Level 2 Gen 2 HMC Project Requirements

L2-RQMT ID	Requirement	Level 1 Trace	Rationale / Comment
L2.1	**Non-Hazardous Trash**		
L2.1.1	The HMC shall process the average trash composition expected, which is captured by the logiistisc trash model. The logistics trash model is: 21.8% cloth, 0.8% paper, 2.6%dry wipes, 7.4% wet wipes, 0.6% disinfectant wipes, 2.8% nitrile gloves, 0.9% shampoo, 0.4% toothpaste, 0.9% chewing gum, 0.4% duct tape, 23.4% food, 7.6% polyethyline terephthalte, 27.4% polyethylene, 0.8% aluminum foil., and 2.2% sweat solids (mostly NaCl). The HMC shall be able to process some variation from the logistics trash model as follows	L1.1.1	expected overall average trash composition.
L2.1.1.a	The HMC shall be able to process items similar to those listed in the logistics trash model.	L1.1.2, L1.1.4	It is not possible to list everything that may go in the trash, but so long as the items are similar to those in the logistics model, the HMC will be able to handle them.
L2.1.1.b	The HMC shall process trash cases that include any of the components of the logistics trash model in different percentages with the following limitations: At least 15% of plastics that melt at or below 140 C (e.g. PE) No more than 40% food; No more than 50% cloth.	L1.1.3	Trash can vary in content, but production of geometrically stable tiles requires limits on key components. The HMC may be able to process loads outside of these limits, but the resultant tile may have poor shape and stability characterisics.
L2.1.1.c	The HMC shall demonstrate the capability to compress foam exclusively. The amount of foam compressed shall be limited by the operational requirements in requirement L2.5.9.	L1.1.3	Typical foams Zotek, Minicell and Pyrell all have very high M.Pts, mostly above the HMC processing temperature. Unless they melt, compaction ratio will only be about 3-4 unlike the model trash where compaction ratio of 10-20 is possible. If the foam does not soften and become tacky at the operating temperature
L2.1.2	The HMC shall be capable of processing the maximum amount that can fit within the volume, power and cooling limitations of an EXPRESS rack double Middeck Locker Equivalent.	L1.1.6	
L2.1.3	The trash processing cycle shall include loading of the trash, processing to remove water and form the tile, and removal of the tile.	L1.1.8	Trash processing cycle time is defined in Level 1 as NTE 14 hrs with a goal of 8 hrs.
L2.2	**Deleted**		
L2.3	**Processed Trash, Geometrically Stable**		
L2.3.1	Shape of compacted tile should minimize the void volume when stored in a minimum sized single (full) CTB (30% or less voids).	L1.3.9, L1.3.10	Greg Pace: this means that the tiles will be sized to 9.0 inches in diameter assuming the one CTB inner dimension is 9.13 inches. 2 rows of 9.0 inch tiles leaves a void space of ~ 28%. The other configuration is based on dividing the 16.1 inch dimension by 2 and using 8.0 in tiles and 4 rows but that leaves a void space of ~ 36%). The minimum diameter/volumes that I mentioned in level 1.1.7 are minimums based on round tile, square tiles with a side length equal to round tile diameter will have greater volumes
L2.4	**Water Recovery / Water Containment**		
L2.4.3	The HMC should limit liquid squeezed out from the trash compaction to less than 5% of total liquid content.		The intent is to perform a phase change so that recovered water is clean and poses less of burden to down stream water recovery. Additionally, it will reduce fouling of the HMC condensation and contaminant control hardware.
L2.5	**Operations**		
L2.5.1	The HMC shall be capable of being stopped, safed and opened at any time during the trash or brine processing cycle.		
L2.5.2	The HMC shall operate in manual and automatice modes		
L2.5.3	The HMC shall be capable of interfacing with the ISS laptop	L1.7.7	
L2.5.4	The HMC shall be capable of receiving software uploads from an external source	L1.7.7	
L2.5.5	The HMC shall be capable of being operated from its front panel.	L1.7.7	
L2.5.6	The HMC should permit changing operating parameters on orbit.	L1.7.7	Changing processing time, temperatures or pressures could allow the operator to tailor the process to a unique
L2.5.7	The HMC shall monitor the position of the ram in the compaction chamber		
L2.5.8	The HMC shall monitor the position of the ram in the compaction chamber		
L2.5.9	The HMC shall provide the ability to normally remove tiles with a thickness up to 1/5 of the ram full stroke distance. The HMC shall provide the ability to remove tiles with a thickness of 1/3 of the ram full stroke distance without disassembly of the hardware.	L1.3.2	There needs to be a capability to remove low density or low plastic (high springback) tiles. The requirement will allow research for compacting foams.
L2.6	**Reliability and Maintainability**		
L2.6.1	The HMC shall operate after cleaning or repair to remedy biofouling or precipitation.	L1.8.1	
L2.6.2	The HMC design shall minimize biofilm and precipitate formation.	L1.8.1	
L2.6.3 REMOVE	The HMC shall operate after non-operation for 18 months.	L1.8.1	The rational is to prevent microbial buildup in fluid lines and condensor during dormant periods of up to 18 months. Rationale based on notional Gateway launch manifest frequency

L2.6.4	The HMC shall be able to be operated after being stopped in any part of the processing cycle.	L1.8.1	
L2.6.5	The HMC shall be designed for maintainability.	L1.8.1	
L2.6.6	The HMC shall be able to be placed in a safe mode after a failure.		
L2.6	**Structural/Mechanical**		
L2.6.1	The dimensions of the flight like portions of the Gen2 HMC shall conform to those of a double Express Rack Payload	L1.6.2	During some cases of compaction and water recovery we may want to stop the ram in a position
L2.6.2	The HMC should provide the capability to set the position of the ram in the compaction chamber		
L2.6.3	HMC materials shall be resistant to degradation due to thermal cycling and exposure to melted trash, brine and brine processing products.		Austin: replaced "thermal fluctuations" with "thermal cycling"
L2.6.4	The HMC shall use factors of safety of 1.25 on yield strength and 1.4 on ultimate strength for structural design and analysis		Emphasing flight requirements rather than NASA ground system requirements. SSP 30559 Section 3.3 (Structural Design and Verification Requirements for ISS) Mark Turner: use Ames APR 8070.1 Section 4.4.3 flight system design requirements
L2.6.5			
L2.7	**Electrical/Power**		
L2.7.1	TheHMC electrical power consumption shall not exceed 1000 Watts but should be less than 500 Watts.	L1.6.4	IAW SSP-52000: 0-500W per single MDL position (1KW per DBL). Greg Pace: This does not include hardware unique to the ground situation that will not occur in flight, for example a device that produces DC voltage from AC voltage is lossy and the losses are not part of the HMC system, but come before the system
L2.7.2	The flight like portions of the HMC shall utilize 28 Volts DC electrical power input in accordance with SSP 52000 - IDD - ERP	L1.6.4	Greg Pace: 24 Volts DC allowable for the Gen2 (cost or schedule)? EMI/EMC is covered within the SSP 52000
L2.7.3	The HMC should be capable of operating with reduced power and extended process cycle time up to 24 hours.	L1.7.4	We'd like the capability to test the Gen2 to determine how best to operate the system.
L2.8	**Thermal Control/Cooling**		
L2.8.1	The HMC shall monitor and control temperature of the internalcompaction chamber surfaces during operation		Will want to monitor the temperature of many locations in the compaction chamber - heating elements, various surfaces.
L2.8.3	The HMC shall meet the themal requirements of SSP 52000-IDD-ERP.	L1.7.5	Capacity of crew HVAC system to cool heat generated by HMC should be determined (Andy Hong: The HMC's external surfaces shall not transfer more than xx Watts of heat to the cabin air.) (SSP 52000 - IDD-ERP: Ducted cooling via Avionics Air Assembly (AAA) is ≤200 W per payload position for MDL)
L2.8.4	The HMC should utilize avionics air cooling only.	L1.7.5	Flight opportunities are more frequent for payloads that use Avionics Air cooling rather than Moderate Temperature Liquid (MTL) Coolant loop. (SSP 52000 - IDD-ERP: Ducted cooling via Avionics Air Assembly (AAA) is ≤200 W per payload position for MDL. Water cooling via the moderate temperature water loop is 500 W per payload position.)
L2.8.5	The uniformity of temperature on the surface of the tile (measured by temperature sensors on the metal surfaces contacting the trash) at the end of the run after water has boiled off and tile is being held for sterilization shall be no greater tha 10 degrees C , with a goal of 5 degrees C	L1.3.5	Needed for reasonable process control and sterilization. Such uniformity of temperature control has already been demonstrated on Gen1.
L2.8.6	The HMC shall provide the ability to heat the sidewalls of the chamber around the area where the tile is finally compressed as well as the sidewalls down to the limit of the ram full retraction.	L1.4.1	Plans to prevent squeezed out water require heat at the edges of the tile, and investigation of the best means for water removal generally and final heating sequence require flexibility in the Gen 2 hardware. This flexibility will enable establishing the best heating sequence for the Gen 3 hardware.
L2.8.7	The heating system of the HMC shall dry the residual solids in the tiles to an average of less than 60% water activity. This dried tile shall have no unencapsulated free water (water that can migrate through porous tile regions after processing) that cause microbial regrowth.	L1.4.1	It is desired to investigate methods of avoiding squeezed out water and methods of avoiding encapsulated water. For example it may be desirable to heat the center to 80 C, the wall to 70 C and let the intermediate area be cooled by the evaporating water. The hot wall helps vaporize water that would otherwise be squeezed out, and a hot center drives the water from the center to the walls. As the water is boiled off the center temperature can be raised to melt followed by the intermediate areas and finally by the wall heaters. It is also desireable to have a temperature gradient for the final melting of the plastic - melt from the middle to the outside to prevent blocking of the gas exit at the outside edge due to melted plastic at the edge.
L2.8.8	The HMC shall be capable of being operated in a degraded mode after the loss of any one heating element.		Unit should be robust. There have been incidents of foil type heaters on-orbit. The rational is to size each heater with additional capacity .
L2.8	**Human Interface**		
L2.8.1	Average human interaction for a single trash processing cycle should not exceed 10 minutes	L1.7.8	Crew time is valuble and therefore should be minimized for HMC opperation
L2.8.2	Average human interaction for a single brine processing cycle should not exceed 20 minutes	L1.7.8	
L2.9	**Safety**		
L2.9.1	The HMC shall not allow access to the compaction chamber during the compaction cycle.	L1.7.10, L1.9.1	

L2.9.2	The HMC shall not allow the compaction chamber door to be opened until temperatures of any exposed surfaces accessible to the operator are below 40 deg C.	L1.7.10, L1.9.1	Greg Pace: also need to add that no surfaces of the hardware exposed to the crew during normal operations can get above 40 C
L2.9.3	The HMC should not permit the compacted tile to be freely ejected from the compaction chamber	L1.7.10, L1.9.1	Is there a hard requirement or an upper energy limit?
L2.9.4	The HMC external surfaces shall not exceed ISS touch temperature requirements per SSPxx.xx.xx.	L1.7.10, L1.9.1	The HMC shall not have any exposed external surfaces that exceed 113 F. or The HMC external surfaces shall not exceed ISS touch temperature requirements per SSPxx.xx.xx.
L2.9.5	The surface temperature of the tile shall meet the touch temperature requirements when accessible to the operator (crew)	L1.7.10, L1.9.1	Ed Austin: This requirement previously was numbers L2.3.2, but since it's a safety requirement, I moved it here.