

## **PITBULL VACUUM VALVE PIT SENSOR MODULE FEATURES**

Created from the International Patent Application, titled,  
A distributed control system for a vacuum sewer system.

The PitBull Vacuum Valve Pit Sensor Module (“Valve Pit Sensor”) provides an easy to install wireless sensor for use in monitoring vacuum valve pits from a Control Center or any location in the world with internet access.

Since the beginning of vacuum sewer systems installations, a basic monitoring system has been needed to address the most common problems seen in vacuum sewer systems. A vacuum sewer system absolutely justifies its existence in areas with high water tables; however, the challenge of maintaining the numerous vacuum valve pits during normal everyday use can consume many man hours. An IP Sensing Vacuum Sewer Monitoring System provides status of the vacuum valve pits through the use of the wireless PitBull Vacuum Valve Pit Sensor Module. Real-time alarms are sent to the Control Center for valve pits that are developing problems, as well as valve pits that have totally failed and need immediate attention in order to prevent the problem from spreading to other valve pits.

Use of the IP Sensing Vacuum Sewer Monitoring System decreases the annual man hours needed to maintain vacuum sewer valve pits by quickly detecting common problems seen during everyday use. For example, the PitBull Vacuum Valve Pit Sensor Module will detect a partially stuck open vacuum valve and then send an alarm to the Control Center for identification of exactly which vacuum valve pit to inspect. Whether or not the stuck open valve clears itself, a warning alarm is sent to the Control Center to identify the exact vacuum valve pit having the problem and that should be inspected. This saves many man hours of time-consuming frantic searching for a stuck vacuum valve by walking the branch lines and listening to each valve pit’s air vent, which may have cleared itself before being located. Since the stuck vacuum valve can cause the vacuum to drop in the whole system, there is no option of letting the problem go unattended.

Using an IP Sensing Vacuum Sewer Monitoring System provides the system operators with daily warning indicators to the exact vacuum valve pits developing problems so that a preventative maintenance call can be made to the specific vacuum valve pits for inspection. This pinpointing of the vacuum valve pits needing attention saves man power resources by servicing only the valve pits developing problems instead of wasting many man hours in routinely inspecting all vacuum valve pits throughout the year. For example, a vacuum valve pit that has the Sensor Tube becoming clogged with grease will send a warning alarm to the Control Center indicating a Sensor Tube problem and that the vacuum valve pit should be inspected.

Overall improvement in vacuum sewer system efficiency and man power resource management is achieved by using the IP Sensing Vacuum Sewer Monitoring System with the PitBull Vacuum Valve Pit Sensor Module. The main feature of the PitBull Vacuum Valve Pit Sensor Module is its ability to determine the amount of liquid sewage flow from the amount of air flow through the vacuum valve and then calculate the Air-to-Liquid ratio. It is well known that the most important condition to maintain in a vacuum sewer system is the Air-to-Liquid ratio in the vacuum sewer transport lines. So let’s get to the features of the PitBull Vacuum Sewer Monitoring System that help maintain this important Air-to-Liquid ratio and improve overall efficiency in maintaining a vacuum sewer system.

## PITBULL VACUUM VALVE PIT SENSOR MODULE FEATURES:

1. VACUUM VALVE CYCLE AIR-TO-LIQUID RATIO DETECTION - Vacuum sewer transport lines operate efficiently when there is a proper Air-to-Liquid ratio, which is largely determined by the vacuum valve controller injecting air into the transport line after liquid sewage has been evacuated from the sump. The Valve Pit Sensor determines the Air-to-Liquid ratio by measuring air flow and liquid sewage flow through the vacuum valve during a sump evacuation valve cycle.
2. SENSOR TUBE MALFUNCTION – The Valve Pit Sensor determines the Sensor Tube is being clogged with grease or other malfunctions by monitoring the Air-to-Liquid ratio and other performance parameters of the vacuum valve pit.
3. SUMP OVERFLOW DETECTION – The Valve Pit Sensor determines the sump overflow condition when the sensor tube pressure level reaches a preset threshold corresponding to the sump overflow condition, which is usually a sewage level of about 14” up the sump sensor tube from the end of the tube.
4. VACUUM VALVE STUCK OPEN DETECTION – The Valve Pit Sensor determines if the vacuum valve is open by monitoring the vacuum on both sides of the vacuum valve. The Valve Pit Sensor determines if the vacuum valve is stuck partially or fully open when the valve is admitting atmospheric air for more than 10 consecutive seconds.
5. HIGH SEWAGE USAGE DETECTION - Vacuum sewer systems can be water-logged when heavy water infiltration and inflow are present due to leaks in gravity lines, improper connections to storm water drains, and broken cleanouts. The Valve Pit Sensor will determine abnormally heavy sewer usage when either of the following occurs:
  - a. the Valve Pit Sensor keeps a counter on the number of vacuum valve cycles and determines heavy sewer usage when the vacuum valve is being actuated more than 30 times per 10 minutes,
  - b. the Valve Pit Sensor determines heavy sewer usage when more than 30 seconds of consistent liquid sewage flow is detected through the valve without any air injection;
6. TRANSPORT LINE SLOW VACUUM RECOVERY DETECTION – During a sump evacuation, the vacuum in the transport line at the valve pit will drop when the vacuum valve is open to admit atmospheric pressure air into the lines following the liquid sewage. After the vacuum valve closes, the vacuum recovery time is an indication of the transport lines condition, i.e., water-logged, blockage, and Air-to-Liquid ratio. The Valve Pit Sensor measures the time it takes for the transport line at the valve pit to recover to a vacuum of 8” Hg and determines a problem if the recovery time is greater than 20 seconds after the valve is closed.
7. VALVE PIT DIAGNOSTICS – The Valve Pit Sensor is continuously monitoring the valve pit sensors and conducting valve pit diagnostics as follows:
  - a. SENSOR TUBE SENSOR DIAGNOSTICS – If the vacuum valve has not cycled in 12 hours, then the Valve Pit Sensor will send an alarm to the Control Center,
  - b. SUCTION TUBE SENSOR DIAGNOSTICS – When the valve is cycled, the Valve Pit Sensor will verify that the suction tube sensors are working properly,
  - c. TRANSPORT LINE SENSOR DIAGNOSTICS – When the valve is cycled, the Valve Pit Sensor will verify the transport line sensor is working properly,

- d. SUMP AIR VENT OBSTRUCTION DIAGNOSTICS – When the valve is cycled, the Valve Pit Sensor will verify the sump air vents are adequate by observing the atmospheric pressure drop in the sump;
8. WIRELESS COMMUNICATIONS FEATURES- The Valve Pit Sensor has a radio frequency transceiver for wirelessly communicating to and from other wireless communication devices external of the valve pit for Drive-by and Fixed-base data exchange, as follows:
- a. PROPERLY OPERATING VALVE PIT – The Valve Pit Sensor continuously communicates its operating status to the Control Center to confirm that the Valve Pit Sensor and its valve pit are operating properly. An alarm at the Control Center is activated if the Valve Pit Sensor loses communications with the Control Center for more than 6 hours. This will identify any possible failure with the Valve Pit Sensor and valve pit before the customer has a sewer backup,
  - b. VALVE CYCLE COUNTER – The Valve Pit Sensor keeps track of the vacuum valve cycles and communicates this Valve Cycle Counter to the Control Center for historical charting of a valve pits usage. An important usage of the cycle counter is tracking valve actuations during rain storms to see which pits increased usage indicating water infiltration and inflow.
  - c. VALVE PIT ALARMS – When the Valve Pit Sensor determines a problem at the valve pit, the problem will be stored in memory and communicated back to the Control Center as the following alarm conditions:
    - i. FULL SUMP ALARM – When a Full Sump is detected by the Valve Pit Sensor,
    - ii. OPEN VALVE ALARM – When a fully or partially open valve is detected by the Valve Pit Sensor,
    - iii. AIR/LIQUID RATIO LOW ALARM – When the Valve Pit Sensor determines the sump is being evacuated and a proper Air-to-Liquid ratio of 3:1 is not reached before the valve is closed,
    - iv. TRANSPORT LINE LOW VACUUM ALARM – When the Valve Pit Sensor detects a vacuum of less than 8” Hg is present in the transport line for more than 4 minutes,
    - v. HIGH SEWAGE USAGE DETECTION ALARM - When more than 30 valve cycles per 10 minutes are detected by the Valve Pit Sensor
    - vi. TRANSPORT LINE SLOW VACUUM RECOVERY ALARM – When the Valve Pit Sensor detects a vacuum of less than 8” Hg is present in the transport line for more than 20 seconds after the valve is closed,
    - vii. SENSOR TUBE SENSOR ALARM – When a faulty sensor tube sensor is detected by the Valve Pit Sensor,
    - viii. SUCTION TUBE SENSOR ALARM – When a faulty suction tube sensor is detected by the Valve Pit Sensor,
    - ix. TRANSPORT LINE SENSOR ALARM – When a faulty transport line sensor is detected by the Valve Pit Sensor,
    - x. SUMP AIR VENT OBSTRUCTION ALARM – When an obstructed sump air vent is detected by the Valve Pit Sensor,

- xi. LOW BATTERY ALARM – When the Valve Pit Sensor battery has less than 6 months battery life remaining;
  - d. DRIVE-BY READING AND CONTROL OF VALVE PIT - The Valve Pit Sensor enables a wireless communicating device to communicate the real-time valve pit conditions from a Drive-by Data Collector, whereby an operator in the field can manually actuate a vacuum valve and monitor the results of the valve actuation,
  - e. DRIVE-BY READING OF HISTORICAL VALVE PIT STATUS AND ALARMS - The Valve Pit Sensor records and saves to memory the valve pit operating parameters and thus enabling a wireless communicating device to communicate the recorded operating parameters to and from a Drive-by Data Collector, whereby an operator in the field can download valve pit operating parameters and identify a problem that has occurred even though the problem is cleared at the present moment;
9. CONTROL CENTER GIS MAP DISPLAY OF VALVE PIT STATUS AND ALARMS – The Control Center computer displays the Valve Pit Sensor’s acquired information of each valve pit on a map for operator viewing via large LCD display.
  10. CONTROL CENTER ALARM NOTIFICATIONS - The Control Center computer can email alarm messages to field operator’s cell phones indicating the Valve Pit Sensor’s valve pit location in Google Maps as well as the exact alarm condition.
  11. CONTROL CENTER HISTORICAL REPORTS – The Control Center computer can generate reports upon request from the server’s historical database of information:
    - a. EXCESSIVE CYCLE COUNT – A cycle counts threshold value is entered by the customer and a report is generated for all pits exceeding the cycle counts threshold value. This report is used for preventative maintenance, i.e., identifying valve pits with leaking gravity line hookups or illegal hookups to storm drains,
    - b. ALARMS REPORTS – Reports can be generated on any or all alarms with the option of selecting a range of dates and times, i.e., last summer’s activity versus this summer’s activity.
  12. WATER SUBMERSIBLE ELECTRONICS – The Valve Pit Sensor has water-proof housings, enabling operation while fully submersed in water and having the minimum requirements to meet a rating of “IP68” as defined in International Standard IEC 60529.
  13. BATTERY OPERATED - The Valve Pit Sensor has a replaceable battery power supply, whereby the PitBull Sensor Module, including its sensors and wireless transceiver, does not need an external power source.
  14. QUICK RETROFIT INSTALLATION WITHOUT REWORKING VALVE PIT OR VACUUM VALVE - The Valve Pit Sensor can be installed or changed out at an average of 15 minutes per pit.