FAQ about ET-DSP™

What is ET-DSP™?

The Electro-Thermal Dynamic Stripping Process, or ET-DSP™, is an in-situ thermal soil decontamination method that combines the three treatment methods of electrical resistance heating, thermal conduction, and steam / hot water injection. ET-DSP™ takes advantage of the naturally occurring electrically resistive properties of soil by the precise application of electrical current into a contaminated plume producing heat throughout its volume to reach a target temperature defined to be the vapor temperature of the contaminants of concern. The vaporized contaminants can then be mobilized and removed from the soil using vapor extraction techniques.

ET-DSP™ has been successfully deployed on dozens of sites across North America. Most ET-DP™ sites have been cleaned to non-detect levels and 'No Further Action' (NFA) status achieved in 4-6 months.

How does ET-DSP™ work?

This process involves heating soil within and across both saturated and unsaturated zones by passing electrical current via electrodes placed at calculated depths and distances. A moderate volume of water is circulated through the electrodes to achieve both conductive and convective heating. Using a customized computer program, the quantity, timing, and location of power application is monitored and controlled on a continuous basis. Power to each electrode as well as water injection can be modified individually in response to the heterogeneous properties throughout a contaminated soil plume. As a result, the heating is precise, uniform, and efficient but rapid under this process.

What science underlies the effectiveness of ET-DSP™?

The design of ET-DSP™ is grounded in science. It is a multi-physics approach that leverages electrical (radial), conductive, and convective heating mechanisms:

1. The electrical (radial) thermal mechanism heats the connate water trapped in pore spaces in the soil. As a result of anaerobic dechlorination in contaminant-saturated zones, an ionic imbalance is created and provides a path for electrical current to flow rapidly.
2. The conductive thermal mechanism results from soil particles being in direct contact with the electrodes and maintained via the injection of water throughout the plume to maintain conductivity.
3. The convective thermal mechanism is induced by the in-situ steam generated which leads to the conversion of contaminants into a vapor phase with resulting vapors being swept into zones of higher permeability towards low pressure areas around extraction wells.

How does heat work as a method of remediating contaminated soils?

All thermal soil remediation methods focus on the chemical property of temperature associated with various contaminants. Typically, chemicals found in contaminated soils exist in the liquid phase at ambient temperatures and pressures. The key is to raise the temperature of the soil so as

to cause a phase change in the contaminant(s) from liquid to vapor – i.e. boil off. Once the contaminants of concern are in the vapor phase they are more readily captured by a conventional vapor extraction system.

How long does it take to remediate a site using ET-DSP™?

In general, target temperatures are achieved within 60 days of commencement of heating. Notwithstanding unique contamination challenges, the heating process of ET-DSP™ generally runs its course within a time frame between 3 to 12 months. Installation and operations commissioning of ET-DSP™ system components typically requires 2 to 6 weeks. At the end of the day, a site cleaned using ET-DSP™ is ready for re-utilization in a matter of months, not years.

What is the range of dimensions and depth within which ET-DSP™ can be practically and economically deployed?

There is no practical depth limitation to using ET-DSP™. ET-DSP™ electrodes have been deployed from surface in their most shallow application to over 300 feet in their deepest application with equal effectiveness.

What type of soil remediation challenges respond to the application of ET-DSP™?

Because ET-DSP™ is a multi-physics process combining the elements of electrical resistive heating, thermal conduction, and thermal convection, it is capable of tackling a broad range of contaminated soil challenges such as:

i) volatile and semi-volatile organic contaminants ~ more commonly benzenes, gasoline, fuels, and other light end hydrocarbons
ii) dense, non-aqueous phase liquids ~ commonly found in the form of chlorinated solvents such as trichloroethylene, perchloroethylene (dry-cleaning fluid), and methylene chloride
iii) absence of micro-organisms in the soil such that the options of bio-remediation or natural attenuation are impractical
iv) contamination plume is situated under a surface structure (i.e. highway, building, tank farm) that must remain intact
v) contamination plume is located where noise is a concern or where flashing and atmospheric release of contaminant fumes would be undesirable and harmful
vi) heterogeneous geology, low moisture, or low permeability
vii) potential for rapid contaminant migration into groundwater

How safe is ET-DSP™?

Rigorous engineering acceptance testing is carried out to ensure quality, reliability, and most importantly safety. ET-DSP™ projects are operated by trained electrical engineers and knowledgeable technical specialists.

ET-DSP™ was designed by a PhD Electrical Engineer and is installed by qualified personnel who are well versed and trained to deal with electricity. Our electrical engineers are always present during system commissioning and "on-call" throughout project operations. ET-DSP™ is designed to achieve proper grounding, meeting IEEE standards, in order to contain all electrical current within the contaminated soil plume. No fugitive currents will escape the subsurface. In the absence of proper grounding, stray electrical currents can result in unintended consequences of damaged equipment and, in the worst case, pose a danger to on-site personnel.

Mc2 has a 100% safe work history since the inception of the Company in 1995.

How much energy is used in the ET-DSP™ process?

The amount of energy varies and depends largely on the:

1. Type of soil and its electrical properties,
2. Nature of the chemicals
3. Clean up goals (maximum concentration levels, and time frame)

Our project experience shows that the energy demand for ET-DSP™ soil remediation ranges between 100 and 300 kWh per cubic yard dependent on the density of the contaminant concern, water gradients, remedial goals, and soil lithology. However, once Mc^2 engineers have completed its analysis and modeling, we can predict very accurately, the ET-DSP™ system power demands for a given site.

Why is water injection important to the ET-DSP™ process? How much water is used?

Soil dessication is an expected result whenever ERH is used. Soil settling, subsidence, and high resistance are the unintended and undesirable consequences. Electrical current will not conduct through dry soil. With ET-DSP™, water is injected, via the electrode, to transform impermeable reservoirs otherwise non-responsive to electrical current, into a conductive medium that takes electricity through its volume and heats the soil rapidly and evenly. ET-DSP™ achieves zero water-table drawdown. The water and energy balance is monitored throughout the process and equilibrium is maintained such that soil settling, subsidence, and high resistance is mitigated.

The quantity of water used ranges from 0.1 to 0.2 gpm per electrode. This water replaces the contaminant volume as it is being extracted from the subsurface. No additional water beyond this is required for ET-DSP™.

What is a "bench scale" study?

ET-DSP™ begins with a thorough understanding of the soil lithology and subsurface conditions unique to each project. Using soil samples from a contaminated site, a bench scale study models the effect of ET-DSP™ mechanisms on remediating the contaminants of concern. From the results, a numerical engineering model is developed – the basis by which trained electrical engineers and technicians are able to customize ET-DSP™ for optimum, predictable performance.

Mc^2 is the only thermal vendor with in-house numerical simulation/computer modeling and electro-thermal laboratory capabilities. The solution for any site is a matter of detailed calculation. Mc^2's team of electrical engineers conduct advanced numerical simulations on the thermal treatment of every site. This provides a thorough and detailed mapping of the site conditions which can be used to formulate the technical milestones (electrode and extraction well placement, energy inputs, vapor and liquid extraction rates, etc.) during operations to ensure that the project is progressing as planned.

How much oversight is required to operate an ET-DSP™ project?

ET-DSP™ maintains dynamic control of the entire system continuously. Once an ET-DSP™ system is functional, it is largely self-monitoring. Operations and project progress can be monitored and adjustments can be made remotely via a proprietary and secure, web-enabled interface application. Therefore, demands for on-site operations personnel are minimized.

Where does the ET-DSP™ equipment come from?

ET-DSP™ equipment is manufactured in-house by Mc^2 at their state of the art manufacturing facility and by professionally qualified and trained technicians who understand thermal soil remediation. All equipment is manufactured in a large, modern, well-equipped, manufacturing plant to exacting UL and CSA/UL standards. Quality and control of the manufacturing process remains in the hands of professionals fully trained with extensive experience in electrical, chemical, mechanical and civil engineering. This eliminates manufacturer delays as well as the need to retrofit pre-manufactured, generic components to fit the demands of a unique ERH project.

Who makes ET-DSP™ electrodes?

Mc^2 is the original manufacturer of ET-DSP™ electrodes which means that aspects such as electrode dimensions as well as subcomponent assemblies can be modified to suit unique circumstances thereby eliminating any potential delays, issues, and additional costs. ET-DSP™ electrodes are engineered and designed specific to the unique demands of each project. ET-DSP™ electrodes can be installed in a single layer for shallow occurrences or stacked as many as five deep in a single well bore to deal with thick contamination plumes.

ET-DSP™ electrodes have been engineered to be 60% more effective and efficient than conventional ERH electrodes – intelligent design to provide reliable, consistent results.

What is an ET-DSP™ "power delivery system"?

A power delivery system, or PDS, is a piece of equipment that is used to deliver electrical current to the subsurface electrodes. This equipment is built to surpass UL and CSA standards with internal logic to control up to as many as 24 electrodes simultaneously with the ability to adjust power to each electrode up to 20 times per second. The ability to react instantly to changing conditions is a critical consideration on a site with many electrode locations. The ET-DSP™ system is simply the most advanced thermal technology available.

Why is a sound electrical grounding system important to electro-thermal heating?

The safe and effective implementation of any electrical heating technology hinges on the design of the grounding system. Because the earth is being electrically heated and also serves as the electrical "ground", a physical conflict is inherent during the implementation of electrical heating technology with further complexities posed by the unique characteristics of each site. This conflict, if not properly engineered, can result in short circuits, stray currents, and uncontrolled electrical current flow. Correcting such issues may cost the Client, time wise and financially. At its worst, a poorly designed grounding system poses a physical danger to personnel and the public at large.

The Mc^2 Team is the only thermal vendor that has qualified electrical engineers and design software to model multi-grounded systems to design a safe ground system for electrical heating under virtually any physical circumstances.

What benefits does ET-DSP™ offer to the Client?

Mc^2 is the acknowledged technical leader in electro-thermal remediation since our involvement on the first ever demonstration of the technology at Lawrence Livermore National Labs in 1991. Mc^2's dedication to the science of heat transfer and physics of electro-thermal processes has resulted in numerous advancements to our technology for which we have crystallized in our patent (US 6,596,142 and Canada 2,341,937). Among these features are the following:

a. A combination of the three predominant heat transfer mechanism of electrical heating, convection, and conduction;
b. Time-distributed control and inter-phase synchronization for power control of individual electrodes;
c. Strategic use of stacked electrodes to target contamination volumes regardless of depth or thickness
d. Safe and effective operations of ET-DSP™ in public areas, beneath occupied apartment complexes, and interstate highways;
e. Safe and effective operations of ET-DSP™ in the presence of buried utilities including natural gas, telephone, sewers, electrical, and fiber optic lines;
f. Electrical engineers and technical professionals on staff with 80+ years of remediation experience with electrical systems and ET-DSP™.
g. Advanced computer control for real-time control and data monitoring using our , internally developed, proprietary digiSource™ data acquisition systems;
h. Customized web interfaces so that clients can track all aspects of the remedial project in real time from any computer in the world; and

These process improvements, our superior technology and design, and the combined resources internal in the company make the Mc^2 Team the most equipped to handle problems, changes in conditions, and to achieve all of the remedial goals for any project.

What advantages does time-distributed control and inter-phase power synchronization bring to tackling a remediation project?

These features provide predictable performance and the lowest power consumption. As a result of continuous computer control on an individual electrode basis, power and water is applied where needed to eliminate cold spots or zones where contaminants are found to be more recalcitrant. The

system will throttle back power and water in zones that have achieved clean-up criteria. ET-DSP™ uses power and water efficiently and effectively all while operating with surgical precision. Predictable performance helps our Clients achieve their remedial goals on time and on budget.