

TO DESIGN AND ENGINEER DETECTION INSTRUMENTATION SUITABLE FOR ENVIRONMENTAL SEAL TESTING OF LIVE AMMUNITION DURING WATER IMMERSION

By Ralph Whittaker

FINAL MAJOR PROJECT

BEng (Hons) Test Range Engineering June 2018



[2]

Engineering problem: Detecting air leaks underwater from Small Arms Ammunition (seal failures)

Project reasoning: Provide Support during environmental Test CL29 – Immersion, Defence Standard 00-035 [1]

As bubbles form and are released from a cavity, they produce a sound wave through water. This analogue signal can be detected by a hydrophone and converted into a voltage signal.

The voltage input signal can be converted into a digital signal by a microchip and processed to control outputs based on design decisions within conditional basic programming software.

OUTCOME: Digital Bubble Counter triggered by amplified signal from a hydrophone above 1V threshold

Within the 30 weeks to complete the project, research included reviewing the niche market of existing leak detection equipment and technology, and identifying a feasible method to achieve similar results as to what are often very expensive products. Due attention was paid to the explosive environment in which this device was to be used. The solution needed to remain independent of the test and not introduce any electrical or fire hazards to the test specimens being monitored. To conclude the project; a safe and low powered device was designed within budget to accompany trial operators during the observational tasks of monitoring for SAA seal leaks.

1.

AIM: To design and make a bubble counter

- To design and produce a display and alarm system for the Basic Seal Testing of Small Arms Ammunition
- To error-proof (poka-yoke) Basic Seal Test procedure at ETC Shoeburyness
- Increase *efficiency* of test procedure whilst continuing to adhere to Test Specifications accordingly
- Increase *accuracy* and *reliability* of test results
- Make the test more *bearable* and *satisfying* for the operator

OBJECTIVES

- Identify the test, environment and problem
- Perform physical observations of current trial procedures to identify the user and technical needs
- Gather solution requirement feedback from onsite Climatic Technicians and Engineers
- Analyse the issues of the test. Use engineering evaluative tools to assess current system and identify aspects that can be tweaked to reduce data loss (risk) and Muda (waste) by introducing new methods and instrumentation
- Locate root causes of issues (Root Cause Analysis)
- Assess the situation (Quality Functional Deployment)
- Research appropriate existing literature relating to underwater leak detection and existing detection equipment
- Identify the possibilities and limitations of detection
- Develop and design idea for a solution
- Test and prove the solution in a simulative working environment

ORDER OF ACHIEVEMENT

- Investigation: Defined the issues of the test using (QFD & RCA engineering tools)
- Defined Operative and Technical Specifications to meet requirements of Operator, Defstan & Customers
- Experiments: Listening for bubbles from an aquarium bubble pump using a Hydrophone
- Literature review: Research existing methods of leak detection & technologies available for development
- Finalised instrumentation for monitor equipment: Use of a hydrophone and temperature sensor
- Brainstorm / defined Inputs & Outputs & designed device / Schematic Designed
- Component research and simulated PIC microcontroller / software written on Proteus Professional 8
- Prototype built on breadboard & installed / PIC microcontroller programmed / software tested & bugs fixed
- Device tested / sensors calibrated in homemade Bubble Station
- Project solution Evaluated & Present

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Investigating the issues and identifying solutions to relieve trial operators from the monotonous and mundane duties of intense test monitoring. A questionnaire and workplace observations were carried out to gain feedback from current Technicians and Engineers at ETC Shoeburyness. A visual display and audible alarm system proved favourable (LCD, flashing LEDs and buzzers).

Defining the Specifications. Experimenting with a hydrophone proved it possible to acoustically detect underwater leaks (bubble formations). Reviewing existing literature and detection techniques (Defstan leak evaluation methods & marketplace research) supported design work. Simulating leaks using Bubble Station confirmed instrumentation to be used. The software on the PIC logs a bubble count when the input signal from the hydrophone is above a +0.9V threshold. The LM35 temperature sensor feeds the PIC temperature data. The analogue signals from the hydrophone and temperature sensors are converted to digital by the PIC.

Prototype designed and built. System calibrated. Device tested in simulative environment. Working prototype proven fit for purpose. Production issues included electrical interference when powered from the mains and so decision was made to power the device from a 9V battery. Further research could include investigating the sensitivities of hydrophones and the ability to detect bubbles of different sizes. Storage of data (bubble logs) could be useful for creating graphical reports of tests for customers. Manual input of display data (trial numbers, date etc.) would be useful for extra display purposes and labelling of trial footage. Software and hardware development could progress the research project and enable the device to cater for features and options such these suggested.