

REMOTE MONITORING AND ALARM SYSTEM

FUNCTIONALITY

- A. The water and wastewater facilities remote monitoring, reporting and alarm notification system shall be comprised of a hosted, Web-based user-interface which communicates to remotely monitored stations via a readily available commercial cellular network. The system shall contain:
 1. Hardware located at each remote station that continually monitors pump activity, fault conditions, tank level and computed volumetric inflow and outflow and reports this information on a periodic and exception basis to a Web-based user-interface using a secure protocol over the cellular network.
 2. A Web-based application that is configured to present all fault conditions, operating conditions, computed values in tabular, graphical, map and report formats. The application will provide alarm notification to designated personnel based on alarms detected by the remote hardware and by computations performed by the Web-based system.
- B. The system shall be fully integrated between the hardware and Web application providing complete programming capability of the hardware from the hardware installed at each station and from the Web application. The Web application shall be automatically updated whenever any configuration changes are made to the hardware.

SYSTEM TECHNICAL DESCRIPTION

- A. Station Hardware:
 1. User Interface.

The station hardware shall include a user interface for operations viewing and configuration. The keypad/display shall allow the user to view the status of any/all pumps being monitored, computed or historic conditions, current and historic faults and configuration of operational parameters.

 - a. Status.

The user shall be able to select any of the monitored conditions to be included in an automatic scrolling display that presents the current value and status of the condition. The following parameters shall be available for the user to select:

 - Level
 - Pump run-times
 - Pump cycles
 - Inflow rate and Inflow total volume
 - Outflow total volume and previous cycle volume
 - Pump running/off
 - Pump starter faults
 - Phase monitor fault
 - Seal failures
 - Over temperatures
 - Intrusion/On-site
 - Cellular signal strength
 - Main power
 - Battery Power
 - Any digital, analog or Modbus channels being monitored

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The user shall be able to stop the display on any parameter of interest and request additional information about that particular parameter. Information shall include:

- For each digital input:
 - the number of cycles for the current day
 - the total run-time in the non-normal state for the current day
 - alarm limits for number of cycles in a day
 - alarm limits for the total run-time in a day
- For each analog input:
 - high alarm limit
 - low alarm limit
 - rate of change limits
- For computed inflow/outflow channels:
 - total inflow and outflow for the day
 - inflow rate
 - outflow for last pump cycle
- For computed pump running channels:
 - pump run time for each individual pump
 - pump run times for P1+P2, P2+P3 and P1+P3
- For flow channels:
 - instantaneous flow
 - total flow for the day or total accumulated flow
 - user-specified preset to match installed flow meter

The display shall automatically cycle through all of the parameters that the user has selected showing the current status and value of each. The status shall include:

- Normal or in alarm
- Acknowledged or not
- Reason in alarm
 - Too many cycles on any pump
 - Run-time too long on any pump
 - Level too high or low
 - Outflow volume too high
 - Input changed state
 - Analog value too low
 - Analog value too high
 - Inflow rate too high
 - Loss of analog signal

b. Alarms.

Any monitored parameter that exceeds the normal operating conditions as defined by the user, shall enter into an alarm state.

The local display shall automatically display all parameters that are in the alarm state. When all alarm states have returned to normal, the display shall automatically revert to the user-configured scrolling display or to the main menu if no scrolling display has been configured.

A unique event shall be created for each alarm state. Each event shall be stored locally for viewing in a chronological order. Each event may also be automatically transmitted to the Aquavx web-service based on a user-specified configuration.

The system shall contain a store and forward buffer capable of saving hundreds of events for later transmission if immediate cellular transmission is not possible due to cellular

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coverage issues. The system shall automatically try to re-establish cellular connection on a continuous basis.

c. **Update Rate.**

Standard status update rates of all monitored conditions shall be available from every minute to once a day. Any alarm exceptions shall be reported immediately. End of Day comprehensive summaries shall be reported at midnight. The user shall have the ability to request a status or End of Day report on demand from the keypad.

d. **Local Programming.**

The user shall be able to program the entire system from the integral keypad and display.

Programming parameters for each monitored condition shall include:

- Channel Name
- Status only or report on alarms
- Delay until considered in alarm
- Report on return to normal state
- Relay to control when in/out of alarm
- For pump monitoring:
 - Daily run-time alarm limit
 - Daily cycle alarm limit
 - Time difference between (P1:P2, P2:P3 and P1:P3) too long
 - Cycle difference between (P1:P2, P2:P3 and P1:P3) too many
- For inflow/outflow monitoring:
 - High outflow volume alarm limit
 - High inflow rate alarm limit
- For digital monitoring:
 - Alarm on change from open/close
 - Alarm on change from close/open
- For analog monitoring:
 - High and low alarm limits
 - Loss of signal alarm limits
 - Total flow too much for a day
- For system monitoring:
 - Loss of primary power
 - Loss of Modbus communication
 - Low backup battery power

The user shall be able to specify parameters allowing the monitoring unit to compute volumetric outflow volume and inflow rate for a single, duplex or triplex pump station.

e. **History.**

The monitoring system shall include a History screen allowing the user to review the following:

- Date and time of alarms
 - Into alarm conditions
 - Out of alarm conditions
 - Acknowledgements
 - E-mail, text and voice callouts
- Date and time of system events
 - Relay controls
 - Parameter changes
 - Communication with the web-service

f. **Control.**

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The remote monitoring system shall include internal physical relay and Modbus relay control capability from the following:

- Digital input exceeding a run-time or cycle limit
- Digital input changing state a pre-defined number of time
- Analog input exceeding a low or high limit
- Loss of analog input signal
- Too high output volume
- Too high input flow rate
- Loss of power
- Loss of Modbus communication
- User request from the keypad
- Optionally: the system shall be support control of tank level from up to 6 remote pumping stations over a cellular network that does not require interaction with the web-based system to perform all control functions.

g. Operator On-site:

The monitoring system shall include an operator on-site login/logout function.

- The login function shall allow an authorized person to acknowledge that they are on-site.
- An automatic message shall be sent to the web-based service to record that the authorized person is on-site.
- The logout function shall allow an authorized person to acknowledge that they have left the site.
- An automatic message shall be sent to the web-based service to record that the authorized person has left the site.
- Man-Down detection - an alarm message shall be able to activate a local alarm and send a message to the web-based service when a timer has expired after an operator has logged in but has not logged out.

h. Security.

The monitoring system shall include a user-configurable access code that must be entered prior to any programming or control operations.

2. Physical.

The monitoring system shall consist of the following:

- a. Hardware shall be available in a NEMA 4X or Panel/Flush mount configuration:
 - NEMA 4X hinged enclosure: 12"W x 10"H x 6"D, weight 6.0 lbs.
 - Panel/Flush mount: 8.3"W x 6.3"H x 3.6"D, weight 2.0 lbs.
- b. I/O:
 - 10 digital/pulse inputs, 0-5Hz, dry contact, open-collector or closure to ground.
 - 4 analog inputs, 0-20ma, 4-20ma or 0-5, 1-5VDC
 - 2 relays 1A@125VAC
 - 20 Modbus RTU read coil/input status digital channels
 - 30 Modbus RTU read holding/register analog channels
 - 8 Modbus RTU write coil relay channels
 - Removable terminal blocks, #14-22 AWG
- c. User Interface: 2x20 line LCD backlight display, 20 key keypad
- d. Serial Port: Modbus RTU Slave/Master or Local Programming
- e. Cellular: Quad-band 3G GSM. FCC, PTCRB, UL and ATT certified.
Dual-band CDMA Verizon certified. FCC, UL certified

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- f. Antenna: Attached, 3dBi. External OMNI and YAGI available.
- g. Operating Temperature: -20 F to 158 F (-28 to 70 C).
- h. Operating Humidity: 0% to 90% @ 140 F.
- i. Power: 115 VAC 10%, 60 Hz; 10 watts, UL rated power supply included.
- j. 12-hour battery backup, included.
- k. Surge protection on power and inputs

3. Warranty.

Two year warranty shall be standard with the purchase of a new unit.

B. Web-based system:

1. User Interface.

The web-based system user interface shall allow authorized personnel the ability to view current and historic conditions for any or all remote monitoring systems. The interface shall allow on-demand polling of information from a remote monitoring system as well as updating new configurations settings to a remote monitoring system.

a. Security and Support.

Any user of the web-based system shall have to provide a valid username and password to gain access to any current or historical information based on their user profile and security levels.

- The system shall provide access to any and all functions based on the pre-defined settings for each individual user. User's access shall be able to be restricted to a single screen, any combination of screens, and any combination of remote monitoring systems.
- 128 bit encryption between the client and the web server shall be used
- An unlimited number of user access levels shall be supported
- The system shall be backed by a 99.5% uptime system level agreement
- The system shall be hosted in a tier 1 data center
- The vendor shall include 24 X 7 X 365 support
- The system shall include one year of online data storage and retrieval and two years of data storage offline
- The system shall be able to process over 8 million data points each day
- The system shall be able to process over one thousand transactions per second
- The system shall have acknowledgment of receipt of all incoming messages
- An unlimited number of users at no additional cost shall be provided

b. Remote Monitor System and Computed Data.

The system shall receive data from Remote Monitoring Systems, perform additional computations on the received field data and store both types of data in secure databases for later presentation and reporting.

Computations shall include summations, counts, pump run-time and cycle comparisons, including:

- Pump run-time differentials between P1-P2, P1-P3, P1-P4, P2-P3, P2-P4 and P3-P4 allowing the user to specify a percentage that the pump run-times must be within. If the run-times differential exceeds that limit, an alarm is created and user-defined notifications are performed.
- Pump cycle differentials between P1-P2, P1-P3, P1-P4, P2-P3, P2-P4 and P3-P4 allowing the user to specify a number of cycles that the pump cycle count must be

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within. If the cycle differential exceeds that limit, an alarm is created and user-defined notifications are performed.

c. Viewing.

The system shall support viewing the most recent received field data from any remote monitoring system. Information viewed may be all data received or a portion of that data that is of particular interest. The web-site shall be viewable from at least Internet Explorer, Firefox, Chrome, Safari, Opera.

The system shall be viewable on smart mobile devices including iPhones, iPads, Tablets and Android-operating system phones.

- The system shall allow users to poll a device to get current data for viewing
- The system shall include an alarm bar to indicate the highest priority alarm state of any alarm on any asset the user has access to view. Priority of alarms to be displayed on the alarm bar is user configurable.
- The system shall allow users to determine their home page view
- The system shall be able to calculate differential run-times for stations with multiple pumps and shall be able to alert users when pumps run for disproportionate numbers of cycles or hours

Data shall be able to be viewed in tabular format, on a map or in graphical format.

- Tabular viewing
The system shall provide an interactive method of selecting which available data is to be included in tabular formatted screens.
- Map viewing
The system shall support viewing any subset of the remote monitoring systems on an interactive map. Users shall be able to select a remote monitoring system and view additional information and data about that system.
- Graphical viewing
The system shall support interactive graphical display allowing the user to select the specific data and time frame for that data to view on a chart. Chart formats shall include line, bars and points.

d. Mapping and Reporting.

The system shall support ad hoc and scheduled reports.

- Reports shall be delivered automatically at daily, weekly and monthly intervals.
- An alarm history report containing the date/time of alarm, date/time of alarm clearing and date/time of acknowledgement shall be available on demand or via schedule.
- The system shall provide a report that shows daily inflow, outflow, run time, and number of cycles.
- The system shall provide the ability to view the location of all monitored units on a map and access sub-menus specific to a site in order to view status of each and all inputs monitored at one or more sites.
- The values of all analog inputs are reported in engineering units.
- The system shall record all voice notifications and responses to include Caller ID when available.
- Custom reports may be emailed or exported to an Excel file or PDF.
- All events are time and date stamped and encrypted. Events and data are stored online for 2 years and 3 years on the hosted server.
- The system shall provide that status of all units on a map and allow users to drill down to each unit.

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- The system shall record all e-mails, text messages and voice notifications and responses for subsequent reporting.
- The system shall provide interactive mapping allowing zooming, panning, road names, geographical features, current weather and current traffic.

e. Alarm Notification.

The system shall issue alerts via email, text, and voice, configurable for each alarm to a user defined list of users. All alarm notifications, clearing of alarms and acknowledging of alarms shall be stored in the system and reported as needed by the user.

The following methods of generating alarms shall be provided:

- Run time on a pump exceeds a user-specified time limit in a day
- Number of cycles on a pump exceeds a user-specified limit in a day
- Difference between pump run-times at a station exceeds a user-specified percent in a day. System shall support differences between any 2 or any 3 pumps.
- Difference between pump cycles at a station exceeds a user-specified amount in a day. System shall support differences between any 2 or any 3 pumps.
- Inflow and/or outflow exceeds a user-specified limit
- Any analog monitored condition exceeds a low or high threshold limit
- Any digital monitored condition exceeds a run-time or cycle count limit in a day
- Any digital changing state
- Loss of communication between the remote monitoring system and Modbus devices connected to the remote system
- Loss of primary power on the remote monitoring system
- Loss of communication between the remote monitoring system and the web-system
- Man-down at site
- Alarm notifications to be delivered via voice messaging (up to 8 call out numbers), text and or emails or a combination fo the three. All text and email messages are delivered simultaneously to listed recipients.
- Acknowledgement of alarms may be performed via voice command and/or phone key touch, or directly from the Web-interface.
- Ability to program a delay time for re-notification of alarms if one or more acknowledged alarms are still in an alarm state after a specified period of time.
- Each individual user may define whether they want to receive notifications on current alarms and/or cleared alarms

f. Graphing.

User shall have the ability to generate graphs and charts that display historic data.

- Charts shall display run-times and flow rates either separately on individual graphs or both incorporated into one graph.
- The user shall be able to select any monitored or calculated data to be graphed over any timeframe.
- Charts shall be able to be printed directly from viewing
- Data being displayed on the chart shall be able to be exported directly to CSV or XML format.
- User shall be able to zoom and/or pan to any portion of the data.

g. Update Rates and On-Demand Requests.

The system shall have a standard report rate of all monitored conditions of every 2 hours. Additional reporting schedules must be available upon request. All alarm exceptions shall be reporting immediately. The user shall have the ability to immediately request a status report or issue control commands to properly configure remote hardware.

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h. Programming Remote Monitor.

The system shall allow users to completely program each remote monitoring system from the web without requiring any unique or additional software.

- Each input on each device to be user configurable
- User changes to any/all configuration settings in the remote monitoring hardware shall be automatically sent to the remote hardware to maintain synchronization between the web and remote systems.

i. Manufacturer.

All monitoring systems shall be manufactured in the United States by Antx, Inc., Cedar Park, TX 78613.