APPENDIX C
Example Checklists

C.1. Design Review Checklist

C.1.1. Site Physical Data

- ☐ Existing Conditions Site Plan
- ☐ Existing facilities, historic facilities
- ☐ Subsurface utilities
- ☐ Representative boring logs
- ☐ Stratigraphic cross sections
- ☐ Groundwater occurrence depth
- ☐ Soil physical properties (e.g., grain size distribution, porosity, vapor phase permeability, water content)

C.1.2. Chemical Data

- ☐ COC and other organic matter distribution and concentration
- ☐ COC physical properties (e.g., boiling point, vapor pressure)
- ☐ Total organic carbon data
- ☐ Presence of NAPL
- ☐ Contaminant-specific clean-up goals
- ☐ Anion and cation concentrations (particularly for chlorinated sites)

C.1.3. Bench/Pilot Test Data. May include some or all of the following, depending on site.

- ☐ Confirm successful application of ISTD
- ☐ Select target treatment temperature
- ☐ Predict vapor stream contaminants and loading
- ☐ Determine acid neutralization/buffering capacity
- ☐ Evaluate potential coke formation

C.1.4. Simulation Results (where applicable). May include some or all of the following, depending on site.

- ☐ Verify selected target treatment temperature
- ☐ Verify vapor stream contaminants and loading projections
- ☐ Project duration of heating
- ☐ Recommend well spacing and well field pattern
- ☐ Recommend per well power input
- ☐ Evaluate coke formation and suggest preventative/corrective measures
- ☐ Determine adjustments/modifications required to address edge effects

C.1.5. Subsurface Design

- ☐ Layout well field pattern over contaminated area(s)
- ☐ Design heater(s) to deliver required power
- ☐ Select controlled or controllerless heater elements
- ☐ Identify subsurface obstructions/conduits to be removed or plugged
- ☐ Detail heater elements
- ☐ Detail heater-only and heater-vacuum wells (coordinate with heater design)
- ☐ Calculate thermal expansion (heaters and wells) – cross check vs. details, revise as needed
- ☐ Specify materials of construction and fabrication methods for thermal wells and heaters
- ☐ Specify thermal well installation methods based on site data
- ☐ Specify location and configuration of well field temperature and pressure monitoring points
- ☐ Evaluate need for groundwater control measures – design if required

C.1.6. Civil/Site Design

- ☐ Evaluate/modify site grading to control runoff/run-on into treatment area
- ☐ Layout sediment and erosion control measures
- ☐ Layout site operations area (well field, off-gas treatment components, material laydown area, decontamination area, job trailer/temporary facilities, water supply, etc.)
- ☐ Design and detail surface seal/insulation – coordinate with simulation results and well details
- ☐ Design and detail surface seal penetrations – coordinate with well and monitoring point details

C.1.7. Process Design

- ☐ Estimate vapor production from thermal well field
- ☐ Develop Process Flow Diagram (PFD)
- ☐ Perform heat and material balance on process equipment
- ☐ Size and select off-gas treatment components
- ☐ Develop Piping and Instrumentation Diagram (P&ID)
- ☐ Develop control loops and interlocks
- ☐ Specify requirements for PLC program (where applicable)
- ☐ Select monitoring instrumentation
- ☐ Water or condensate treatment

C.1.8. Mechanical Design

- ☐ Thermal design (total and rate of consumption)
- ☐ Layout vapor collection pipe manifold, incl. valves, expansion joints, etc.
- ☐ Calculate vapor conveyance piping sizes (head loss)
- ☐ Calculate pipe manifold thermal expansion, adjust layout as required
- ☐ Detail vapor conveyance piping manifold and supports
- ☐ Specify pipe materials of construction, incl. valves, expansion joints, etc.

- ☐ Calculate manifold pipe supplemental heat and insulation requirements
- ☐ Specify pipe heating measures and insulation requirements
- ☐ Design condensate collection and conveyance system (where applicable)
- ☐ Detail off-gas treatment system interconnecting piping

C.1.9. Electrical Design

- ☐ Potential for presence of explosive vapors and fire hazards
- ☐ Consult with utility supplier regarding power availability
- ☐ Calculate well field circuits based on individual heater design
- ☐ Develop field wiring strategy to balance circuits
- ☐ Calculate manifold pipe heater electrical load, select heaters
- ☐ Calculate additional system loads (manifold pipe heating, motors, etc.)
- ☐ Specify main transformer size and power requirements
- ☐ Develop wiring strategy for off-gas treatment components (MCC or remote)
- ☐ Select variable frequency drives (VFDs) and/or soft-starts when appropriate
- ☐ Develop electrical one-line distribution diagram
- ☐ Select distribution panels/switchboards and breakers to accommodate design
- ☐ Specify over-current protection requirements, trip settings, etc. (include allowances for continuous duty)
- ☐ Select well field and system component conductor and ground wire sizes (account for voltage drop)
- ☐ Calculate emergency generator load, select generator and transfer switch
- ☐ Specify site lighting (night-time) requirements and select lights

C.1.10. Cost

- ☐ Estimate material costs
- ☐ Estimate construction costs
- ☐ Estimate operating costs, including supplemental fuel for oxidizer and electricity
- ☐ Estimate decontamination and decommissioning costs
- ☐ Compare projected costs with budget allowance

C.2. Checklist for Review of Models for In Situ Thermal Destruction/Desorbtion

C.2.1. Domain

- ☐ Is the horizontal domain large enough to simulate stable background temperature and pressure conditions outside the treatment area?
- ☐ Does the vertical domain extend far enough to include relevant influences such as soil caps, leaky lower aquifers, etc.

C.2.2. Grid

- ☐ Is the horizontal grid size or node spacing small enough to provide proper definition of heat flow, fluid flow, and steam-zone propagation between electrodes, injection wells, and extraction wells?

- ☐ Is the layer thickness or vertical node spacing small enough to allow proper definition of steam override, saturation changes in the vadose zone, stratigraphic layers, soil caps, and vapor collectors?
- ☐ If a variable node-spacing is used, is each increase in node spacing limited to 50% of the adjacent smaller node spacing?

C.2.3. Boundaries

- ☐ Are the lateral boundaries distant enough to prevent the boundary conditions from constraining modeled stresses within the treatment zone?
- ☐ Do the boundaries properly represent influences of lateral features such as barrier walls or shorelines?
- ☐ Does the upper model boundary accurately simulate the effects of atmospheric pressure and temperature?
- ☐ If the model simulates only a portion of a well field or array, are the boundaries properly aligned with axes of symmetry (fluid flow divides)?
- ☐ Does the lower model boundary accurately reflect recharge from or discharge into aquifers below the treatment zone?

C.2.4. Sources and Sinks

- ☐ Do the simulated wells accurately account for well efficiency?
- ☐ For pressure-controlled wells, do the input parameters account for the difference between well diameter and model cell width?
- ☐ Is the vacuum in multiphase extraction wells appropriately applied, only above the pumping water level?
- ☐ Are injected steam temperatures correctly derived from steam table data for anticipated injection pressures?

C.2.5. Initial Conditions

- ☐ Are representative initial soil and groundwater temperatures used, based on site measurements?
- ☐ Is the average air temperature for the anticipated treatment period used for the upper model boundary?
- ☐ Do the initial pressures accurately portray anticipated fluid levels at the beginning of thermal treatment?

C.2.6. Media Properties

- ☐ If permeability data is obtained from hydraulic conductivity testing, have the proper conversions been made to obtain intrinsic permeability values for model input?
- ☐ Has the vertical anisotropy of the soil materials been carefully evaluated and properly simulated? Steam propagation and override is sensitive to this parameter.
- ☐ Is the proper conversion being made between wet versus dry thermal coefficients (heat capacity and conductivity), prior to model input, or in the model computations?

- ☐ Does the model utilize appropriate thermal coefficients for the anticipated temperature range? Heat capacity and conductivity can both vary as much as 50% between ambient and operating temperatures.
- ☐ Are representative pressure-saturation-permeability relationships used for the site soils.

C.2.7. Fluid Properties

- ☐ Is the temperature-dependency of density and viscosity properly simulated for water liquid and vapor? Steam tables should be used for data input, or should be included in the numerical modeling code.
- ☐ Is the temperature-dependency of density and viscosity properly simulated for NAPL? Input values for analytical solutions, or temperature-dependent coefficients for model input, need to be derived from available test data.

C.2.8. Contaminant Properties

- ☐ Is the temperature-dependency of solubility and other partitioning coefficients accurately portrayed?
- ☐ Are the effects of non-equilibrium partitioning adequately considered? Most modeling codes assume equilibrium, and the resulting uncertainty should be recognized during interpretation of the results.
- ☐ Is the selection of pseudocomponents suitable for existing site contamination? Have the contaminants been grouped appropriately for combining into pseudocomponents (i.e. aliphatic compounds, halogenated hydrocarbons, high molecular weight PAH, low molecular weight PAH, etc.)?

C.2.9. System Operations

- ☐ Is the anticipated operations strategy based on a consensus within the project team, and is it properly portrayed in the model?
- ☐ Are the modeled well and electrode flows, pressures, and energy inputs within the capabilities of the existing or proposed energy conveyance and treatment systems?
- ☐ Are allowances being made for potential system malfunctions, maintenance, and downtime?

C.2.10. Uncertainties and Sensitivity

- ☐ Are uncertainties in the model input values properly addressed? Sensitivity runs can be performed to test the effect of input values on model results.
- ☐ Can the treatment strategy be altered to accommodate uncertainties in underground conditions? Reasonable maximum and minimum input values can be used in the model, to evaluate operational changes that might be required.
- ☐ Can the energy conveyance and treatment systems be designed to allow for uncertainties in underground conditions? Model input values can be varied to establish ranges of flow rates, energy requirements, temperatures, or contaminant loads that the systems may need to accommodate.