SRC TELEMETRY INC.

October 13, 2011
Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A-1S6

Re: ENSC 440 Functional Specification - SmartFlow

Dear Dr. Rawicz,

Please find the enclosed document describing the functional specifications for our company's product, *SmartFlow*. Our team at Smart Remote Communications (SRC) Telemetry Incorporated is designing, implementing, and creating this product to allow clients the ability to control a remotely located fluid tank through the use of text messages via a GSM enabled cellular phone. Our finalized product will include various feedback mechanisms to ensure that the desired reliability and accuracy of operation of the product is attainable. Furthermore, additional safety and security protocols will be integrated and incorporated into our device to certify and to authenticate customers prior to the transmission of their requests and commands to the fluid tank control system.

The functional specifications document enclosed provides a set of high-level design details for the development of our product and includes the requirements of the various components used. Additionally, this document will be employed as a guiding source by our engineers throughout the design, construction, integration, and debugging stages of our product's development life cycle.

SRC Telemetry is comprised of five undergraduate engineering students at Simon Fraser University: Yazan Shehadeh, Zhi-Yu (Mark) Zhou, Monir Pejgaleh, Shervin Asgari Pour, and Amit Verma. Should you have any questions or inquiries please do not hesitate to contact us at src.telemetry@gmail.com. Alternatively, you may contact me by phone at 778.838.4778.

Yours sincerely,

Amit Verma

Amit Verma
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Enclosure: *Functional Specifications for SmartFlow*

Smart Remote Communications Telemetry Inc.

SmartFlow
Functional Specifications

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Issue Date:

October 13th, 2011

Executive Summary

Our team at SRC proposes to design and to build a highly innovative and creative device, SmartFlow. Our product will allow a person or an organization to control a remotely located system or device by use of telemetry. Our finalized product, SmartFlow, will be capable of sending and receiving instructions and will be able to control remotely located fluid tank systems via text messages using a GSM cellular phone.

After careful research of the existing technologies on the market today, our team at SRC has come up with a more effective product in order to reduce the complexity and the associated operational costs of controlling remotely located oil tanks. Unlike existing technologies, SmartFlow will only depend upon the availability of the GSM network. For demonstration purposes, our team will build a scaled down model of SmartFlow and will utilize it to pump water, rather than oil, into storage vessels; the reasoning behind this decision was based upon the volatile nature of oil.

Our team is currently working hard on completing a prototype SmartFlow device, and should have an operating product by early December of 2011. The finalized product should have the following functionalities:

- Authenticate and verify that the text messages received are by authorized clients only.
- Check for proper message formatting and perform the conversion of the message into machine readable instructions.
- Perform a client's commands in a timely and predictable manner.
- Notify clients of the status of their requests.
- Include an emergency shut off system for security purposes.

Once our team has successfully built a working prototype, we can work on creating a possible iPhone application to allow our clients an easier way to access and to control the system that they want to command (time permitting). Furthermore, our team can also work on researching and on implementing additional safety and security measures that would be required for the proper operation of the system for its intended use of controlling remotely located oil storage tanks.

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1 Introduction

SmartFlow is a sophisticated product that aims to give its users the ability to control fluid levels in remotely located storage vessels and tanks through the use of SMS messages over the GSM network. Initially, text messages sent by clients are checked for authentication and for proper message formatting at the GSM receiver. Messages that have been validated are then converted into a string of instructions and transmitted wirelessly to the controller, which performs the requested actions. An SMS text message is then generated and transmitted to the client to inform them of the success or failure of their request. The detailed functional requirements for the SmartFlow device, as proposed by SRC Telemetry Inc., are described in this document.

1.1 Scope

This document provides the functional specifications that must be achieved by the upcoming SmartFlow product. This in-depth list of requirements provides a complete description for a proof-of- concept model and it also partially details the production device. These requirements will be closely adhered to in the design and production of the device and will be reflected in the final product.

1.2 Intended Audience

This functional requirements document is intended to be used by all the engineers working at SRC Telemetry. Design engineers will use this document and interpret the given requirements as the overall design goals that are to be implemented in the finalized product. Test engineers will assess the similarity between the device built and the criteria given in this document to ensure that adherence to the specified requirements has been kept.

1.3 Classification

The following convention will be used throughout this document to denote the functional requirements:

[Rn-p] A functional requirement.

Where **n** denotes the functional requirement number and **p** represents the priority of the functional requirement based on the three levels described in the table below:

Table 1 Functional Requirements Priority Level Classification

Priority Level	Priority Description
I	The requirement applies to the proof-of-concept system only.
II	The requirement applies to both the proof-of-concept system and the final production system.
III	The requirement applies to the final production system only.

2 System Requirements

The overall functional requirements of SRC's SmartFlow is outlined and detailed in the following sub-sections.

2.1 System Overview

The following flow chart illustrates the high-level design of SRC Telemetry's SmartFlow device. Each command is send and authenticated once received by the controlled device. If format is correct and operator is legal, command will be used to determine the next operation state.

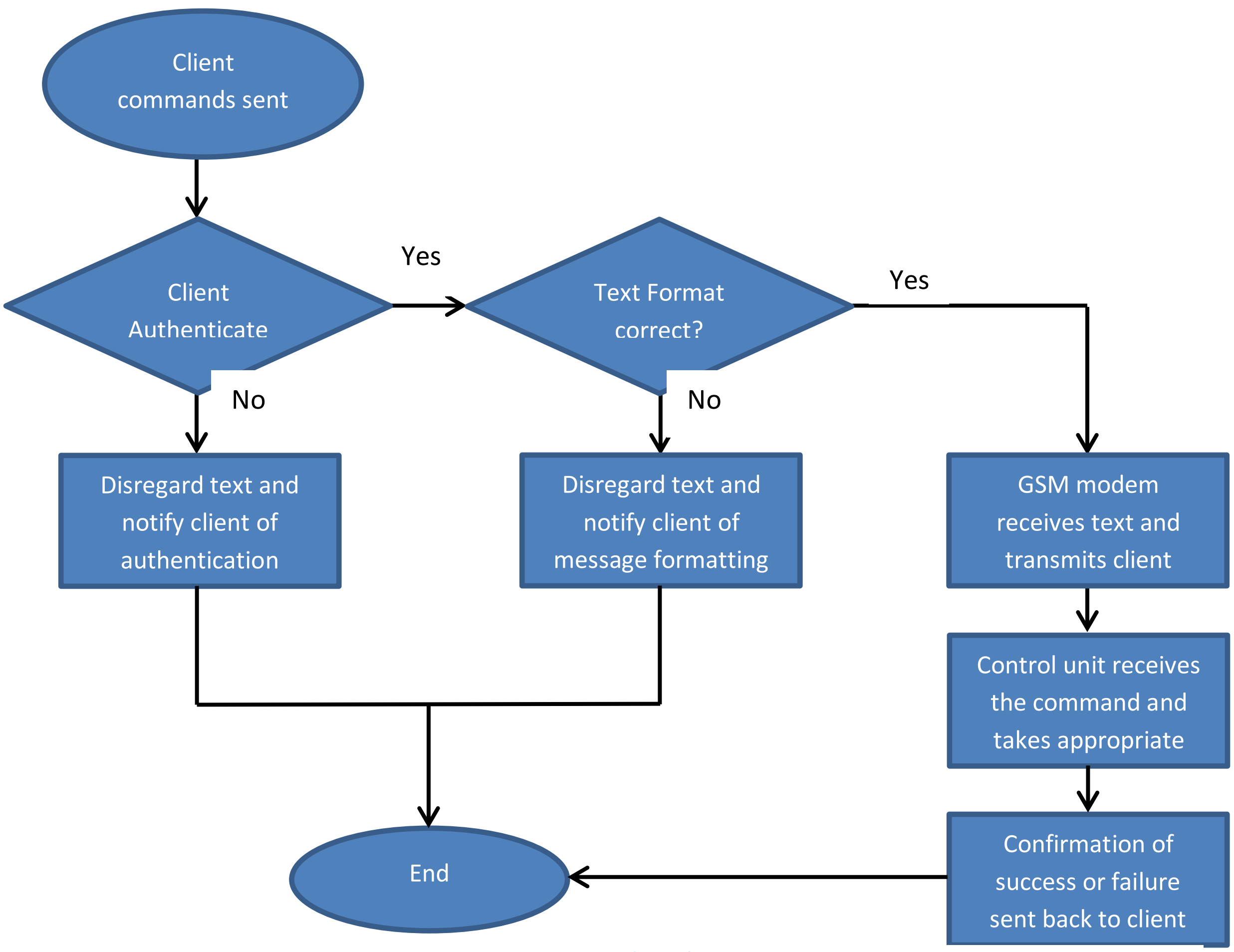

Figure 1 System Flow Chart

2.2 Components Overview

The section below outlines an overview of the major components that are utilized in the SRC's product.

The GSM modem interface and some of its relevant attributes are shown in Table 2 below. The GSM receiver is able to receive and transmit text messages from the client and from the controller.

Table 2 GSM Modem Attributes

GSM Modem Interface	
Attribute	**Value**
Dimensions (W x D x H)	98 x 54 x 25 mm
Supply Voltage	$12 - 24\ V$
Input Voltage	$5 - 32\ V$
Frequency	$900/1800\ MHz$
Output Power	$2W$ at 900 MHz $1W$ at 1800 MHz
Ambient air temperature for operation	-20…55°C

The Communication Interface shown in Table 3 provides the necessary link for the transmission and receiving of text messages and notifications to and from the controller.

Table 3 Communication Interface Attributes

Modem Communication Interface	
Attribute	**Value**
Dimensions (W x D x H)	107.6 x 72 x 59.5 mm
Supply Voltage	$10 - 28.8\ V$
Power dissipation in W	$1.1\ W$
Supply current	$<=\ 550\ A$
Ambient air temperature for operation	$-20°C$ to $40°C$
Relative humidity	95% without condensation or dripping water

The Programmable Logic Controller shown in Table 4 below can be programmed to do the tasks required by the process. It has a straight connection with the communication interface and the power circuit, shown in the overview of the system.

Table 4 PLC Component Attributes

Programmable Logic Controller (Zelio Logic Smart Relay)		
	**Attribute**	**Value**
	Dimensions (W x D x H)	124.6 x 59.5 x 107.6 mm
	Supply Voltage	$19 - 30\ V\ DC$
	Discrete Input Voltage	$24\ V\ DC$
	Resistive Discrete Inputs	6
	Common Mode Analogue Inputs	6
	Relay Outputs with Internal Clock	8
	Ambient air temperature for operation	$-20°C$ to $40°C$

For the purposes of product demonstration the Mini Jet water pump shown in Table 5 will be utilized. This component has an exceptional pumping capacity as well as the small dimensions required for the scaled down product produced at SRC. Even though, there are many pumps available in the market that are compatible with the overall unit, the Mini Jet water pump is ideal for use in small enclosed areas, such as sumps, reservoirs, vessels, or small containers. Additionally, these pumps are equipped with a flow-adjusting feature in order to allow for the control of the flow rate to fit with different applications.

Table 5 Water Pump Attributes

Mini Jet Water Pump		
	**Attribute**	**Value**
	Dimensions (W x D x H)	31.75 x 57.15 x 69.85 mm
	Capacity	106 GPH (Gallons Per Hour)
	Required Voltage	$120V$
	Frequency	$60Hz$
	Power Consumed	$5\ W$
	Expected Life	$4 - 5\ Years$

Level sensors will be used to monitor the liquid level in the tanks; the sensors will be directly connected to the PLC in order to send and receive liquid level information, such as the height. The sensors will have the specifications illustrated in Table 6.

Table 6 Level Sensor Attributes

Omega LV3000 Series Level Sensor		
	**Attribute**	**Value**
	Dimensions (W x D x H)	44 x 82 x 110 mm
	Input Voltage	$22 - 24\ V$
	Operating Voltage	$24\ V$
	Maximum Pressure	$290\ psi$
	Accuracy	0.5%
	Repeatability	$\pm 1\ mm$
	Operating Temperature	$-10\ °C$ to $120°C$

In addition to the level sensor shown above, temperature sensors will be also be utilized to record and observe the temperature of the liquid in the tanks. This sensor must be placed in direct contact with the PLC as well as the liquid in the vessel. Additionally, it must have the attributes shown in Table 7.

Table 7 Temperature Sensor Attributes

Analog Devices AD592 Temperature Sensor		
	**Attribute**	**Value**
	Dimensions (W x D x H)	5.2 x 12.7 x 10.5 mm
	Supply Voltage	$4 - 30\ V$
	Operating Voltage	$24\ V$
	Operating Temperature	$-25\ °C$ to $105°C$
	Linearity	$0\ °C$ to $70°C$
	Pre-calibrated Accuracy	$0.5\ °C$

In addition to the above components, a power circuit will also be used in order to deliver safe power levels to the pump. Furthermore, it will also be used to get the control command and to energize or to de-energize the pump. This power circuit component will also have an additional failsafe feature by the self-holding contactor that will de-energize the pump in the case of power loss.

3 Functional Requirements

3.1 PLC

3.1.1 Physical Requirements

[R1-II] The dimensions of this unit shall be 124.6 x 59.5 x 107.6 cm.
[R2-I] The weight of the unit shall not exceed 4 pounds.
[R3-II] It shall be located beside the GSM modem.
[R4-II] A simple on/off button will be provided to control the power to the box.
[R5-II] The robotic device will have a UPS backup battery sufficient to give at least 2 hours continuous operation.

3.1.2 Electrical Requirements

[R6-II] Power cords shall have the capability to handle high currents.
[R7-II] The Unit shall have 20 input/outputs.

1- 6 Discrete Inputs
2- 6 Analog Inputs
3- 8 Relay Outputs

[R8-II] PLC shall operate at 24 volts DC supply using an AC to DC adapter.
[R9-II] The relay gates shall respond to 5 volts (tolerance of ± 0.2 volts).
[R10-III] The system will enter a low power state once the ideal water condition has been achieved, to save on energy costs.
[R11-I] The layout of major electrical connections should be easily accessible for the ability to switch components out easily and also to debug any main connections during development.
[R12-II] The device will have a UPS backup battery sufficient enough to give standby time of at least 45 minutes.
[R13-II] The device will have a UPS backup battery sufficient enough to give active time of at least 30 minutes.
[R14-III] The recharge time of the module is under 30 minutes.
[R15-III] The UPS battery has a functional lifetime of at least three years under typical use.

3.1.3 Safety Requirements

[R16-I] Power cord shall be well-coated with a double layer of insulating material as it shall be carrying high amounts of currents.
[R17-II] The frequency of receiver shall be under 300 MHz to avoid interference with other devices.
[R18-II] A heat sink shall be used to avoid overheating of the device.
[R19-I] Relays shall open and close without arcing.
[R20-I] Relays shall generate minimal EMF.

3.2 Sensors

3.2.1 Physical Requirements

[R21-II] The dimensions of this unit shall be 78.3 x 108 x 120 mm.
[R22-II] The diameter of the probe shall be 16 mm.
[R23-II] The max probe length must not exceed 1.8 m.
[R24-II] The max pressure applied must not exceed 290 psi.
[R25-II] It shall be placed on the inner surface of the tank.
[R26-II] Strong double sided adhesives shall be used to place the unit.
[R27-I] Additional brackets will be provided to mount the device, if the user is not comfortable in mounting with adhesives.
[R28-I] The Sensors shall have a heat resistant covering made of high tensile strength to withstand high amounts of heat.
[R29-I] The enclosed material shall be glass-filled nylon or aluminum die cast.
[R30-I] Sensors will be able to last over a year of constant use with little drift or wear but be low in cost- this will keep system reliable.
[R31-II] The sensor unit shall be made compatible with the microcontroller box.

3.2.2 Electrical Requirements

[R32-II] The sensor shall operate at 12V to 30V DC.
[R33-II] The sensor should operate at an output current of about 4 to 20 mA.
[R34-II] The accuracy of measurements should be 0.5%.
[R35-II] Sensors should operate in a temperate range from -10 to 120 degrees Celsius.
[R36-II] The range sensitivity has to be 100 to 5500 pF.
[R37-II] The sensors shall have a frequency oscillation of 400 KHz and a repeatability of ±1 mm.
[R38-II] Output will be in standard form of 1-5V or 4-20mA to maintain simplicity.

3.3 GSM Modem

3.3.1 Physical Requirements

[R39-II] The box shall have dimensions of 98 x 54 x 25 mm.
[R40-I] The weight of the box shall not exceed 4 pounds.
[R41-II] The box shall be enclosed in a heat resistant material.
[R42-II] UPS back up battery remover slot will be towards the bottom of the box.
[R43-III] A simple on/off button will be provided to control the power to the box.
[R44-III] The internal UPS backup battery will be easily replaceable by the user.

3.3.2 Electrical Requirements

[R45-I] The overall unit shall withstand heat of up to 100 degrees Celsius.
[R46-II] The overall circuitry shall transmit 120-240 volts.
[R47-II] The GSM unit must operate at a frequency of 900/180 MHz.
[R48-II] The unit must supply a voltage of 12 to 24 V.
[R49-III] The GSM device will have a UPS battery life sufficient to give at least 30 minutes continuous operation.
[R50-III] The GSM device will have a UPS battery life sufficient enough to give standby time of at least 45 minutes.

3.3.3 Safety Requirements

[R51-III] The system does not emit any harmful radiation or interfere with other devices.
[R52-III] The product shall be able to detect mechanical and electrical failure. Should any such failure be recorded, the system will enter a safe mode and notify the user.
[R53-III] The device will have no exposed electrical wires or circuit components.
[R54-III] The readings will be highly accurate with a maximum error of 2%.
[R55-III] The failure of any electrical component will not harm the user.

3.4 General Requirements

3.4.1 User Documentation

[R56-III] A simplified and basic installation and repair manual shall be created for the users.
[R57-III] The user manual shall use language for an audience with minimal knowledge of electrical and electronic devices.
[R58-III] The user manual shall be available in English and French to ensure a wider user base.
[R59-III] A detailed installation guide shall be prepared for technicians and vendors.

3.4.2 Electrical Requirements

[R60-III] The electronic and mechanical components and power connections shall be enclosed.
[R61-III] The electronic components of the device shall not cause interference with other devices.
[R62-III] No harmful substances shall be released into surrounding as per Canadian health standards.
[R63-II] The device must be able to establish connection to the local GSM network.
[R64-III] The retail price of the device and controlling software will not exceed $650.
[R65-III] The range of the system is large enough to function in various mobile locations with GSM connection available

3.4.3 Environmental Requirements

[R66-II] The device will be used only outdoors.
[R67-III] The device will operate in outdoor temperatures between 5 - 60°C.
[R68-III] The device will operate in outdoor humidity between 60-75%.
[R69-III] The scale will operate normally at an altitude ranging from sea level to 1500m.
[R70-III] All components used are digital, so no harmful substances will be released in the environment.
[R71-III] Double layer insulation on high current carrying wires will avoid heat dissipation into surroundings.
[R72-III] The system's packaging will minimize waste and use recyclable materials.

3.4.4 Performance Requirements

[R73-II] The device shall respond to manual adjustment user input within 4 ms.
[R74-II] ` The device shall indicate that it is within the range of operation when activated.
[R75-II] The total time taken to perform automatic adjustments shall not exceed 8 minutes.
[R76-II] The device must respond to mode changes within 1 s.
[R77-I] The power adapter shall be usable with a wall supply of 110v/120v at 60Hz AC according to North America standards.
[R78-II] The failure of any electrical or mechanical component of the system will not cause any danger to the user.
[R79-III] The electronic components shall not cause interference with other devices.

[R80-III]	The system shall be able to detect mechanical and electrical failure. Any error shall be notified to the user. In error mode, the system should not allow water to flow into the tanks.
[R81-III]	The system will be able to maintain ideal water conditions with minimal fluctuations and overshoot.
[R82-III]	The system is scalable and can realistically be produced in large volumes.
[R83-III]	The product is able to withstand day-to-day usage.

3.4.5 Usability Requirements

[R84-III]	The system will be simple and intuitive to use.
[R85-III]	The system will be used for maintaining water conditions and not treating water.
[R86-III]	The system will be operable by one person.
[R87-III]	The system will not require regular cleaning or maintenance.
[R88-III]	The system's interface is simple and user friendly.

3.4.6 Reliability Requirements

[R89-II]	The device shall be able to operate under specified working conditions such as temperature and pressure without critical failure.
[R90-II]	The device shall be able to easily communicate in the remote areas, with the compatible GSM networks and ranges.
[R91-I]	The lifetime of the device shall be at least 4-5 years.

4 Manual and Automation Test Plans

Due to variety of the product's system's application, there will be multiple test plans derived making sure individual components work as well as the overall functionality as described. First of all, there will be a manual test plan consisting of all manual test cases covering all unit test scenarios on each individual component. Secondly, there will be a manual test plan consists of system-level unit testing scripts of the integrated product. Last, there will be a fully automated test plan that focuses on both first and second part of the test plan, but will automation capability.

4.1 Manual Test Plan and Automation Test Plan Overview

The first and second part of the test plan is manual test plans, which means they are prepared and developed for manual, physical test. However, they are insufficient and costly because of human efforts involves, and will be ultimately replaced by the third test plan, which is fully automated. This automated test plan requires much more work because it itself requires further implementation such as realization of automation capability in both hardware and software, as well as testing plan and stubs for itself.

Because of the nature of the system, and possible harsh environment it may encounter once deployed, we need to specifically design and test our overall system bearing those in mind. Heat and moisture will be two of the critical factor throughout all levels of testing.

For example, because our system is capable of being deployed to many different applications, such as remotely controlling oil wells and tanks in the middle of desert, it needs to be operable and stable under all ambient temperature found in typical deserts around the world. This effectively means that the operating range of our system is between -20 to 80 C. Also, because our system's application includes liquid storage and such, and often time, oil exploration sites are located offshore, we need to have our system tolerable of high moisture with high salt concentration.

4.2 Breakdown of Manual Test Plans

This section briefly lists all necessary test plans and their general description, and no implementation details are included to maintain a concise structure. Details will be provided as separate document if required.

4.2.1 General Test Plan for Component Testing

The following list shows a set of sub test plans of unit testing and functional testing.

Table 8 Lists of Manual Component Unit Test Plans

Section	Test Plan Name	Description
1.	Component Testing Plan	This test plan covers general test plan testing individual component or module used in the system, and it includes the following test plans.
1.1	Sensors	This test plan covers unit testing of all sensors; each sensor needs to meet their physical and electrical requirement such as their I/O voltage, current and resistance, operating temperature tolerance, resolution, etc.
1.2	Electrical Pumps and Motors	This test plan covers unit testing of all electrical component including fluid pumps and motors. All electrical components need to comply to control input voltage and current as well as supply voltage and current. They also need to be tested for maximum RPM related to fluid transfer rate and number of hours before failure.
1.3	GSM Modem Board	This test plan covers unit testing on embedded GSM modem board, which includes the GSM 2G SIM card. The GSM board need to be tested to comply with the 3GPP standard GSM wireless protocol stack so it will be able to communicate with the GSM network correctly.
1.4	PLC Board	This test plan covers the unit testing of PLC board. All I/O voltage and current shall be tested to guarantee its correct operating range. Also, embedded software running on this board will be tested to meet all functional requirements.
1.5	Power Supply	This test plan covers the unit testing for power supply including UPS.
1.6	Relays and Emergency Break	This test plan covers the unit testing for all relays and emergency breaks.

4.2.2 General Test Plan for Integrated System

The following list shows a set of sub test plans of system level unit testing such as usability testing, tolerance testing and other high-level testing.

Table 9 Lists of Manual System Test Plans

Section	Test Plan Name	Description
2	System Test Plan	This test plan covers system-level testing of performance, usability, reliability and durability.
2.1	Hardware System Durability and reliability	This test plan covers tests of system durability including motor and actuators reliability, durability under different stress and environment. It also tests for overall correct operation of hardware.
2.2	Software System Reliability	This test plan covers all tests on embedded software on GSM modem board and PLC board. All valid operation as well as operation not allowed but falls within the operating range will be tested. All system level software control and message communication channels such as GSM cellular link will be tested. Task scheduling, message hand shaking and status reporting will be tested.
2.3	Emergency Stop Operation	This test plan covers all tests on emergency stop functionality. Specifically, responding time and 100% operation compliance need to be met.
2.4	Operator Authentication and GSM Security	This test plan covers all tests on system level security, including GSM channel operator authentication and verification.
2.5	Operating Environment Test	This test plan covers all tests on system operation within designed range including temperature tolerance, moisture tolerance and corrosive (salt particles) environment tolerance.
2.6	Battery Life and UPS Time	This test plan covers all tests on minimum battery life of normal and extreme operation, and minimum time of operation on UPS power supply.
2.7	GUI and usability test	This test plan covers all tests on user interface testing and usability test. Tests will be conducted by external parties to evaluate the effectiveness of software and hardware interface.
2.8	Electrical and radio frequency certification and compliance test	This test plan covers all tests that are required to meet various government regulatory agencies and certification groups for user and operator acute and chronic safety.

5 Reliability and Durability

Reliability is an important characteristic of an item expressed by the probability that a device will perform its function under given conditions and stated time interval. A reliability evaluation is an extremely critical phenomenon to evaluate any product. Not only does it help to estimate the longevity of the product, but also to develop a safe product, pertaining to international and local standards.

5.1 Pump Reliability and Serviceability

A Pump's efficiency is a measure of the ratio of the power imparted on the fluid by the pump in relation to the power supplied to drive the pump. Other detrimental factors that influence the operation of the pump away from the best possible achievable efficiency are experienced due to:

- Suction recirculation
- Discharge recirculation
- Larger radial loads
- Power consumption

In SRC's case, the pump is selected based on the performance curve. As shown in the Figure below, pump selection is made by observing the curve between the pressure head and the flow rate and considering the points above it.

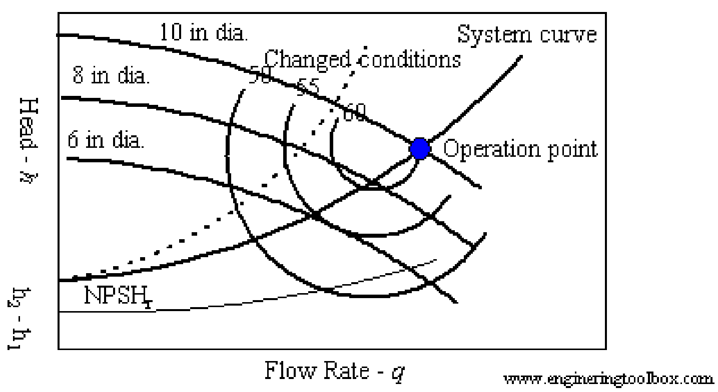

Figure 2 Pressure Head and Flow Rate

The pump's suction cup support provides stable and silent operation. Additionally, the pump is connected to an exclusive circuit breaker on the electrical panel in order to protect against overloading which may occur if the pump and other appliances are simultaneously activated.

5.2 Logic Relay Reliability and Serviceability

The Logic relay reliability and serviceability is demonstrated by doing tests on a sample randomly selected from each manufacturing lot. Lot sizes vary to a maximum of about one week's production of a particular configuration. Generally, the testing is carried out at the maximum ambient temperature and at the rated contact loads in a controlled environment. The samples are cycled to the minimum rated life of the relay, and the failures are used to calculate the demonstrated reliability.

Table 10 Failure Tests of Relay

	METHOD	TOTAL OPERATIONS	FAILURES	* FAILURE RATE
Accepted	TERMINATE TESTING WITH A FAILURE AND ONE OPERATION IS ONE COIL ENERGIZED AND DE-ENERGIZED CYCLE.	10,000,000	6	0.600
I	TERMINATE TESTING WITHOUT A FAILURE AND ONE OPERATION IS ONE COIL ENERGIZED AND DE-ENERGIZED CYCLE.	10,000,000	5	0.500
II	TERMINATE TESTING WITH A FAILURE AND ONE OPERATION IS A CONTACT MAKE/BREAK PER COIL ENERGIZE AND DE-ENERGIZED CYCLE.	80,000,000	6	0.075
III	TERMINATE TESTING WITHOUT A FAILURE AND ONE OPERATION IS A CONTACT MAKE/BREAK PER COIL ENERGIZE AND DE-ENERGIZED CYCLE.	80,000,000	5	0.063

** Failure rate is expressed in failures per million operations.*

5.3 GSM Reliability

In any GSM system the most important thing to consider is the network reliability. Since the overall unit is a combination of several different sub-units, the engineering team at SRC has a priority to minimize capital and operational expenses by reducing network complexity and simplifying network management. Therefore, microwave technologies which are expensive, and radio frequency technologies which are more primitive have not been used. SRC's product will help in reducing operational costs and maximizing the efficiency.

Quality control is also a key factor for the proper operation and maintenance of the product. In order to do so, SRC engineers ensure that the management of process performance, integrity criteria, and identification of records will be well maintained, tested, and documented. Additionally, because mobile and telecom market bases have grown their networks in extreme areas, their GSM offers targeted coverage and capacity solutions to meet the users specific network needs. The ultimate goal is always to maximize the quality of services delivered to SRC's customers.

5.4 Redundancy of the overall unit

Redundancy is an important criterion with the purpose of increasing reliability of the system. SRCs overall unit is a combination of several sub-units which are completely independent. Therefore, it is viable to have a back up system for each individual unit. Mathematically, failure is defined as

$$\lambda = \frac{\Delta n}{n_o \, \Delta t} \qquad (1)$$

where Δn is the number of failures in Δt and n_o is the number of good items.

For a constant λ, it is possible to write

$$\lambda = 1/MTBF \qquad (2)$$

where MTBF is the Mean Time between Failures

For example, if there are two electric units with a MTBF of some hours and the units are independent; one can easily switch from the failed unit to the backup unit. The remaining sub-units will be still in the working state. Similarly, there will be back up units for each individual subunit. Additionally, as the redundancy of a system rises, its equipment and maintenance will drastically increase in cost. However with SRC's product, the individual unit's lifetime ensures that it lasts longer and is capable of handling pressure without vast deterioration as the time passes. The foundation for further improvements can also be placed in the product by ensuring that the existing network is achieving its optimal goals. One of the foundations could be achieved in the feature of supervisory software such as Internet based user accessibility.

6 Conclusion

The functional specifications that have been discussed in this document are the fundamental guiding blocks that will lead to the successful creation of the SmartFlow device; and as such must be diligently and closely followed at every stage of product development. The design process has already been started and the team is on schedule to meet its hardware and software testing deadlines of mid-November, and successful building of the product by early December; and any additional enhancements will be addressed at that time.

7 References

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