# Texas Commission on Environmental Quality

# Class I Underground Injection Control

## Basic Guidelines for Mechanical Integrity Tests and Related

## Cased Hole Wireline Logging

As stated in 30 TAC §331.43(a): "An injection well has mechanical integrity if there is no significant leak in the casing, tubing or packer, and if there is no significant fluid movement through vertical channels adjacent to the injection wellbore." The Texas Commission on Environmental Quality (TCEQ) requires an annual demonstration of mechanical integrity (MIT) for all Class I injection wells (30 TAC §331.64(e)) and whenever there has been a well workover which involves removal of the injection tubing (30 TAC §331.63(j)).

The tests usually performed to satisfy TCEQ requirements to demonstrate mechanical integrity are an annulus pressure test (APT) and a radioactive tracer survey (RAT). In addition, a cement bond log, a casing inspection log, and a temperature or noise log are required for newly constructed wells. These may also be required as part of the routine annual MIT in certain instances. A temperature or noise log is required every five years, and a casing inspection log may be required every five years. The TCEQ will generally require that a casing inspection log be run during workovers where the injection tubing is pulled, if none has been run in the previous five years. The Executive Director may waive this requirement due to well construction or other factors which limit the test’s reliability or based upon the satisfactory results of a casing inspection log run within the previous five years.

The following procedures are recommended for the purpose of standardizing the testing throughout the Texas Class I Underground Injection Control (UIC) program and to ensure that an adequate demonstration of mechanical integrity is achieved. Changes or deviations from any of the procedures below, or the use of alternate MIT demonstrations, should be reviewed with the TCEQ UIC staff for concurrence to minimize the potential need to rerun the tests.

### **General**

All wireline logs should be run on API paper and should be formatted according to the standard practice of the petroleum logging industry in the region. For quality control purposes, all appropriate log header entries should be completely filled in and all curves should have repeat sections. All curves and scales on the log itself should be clearly labeled. Though the vertical and horizontal scales should normally be set as outlined below, if any of the logs below have previously been run, subsequent logs may be scaled the same as the previous logs.

All logs should have depth correlation curves recorded in track 1. These would typically be natural gamma radiation and/or casing collar locator logs (preferably both). Gamma correlation curves should be run at 100 or 150 API units per track. Vertical depth scale for all logs should be 5 inches per 100 feet to facilitate correlations with open hole and other logs. Logs run on time drive should be scaled at 1 inch or more per minute.

For hazardous waste disposal wells, waste fluids should be flushed from the well prior to any operations which have the potential for exposure of the wastes to the environment or to the public (30 TAC §331.63(k)). The use of non-hazardous brines for well tests involving injection is one recommended method for addressing this concern.

All testing, log analyses, and technical interpretations should be done by personnel with the qualifications and experience required to competently perform these tasks.

### **Annulus Pressure Tests**

The Annulus Pressure Test (APT) consists of holding a positive annulus pressure of 100 psig greater than the permitted maximum surface injection pressure (MSIP) for a minimum of 30 minutes, with a loss or buildup of less than 5% of the starting annulus pressure. Testing may be performed while injecting into the well or under no flow conditions. A minimum annulus differential pressure of 100 psi must also be maintained.

Pressures should be recorded on a time-drive recorder for at least 30 minutes in duration and the chart or digital printout of times and pressures should be certified as true and accurate. The pressure scale on the chart should be low enough to readily show a 5% change from the starting pressure.

### **Radioactive Tracer Survey**

The recommended technique for the Radioactive Tracer Survey (RAT) is to use a logging tool with a gamma detector above the ejector port and one or two below it. The tool should be able to continuously record during tracer fluid ejection. The upper detector should be recorded in track 1 at a scale of 0 to 100 or 150 API units. The lower detector(s) should be recorded in tracks 2 and 3 at a higher scale, typically 0 to 1000 API units.

Prior to testing, an initial gamma ray base log should be recorded from at least 100 feet above the injection tubing packer to total depth or plugged-back depth (TD/PBTD) of the well, or as agreed between the well operator and TCEQ staff:

1. at least 100 feet below the lowest perforated interval, or
2. the top of the screen, or
3. the top of fill or obstructions,

whichever is deepest. A concurrent casing collar locator log for depth correlation is recommended. Two five (5) minute time drive statistical checks should also be run prior to the ejection of tracer fluid. These logs and statistical checks are run to determine background radiation prior to tracer fluid ejection.

During the survey, injection flow rates should be set at the rate at which the fluid will be under laminar flow, while remaining within the maximum permitted operating parameters. The volume of the tracer fluid slug should be sufficient to cause a gamma curve deflection of at least 25x background reading as the ejected slug passes the lower detector(s). This would typically be a full-scale deflection.

A constant injection (moving) survey should be run from, at least, above the packer to the perforations or screen to check for leaks between those two points. This survey should consist of ejecting a slug above the packer, verifying the ejection, and then dropping down through the slug, and then logging up through the slug to above where the slug was first ejected. The tool should then be dropped down through the slug again and logging should continue upward to above where the slug was encountered on the previous pass. This process should be repeated a minimum of two times, until the slug passes out into the formation. If necessary, the injection rate may be decreased to accomplish this test.

A stationary survey should be run approximately 20 feet or less above the top of the perforated interval or screen to check for upward fluid migration outside the cemented casing. If this depth cannot be reached due to fill or obstructions, the log should be run at the lowest possible depth. Flow during the stationary surveys should be at sufficient rates to approximate normal operating conditions in the well. This rate can be determined by dividing the total volume injected by the total hours the well was operated for the previous year (not the total number of hours in a year unless the well was operated non-stop).The procedure consists of logging on time drive, ejecting a slug, verifying the ejection, and waiting an appropriate amount of time to allow the slug to exit the wellbore and return through channels outside pipe. The time spent at the station will vary but should be at least twice the time estimated to detect the tracer fluid if channeling existed, or for a minimum of 15 minutes, whichever is greater. If tracer fluid is detected channeling outside of the pipe at any time during the stationary survey, then the survey may be stopped and the tracer fluid's movement should be documented by logging up on depth drive, until the tracer exits the channel.

If a satisfactory APT has not been performed in conjunction with the RAT survey, an additional stationary survey may be run approximately 20 feet or less above the injection tubing packer to check for packer leaks. There should be no pressure at the wellhead on the annulus when this test is performed. This additional procedure is not a stand-alone test for use in lieu of an APT but is to be used to investigate a known annulus leak problem.

Other stationary or moving surveys may be required, depending upon well construction, test results, or to investigate previously known problem conditions. At least two repeatable logs of every tracer survey, moving and stationary, should be run. On completion of the tracer surveys, a final background gamma log should be run for comparison with the initial background log.

One or more of the following logs may periodically be required as part of an MIT, or other well testing program.

### **Cement Bond Log (CBL)**

The CBL is for the purpose of evaluating cement condition after well construction and over time. It should be run over the entire interval of cemented casing. In instances where a micro annulus is suspected, the CBL should be repeated under pressure. The log should consist of a minimum of a casing collar log (preferably with a natural gamma curve) for correlation purposes, amplitude and travel time curves, and an acoustic variable density log (VDL).

The recommended format is to record the correlation log(s) in track 1, the acoustic curves in track 2, and the VDL in track 3. This is a standard format in the logging industry, but other formats or techniques unique to an individual wireline logging company may be used subject to prior review with concurrence of TCEQ staff.

The wireline logging engineer should be provided with a simulated or actual free pipe section for the bond tool calibration unless it can be shown that the tool does not require a free pipe calibration for equipment setup.

### **Temperature Log**

The temperature log is one of the EPA-approved logs for detecting fluid movement outside pipe. It should include both an absolute temperature curve and a differential temperature curve. The well should be shut-in at least 36 hours to allow for temperature stabilization, though a shorter time period may be used with concurrence of TCEQ staff.

The log should be run over the entire interval of cemented casing, logging down from the surface to TD. A correlation log(s) should be recorded in track 1, and the two temperature curves recorded in tracks 2 and 3. The temperature log should be scaled at or about 20° F or 10° C degrees per track. The differential curve may be scaled in any manner appropriate to the logging equipment design, but it must be sensitive enough to readily indicate anomalies.

### **Noise Log**

The noise log is also approved by EPA for the detection of fluid movement outside pipe. It should be recorded from TD/PBTD to the surface, and also directly opposite areas of suspected fluid migration. Vertical spacing between noise log stations may vary with the individual well conditions and tool sensitivity, but in general should not be greater than 50 feet.

The tool response should be filtered and recorded as a minimum of four frequency curves at or near 200, 500, 1000, and 2000 Hz. The actual frequencies recorded may be determined by the design of the logging equipment.

### **Other Logs**

Other EPA-approved logs and log formats unique to a logging service company such as casing caliper inspections, cement evaluation surveys, and oxygen activation logs can be recorded according to the logging service company's standard format. However, the general guidelines outlined above still apply.

### **Reports**

A report of results of the MIT is required to be submitted to the TCEQ UIC staff within **30 days** of the completion of testing in accordance with 30 TAC §331.65(c)(4), and should contain, at a minimum, the following information:

1. a complete chronology and description of all tests performed and procedures followed, including reasons for any unusual testing procedures if applicable;
2. an APT time/pressure table, and a copy of the recorder chart or digital print-out if one was made;
3. copies of all logs run;
4. interpretation and discussion of all testing and logging results, including the identity of personnel making the technical interpretation;
5. certification by the individual preparing the report that all test data are true and correct; and,
6. documentation of any concurrence received from the TCEQ staff on the necessity or advisability of using non-standard testing procedures.