

# DISCO Glossary

Definitions of terms and how they are used in DISCO are presented on this and the following pages. This glossary is actually a separate pdf document. Users should close or minimize this document to return to where they were in the main part of DISCO. Further explanation of these terms is provided in Krembs (2008) and the TPM Part III.

- **ACLs** are Alternative Cleanup Levels, which are a specific concentration that is greater than MCLs. ACLs are often used with site-specific risk assessments or in regulatory contexts which allow for less stringent standards in low risk situations (e.g. low yield aquifers, lack of nearby receptors).
- **BTEX** stands for Benzene, Toluene, Ethylbenzene, and Xylenes. BTEX is a component of gasoline and other light hydrocarbon mixtures.
- **Chloroethanes** are similar in structure to ethane ( $C_2H_6$ ) with chlorine atoms substituted for hydrogen. TCA and DCA are the most commonly encountered of the chloroethanes based upon the DISCO case study data. DCA may be formed by dechlorination of PCE and TCE.
- **Chloroethenes** are similar in structure to ethene ( $C_2H_4$ ) with between one and four chlorine atoms substituted for hydrogen. They include the degreasing agents PCE and TCE, and the breakdown products DCE and VC.
- **CHP** is Catalyzed Hydrogen Peroxide, also known as modified Fenton's reagent. This oxidant system uses an iron chelate, iron salts, or naturally occurring iron to activate hydrogen peroxide, which then forms hydroxyl free radicals as well as a host of other free radical species.
- **cis-DCE** is cis-1,2 dichloroethene (DCE).
- **Coupling** refers to use of another remediation technology in addition to ISCO, and includes monitored natural attenuation (MNA). Coupling includes remediation of nearby areas that were contaminated by the same source as the COCs being treated by ISCO (e.g. excavation or SVE in the vadose zone and ISCO in the saturated zone).



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- **COCs** are Contaminants Of Concern, and are defined in DISCO as the contaminants that ISCO attempted to oxidize.
- **DCE** is dichloroethene (or dichloroethylene).
- **Delivery Events** are the number of times the field team returned to the site to deliver oxidant to the TTZ. Most ISCO implementations use multiple events, with the time between events used to: refine the ISCO design based on data gathered during the previous event; and to allow the COCs to re-equilibrate in the subsurface (e.g. move from NAPL or sorbed phases to the more treatable aqueous phase).
- **DNAPL** is Dense Non-Aqueous Phase Liquid, or separate phase contaminants that are denser than water (e.g. PCE, TCE). DNAPL sinks below the water table, and is therefore difficult to observe directly in the subsurface. The presence of DNAPL at case study sites in DISCO was based upon statements made regarding DNAPL's presence and concentrations of aqueous phase DNAPL compounds greater than 1% of the compound's solubility.
- **Direct push** is a drilling technique in which a percussive hammer advances a temporary wellscreen (or probe) to the desired treatment depth. ISCO reagents are injected, most often under pressure, and the wellscreen may be moved to another depth at the same aerial location. After all depth intervals are treated at a location, the wellpoint is withdrawn and the borehole sealed with grout.
- **DRO** is Diesel Range Organics, a suite of hydrocarbon alkanes in the range between C<sub>10</sub> and C<sub>28</sub>. DRO is a component of TPH associated with diesel fuel.
- **Fracturing** refers to the intentional creation of fractures using hydraulic or pneumatic techniques. Fracturing techniques include those in which ISCO reagents (in solution or slurry) were injected during the fracturing process, and also applications in which fractures were created using a proppant and ISCO reagents were injected at a later time.
- **Free Radical Based Oxidants** are those that generate free radicals, including CHP, ozone, peroxone, percarbonate, and persulfate.



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- **g** is grams.
- **GW** is groundwater
- **Heterogeneous** geologic materials are unconsolidated materials which were inferred to have greater than a factor of 1000 between the most permeable (highest K) and least permeable portions of the target treatment zone (TTZ). This distinction was based upon assessment of the source files' lithologic descriptions and boring logs of the TTZ, not necessarily on aquifer testing results. For example, a TTZ mostly comprised of sand that contained minor clay stringers would be classified as heterogeneous even if the clay stringers were thin enough that macro scale aquifer test results (e.g. slug tests) did not vary by a factor of 1000. Heterogeneous is defined in DISCO to be the opposite of homogeneous.
- **Homogeneous** geologic materials are unconsolidated materials which were inferred to have less than a factor of 1000 between the most permeable (highest K) and least permeable portions of the TTZ. As with the definition of heterogeneous, this distinction is based upon assessment of specific strata in the treatment zone.
- **Horizontal Wells** refer to aqueous or gaseous phase oxidants delivered through a horizontal well or sparge point. This category does not include angled wells or direct push points.
- **Infiltration Galleries / Trenches** are projects that delivered oxidants in solution to an area above the TTZ and relied upon downward migration of the oxidant to the TTZ, and perhaps density driven transport of the oxidant once it contacted the water table.
- **Injection Wells** are permanent wellpoints installed for the purpose of injecting ISCO reagents.
- **Impermeable** geologic materials are those which had an average K less than  $10^{-5}$  cm/s (0.028 ft/day) in the TTZ. This category is defined to be the opposite of permeable geologic media, and is applied to unconsolidated media only.



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- **K** is saturated hydraulic conductivity, which describes how easily water travels through geologic media.
- **kg** is kilograms.
- **MCLs** are Maximum Contaminant Levels, a concentration above which the applicable regulations deem the groundwater to be contaminated with a given COC. This category represents the most stringent cleanup goal attempted by projects within DISCO. The fact that sites met MCLs was confirmed by the creators of DISCO through personal correspondence with the regulatory official overseeing these case studies.
- **MNA** is Monitored Natural Attenuation, a remediation technology that relies on naturally occurring processes such as biodegradation, sorption, and/or dissolution to reduce the concentration of COCs in groundwater. MNA is most commonly used for large, diffuse plumes, low-risk situations, and at the back end of remediation treatment trains as a polishing technology. MNA was only entered as a coupled remediation technology in DISCO when project source documents specifically stated that it would be used. For this reason, the incidence of the use of MNA after ISCO is likely underestimated.
- **MTBE** is methyl tert-butyl ether (or methyl tertiary butyl ether), a fuel oxygenate added to gasoline to reduce air emissions.
- **n** is the sample size (number of sites) included in a given analysis.
- **na** stands for Not Applicable.
- **NAPL** is a Non-Aqueous Phase Liquid, or free phase contaminant. As used in DISCO, NAPL sites are those in which NAPL was inferred to be present in the TTZ. When present, NAPL often represents the phase in which a majority of the COC mass resides (Pankow and Cherry, 1996), and its presence represents a challenge to ISCO as well as other remediation technologies. Sites with considerable sorbed phase COCs (e.g. high total organic carbon in soil) may react to ISCO treatment in a similar manner to sites containing NAPL.



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- **Observational Approach** (or Observational Method) is a remediation philosophy adapted from geotechnical engineering in which a relatively greater level of uncertainty is acceptable during design. Additional data used to reduce uncertainty is collected during implementation, and the design includes contingency plans should subsurface conditions deviate from those expected.
- **Oxidant Dose** is the mass of oxidant delivered to the TTZ divided by the mass of geologic media in the TTZ, in the units g oxidant / kg geologic media.
- **P&T** stands for Pump & Treat, a remediation / containment technology.
- **PAHs** are Polycyclic Aromatic Hydrocarbons, a class of semi-volatile organic compounds (SVOCs) including pyrene, benzo[a]pyrene, anthracene and others. PAHs are commonly found at former manufactured gas plants and wood treatment facilities.
- **PCE** is tetrachloroethene (or perchloroethene, perchloroethylene), a chloroethene used as a degreasing agent.
- **Percent Reduction of COC Concentration** is calculated based upon the single maximum concentration recorded in the TTZ before ISCO vs. the single maximum in the TTZ after ISCO. The post-ISCO concentrations include any rebound effect, if any was noted (i.e. are based on highest post-ISCO result collected within one year after the end of injection activities).
- **Permeable** geologic materials are those which had an average saturated hydraulic conductivity (K) greater than  $10^{-5}$  cm/s (0.028 ft/day) as determined through aquifer testing results or inferred from lithologic descriptions and boring logs.
- **Pilot Tests** are smaller scale implementations of an ISCO design conducted at the field site. Pilot tests are generally conducted to evaluate oxidant deliverability issues (e.g. ROI) and are not expected to lead to site closure.



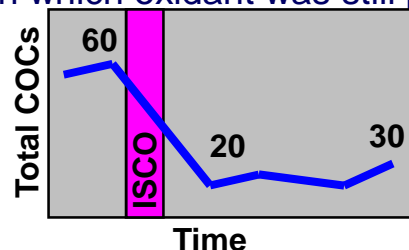
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- **Pore Volumes** is a ratio of the volume of injected oxidant solution divided by the volume of the pore space in the TTZ. This ratio does not include injected activators unless they are injected simultaneously with the oxidant.
- **Program Modification** is a change in the injection spacing, oxidant concentration, or other ISCO design parameters made during the course of implementation, and is included as a measure to assess the frequency of the use of the Observational Approach.
- **Q1** is the 25th percentile, the value that is greater than 25% of the data points and less than 75%.
- **Q3** is the 75th percentile, the value that is greater than 75% of the data points and less than 25%. Half of the data points are, by definition, between Q1 and Q3 (this is referred to as the interquartile range).
- **Query Input** is the part of DISCO in which users select a subset of the case study to view based upon the geologic media and COCs in the TTZ.
- **Query Result** (or **Query Output**) is the results obtained by the user after executing a query in DISCO. The statistics included in these results are based upon the field scale case study data collected by this project.
- **Rebound** generally refers to an initial decrease in COC concentrations in the aqueous phase immediately after remediation followed by an increase in COC concentrations during the post-remediation monitoring period. In DISCO, rebound was assessed at each monitoring well within the TTZ using the following formula:

(Highest Post-ISCO - Immediately after ISCO) / Pre-ISCO Baseline.

Rebound was said to occur if the above formula result was greater than 25% (see example below).

Rebound occurred at a site if one or more monitoring locations exceeded this 25% threshold. One year of post-ISCO monitoring data was required to perform this calculation. The sample results used in these calculations may have included situations in which oxidant was still present at the TTZ, though efforts were made to avoid this situation.



$$\frac{30 - 20}{60} = 17\%$$

**Result at left is less than 25%, and is not rebound**



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- **Recirculation** oxidant delivery systems are those in which oxidant solution is injected at some locations, swept through the TTZ, and extracted at other locations. After extraction, the groundwater is filtered, amended with additional oxidant as necessary, and reinjected.
- **ROI** is the Radius Of Influence, and is the average distance the oxidant solution travels from an injection point during implementation. While this term implies that a cylindrical volume of materials are contacted around each injection point during delivery, even slight differences in geologic media will result in uneven oxidant distribution.
- **RRO** is Residual Range Organics, a suite of alkanes greater than C<sub>28</sub>. RRO is the component of TPH associated with fuel oils.
- **Site Closure** refers to situations in which the site regulators did not require additional remediation or monitoring after the use of ISCO because COC concentrations were reduced to the degree required by the regulations under which the work was being performed. For this reason, the ability of ISCO to attain site closure is highly dependent on the regulatory framework in place. Site closure as defined in DISCO includes both “clean closures” in which no restrictions were placed on the property, and closures requiring institutional or engineering controls.
- **Soil Mixing** is a delivery technique in which oxidant (in a solid or liquid form) is blended into the TTZ using specialized augers or similar equipment.
- **Sparge Points** are wellpoints specifically designed to allow delivery of bubbles of gaseous phase ISCO reagents (ozone) to the subsurface.
- **SVE** stands for Soil Vapor Extraction, a vadose zone remediation technology.
- **TCE** is trichloroethene (or trichloroethylene), a chloroethene used as a degreasing agent. It is also a dechlorination product of PCE.



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- **Total Cost** is the total amount spent on an ISCO remediation as reported in case study source documents. The units are US dollars, and were not adjusted for inflation.
- **TPH** stands for Total Petroleum Hydrocarbons.
- **Treatability Tests** are laboratory scale tests performed on soils and/or groundwater collected from the TTZ (or similar nearby area on site). These include both batch (or vial) tests and column tests. Tests that were performed at the field scale are classified in DISCO as pilot tests even if they were given the name treatability study in project documents.
- **Unit Cost** is the total cost divided by the volume of the TTZ, in units of US dollars per cubic yard treated.
- **VC** is Vinyl Chloride, a chlorinated ethene that is used in manufacturing and is also a dechlorination product of PCE and TCE.

