Project Deliverable [C]: Design Criteria

GNG1103[F]: Engineering Design

Professor: Rubina Lakhani

Team 5:

Amenah Waheed (300018138)

Thomas Baycroft (300157691)

Krishna Patel (300171101)

Jonathan Rivington (300164793)

Lucy McKenzie (300120299)

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Introduction:

In this report, Team 5 performed technical benchmarking by researching existing products such as glycol/water and electric-powered heated sidewalks and their technical specifications. In Project Deliverable B, Team 5 analyzed the aforementioned existing products to perform user benchmarking (i.e. understand user perceptions of these products), which helped determine a list of needs and their importance with respect to the client, Jonathan Rausseo, after Client Meet 1. In this deliverable, to begin the technical benchmarking process, design criteria were determined from the needs in Project Deliverable B, and were prioritized in terms of importance. From this list and by comparing the glycol/water and electric heated sidewalks, the following types of design specifications were established and tabulated in the Appendices: design constraints, functional and non-functional requirements. For each need identified, at least one corresponding design criterion was established to satisfy the need. Team 5 also reflected on how Client Meet 1 impacted the development of the design specifications, to update any needs from Project Deliverable B, and to further develop links between the research done for the Project Deliverables, and the Design Problem. Lastly, gaps in knowledge were identified, such as scalability and operating conditions and costs of the glycol/water and electric sidewalks, as the heated sidewalk technology is relatively new. To correct these gaps, additional research will be performed, and questions will be determined for Client Meet 2, before Team 5 can begin developing solutions for the Design Problem.

Design Criteria:

Using previously obtained data, customer statements were translated into specific design needs in order to further analysis to information accumulated through research. Listed from highest to lowest in terms of importance for the design with respect to client needs, the design specifications are listed (See Appendix A, Table 1). This is based on the interpreted needs of the client. It can be observed that the electrical designs fit the design criteria better as they encompass all the requirements whereas the hydraulic designs do not meet all the criteria. These design criteria will serve as a guidelines when designing our prototype. Implementation of these target specifications will aid in creating a design that meets all the user needs. Each identified need will be met by multiple design criteria to ensure sufficient integration into the final design.

During the initial client meeting, our client, Jonathan Rausseo, identified that this project is a passion-project for him as he is involved in preserving and protecting the natural environment and all its inhabitants. As this was important to our client, it became a design criteria that would later be implemented into the final design. Along with its ability to maintain a chemically-safe environment; the client needed a product that would be modular and user-friendly. This was repeated many times during the meeting thus required implementation into the final design. To establish this functional requirement, modularity, stability and durability were specified as design criteria.

In order to ensure the functionality of this device would meet client expectations,the final design would have to be able to melt snow off the surface at a constant and controllable rate. As this design is being implemented as an alternative to road salt, a cost effective method, the budget of this project would not be sufficient if it were too high, thus a budget of $100 CAD was applied. Taking into account all critical information provided to us through the first client meet, including expectations and underlying requirements, we were able to construct a list of design criteria that would later be the basis of our design.

Technical Benchmarking:

Technical Benchmarking is an important section of Deliverable C. Based on the Design Criteria developed from the client's needs, technical benchmarking was executed by researching the designs of existing products and comparing their best features to determine design specifications. Glycol/Water Mixture Heated Sidewalks and Electric Heated Sidewalks are the two main designs that are widely popular for ice and snow removal in high traffic areas. Multiple designs for the two systems were researched and benchmarked separately. The ranking system used for the technical benchmarking considers the client's needs, weighed by importance, and calculates a value for each design. This allows for the comparison and provides a broader perspective for generating the design specifications. The benchmarking tables are colour coded based on the quality of the design scale (See Appendix B, Table 2).

Glycol/Water Mixture Heated Sidewalks:

The Technical benchmarking of the Glycol/Water mixture system evaluated seven different designs. The general design for this type of system consists of a very hot solution of glycol and water, that is pumped through a series of tubing. The tubing covers the entire area that is required to be maintained. Depending on the type of design, the tubing may be installed in individual panels (attached and connected underneath the panel section), or the tubing is installed on the base foundation and a concrete/asphalt mixture is poured over the top of the tubing. The heat from the glycol/water mixture is transmitted through the panels or concrete layers to maintain a constant surface temperature to melt snow and prevent ice from forming. From the analysis of the design criteria and technical benchmarking, the most effective design was the *Therma-Hexx* solution. This design had ranked the highest score of 166 and satisfies most of the design criteria requirements (See Appendix E, Table 5; Appendix F, Table 6). This was the only design that allowed for the system to be installed in panels. Although this system is a long-term solution, this feature allows for easier access to managing the overall system, if something were to break. The cost and approximate area the system would cover were not listed. The dimensions and material of both the panel and tubing were listed, providing insight on different materials that could be used for harsh weather conditions, aside from the standard concrete/asphalt. This design allowed for insulation properties of the individual panels sections and foam added to the underside of each panel, to help maintain the overall surface temperature. There were no heating requirements, operating conditions or sensors listed for this design. The maximum temperature of the solution would be of approximately 140°F (60°C). Overall, this design allowed for a more detailed understanding of the different requirements for an Glycol/Water Mixture-based system that can be used to develop design specifications.

Electric Heated Sidewalks:

The Technical benchmarking of the Electric system evaluated six different designs. The design for this system consists of a wire coil that is connected to a sufficient supply of energy, which lines the entire area that is required to be maintained. There is no drainage system incorporated within this design. The product is sold as individual mat sections that are expandable. The heat from the electric wire coil is transmitted through the surface of the mat to melt snow and prevent ice from forming. From the analysis of the design criteria and technical benchmarking, the most effective design was the *Heat-Trak HR20-60* solution. This design had ranked the highest score of 135 and satisfies most of the design criteria requirements (See Appendix C, Table 3; Appendix D, Table 4). This design is a seasonal product, meaning that it can be removed at the end of the winter season. The design is portable and expandable, allowing for the use on stairs and in high traffic areas. The product has a non-slip surface and is very durable (2-year warranty). Compared to the other designs, it is the most cost-efficient option. The product has an on/off switch option that is automated with sensors, to minimize the amount of energy used. The minimum temperature the product can work efficiently until is -21°C (-5.8°F). The melt rate is approximately 5.08 cm/hr (2 in/hour), this was standard across all products evaluated. Overall, this design allowed for a more detailed understanding of the different requirements for an electric-based system that can be used to develop design specifications.

Comparison of Glycol/Water Mixture and Electric Heated Sidewalks Designs:

Based on the research provided, the overall design system that satisfies the design criteria is an electric-based system. The design of the system is easier to install and remove, a seasonal item. The product is more cost-efficient than the Glycol/Water mixture system, as it requires less energy to run current through a wire to generate heat, compared to increasing the temperature of a solution and then pumping it throughout the entire system. The glycol/water mixture system would also require more equipment underground such as sensors and pressure gauges, to monitor the flow of the liquid and damages within the system. Although there is no drainage system on the mat, the mat can be lifted off the ground to remove excess water. The overall technical benchmarking process provided sufficient insight on previously designed products to narrow down the design criteria to the most feasible option, in determining the design specifications.

Design Specifications:

Using the list of design criteria and the benchmarking, design specifications were developed (See Appendix G, Table 7; Appendix H, Table 8; Appendix I, Table 9). The specifications are categorized into three sections: functional requirements, constraints, and non-functional requirements. These specifications give more specific guidelines to the design criteria by setting values that need to be accomplished which will be checked in a verification process. Each specification will have an acceptable value assigned to it that will need to be obtained for the final product.

Identifying Gaps in Knowledge:

Heated sidewalks are still a relatively new concept and this leads to some gaps in knowledge. Electricity is the most prevalent technology used when the heated sidewalks are supposed to be removable, however, the glycol and water technology does not have much information available. One piece of information that is not provided for both sidewalks, is the expected cost of maintaining and using the systems. The electric-powered sidewalks do give the voltage and amperage so power consumption can be determined, and the glycol/water systems do not talk about the heat required to run the system. This information would be very helpful when working on a certain budget and will need to be determined in our solution. Another significant gap in our knowledge is the operating conditions of these products. Very little is said about what conditions they work in, and without that knowledge it is difficult to know if any of these current solutions are effective in Ottawa where it can get very cold for days at a time in the winter. One last major gap in our knowledge when it comes to the glycol/water solutions is that the scale of this system is unknown. The manufacturers do not give out the minimum or maximum sizes that these systems can be so we do not know if they are able to be scaled to the requirements that the University of Ottawa has stated. Our solution will need to meet these requirements and be scalable. To correct these gaps in knowledge, we will determine another list of questions to ask our client, Jonathan Rausseo, during Client Meet 2, along with performing additional research, and potentially reaching out to manufacturers (if possible) to gain an understanding of the aforementioned points in question.

Conclusion:

To summarize, in this Project Deliverable report, Team 5 further analyzed and updated the interpreted user needs identified in Project Deliverable B, to develop design criteria (i.e. design constraints, functional, and non-functional requirements) to satisfy each need; design criteria was also ranked by level of importance of the client's interpreted needs. This was done through the technical benchmarking process, where quantifiable technical specifications of glycol/water and electric-powered heated sidewalks were analyzed and compared to create design criteria for the Design Problem. Additionally, through reflection, Team 5 recognized the impact of Client Meet 1 on the design specifications determined in this Deliverable. After extensive research, Team 5 also determined gaps in knowledge such as operating costs of the glycol/water and electric heated sidewalks. These gaps will be corrected by determining questions for client, Jonathan Rausseo, during Client Meet 2, and by performing additional research, before brainstorming solutions for the Design Problem in future Deliverables.

Appendices:

Appendix A: Translation of Client needs into Applicable Design Criteria

Table 1: Translation of client needs into applicable design criteria

Number	**Need**	**Design Criteria**
1	Safe to walk on and ensurable slip-free surface to prevent any injuries	1. Effective drainage system 2. Maintain constant heating temperature (preventing iced-over areas) 3. Minimal voltage input with controllable heat output
2	Melt any precipitation as it is falling	1. Effective/quick melt rate
3	Storable	1. Compact design 2. Dimensions 3. Weight (lb)
4	Ability to be deconstructed and reassembled as needed (modularity)	1. Lightweight design made of lightweight materials 2. Expandability 3. Multiple sizes 4. Portability
5	Safe for the environment	1. No/minimal chemical requirements/input 2. Recyclable materials
6	Easy to maintain in good condition	1. Fabricated using durable materials (low maintenance)
7	Low cost	1. Within prototype budget of $100.00 CAD
8	Energy efficient	1. Minimal input, maximum output 2. On/Off controlled device

Appendix B: Colour Legend for Ranking Scale

Table 2: Colour Legend for Ranking Scale

Good = 3
Average = 2
Bad = 1

Appendix C: Technical Benchmarking Electric Heated Sidewalk

Table 3: Technical Benchmarking Electric Heated Sidewalks

Specifications	**Electric Heated Sidewalks**					
Company Or Name	Roof Heating Systems: RHS Snow Melting Mat/System	Power Blanket: Summer step Home DM24x36C-RES Residential Snow Melting Heated Door Mat	Cozy Products ICE-SNOW Ice-Away Heated Snow Melting Mat	HeatTrak HR20-60	HOTflake Outdoor Heated Snow Melting Walkway Mat	SEAL Snow Melting Mat
Cost	Size dependant (average: $23.85/ft^2$)	$48.33/ft^2$	$27.87/ft^2$	$9.58/ft^2$	$39.29/ft^2$	$23.19/ft^2$
Dimensions	Variable [Options Include: 2’ft x 3’ft, 2’ft x 4’ft, 2’ft x 5’ft, 2’ft x 6’ft, 2’ft x 10’ft, 2’ftx 15’ft] Thickness:1.5”	3’ft x 2’ft x 0.03’ft	3’ft x 2’ft x 0.03’ft	3’ft x 2’ft x 0.03’ft	2.67’ft x 4.67’ft x 0.01’ft.	0.92’ft x 15’ft x 0.25’f
Durability	Weight will damage heating element (wheelchair is fine)	1 year warranty	6 month warranty	2 year warranty	2 year warranty	Not listed
Weight (per ft)	10 lb	8.95lb	17 lb	11.40 lb	39.6 lb	31.4 lb
Multiple sizes	Yes	No	No	No	No	No
Expandable	No	Yes	No	Yes	No	No
Melt rate	2 inches/hour	2 inches/hour	2 inches/hour	2 inches/hou r	2 inches/hour	2 inches/h our
Non-slip surface	Yes - (sand-papaer texture)	Yes - (tacky-anti-slip durable rubber)	Yes	Yes	Yes	Yes
Voltage	540 Watts 120 Volt (~11.3 Amps for the 2’ft x 5’ft mat)	180 Watts 120 Volts 1.5 Amps	240 Watts 110 Volts 2.18 Amp	100 Watts 120 Volts 1.3 Amps	350 Watts 120 Volts 15 Amps	120 Volts
Portability	Yes	Yes	Yes	Yes	Yes	Yes
Power Cord length	5’ft	6’ft	15’ft	6’ft	6’ft	15’ft
Customer ratings	4.4/5 stars (42 ratings)	3.8/5 stars (135 ratings)	3.6/5 stars (119 ratings)	4.6/5 stars (425 ratings)	3.5/5 stars (11 ratings)	3.7/5 stars (7 ratings)
Temperature range	12℃-18℃	~4.4℃	5℃-10℃	Works up to -21℃	5℃	4℃-7℃
On/Off options	No - plug/unplug	Yes	Yes - automated	Yes - automated	No - plug/unplug	Yes

				with sensor		
Stair safe	No	Yes	Yes	Yes - as an option	Yes	No

Appendix D: Technical Benchmarking Electric Heated Sidewalk by Ranking

Table 4: Technical Benchmarking Electric Heated Sidewalks Ranking by Importance

Specifications	Importance	Electric Heat Sidewalks					
Company Or Name	N/A	Roof Heating Systems: RHS Snow Melting Mat/System	Power Blanket: Summer step Home DM24x36C-RES Residential Snow Melting Heated Door Mat	Cozy Products ICE-SNOW Ice-Away Heated Snow Melting Mat	HeatTrak HR20-60	HOTflake Outdoor Heated Snow Melting Walkway Mat	SEAL Snow Melting Mat
Cost	3	2	1	2	3	1	2
Dimensions	3	3	1	3	2	1	3
Durability	5	1	2	2	3	3	1
Weight (per ft)	3	1	2	2	2	3	1
Multiple sizes	3	3	1	1	1	1	1
Expandable	4	1	3	1	3	1	1
Melt rate	4	2	2	2	2	2	2
Non-slip surface	5	3	3	3	3	3	3
Voltage	3	1	3	2	3	1	2
Portability	5	3	3	3	3	3	3
Power Cord length	2	1	2	3	2	2	3
Customer ratings	3	1	2	2	3	2	2
Temperature range	3	3	3	3	2	3	3
On/Off options	4	1	3	3	3	1	3
Stair safe	3	1	3	3	2	3	1
Total		98	124	124	135	110	110

Appendix E: Technical Benchmarking Glycol/Water Mixture Heated Sidewalk

Table 5: Technical Benchmarking Glycol/Water Mixture Heated Sidewalks

Specifications	**Glycol/Water Mixture Heat Sidewalks**						
Company Or Name	Hydronics.com	Therma-Hexx	Hydronic Snowmelt System	SIM Systems	Metrolinx: Glycol Solution Snow Melting System	Lee's Hydronics'	Watts Heatway
Cost	roughly $40/8hr	Not listed	Not listed	Not listed	Not listed	$5-10 per square foot	12-25 cents per square foot
Approximate Area	1,000 ft²	Not listed	Not listed	Not listed	Not listed	Not listed	Not listed
Weight	Not listed	1.6 lbs. per square foot including fluid and 1 lb. density EPS insulation	Not listed	Not listed	Not listed	Not listed	Not listed
Tube Dimensions	3/4" Diameter, spaced at 9" apart, 6" below the surface	.625” OD (1/2” CTS) SDR-9	½ to one-inch diameter, 3/4-inch pipe can see loop lengths around 300 ft., 5/8-inch will see should be between 200 and 250	Tube size (3/4 NTS tubing is typical; 1/2 and 5/8 tubing is sometimes used), Tube spacing (6 to 9 inch tube spacing is typical, based on width of area), Tube circuit lengths (150 ft. to 300 ft. circuit length is typical, but this is based on load, tubing size, heated area and the selected circulator), (5 - 8 cm) below the surface	25.4 mm (1") to 38.1 mm (1 ½") diameter, Control valves 2” (50mm) and smaller shall be complete with screwed ends type, except for bronze valves installed in soldered copper piping which shall be complete with soldering ends. Control valves larger than 2” (50mm) shall be complete with flanged end type and proper flange adapters to copper shall be provided where flanged valves are installed in copper piping. The water control valves shall be sized for a pressure drop of 6 ft. water column or as indicated on mechanical drawings	Not listed	Not listed
Tube Material	O² Barrier PEX tubing	bimodal copolymer of LLDPE and HDPE with UV and chlorine	PEX tubing	PEX or PE-RT, CPVC: Chlorinated Polyvinyl Chloride, PP: Polypropylene (PP-R or PP-RCT)	Copper and other materials	Flexible polymer tubing	Flexible polymer tubing

		resistant properties					
Fluid Capacity	Not listed	.26 gallons (Imperial) (+/- 10%)	Not listed	Not listed	Not listed	Not listed	Not listed
Panel Dimensions	Not listed	23.5" x 23.5" x 1.4"	Not listed	Not listed	Not listed	Not listed	Not listed
Material: Panel or Concrete	Concrete/Asphalt	Panel: Bimodal copolymer of LLDPE and HDPE with UV and chlorine resistant properties	asphalt, concrete and sand bed	Concrete/Asphalt	Concrete/Asphalt	Concrete/Asphalt	Concrete/Asphalt
Minimum Thickness	Not listed	1" thickness	Not listed	Not listed	Not listed	Not listed	Not listed
Insulation Requirements	R10	rigid EPS or XPS foam insulation attached to the underside of the Panels	Not listed	R5-R10	Use a 50 mm (2") rigid layer of Styrofoam insulation under the tubing, Multilayered, closed-cell, PEX-foam insulation with a thermal conductivity of 0.26 BTU in./sq. ft./hour/°F; vapor permeability of 0.1g/100 sq. in./day Jacket: Corrugated seamless high-density polyethylene (HDPE), UV-protected	Not listed	Not listed
Connecting Panels/Installation	Concrete laid over tubing	Modular/panels - connected to each other with tubing of similar material to that of the Panels using fusion welding technology	Concrete laid over tubing	2-3" of concrete over and under tubing	Not listed	Yes - Put in place then concrete is poured on top	Yes - Put in place then concrete is poured on top
Maximum Pressure	Not listed	40 PSI	Not listed	Tube: 160 psi @ 73°F (1,110 kPa @ 23°C) - 100 psi @ 180°F (690 kPa @ 82°C), Actual burst pressure is well over 500 psi	The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B62 for valves rated up to 150psig (1035 Kpa) working pressure and to ASTM B61 for valves rated at 200 psig (1380 Kpa) working pressure	Not listed	Not listed
Minimum Temperature	approx. -40	approx. -41	approx. -42	approx. -43	Not listed	Not listed	Not listed

Maximum Temperature	Not listed	140°F	Not listed	Not listed	Not listed	Not listed	Not listed
Requires Anti-Freeze	Yes - glycol/water solution	Yes - glycol solution	Yes - glycol mixture	Yes - glycol/water solution	Not listed	Yes - Glycol and water mixture	Yes - Glycol and water mixture
Coil/tubing imbedded in product	Yes - tubing embedded throughout concrete	Yes - tubing laid throughout panel	Yes - using a double serpentine, reverse-return or double spiral model	Yes - tubing embedded throughout concrete	Not listed	Not listed	Not listed
Sensors	Not listed	Not listed	Not listed	Not listed	Yes - inslab and outslab	Not listed	Not listed
Seal Check	Not listed	Not listed	Helium is often used to find leaks. The system is drained and filled with helium.	Not listed	Not listed	Not listed	Not listed
Oxygen Barrier	Yes	No	Not listed	Yes	The oxygen diffusion barrier does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 40 °C (104 °F) water temperature in accordance with German DIN 4726 Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated: 1) 12.7 mm (½"); 2) 19.05 mm (¾"); 3) 25.4 mm (1")	Not listed	Not listed
Heating Requirement	150,000 BTU/h	Not listed	200 and 220 BTUs per sq. ft. per hour - Requirements for busy streets and emergency exits	150,000 Btuh	Not listed	Not listed	100 to 150 Btu per square foot of slab surface required
Operating Conditions	Not listed	Not listed	Not listed	Not listed	-50°C to 95°C (-58°F to 203°F) at 87 psig	Heated 140-180f	Not listed
Temporary/long term	Long Term	Long Term	Long Term	Long Term	Long Term	Long Term	Long Term
Pump required	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix F: Technical Benchmarking Glycol/Water Mixture Heated Sidewalk by Ranking

Table 6: Technical Benchmarking Glycol/Water Mixture Heated Sidewalks By Ranking

Specifications	**Importance**	**Glycol/Water Mixture Heat Sidewalks**						
Company or Name	N/A	Hydronics.com	Therma-Hexx	Hydronic Snowmelt System	SIM Systems	Metrolinx: Glycol Solution Snow Melting System	Lee's Hydronics'	Watts Heatway
Cost	3	2	1	1	1	1	2	3
Approximate Area	3	2	1	1	1	1	1	1
Weight	3	1	3	1	1	1	1	1
Tube Dimensions	2	3	3	3	3	3	1	1
Tube Material	3	3	3	3	3	2	3	3
Fluid Capacity	2	1	3	1	1	1	1	1
Panel Dimensions	4	1	3	1	1	1	1	1
Material: Panel or Concrete	4	2	3	2	2	2	2	2
Minimum Thickness	2	1	3	1	1	1	1	1
Insulation Requirements	3	3	3	1	3	3	1	1
Connecting Panels/Installation	4	2	3	2	2	1	2	2
Maximum Pressure	2	1	3	1	3	3	1	1
Minimum Temperature	2	3	3	3	3	1	1	1
Maximum Temperature	2	1	3	1	1	1	1	1
Requires Antifreeze	4	3	3	3	3	1	3	3

Coil/tubing imbedded in product	3	2	3	3	2	1	1	1
Sensors	3	1	1	1	1	2	1	1
Seal Check	3	1	1	3	1	1	1	1
Oxygen Barrier	4	3	1	1	3	3	1	1
Heating Requirement	4	2	1	3	2	1	1	3
Operating Conditions	4	1	1	1	1	2	2	1
Temporary/long term	5	2	2	2	2	2	2	2
Pump required	4	3	3	3	3	3	3	3
Total		143	166	136	141	122	115	122

Appendix G: Design Specifications Functional Requirements

Table 7: Functional Requirements

	Design Specifications	*Relation (<,>,=)*	*Value*	*Units*	*Verification method*
	Functional Requirements				
1	Melt rate	>	2	Inches/hour	Test
2	Heating system	=	Yes	N/A	Test
3	Drainage	=	Yes	N/A	Test
4	Portable	=	Yes	N/A	Test
5	Slip-resistant	=	Yes	N/A	Test
6	Multiple Sizes	=	Yes	N/A	Test

Appendix H: Design Specifications Constraints

Table 8: Constraints

	Design Specifications	*Relation*	*Value*	*Units*	*Verification method*
	Constraints				
1	Cost	<	100	$	Estimate, final check
2	Dimensions	<	3 x 2 x 0.03	ft	Analysis
3	Weight	<	8	lbs/ft	Analysis
4	Operating conditions: temperature	>	-40 to 20	°C	Test

5	Operating conditions: snow, ice, salt and sand	=	Yes	N/A	Test

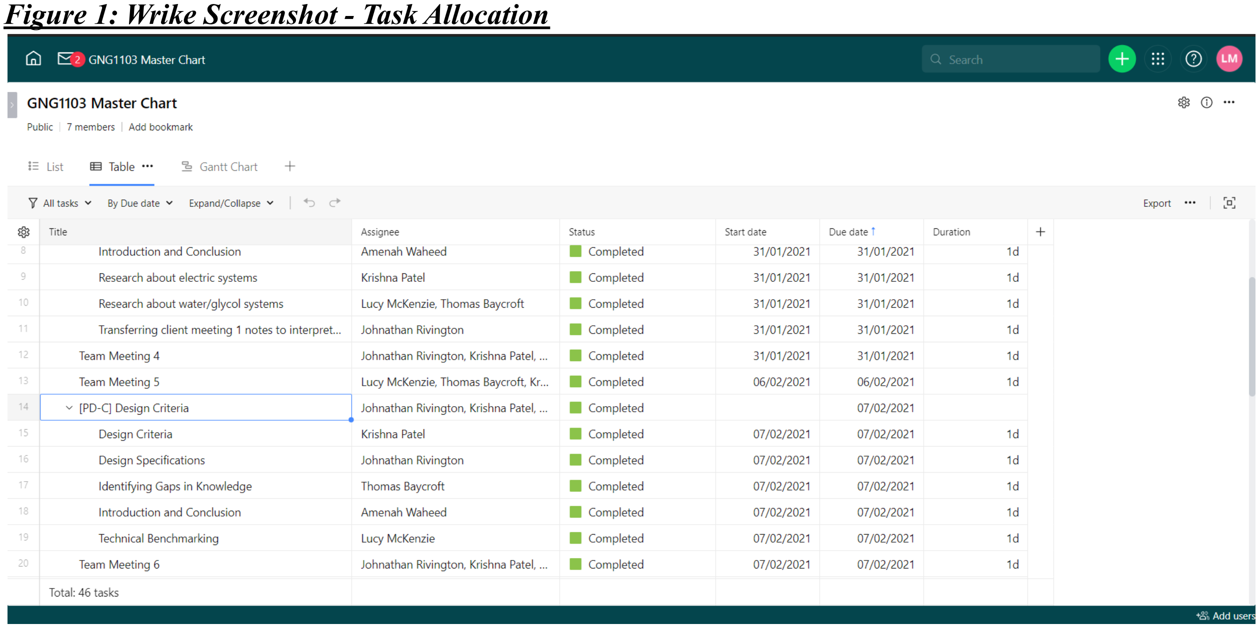
Appendix I: Design Specifications Non-Functional Requirements

Table 9: Non-Functional Requirements

	Design Specifications	*Relation*	*Value*	*Units*	*Verification method*
	Non-functional Requirements				
1	Durable	=	Yes	N/A	Test
2	Chemical requirements	=	No	N/A	Analysis
3	On/off option	=	Yes	N/A	Test
4	Product life	>	15	years	Analysis
5	Level changes	=	No	N/A	Test

Appendix J: Wrike Screenshot

Figure 1: Wrike Screenshot - Task Allocation



GNG1103 Master Chart

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List | Table | Gantt Chart

All tasks | By Due date | Expand/Collapse | Export

	Title	Assignee	Status	Start date	Due date	Duration
8	Introduction and Conclusion	Amenah Waheed	Completed	31/01/2021	31/01/2021	1d
9	Research about electric systems	Krishna Patel	Completed	31/01/2021	31/01/2021	1d
10	Research about water/glycol systems	Lucy McKenzie, Thomas Baycroft	Completed	31/01/2021	31/01/2021	1d
11	Transferring client meeting 1 notes to interpret...	Johnathan Rivington	Completed	31/01/2021	31/01/2021	1d
12	Team Meeting 4	Johnathan Rivington, Krishna Patel, ...	Completed	31/01/2021	31/01/2021	1d
13	Team Meeting 5	Lucy McKenzie, Thomas Baycroft, Kr...	Completed	06/02/2021	06/02/2021	1d
14	[PD-C] Design Criteria	Johnathan Rivington, Krishna Patel, ...	Completed		07/02/2021	
15	Design Criteria	Krishna Patel	Completed	07/02/2021	07/02/2021	1d
16	Design Specifications	Johnathan Rivington	Completed	07/02/2021	07/02/2021	1d
17	Identifying Gaps in Knowledge	Thomas Baycroft	Completed	07/02/2021	07/02/2021	1d
18	Introduction and Conclusion	Amenah Waheed	Completed	07/02/2021	07/02/2021	1d
19	Technical Benchmarking	Lucy McKenzie	Completed	07/02/2021	07/02/2021	1d
20	Team Meeting 6	Johnathan Rivington, Krishna Patel, ...	Completed	07/02/2021	07/02/2021	1d

Total: 46 tasks

References:

Amazon.com : RHS Snow Melting Mat, Heated Outdoor Walkway, Melts 2 inches o of Snow per Hour, Color Black, Anti-Slip Traction, Sandpaper Design, Prevents Ice Accumulation, Size 2-feet x 5-feet : Garden & Outdoor. (n.d.). Retrieved January 30, 2021, from https://www.amazon.com/gp/product/B079H3DSKC/ref=ask_ql_qh_dp_hza

Amazon.com : SEAL Snow Melting Mat, 120V Heated Snow Melting Non-Slip Walkway Outdoor Mat, UL Certified Components, for Residential and Industrial Use (11in x 15ft) : Garden & Outdoor. (n.d.). Retrieved January 30, 2021, from https://www.amazon.com/dp/B08LP67VHW/ref=sspa_dk_detail_0?psc=1&pd_rd_i=B08LP67VHW&pd_rd_w=vGOer&pf_rd_p=b34bfa80-68f6-4e86-a996-32f7afe08deb&pd_rd_wg=qepnO&pf_rd_r=FNJFAAH0FWX9YB9GAWYJ&pd_rd_r=4b0688a6-36fd-44fb-8f4d-80ab46bb2ade&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyTVhZQjVPWk5DQU5XJmVuY3J5cHRlZElkPUEwMTY2MTQwMVE1UFRPUkpUN0RPRyZlbmNyeXB0ZWRBZElkPUEwMjU5MTM2M0xXNEVaTzFRRlIxTiZ3aWRnZXROYW1lPXNwX2RldGFpbCZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=

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