Hull Parameterization Constraint Definitions

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The following table defines the algebraic constraints defined in the HullParameterization code. These algebraic constraints were defined such that satisfying these constraints will lead to producing a hull mesh that does not intersect itself and is watertight. The index listed in the table is the index of the constraint from calling the hull.input_Constraints() function. Many of these constraints are defined for human generation of a parametric hull. Some of these constraints were automatically satisfied simply by the range for particular terms for the random generation of hulls for the dataset.

Hull Section	Constraint Index	Satisfaction Criteria
Principle Dimensions	0	Lb + Ls < 1 so that the bow taper and the stern taper are confined within LOA
	1	WL < 1 so that any bulb definition does not
Cross Section	2	The intersection of the gunwale and the chine filet is above the height of the chine, Dc
	3	Rc > 1 – 'Chine radius is strictly positive'
	4	Bc > 1 – 'Beam at the chine is strictly positive'
	5	Dc > 1 – 'Height of the chine is strictly positive.' Dc is defined algebraically with Rk, Beta, and Bc.
	6	The intersection of the chine fillet and the hull bottom is inboard of Bc. This avoids jump discontinuities in the mesh.
	7	The intersection of the (keel radius and the hull bottom) is inboard of the intersection of the (chine radius and the hull bottom). This avoids jump discontinuities in the mesh
	8	Rk is not equal to exactly 0. This avoids divide-by-zero errors in solving for the hull. This defined with some margin so |Rk| > 1e-8
Bow Section	9	The start of the keelrise at the bottom of the hull is forward of DELTA_BOW at Z = 0. This avoids jump discontinuities in the mesh and provides some length for bow taper to happen
	10	The drift angle at Z = 0 is less than 90 degrees. This constraint avoids errors in solving for the bow taper.
	11	The drift angle at Z = 0 is greater than or equal to 0. This constraint avoids errors in solving for the bow taper.
	12	The drift angle at Z = Dd is less than 90 degrees. This constraint avoids errors in solving for the bow taper.
	13	The drift angle at Z = Dd is greater than or equal to 0. This constraint avoids errors in solving for the bow taper.
	14	The drift angle at Z where Z is the vertex of the drift angle parabola function is less than 90 degrees. This constraint is only considered if the vertex is between Z = 0 and Z = Dd. This constraint avoids errors in solving for the bow taper. All the drift angle constraints ensure that the drift angle is between 0 and 90 degrees across the depth of the hull
	15	The drift angle at Z where Z is the vertex of the drift angle parabola function is greater than or equal to 0 degrees. This constraint is only considered if the vertex is between Z = 0 and Z = Dd. This constraint avoids errors in solving for the bow taper. All the drift angle constraints ensure that the drift angle is between 0 and 90 degrees across the depth of the hull
	16	The intersection of the bow rake and the keel rise, BKx, is at an X >= 0.
	17	The intersection of the bow rake and keel rise, BKx, is forward of the start of the keel rise along the bottom of the hull
	18	The height of the intersection of the bow rake and keel rise, BKz, is greater than or equal to 0
	19	The height of the intersection of the bow rake and keel rise, BKz, is less than or equal to Dd
	20	The length of the bow taper at Z = Dd is positive.
	21	The length of the bow taper at Z = BKz is postiive

	22	The length of the bow taper at Z, where Z is the vertex of the parabolic function defined by DELTA_BOW, is positive. This constraint only applies of the vertex of DELTA_BOW is between Z = 0 and Z = Dd
	23	The length of the bow taper at Z, where Z is the vertex of the parabolic function defined by BOW (the bow rake) is positive. This constraint only applies of the vertex of BOW is between Z = 0 and Z = Dd
Stern Section	24	The start of the stern rise at the bottom of the hull is aft of DELTA_STERN at Z = 0. This avoids jump discontinuities in the mesh and provides some length for stern taper to happen
	25	The stern taper at Z = SKz, the height of the intersection between the stern rise and the transom, is positive
	26	The stern taper at Z, where Z is the vertex of the parabolic function defined by DELTA_STERN, is positive. This constraint only applies of the vertex of DELTA_STERN is between Z = 0 and Z = Dd
	27	The stern taper at Z = Dd is positive.
	28	The intersection of the transom and stern rise, SKx, is aft of the start of the stern rise along the bottom of the hull
	29	The beam of the transom chine is less than the beam of cross section at the height of the transom chine
	30	The intersection of the transom gunwale and the transom chine filet is above the height of the transom chine, Dc_trans
	31	Rc_trans > 1 – 'Transom chine radius is strictly positive'
	32	Bc_trans > 1 – 'Beam at the transom chine is strictly positive'
	33	Dc_trans > 1 – 'Height of the transom chine is strictly positive.' Dc_trans is defined algebraically with Rk_trans, Beta_trans, and Bc_trans.
	34	The intersection of the transom chine fillet and the transom bottom is inboard of Bc_trans. This avoids jump discontinuities in the mesh.
	35	The intersection of the (transom keel radius and the transom bottom) is inboard of the intersection of the (transom chine radius and the transom bottom). This avoids jump discontinuities in the mesh
Bulb Forms Note: Bulb constraints only activated if Bit_BB or Bit_SB are activated	36	Bulbous Bow, BB, lower vertical radius is less than Rk
	37	BB longitudinal radius is less than Rk
	38	BB beam is less than the beam of the hull cross section at Z = the lower vertical radius of BB
	39	BB is forward of DELTA_BOW at Z = 0
	40	BB is forward of DELTA_BOW at Z = the vertex of DELTA_BOW if the vertex is between Z and WL
	41	BB is forward of DELTA_BOW at Z = WL
	42	Bulbous Stern, SB, lower vertical radius is less than Rk
	43	SB longitudinal radius is less than Rk
	44	SB beam is less than the beam of the hull cross section at Z = the lower vertical radius of SB
	45	SB height overall (HSBOA) is less than SKz
	46	SB is aft of DELTA_STERN at Z = 0
	47	SB is aft of DELTA_STERN at Z = HSBOA
	48	SB is aft of DELTA_STERN at Z = the vertex of DELTA_STERN if the vertex is between Z = 0 and HSBOA.