

TECHNICAL SPECIFICATION FOR WATER, FUEL HYDRANT AND UNDERTANK LEAK DETECTION SYSTEMS

FOR AIRPORT LEAK DETECTION - TRACETEK

SCOPE

This specification establishes the minimum requirements for design, engineering, materials, manufacture and assembly, inspection, testing, marking, shipping and supply of fuel hydrant and under tank leak detection system and its accessories.

REFERENCE CODES AND STANDARDS

API 1160	Managing system integrity of a hazardous pipeline
FM	Factory Mutual
UL	Underwriters Laboratory
ISO9001:2015	ISO9001:2015 Certified Quality Management System

PRE QUALIFICATION CRITERION

1. The manufacturer of leak detection system must have supplied and installed fuel leak detection systems successfully at twenty (20) major airports worldwide and have more than 35 years of manufacturing experience in direct leak detection.
2. The manufacturer of leak detection system must have all the sensing sensors and panels approved by UL.
3. The manufacturer of leak detection system must have a direct presence in China for the past minimum five (5) years.
4. The manufacturer of leak detection system must have done three (3) major projects for under tank leak detection systems.
5. The manufacturer of leak detection system must have been tested to and passed third party procedures developed according to the U.S. EPA's "standard test procedures for evaluating leak detection methods: liquid phase out of tank product detectors".
6. The manufacturer of leak detection systems must offer an extended warranty of at least five (5) years for hydrocarbon detection cables and 10 years for water detection cables.

SYSTEM IMPLEMENTATION METHODOLOGY

1. The fuel hydrant pipeline and under tank leak detection system may have some of following components:
 - a. Carbon enriched polymer sensor cables with the ability to locate point of liquid hydrocarbon contact.

- b. Sensor Interface Modules (SIMs) capable of delivering excitation voltage to carbon enriched polymer detection probes and sensor cables.
 - c. Control room monitoring equipment and alarm panels capable of monitoring multiple SIMs.
 - d. All associated devices, equipment and accessories necessary for the implementation of integrated systems for interfacing the above system elements.
2. The control system of the leak detection system shall be UL/FM certified.
- a. Primary requirements of the subject system shall be for safety control and shall have the capability for implementation of safety functions related logic signals for leak detected and communication with BMS/PLC control.
 - b. Secondary requirements of the subject systems shall be for environmental monitoring and shall have the capability of alerting facility operators to the existence of leaking liquid hydrocarbons that have the potential to pollute storm drains, surface water bodies such as stream, rivers, lakes or ocean shorefront or to seep into the ground and potentially contaminate underground aquifers.
 - c. The leak detection system shall have the capability to display current status including leaks detected or sensors out of service for all hydrocarbon detection sensor cables. Event history shall be maintained. Graphic presentation of leak detection locations is desired when made available by system suppliers.
 - d. All connections between sensors and SIMs shall be self-monitoring such that a disconnected sensor probe or cable or damage to the interconnecting wire shall be detected and reported as a cable or loop break to the control room equipment.
 - e. All controllers providing relay output signals for leak detection and/or cable break shall provide normally open- common- normally closed relay contacts such that wire integrity of the relay monitoring circuit can be monitored via a normally closed contact. SIMs using digital messaging protocols (i.e. Modbus) shall be monitored by the control room alarm panel and user interface for "lost communications" events such that control room staff are notified in the event that a remote SIMs goes off-line for any reason.

SYSTEM DESCRIPTION

The system design depends on detecting fuel leak using tracing cable laid along the pipeline. The entire length of the cable is sensitive to any hydrocarbon liquid. The wall material of the cable is a conductive polymer. The core of the cable contains several wires (normally seven (7) wires). If the fuel liquid comes into contact with sensor cable, a small portion is absorbed into the wall of the cable sensor. This causes the wall of the sensor to swell. The swelling action will form a conductive path from one electrode to the other; resulting in a short circuit. That can activate an alarm in a control panel beside location of the leak can be detected.

SYSTEM COMPONENTS

The Raychem TraceTek leak detection system is comprised of the following equipment:

- 1. Main leak detection panel
- 2. SIM

3. Sensing cable and/or point sensors
4. Zener Barrier
5. Slotted, solid conduits and pull boxes

LEAK DETECTION PRINCIPLES – LIQUID HYDROCARBONS

1. Hydrocarbon sensor cable shall be the sensor element of the system. The entire length of the cable shall be sensitive to liquid hydrocarbons such as crude oil or refined products. The wall material of the sensor cable shall be conductive polymer. If hydrocarbon liquids come into contact with the sensor cable, a small portion is absorbed to the wall of the sensor. This causes the wall of sensor cable to swell.
2. The core of sensor cable shall contain several wires. Two (2) of these wires are electrodes. The electrodes are spiraled in arrangement that prevents them from contacting each other under normal conditions. However, if the wall of the sensor cable absorbs sufficient oil, then the swelling action forms a conductive path from one electrode to the other.
3. The sensing cable shall be placed along the underground pipelines inside a slotted conduit at any of the bottom sides of the pipelines and on the same layer of sand that pipe rests upon.
4. The sensing cable shall be connected to the SIM through leader/jumper cable. Each cable circuit can serve up to maximum 1000 meters in 100 to 250 meter spans for pull boxes location and easy cable pulling.
5. The leak detection system shall detect hydrocarbon liquids that have escaped their intended confinement structures. The system shall alert facility staff to the presence of such liquids. The system provides an independent safety layer for mitigation of consequences that help achieve overall process safety requirements of the plant and to prevent harmful impacts to the environment.
6. The system shall be designed to perform its function during normal, abnormal, and design basis conditions.
7. Control systems for leak detection system shall be by open architecture system topology with fault tolerant network capabilities.
8. The sensor device shall be energized and monitored with a SIM capable of providing the required excitation voltage, monitoring the status indicative electrical parameters of the sensor and transmitting the current status of the sensor and location of any detected spill or leak to the control room monitor panel and or host control system.
9. The SIM shall locally determine the status of any connected sensor devices and interconnect wiring such that leak detection or damaged sensor or interconnect wiring shall be determined without ambiguity.
10. The control system shall generate a liquid hydrocarbon leak detection alarm with an average response time as described on the vendor's product data sheet. Such response times will vary based on the molecular weight, viscosity, volatility, temperature and chemical compatibility of the spilled liquid hydrocarbon and the sensor cable.

11. The sensor cable shall be designed in such a way that all internal wiring is continuously monitored. Any breakage of an internal conductor or damage or disconnection of a connector or wiring between the SIM and the sensor cable shall be immediately detected and reported to the control room as a "cable break" or "loop break".
12. The sensor cable shall be equally sensitive to leak spill size at any point along its length and shall generate a leak detection alarm when exposed to no more than 10 millimeters of spilled hydrocarbon.
13. The sensor cable and SIM shall be capable of determining the location of a detected leak or spill to +/- 1 meter or 0.1% of the cable length of the sensor cable, whichever is greater.
14. The sensor cable shall permit the use of branching connectors in multiple nested layers to permit the cable to easily trace multiple branched pipe systems (e.g. manifold) without looping back. Cable systems that require loop back of sensor or jumper cable shall not be permitted.
15. The sensor cable system shall permit the use of non-sensing jumper cable such that the SIMs may be installed in a convenient junction box or panel while the sensor cable is located at a remote location near the vessel or pipe system to be monitored. The maximum permissible distance between SIMs and beginning of the sensor cable shall be no more than 1000 meters although offset distances of less than 1000 meters will be more typical.
16. All jumper cable wiring shall be monitored for circuit integrity, continuity and damage by the same method as used for the sensor cable itself. Any breakage or loss of continuity in the jumper cable shall generate a CABLE BREAK or LOOP BREAK alarm at the SIMs and in the control room.
17. For systems that provide the maximum amount of sensor cable that can be monitored by a SIM, the jumper cable used to connect the SIM to the sensor cable shall not count against the sensor cable monitoring limit for the SIM.
18. The fuel detection cable, SIM, interconnection wiring (including wireless or fiber optic telemetry system if used) and user alarm panel shall be capable of end-to-end periodic "pinch" testing by bending a short length of sensor cable in a tight radius to simulate a leak detection event. At such periodic testing the complete system shall report leak detection and accurately indicate the leak location.

INSTALLATION

A slotted PVC conduit shall be placed in the hydrant pipe trenches on the same layer of sand that the pipe rests upon. The conduit shall be placed while the pipeline is being installed. During conduit installation a pull rope shall be pulled into the conduit. Sensor cables shall be pulled into place using pull ropes. The slotted conduit shall be provided with suitable aqua sleeve to prevent the ingress of sand or any other particles inside the conduit. The sleeve along with the slotted PVC conduit, pull rope etc. shall be provided by the vendor.

PULL BOXES

Pull boxes shall be typically spaced at 100 to 250 meters intervals or wherever there is a sharp change of direction. Pull boxes shall be constructed from pre-formed HDPE utility grade medium duty vaults with polymer/concrete covers. Air locks shall be inverted over the cable connector to form a dry space within the pull box. This process shall allow the cable to be cut in length and terminated in the field. The pull boxes shall be rated for the aircraft load. The pull boxes shall be provided by the vendor.

CAPABILITIES OF THE SIM

1. The SIM shall provide the excitation voltage for the sensor cable.
2. The SIM shall measure current flow to and from the sensor probe or sensor cable and use the information thus obtained to determine the status of the sensor, the presence of any leaked or spilled liquid hydrocarbons, the location of any spill or leak and the presence of any damage to the sensor or interconnecting wiring that would prevent the sensor from making a liquid hydrocarbon detection.
3. The SIM shall be a low voltage device with voltage requirement typically 12 V DC, 24 V DC or 24 V AC) and require less than three (3) watts of total power to monitor up to three (3) sensor probes and or up to 1000 meters of sensor cable. The 12 V DC version shall be suitable for solar powered remote enclosures.
4. The output of the SIM shall be Modbus-RTU serial data delivered at an RS-485 two wire interface.
5. The Modbus data map shall be published by the system supplier such that third party system integrators may access and utilize the data produced by the SIM for customized display and event logging.
6. The SIM shall also provide data to the vendor supplied alarm panel as discussed in the following section.
7. The SIM shall provide power, status and communications LEDs visible for field personnel involved with system commissioning, testing or troubleshooting.
8. The SIM shall be compact and suitable for mounting on 35 millimeter DIN rail and require less than 100 millimeter of rail space per device.

CAPABILITIES OF THE CONTROL ROOM ALARM PANEL

1. The control room alarm panel shall be capable of simultaneously monitoring up to 250 SIMs. The control room alarm panel shall display the current status of all monitored SIMs including NORMAL, LEAK DETECTED, CABLE BREAK, LOOP BREAK, COMM ALARM, and other diagnostic conditions requiring operator attention. The primary display shall be touch screen type with a 12"LCD display.
2. In addition to the LCD display a buzzer shall be activated for any new event and the panel shall provide a silence button to silence the buzzer on command. The panel should also have a USB port for programming and should also have the capability to be accessed remotely through IP address
3. The control room alarm Panel shall log no less than the last 5000 events and each event record shall contain:
 - a. Date and time of occurrence
 - b. Channel number of sensor interface making the leak detection or trouble report
 - c. Type of alarm

- d. Location of leak detection (applicable for sensor cable or multi-probe circuits)
 - e. Sequential number (note alarm acknowledgement and reset shall be logged as a separate event)
4. The control room alarm panel shall maintain a complete database for all currently monitored SIMs and event history. Access to this database shall be via Modbus RTU and Modbus TCP/IP. Modbus registers shall be made available through an RS-232/RS-485 (field selectable) serial data port at data rate of 9600, 19200 or 38400 Baud Rate. This database shall be in addition to the locally maintained current status Modbus registers maintained at the individual SIM.
 5. The control room alarm panel shall be suited for controlled environment installations. The area where the control room alarm Panel is mounted shall be classified as non-hazardous, maximum ambient temperature of 50°C, minimum ambient temperature of 0°C with humidity ranging from 5% to 95% non-condensing.
 6. The control room alarm panel shall be Listed by UL/TUV or equivalent internationally recognized approval agency.

UNDER TANK LEAK DETECTION SYSTEM

1. The entire length of the cable shall be sensitive to liquid hydrocarbons such as jet fuel oil products. Leak detection cables shall be installed in slotted conduits buried under the tank bottom plate. The slotted PVC conduits shall be supplied by the vendor and installed by the contractor. The sheath of the sensing cable shall be made of conductive polymer which shall swell in the presence of hydrocarbon liquids thus creating a circuit between the sensing wires within the cable. The measure of change in resistance, due to the circuit formation, indicates the presence of a leak and its location.
2. The sensing cables shall be capable of accommodating any number of branches using branching connectors. Jumper cable shall be available to interconnect sensing cables or to facilitate remote mounting of the SIM. Use of interconnect wiring to remotely mount the SIM shall not reduce the maximum amount of sensor cable the SIM can monitor.
3. Perforated conduits and pull boxes shall be supplied by the same vendor of leak detection system and shall be installed at fixed intervals from the center of the tank bottom in both directions as recommended by the leak detection vendor. Sensor cable shall be placed from edge to edge (of tank bottom circle). It shall be possible to cut sensor cable to length and terminate in the field. Leader cable shall be provided with sensor cable connectors on one end, with the other end ready for connection to the terminal blocks in a SIM by vendor.
4. For installations outside the tank bottom plate non perforated conduits shall be used. It shall be possible to install cables using a pull box included in the vendor scope of supply. The sensor cable shall be only sensitive to liquid hydrocarbons and should not be sensitive to water and/or other solvents.

WATER LEAK DETECTION SYSTEM FOR CRITICAL AREAS

1. Contractor to provide a complete water leak detection system including agency approved controls designed for the areas listed below. Contractor to submit system design and system drawings to owner's agent for approval.

2. Water Sensing Cables and Water Point Sensors

- 1) Engineer in collaboration shall specify the installation of water detection cables and point sensors in the following areas: **[Select one or more of the areas listed below]**
 - a. Computer room
 - b. Control tower
 - c. Server room
 - d. Under raised floors
 - e. Switch gear room
 - f. Electrical room
 - g. Overhead domestic hot water (DHW) or chilled water (CW) pipes
 - h. Other - specify
- 2) Engineer in collaboration with Rep shall select water sensing cables and water point sensors depending on the application:
 - a. **[Select for Raychem TraceTek TT1000 water sensing cable]** The water sensing cable (TT1000) shall be a four (4) wire design, with two (2) sensing wires, one (1) alarm wire and one (1) continuity wire embedded in a fluoropolymer carrier rod which can sense the presence of water at any point along its length and shall not detect hydrocarbons. The sensing cable design shall have the ability to provide continuous verification of sensing circuit integrity. The sensing wires shall be jacketed with a conductive fluoropolymer and shall be constructed with no metal parts exposed to the environment for corrosion resistance. Sensing cable shall be quick drying and reset within 15 seconds of removal from free water; sensing cable that is braided in construction is not acceptable. No more than one foot of tap water, in contact with a sensing cable at a depth of 1/16 inch, shall be required to cause an alarm at the electronic alarm module. The water sensing cable shall be UL Listed and rated Type CL2P for plenum use. The sensing cable shall have a tensile breaking strength of 160 pounds and an abrasion resistance of >65 cycles per UL719. The sensing cable shall be vibrant yellow for easy identification within floor voids, drip trays and general service areas. Water sensing cable shall be pre-terminated and modular for quick connection to cables and leak detection components. Soldering or the use of wire nut shall not be a permitted method to join leak detection cable. The sensing cable system shall feature modular branching connectors in order to introduce tee splices into the layout.
 - b. **[Select for Raychem TraceTek TT1100-OHP water sensing cable for suspended pipe]** The water sensing cable for suspended pipe (TT1100-OHP) shall be a four (4) wire design, with two (2) sensing wires, one (1) alarm wire and one (1) continuity wire embedded in a flame retarded polymer carrier rod which can sense the presence of water at any point along its length and shall not detect hydrocarbons. The sensing cable design shall have the ability to provide continuous verification of sensing circuit integrity. The sensing wires shall be jacketed with a conductive fluoropolymer and shall be constructed with no metal parts exposed to the environment for corrosion resistance. Sensing cable

shall be supplied with an absorptive synthetic fiber braid that provides extra mechanical protection and designed to wick water along the cable even when the water leak is dripping from a single small pin hole or crack. The sensing cable shall have a tensile breaking strength of >220 pounds. Water sensing cable shall be pre-terminated and modular for quick connection to cables and leak detection components. Soldering or the use of wire nut shall not be a permitted method to join leak detection cable. The sensing cable system shall feature modular branching connectors in order to introduce tee splices into the layout. The sensing cable shall be fastened to the pipe every 18 inches and shall be positioned at the lowest point of the pipe or fittings (typically the 6 o'clock position on horizontal pipes) such that any liquid leaking from the pipe or fittings will drip onto the cable surface as it drips off the bottom of the pipe or fitting. For vertical or angled pipes, the sensing cable shall be spiraled around the pipe and secured with straps.

TESTING AND INSPECTION

The vendor shall provide a fully detailed Factory Acceptance Test (FAT) procedure and schedule. During FAT the system shall be fully functionally tested including but not limited to the full function test of the Modbus communication links with the local control modules.

END OF SECTION