**Preliminary Requirements Document**

**K1 Water Disinfection Generator**

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# Introduction

This document contains the system requirements for K1 Chlorine Generator. These requirements have been derived from several sources, including a ***brief listing of most important sources***.

## Purpose of This Document

This document is intended to guide development of *K1 Water Disinfection Generator*. It may go through several stages during the course of the project. The first version is compiled after the Statement of Work has been formally approved and is then proposed as a potential requirements specification for the project. The proposed document should be reviewed by several parties, who may comment on any requirements and any priorities, either to agree, to disagree, or to identify missing requirements. Readers include end-users, developers, project managers, and any other stakeholders. The document may be amended several times before moving to the next stage. Once the various stakeholders have agreed to the requirements in the document, it is to be signed by all parties as an appropriate statement of requirements for the project. The developers then use these approved requirements document as a guide to implementation of the Functional Specification.

## How to Use This Document

expect that this document will be used by people with different skill sets. This section explains which parts of this document should be reviewed by various types of readers.

### Types of Reader

This document is aimed at a variety of readers who are interested in investing in the future of water purifying technology. This includes individuals in the field of search and rescue (i.e. natural disaster relief), military operations, industries (i.e. agriculture, water treatment facilities, meat industry to feed livestock), and international groups (NATO, Red Cross etc.), or finally the recreational user (for camping, family events or corporate retreats, or any environment of that nature).

Specific Readers will be interested in these sections:

* Disaster Relief: 1,2-2.5, 3.1-3.5
* Military: 1, 2-2.5, 3.1-3.5, 4
* Industry: 1, 1.3-1.4, 2-2.5, 3.1-3.5
* International groups: 1, 2-2.5, 3.1-3.5
* Recreational user: entirety of this document

### Technical Background Required

This document is relatively easy to understand in that it doesn’t review the exceptionally specific details until the basics have been addressed. In whole the entire system will be designed such that individuals in remote areas of the world can use the K1 easily without any previous technical background. User friendliness is a key aspect when designing this system so if a user does not speak English, they would still be able to use the K1 system.

For certain sections of this document, however, some expertise is required. The sections: 2-5, 8; will be necessary for anyone with a technical background in electrical engineering, computer engineering, mechanical engineering, Networking engineering. While a project leader or investor would be more interested in the sections: 1-2 and all the subsections in order to determine whether this product fulfills their needs.

### Overview Sections

For an individual who wishes to grasp the overall functions and characteristics of this project and resulting product, focus on sections 2-2.5, and 7-8 (the glossary and references for further reading concerning research) which overviews the basics of the K1 chlorine generator’s aspects for understanding.

### Reader-Specific Sections

For this document, only specific portions are necessary for certain parties or individuals to read rather than read the entirety of this document, one may skip over some portions.

Specific sections for their respected readers:

* Disaster Relief: N/A
* Military: N/A
* Industry: 1.4
* International groups: N/A
* Recreational user: entirety of this document

### Section Order Dependencies

The entirety of this document can be read in any order at no consequence of depreciation to the understanding of the scope and outcome of this project. However, for ease of the reader, this document is laid out in a manner which is convenient and clear for any level of technical experience.

## Scope of the Product

The K1 chlorine generator has been developed by Mr. Herrington as well as designed into the prototype platform for the final stages of hardware design including control elements to be implemented by our team. Aqua Research believes this product is a key component of their product line in making purified water readily available to areas in need of access to clean water in an on-site, easy-to-use and robust manner.

## Business Case for the Product

Water is an essential need for humanity, without water all life on earth would perish. Water can be deceiving and look safe to drink, but may contain like Cholera, Giardia, Legionella, Shigellosis, among countless others.

The required starting capital to make water safe to drink for third world countries is a significant investment to build a Water Treatment System, and this is frequently not possible for emerging countries. About 790 million people don’t have access to safe water around the world (source: *https://www.cdc.gov/healthywater/global/wash\_statistics.html*).

Aqua Research offers affordable and sustainable lifesaving technology to improve the quality of life for those who do not have access to clean water. The H2gO Purifier, developed by Aqua Research, is a compact and affordable device to clean dirty water. The device has been used to purify water in many situations, like camping, emergency kits, military, hiking, and natural/manmade disasters. The recent Flint Michigan Legionnaires disease outbreak is an example of where the H2gO could provide disease free water thus saving countless lives.

## Overview of the Requirements Document

* Send alarm/notification to outside world if K1 system needs general maintenance (could be as simple as putting more salt into brine tank) or a part on the system failed and needs replacement/repair.
* Weatherproof
* Produce chlorine with the only consumables being salt and water

# General Description

This section will give the reader an overview of the project, including why it was conceived, what it will do when complete, and the types of people we expect will use it. We also list constraints that were faced during development and assumptions we made about how we would proceed.

The K1 Chlorine generator was developed in response to huge need for safe water supplies and sanitation needs across the world. There is an overwhelming number of people in the world with little to no access to water, and much of the time one will drink contaminated water to satisfy their thirst without taking into consideration the life-threatening consequences of contaminated water. The K1 Chlorine generator can solve this global crisis as it is designed to be both portable and produce a relatively large amount of chlorine solution to produce clean water.

## Product Perspective

To produce clean and affordable method to produce clean water is the primary goal in choosing to take on this challenging project, in developing the K1 product. A steady distribution of this low-cost system would save countless lives. There are an estimated 790 million people who do not have access to clean water and risk their lives every time they drink water.

Stakeholders may include government agencies, good Samaritan companies or international interest groups (NATO, The Red Cross, UNICEF, WHO), humanitarian aid, missionaries, and even recreational users. Aqua Research currently has a product line of chlorine generators and is developing the K1 chlorine generator to produce chlorine at a large scale while still maintaining portability. There are a number of people who will benefit from the K1 system, the most influential communities in need would be anyone who does not have access to a clean water supply most notably underdeveloped countries or disaster-stricken areas.

## Product Functions

The K1 system is a chlorine generator that utilizes water and ordinary table salt to make a fully saturated brine solution. The brine solution then goes through an electrolysis process in an electrolytic cell to create sodium-hypochlorite, a very potent bleach solution. The chlorine is then used to disinfect contaminated water, so it becomes consumable. The K1 system will be fully automated, the only activities that will be required are to periodically resupply the salt in the brine tank as well as occasional maintenance if any part of the system fails.

There are a few functions we will incorporate into this system including fault alarm diagnostics, communications via ethernet, and other features to make the operator/owners job easy.

## User Characteristics

Any ordinary person with no technical knowledge can use the K1. The K1 system will primarily be used in third world countries where little to no education exists. The system will be as easy as filling the brine tank with water, salt and pressing a single button to start the chlorine generation process. If the system has any failures, diagnostics routines will be included to make maintenance easy.

## General Constraints

A primary concern is cost. The cost of goods target for the entire K1 system is less than $1,500. This product will be independent from other products. The software will be unique to each K1 system.

## Assumptions and Dependencies

At the beginning of this project, there were several assumptions. The design team is responsible for selection of some of the hardware and for designing the software. When meeting with the CEO of Aqua Research (Rodney Herrington), the team received a good idea of what was available in terms of lab equipment and other resources. Aqua Research also had a CAD model for the team to work with to begin development of the hardware and most of the control inputs and outputs, etc.

The K1 chlorine generator has several dependencies. One of those is communications capability for the operator or customer service at Aqua Access for receiving status updates periodically from the device via email. This includes alarms or warnings to replenish salt in the brine tank, or to indicate fatal faults that have occurred with the system.

# Specific Requirements

This section of the document lists specific requirements for K1 Water Disinfection Generator. Requirements are divided into the following sections:

1. User requirements
2. Reporting requirements
3. System and Integration requirements
4. Security Requirements
5. User Interface requirements.

## User Requirements

From a user standpoint we want LCD as simple and user friendly as possible. The K1 system will primarily be used in underdeveloped countries so anyone who operates the system will not need to have a technical background. Desired user features:

• Simple interface for user, minimal buttons

• Simple operation, one button pushes to operate process

• Simple display, make it easy for user to recognize the state of the K1 system

• Easy power on and off

• Visuals to indicate the state of K1 system, indicator lights

## Reporting Requirements

The team will report to Aqua Research, specifically the sponsor Rodney Herrington. Everything must be approved by the mentor for any of decisions our group agrees upon from selecting and purchasing electronics, the design of the software logic, to the development process of the software for the controller. All periodic, summary and final reports will be issued to Aqua Research.

## System and Integration Requirements

System requirements for controls system include:

• Activate power on venting fan when the system is powered on.

• Open solenoid valve EOV 003 going from brine tank to electrolyte tank.

• Close solenoid valve EOV 003 when electrolyte tank brine switch is activated.

• Open solenoid valve EOV 001 going from water source to electrolyte tank.

• Close solenoid valve EOV 001 when electrolyte tank water switch is activated.

• Activate power to electrolytic cell from power supply.

• Monitor cell amperage. If amperage is high, open water solenoid valve for duration to bring amperage down to correct value. If amperage too low, open brine solenoid for duration to bring amperage up to correct value.

• Maintain power to electrolytic cell for predetermined number of amp seconds.

• Power off electrolytic cell after number of amp seconds is reached.

• Open solenoid valve EOV 002 going from electrolyte tank to oxidant tank for predetermined number of seconds.

• Close solenoid valve EOV 002 when number of seconds is reached.

• Repeat previous steps until high level oxidant tank switch is activated.

• Stop chlorine generation process when high level oxidant tank switch is activated.

• Start chlorine generation process when low level oxidant tank switch is activated.

• On every tenth cycle after the electrolyte tank is full, reverse polarity on cell for five minutes, and then switch back to normal polarity and finish the cycle. This function to be programmable on/off in software.

• If K1 system power is interrupted, the controller must save the accumulated amp-seconds, and then continue the cycle to completion when power is restored. Send alarm/notification to outside world via ethernet and LCD screen if K1 system needs general maintenance (could be as simple as putting more salt into brine tank) or a part on the system failed and needs replacement/repair.

Monitor Discrete and Analog inputs and outputs of system:

Discrete Inputs:

* Oxidant Tank Level Switch High
* Oxidant Tank Level Switch High
* Oxidant Tank Level Switch Low
* Oxidant Tank Level Switch Low
* Internal Run/Standby Switch
* Electrolyte tank brine level switch
* Electrolyte tank water level switch
* Electrolyte tank high switch
* Cell Power Supply status

Discrete Outputs:

* Electrolyte tank drain solenoid
* Water solenoid valve
* Internal Indicator Light Red input
* Internal Indicator Light Green input
* Internal Indicator Light Yellow input
* External Alarm Output switch
* Cell Power Enable
* Brine solenoid valve

Analog Inputs:

* Current sensor #1 (0-4V) = (0-50A)
* Cell Voltage (0-10V) = (0–50V)

Weatherproof.

Note: Additional requirements may be added as project becomes more concise.

## Security Requirements

There will be no security features for the HMI or controls system of the K1 system. Although the K1 project is connected to the internet it will be *Send only* eliminating potential of hackers.

## ***User Interface Requirements***

Features that may be desired for the human machine interface include:

• One master switch to power on K1 system.

• One button pushes to start or stop the chlorine generation process.

• HMI display to show how much time is left to finish current electrolysis process.

• HMI will let user know if salt and/or water needs to be added to brine tank.

• HMI will let user know If K1 system is not functional and any part of system needs repair.

• HMI will let user know if power is applied to K1 system. Indicated by illuminated LED.

• HMI will let user know if K1 system is performing chlorine generation process at any given time system is on. Indicated by illuminated LED.

• HMI will let user know oxidant tank is full and complete chlorine generation process is done. Indicated by illuminated LED for standby condition.

Note: Each of these features may be subject to change as well as addition of new features.

# High-Level Technology Architecture

[To Discuss]

# Customer Support

Errors will be sent via ethernet to a dedicated server, in which a dedicated team can help maintenance the K1. Customer support discussion is still in progress.

# Appendices

[To Discuss]

# Glossary

* LCD- Liquid Crystal Display
* HMI- Human-Machine Interface
* Light-emitting diode

# References

* Preliminary Requirements Document REG 112215
* Ccdc.gov: <https://www.cdc.gov/healthywater/global/wash_statistics.html>

# Index

[To Discuss]

# Approvals

The signatures of the people below indicate an understanding in the purpose and content of this document by those signing it. By signing this document, you indicate that you approve of the proposed project outlined in this Requirements Document and that the next steps may be taken to create a Functional Specification and to proceed with the project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Approver Name** | **Title** | **Signature** | **Date** |
| Rodney Herrington | Sponsor |  |  |
|  | Technical Mentor |  |  |
|  | Project Manager |  |  |
| Ramiro Jordan  Ravi Jain | Instructor(s) |  |  |