contaminant migration or infiltration of cold water into the TTZ. Provide clear information and direction to the contractor on what utilities exist in the area of the TTZ in Government-furnished information or drawings.

****

Protect or relocate critical infrastructure indicated on the drawings.

Other utilities and infrastructure within the TTZ may be left in place, abandoned, or removed. Properly decommission monitoring wells that would be damaged during ISTR treatment in accordance with all applicable State and local requirements. Assure all materials used in the monitoring well decommissioning are compatible with temperatures and pressures to be generated during treatment so the locations will not allow releases of contaminants to the atmosphere or detrimentally affect treatment. Describe all procedures for protection, relocation, and decommissioning in the RAWP.

3.2.4 Monitoring Well Replacement

****

NOTE: The presence of monitoring or extraction wells within or near the TTZ that are not constructed with materials compatible with the elevated temperatures during treatment (e.g., PVC) or that may interfere with heating (e.g., metal wells near electrodes) need to be abandoned, and where necessary replaced with appropriately constructed wells. Section 33 51 39 MONITORING WELLS can be used to describe the installation requirements for the monitoring wells, but modifications to that specification would be necessary to address the conditions during ISTR. If Section 33 51 39 is used, delete all but the first sentence of this paragraph and replace with a reference to Section 33 51 39.

****

Replace or abandon monitoring wells identified on the drawings and in Table 3 with materials compatible with the conditions to be created during treatment. Follow State and local requirements, including regarding licensing of any driller, and ASTM D5092, with necessary and allowable modifications for the ISTR application. Develop the new wells until turbidity levels are less than [10][_____] nephelometric turbidity units (NTUs)[or as approved by the Government]. Install pressure- and temperature-rated wellhead fittings on monitoring wells within or near the TTZ. Include a sample port, and ball valve to allow pressure relief prior to opening. Describe well construction, installation methods, development, and abandonment techniques in the RAWP. Submit documentation of well construction and materials encountered in accordance with ASTM D5092 and ASTM D2488.

TABLE 3 - MONITORING WELLS

Well Name	Construction Details (Depth, diameter, screened interval, casing and screen material, grout type)	Abandon	Replace
[_____]	[_____]	[_____]	[_____]

3.2.5 Pre-Heating Sampling

****
NOTE: If groundwater remediation is required, sampling of new and existing groundwater monitoring wells in and near the TTZ prior to treatment should be conducted to establish a baseline condition. Pre-treatment soil or soil vapor sampling may be conducted if groundwater treatment is not required and remediation of the unsaturated soil is desired, or if unsaturated soil and groundwater are both to be remediated.
****

Sample the monitoring wells listed in Table 4 within [_____] days prior to initiating heating.[Collect soil samples during the installation of new monitoring wells and temperature monitoring strings.] Collect, transport, and analyze samples in accordance with the requirements of the UFP-QAPP. Submit pre-heating sampling results in a Baseline Sampling and Monitoring Point Installation Report.

TABLE 4 - MONITORING WELL SAMPLING

Well to be Sampled	New/Existing	Analyses to be Performed	Depth/Screened Interval
[_____]	[_____]	[_____]	[_____]

3.3 SYSTEM INSTALLATION

3.3.1 Equipment

Stage equipment in a location that minimizes impact to nearby residences and offset the staging area from the property boundary by at least [23][_____] meters [75][_____] feet. Assure all outdoor installations are weather-proof and all installations in hazardous locations meet NEC, NFPA, UL, National Electrical Manufacturers Associated (NEMA), and the US Occupational Safety and Health Administration (OSHA) requirements.[Winterize the ISTR system to allow operation during subfreezing conditions. Winterization may include, but is not limited to, insulation and heat tracing around piping and liquid vessels, insertion heaters, and recirculation within liquid storage vessels.]

3.3.2 Subsurface Instrumentation

Decontaminate drilling equipment prior to use at the site. Provide a copy of the drillers' licenses as part of the RAWP along with other personnel qualifications. Provide logs at representative locations as proposed in the RAWP with descriptions of materials encountered during drilling for information in accordance with ASTM D2488, including evidence of contamination potentially above treatment goals outside the TTZ.[Include details about the installation, location, and construction of temperature

and pressure monitoring points in the Baseline Sampling and Monitoring Point Installation Report.]

3.3.2.1 Heating Infrastructure

Install [electrodes][heater wells][steam injection wells] at locations and to depths necessary to achieve treatment requirements and prevent contaminant migration from the TTZ in accordance with the RAWP.

3.3.2.2 Temperature Monitoring

Install temperature monitoring strings at locations indicated in the RAWP in boreholes dedicated for this purpose. Provide temperature sensors at a vertical interval of[1.5 meters 5 feet][3 meters 10 feet] [_____] meters [_____] feet within and including 3 meters 10 feet above and below the TTZ and with a density of one temperature string per[[380][_____] square meters [4,000][_____] square feet][[3,800][_____] cubic meters [5,000][_____] cubic yards]. Install a minimum of [75][_____] percent of temperature strings at the centroid between heating locations. Install additional temperature strings [3][_____]meters [10][_____] feet laterally outside the TTZ with a spacing of [15][_____] meters [50][_____] feet around the perimeter of the TTZ[and within [3][_____] meters [10][_____] feet of sensitive receptors].

3.3.2.3 Vapor and Pressure Monitoring

Install vapor monitoring points at locations indicated in the RAWP to allow vapor sampling and temperature and pressure monitoring. Provide vapor monitoring points within the vadose zone within and above the TTZ at a rate of at least one vapor monitoring point per [460][_____] square meters[5,000][_____] square feet and surrounding the TTZ at a rate of at least one every [60][_____] meters [200][_____] feet where no buildings are adjacent to the TTZ and every [30][_____] meters [100][_____] feet where buildings are adjacent to the TTZ. Install vapor monitoring ports every [3][_____] meters [10][_____] feet vertically above the TTZ and at likely steam migration depths outside the TTZ.

3.3.2.4 Subsidence Monitoring

****

NOTE: Where soils with high organic content (e.g., peat) exist within the TTZ, subsidence may occur during treatment. Monitoring of ground subsidence and settlement of engineered structures over or near the TTZ should be monitored.

****

Conduct a baseline elevation survey using a surveyor licensed in the state and monthly subsidence monitoring of surveyed elevation points over the TTZ and near footings or other load-bearing engineered structures. Survey in accordance with Section 33 51 39 MONITORING WELLS. Conduct a pre-heating structural survey of building over and near the TTZ. Report the results of the baseline surveys and the pre-heating structural survey in the RAWP and the results of monthly settlement measurements in the [weekly][monthly][_____] reports.

3.3.2.5 Vapor Recovery

Install vapor recovery wells [and surface plenum] as described in the

RAWP. Vapor recovery wells may be integrated with heating wells. Install an adequate number and distribution of vapor recovery wells to recover volatilized contaminant mass and to prevent lateral contaminant vapor migration outside of the TTZ or uncontrolled contaminant vapor discharge to the atmosphere. Capture, manage, and transport volatilized and mobilized contaminants through a vapor recovery system to a treatment system.

3.3.3 Utilities

Arrange for the design, permitting, furnishing, and installation of all utilities required supporting the ISTR operations, including the electrical service drop and natural gas and process water supply. Provide a description of all utility work to be conducted and a drawing of the proposed utility layout as part of the RAWP. Install all wiring, conduits, and interconnections necessary for a fully operable system.

3.3.4 Surface Cover

****

NOTE: Unless the top of the TTZ is deep and there are no potential surface receptors, a surface cover is typically required to prevent vapor/steam emissions at the surface, prevent infiltration, and to insulate the ground surface to prevent condensation of contaminant vapors near the surface.

****

Install the surface cover over the [entire][portions of the] TTZ as described in the RAWP. Where the TTZ extends to within 3 meters 10 feet of the existing ground surface, extend the surface cover a minimum of [3][_____] meters [10][_____] feet beyond the lateral limits of the TTZ.

3.3.5 Piping and Cables

Construct all piping and other lines in such a manner (sloped) to prevent any media from condensing or collecting where it would not be recovered or otherwise interfere with effective operations. Install and maintain all piping/connections in a neat manner and properly support all piping in accordance with local and national codes. Lay out electrical supply lines and cables between power distribution equipment and the well field and treatment system using conduit, ramps, and cable bundling to minimize slip, trip, and fall hazards and exposure to vehicle traffic. All cables and conductor must be rated for electrical loading specified in the RAWP and constructed with materials compatible with its designated environment.

3.4 SITE SECURITY

Provide site security during ISTR installation and operation to protect site equipment and public safety[, including on-site security personnel,][security patrols,][and][cameras and motion detectors]. Provide[temporary]fencing with warning signs and gate access that is lockable. Provide adequate area lighting to support security monitoring and inspection of facilities[and assure that lighting is not directed at nearby residences]. During operation, integrate controls to shutdown the system if unauthorized site intrusion occurs. Provide security and fencing plans as part of the RAWP.

3.5 FIELD QUALITY CONTROL

3.5.1 Tests

Identify all field quality control tests in the [RAWP][Contractor Quality Control Plan required in accordance with Section 01 45 00 QUALITY CONTROL]. Report the results of these tests in the Daily Contractor Quality Control Reports.

3.5.2 Inspection

Allow on-site audits and inspections by the Government during the remedial construction and operation.

3.6 COMMISSIONING AND STARTUP

Submit a Commissioning Plan as part of the RAWP. Notify the Contracting Officer at least 14 calendar days before starting commissioning. If multiple phases of thermal treatment are proposed, a separate commissioning plan is not required for each stage of treatment, but submit significant changes to the Commissioning Plan as an addendum.

3.6.1 Start-up Testing

Designate team members to participate in the pre-commissioning checks and the functional performance testing. Prepare pre-commissioning checklists that detail the critical system interlocks including type of alarm (shutdown or warning), instrument involved, and equipment affected by the alarms. The Government will be represented by the Contracting Officer[, the Design Agent's Representative, and a representative of the Using Agency]. Include the following team members:

Contractor's Chief Quality Control Representative
Contractor's Mechanical Representative
Contractor's Electrical Representative
Contractor's Testing, Adjusting, and Balancing Representative
Contractor's Controls Representative

Prepare commissioning checklists to be included with the Commissioning Plan. The commissioning team will complete each checklist. Indicate acceptance by each commissioning team member of each pre-commissioning checklist item by initials and date. Acceptance by each commissioning team member for each functional performance test checklist must be indicated by signature and date.

3.6.2 Commissioning Testing

Provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. Abort the pre-commissioning check or functional performance test if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test.

3.6.2.1 Pre-Commissioning Tests

Perform pre-commissioning checks for the items indicated on the checklists. Correct deficiencies discovered during these checks and re-test in accordance with the applicable contract requirements. Complete

and submit the Pre-Commissioning Checklist for Government approval.

3.6.2.2 Functional Performance Tests

Conduct functional performance tests for the items indicated on the checklists. Begin functional performance tests only after all pre-commissioning checks have been successfully completed. Tests must prove all modes of the sequences of operation and must verify all other relevant contract requirements. Begin tests with equipment or components and progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, correct all deficiencies in accordance with the applicable contract requirements. The checklist must then be repeated until it has been completed with no errors. Submit a Commissioning Report.

3.7 APPLICATION

Commence operations following successful commissioning in accordance with the RAWP.

3.7.1 Safety and Environmental Controls

Take corrective measures to cease any unexpected release of steam and contaminant vapors at the surface or in nearby potentially occupied spaces.[Prevent stray voltages above 15 Volts within the TTZ and within [_____] meters [_____] feet of the TTZ.] Prevent contact with hot piping and equipment by workers, visitors, and trespassers.

3.7.2 Monitoring and Data Collection

****

NOTE: Most ISTR contractors have automated data collection systems that record temperature data from thermistors and flow rates on essentially a continuous basis. Concentration data for vapors are typically collected using photoionization detectors or similar equipment on a daily (or more frequent) basis, supplemented by confirmatory fixed-laboratory analyses. Treated vapor and liquid effluent concentrations are measured on a frequency that are sensitive to the rate of contaminant loading, regulatory expectations, and the robustness of the treatment system.

****

Monitor the following parameters in accordance with Table 5. Describe the sampling locations and frequencies for parameters not listed in Table 5 in the RAWP. Include summaries of recorded parameters and interpretations of these data in weekly reports. Submit monthly reports that roll up the interpretation of these data and propose any changes necessary to operations.

3.7.2.1 Temperature Monitoring

The Government may require replacement of a temperature sensor if it fails and is critical for evaluating the attainment of performance goals.

3.7.2.2 Mass Removal Monitoring

Monitor mass removal rates in all media including vapor and condensed liquids based on the inflow to the treatment systems. Monitor, as needed for optimization of subsurface treatment, mass removal from specific wells or system legs.

3.7.2.3 Air Monitoring

Prepare and implement under the supervision of the Safety and Health Manager an exposure monitoring and air sampling program to identify and quantify safety and occupational health hazards and airborne levels of hazardous substances to assure proper selection of engineering controls, work practices and personal protective equipment for affected site personnel[and nearby residences, business, and other occupied structures or activities]. Describe the program in the [Site Safety and Health Plan][RAWP] in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

3.7.2.4 Power Input

Monitor total power input to the TTZ and to all individual energy delivery points daily.

3.7.2.5 Piezometric Monitoring

Monitor piezometric levels to assess groundwater flow through or below the TTZ.

3.7.2.6 Groundwater Monitoring

Collect groundwater samples from locations and with a frequency as specified in Table 5. Propose well-head design and hot groundwater sampling methods in the UFP-QAPP and conduct the sampling in accordance with all safety requirements described in the Site Safety and Health Plan.

TABLE 5 - OPERATIONAL MONITORING

Parameter	Frequency	Locations	Required Analysis Turn-Around Time (days)	Notes
Subsurface Temperature	[continuous] [daily] [_____]			
Subsurface vapor concentrations	[weekly] [_____]			
Subsurface pressures or vacuum	[weekly] [_____]			

TABLE 5 - OPERATIONAL MONITORING				
Parameter	Frequency	Locations	Required Analysis Turn-Around Time (days)	Notes
Piezometric levels	[monthly] [_____]			
Groundwater contaminant concentrations	[monthly] [_____]			
Air monitoring results	[per permit equivalent] [_____]			
Power input (total and by individual point)	[weekly] [_____]			
Extracted vapor contaminant concentrations	[daily] [_____]			
Condensate contaminant concentrations	[weekly] [monthly] [_____]			
NAPL recovery	[weekly] [_____]			
Total extracted vapor flow rate	[daily] [hourly] [_____]			
Recovered liquid flow rates	[daily] [_____]			
Liquid treatment effluent contaminant concentrations, permit parameters	[per permit equivalent] [_____]			

TABLE 5 - OPERATIONAL MONITORING				
Parameter	Frequency	Locations	Required Analysis Turn-Around Time (days)	Notes
Vapor treatment effluent contaminant concentrations, permit parameters	[per permit equivalent] [_____]			

3.7.3 Availability of Monitoring Data

Make all parameter data available to the Government via a secure project web page or similar means. Include tabulated data identified in Table 5, and provide temperature[, subsurface vacuum/pressure data][, power input,][and][_____] available in graphical form in both map and cross-sectional view to facilitate Government assessment of project progress. Include the same data in weekly and monthly reports.

3.7.4 Adjustments to Operations

Make adjustments to vapor [and liquid] recovery system, energy input, or groundwater controls to address areas that are not making necessary progress toward meeting treatment goals as expected or where unacceptable contaminant migration may be occurring. Propose cessation of heating to limited portions of the site that are believed to have met treatment goals for Government approval in weekly and monthly report.

3.7.5 Notification of Critical Alarms and Shutdowns

Notify the government within [24][_____] hours of critical alarms and unplanned shutdowns that last longer than 2 hours. Outline these alarm conditions in the RAWP.

3.7.6 Weekly and Monthly Reports

Submit an electronic version of the process monitoring result reports to the Government on a weekly basis during the ISTR start-up, testing, operation and maintenance phases of the project to document monitoring of the treatment process. The electronic data must be submitted in a spreadsheet (e.g., Microsoft Excel). The process monitoring data to be included are specified in paragraph MONITORING AND DATA COLLECTION, and include the following parameters, tabulated, when possible, with a short associated text description:

a. Power and energy input during period.

b. Temperatures at each measurement point and depth as well as at heater wells.

c. Pressures at each measurement point and depth.

d. Vacuums and flow rates from each vapor recovery well and through the

entire system.

e. Vapor volatile organic compound (VOC) measurements at each location monitored.

f. Mass (discrete and cumulative) of total VOCs removed.

g. Running mass (discrete points and cumulative total) of VOC emissions from the well-field.

h. Running indication of vapor treatment removal efficiency.

i. Amount of groundwater/process water generated during the reporting period.

j. Description of any wastes generated during reporting period and their disposition.

k. System runtime hours, and downtime log with description of reasons and corrective actions; and

l. Any other data (soil, groundwater, air, soil gas, etc.) obtained during the reporting period.

Monthly progress reports must be submitted within 14 days of the reporting period. Monthly reports must include all cumulative routine operational data, any available analytical data collected, and a summary of progress towards meeting the performance criteria.

3.8 SHUTDOWN AND CLOSEOUT

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NOTE: The cessation of heating is based on the interpretation of the temperature, energy delivered, mass removal rates, and media concentrations, in that order, conducted jointly by the contractor and the Government. The contractor may propose the cessation of heating for Government approval. The Government may allow a temporary shutdown of power input to facilitate sampling of soil and groundwater with the understanding that the system may need to be restarted based on the sampling results. Until confirmation is received that all performance requirements have been attained, all contractor equipment should remain on-site.
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3.8.1 Basis for Shutdown

Propose cessation of heating when it can be inferred based on parameter measurements, including temperatures, energy input, mass removal, and media concentrations, that the [soil][and][groundwater][has][have] achieved performance goals set forth in paragraph PERFORMANCE REQUIREMENTS. Cease heating only with the approval of the Government. Assume Government review and approval will be provided within [5][_____] business days. Continue vapor control measures following cessation of heating[for two weeks][for four weeks][for [_____] days][, and until vapor migration to the surface and contaminant condensation outside the TTZ is no longer a risk to workers or the community]. Maintain all

equipment in stand-by condition pending confirmation of attainment of all performance goals. These requirements also apply for cessation of heating in a portion of the TTZ. If performance goals have not been attained, resume heating throughout the TTZ, or with Government approval, within a portion of the TTZ that has not attained performance goals. Submit all Post Heating Sampling Results to the Government in a timely manner to support shutdown decisions.

3.8.1.1 Confirmation Groundwater Sampling

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NOTE: If groundwater concentration targets are part of the treatment goals, requiring the acquisition of groundwater samples at other locations may be prudent, especially those areas that did not sustain boiling temperatures or that were still yielding some contaminant mass. Specifying obtaining groundwater grab sampling at a number of location as directed by the Government is optional, but recommended.

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Consider groundwater sampling results in assessing attainment of performance goals, including the potential for rebound and inflow of contaminants from areas outside the TTZ. Conduct a minimum of [one][two] [_____] round[s] of groundwater sampling after cessation of heating to verify attainment of the performance goals. Obtain samples from the monitoring wells identified in Table 4 and analyze the samples for the analytes in Table 4. Conduct all sampling in accordance with hot sampling methods outlined in the UFP-QAPP and the Site Safety and Health Plan.[Obtain additional groundwater grab samples during soil sampling at [_____] locations directed by the Government, and analyze these samples for the same list of contaminants as the samples from the monitoring wells.]

3.8.1.2 Soil Sampling

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NOTE: Subsurface soil sampling is difficult during active heating given the typical presence of piping, cabling, and a surface cover that prevents access for even small drill rigs. Pre-planned drilling access or temporary removal of piping and other infrastructure can make sampling possible. Such sampling can be very useful in assessing progress. Soil sampling can be conducted after cessation of heating for confirmation sampling. Removal (or extraordinary protection) of surface infrastructure is required, so confirmation soil sampling is not typically conducted without a high level of confidence that performance goals have been achieved.

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Conduct soil sampling to confirm attainment of performance goals only after other evidence, including mass removal rates and extracted concentrations, indicate a high likelihood of attainment of these goals. Remove surface cover, if this can be safely done without allowing discharge of contaminant vapors and steam, and relocate piping and cabling as necessary to provide access for drilling equipment.[Replace surface cover following the soil sampling.] Sample soil at[one location per

[____] square meters [____] square feet of the TTZ] [[____] locations][as specified in the UFP-QAPP][as directed by the Government][at the centroid of areas between heater locations][and at locations that either did not attain target temperatures or attained them for the shortest time]. Obtain soil samples at up to [5][_____] locations above and below the TTZ and at locations [2][_____] meters [6][_____] feet outside the TTZ lateral boundary and spaced every [30][_____] meters [100][_____] feet around the perimeter of the TTZ to assess condensation or downward migration of contaminant. Conduct hot soil sampling in accordance with procedures described in the UFP-QAPP and in accordance with the Site Safety and Health Plan.

3.8.2 Retention of Equipment

Retain all contractor-furnished equipment upon the verification of the attainment of the treatment goals. Government-furnished equipment will remain the property of the Government.

3.8.3 Basis for System Restart

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NOTE: It is common for the ISTR system to be restarted after confirmation soil sampling at least until the receipt of the analytical results.
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Following the initial cessation of heating, restart the system upon the direction of the Government or if the [soil][and][groundwater] sampling results indicate the treatment goals have not been fully achieved. These criteria also apply for restart of heating in a portion of the TTZ.

3.8.4 Close-Out Activities

Begin close-out activities only after receiving authorization from the Government.

3.8.4.1 Equipment, Cover, and Piping Removal

Remove all the contractor-furnished equipment, material, temporary facilities, and supplies from the site and clean the area. If a surface cover is used, remove and dispose of it off site in accordance with applicable local, state, and federal requirements. Restore the site to the condition that existed before commencement of the ISTR. Restore any impacted stormwater drainage pipes to full working condition at the end of ISTR operations. If the Contractor protected existing infrastructure from elevated temperatures in the TTZ, conduct tests during restoration to document restored conditions match or exceed baseline conditions.

3.8.4.2 Recycling and Waste Disposal

Recycle or process for reuse any materials and equipment that would have suitable value. This may include plastic and/or concrete cover materials, piping, wiring, and spent non-hazardous granular activated carbon.[Manage spent carbon and other wastes in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.] Decontaminate materials for recycling or reuse to the extent necessary prior to removal from the site.

3.8.4.3 Well Decommissioning

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NOTE: Suggest including an approximate estimate of the number of monitoring wells that will be retained. The number of monitoring wells to be retained will likely depend on the results of the ISTR and can't easily be predicted. It may be best to retain all monitoring wells and decommission them at a later date under separate contract.

Well abandonment procedures are usually governed by state or local requirements and often involve pressure grouting and removal of the upper 0.6 to 1.5 meters 2 to 5 feet of the well or other infrastructure with necessary backfilling.

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Decommission subsurface infrastructure, including heater, extraction, and injection wells, temperature sensor strings, vapor/vacuum monitoring points in accordance with state and local requirements with modification as necessary for the construction of the features and the residual heat in the TTZ. The Government will identify monitoring wells to be retained for future monitoring. Provide documentation of the decommissioning activities in the remedial action report.

3.8.4.4 Site Restoration

Restore the site to the condition that existed before commencement of the ISTR (except for the items discussed above), grade to ensure proper drainage, and revegetate to prevent erosion until final site restoration. Provide photographic documentation of completed restoration activities in the remedial action report.

3.8.4.5 Remedial Action Report

Submit a Remedial Action Report. The remedial action report must include, but is not limited to the following:

a. Description of field operations including energy applied, duration of treatment, temperatures reached, mass removal rates and cumulative totals over time, monitoring point concentrations over time.

b. Evaluation of ISTR effectiveness relative to treatment requirements.

c. All sampling results, which are to include process monitoring and confirmation sampling results, perimeter and work zone air monitoring results, and monitoring results.

d. Any deviations from the approved RAWP, UFP-QAPP, and rationale/justification for each.

e. Any site restoration activities.

f. As-built drawings which are to detail well field infrastructure locations, all confirmation sampling locations, air monitoring locations, monitoring well locations, and depict post restoration site conditions.

g. As-built drawings for excavations detailing the horizontal and vertical extent of excavations and confirmation sampling locations.

h. Wastes generated and disposition (including characterization analysis of wastes).

i. Chemical data final report.

j. Lessons Learned as an appendix.

k. Photos of the installed wells, piping, surface cover, treatment equipment, sampling activities, effluent discharge locations, any recovered NAPL, and pre- and post-treatment site surface conditions, as appropriate.

-- End of Section --