

LSC Pre-Preliminary Design
SHP 0071-0074 and 0078 Ground Rules
Flexibility: Additional Feasibility Excursions for
CEP Approach

22 July 2020

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Intent: LSC Set-Based-Design Evaluation and Affordability Analysis

Based on the evaluation of Capability Extension Program (CEP) SHPs 0067 and 0068 with forward fit hull extensions (Reference 1), additional analyses have been proposed to investigate:

1. Revised IPS machinery arrangements and configurations to address concerns with machinery locations, and LCG/trim concerns (SHP 0071 and SHP 0078)
2. The potential for retro-fitting a revised/lengthened bow section in lieu of a midship hull insert as a means of providing future growth capability (SHP 0072).
3. Alternate motor configurations to support future speed growth with CEP (SHP 0073 & SHP 0074)

These concepts are intended to support evaluation of the LSC Pre-Preliminary Design Flexibility Tradespace (WBS 8.0), and are more fully described below;

- **SHP0071: Improved Arrangement CEP + Increased Sustained Speed (PMM Constant)**
 - This SHP Concept Excursion will investigate a modification of the SHP 0068 concept (Ref 1) to improve the LCG balance and increased sustained speeds.
 - It will be used to evaluate the feasibility of achieving an acceptable trim range on a both intended Block 1 and Block Future CEP designs.
 - This excursion will include two variants;
 - SHP 0071A, a lengthened CEP vessel (as described in the Hull Length section, below) with additional warfighting capability (WSS 30) outfitted in the mid-body hull section forward of MMR1. It will be outfitted with larger PMMs and increased Power Generation capability (in comparison to SHP 0068) to allow the vessel to attain a 30kt sustained speed and meet ASM-SHP-005 while equipped with WSS 030.
 - SHP 0071, the Base Model vessel without CEP, will be outfitted with the same PMMs and Power Generating plant as SHP 0071A, [sustained speed will be calculated as a product of the reduction in hull length required for the CEP.](#)
 - These concepts will maintain the same PMM motors between concepts, and achieve increase sustained speed by increasing ship length.
 - This variant will rearrange the main machinery to locate the Main GTGs under the forward deckhouse, and move the propulsion motors further forward to improve LCG and reduce shaft rake. Initial threshold requirements for separation between propulsion and power generation associated with the Main GTGs, forward APU and supporting Diesel Generator will be maintained.
 - This will require rearranging the APUs. Based upon latest VUL ASM discussions, the APU installation will be reduced to 2 MW to make between 5-7 kts on the APU – which will allow greater arrangements flexibility than 3 MW APU installation on SHP0068.
 - This excursion will also evaluate the Affordability impact of increasing the sustained speed of a Base Model variant to 30 kts. Based upon 4.0 studies on the relationship

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between powering and length, it is anticipated that the installed power for 29 kts on the ~160 m LBP “base model” will be the driver for installed power, and will allow the design to make 30 kts sustained at the longer “full capability” ship at approximately 176 m LBP.

- **SHP0078: Improved Arrangement CEP + Increased Sustained Speed (AIM Constant)**
 - This SHP Concept Excursion will provide a direct comparison of CEP feasibility and Affordability of an IPS ship outfitted with Advanced Induction Motors (AIMs), versus the PMMs equipped on SHP0071.
 - It will investigate a modification of the SHP 0068 concept (Ref 1) to improve the LCG balance and increased sustained speeds.
 - It will be used to evaluate the feasibility of achieving an acceptable trim range on a both intended Block 1 and Block Future CEP designs.
 - This excursion will include two variants;
 - SHP 0078A, a lengthened CEP vessel (as described in the Hull Length section, below) with additional warfighting capability (WSS 30) outfitted in the mid-body hull section forward of MMR1. It will be outfitted with AIM motors and Power Generation capability to allow the vessel to attain a 30kt sustained speed and meet ASM-SHP-005 while equipped with WSS 030.
 - SHP 0078, the Base Model vessel without CEP, will be outfitted with the same AIMs and Power Generating plant as SHP 0078A, [sustained speed will be calculated as a product of the reduction in hull length required for the CEP.](#)
 - These concepts will maintain the same AIM motors between concepts, and achieve increase sustained speed by increasing ship length.
 - This concept will have the same machinery arrangement as SHP0071.
 - Locate the Main GTGs under the forward deckhouse, and move the propulsion motors further forward to improve LCG and reduce shaft rake. 2 MW APU.
 - Maintain initial threshold requirements for separation for POG+PRO equipment.
- **SHP0072: Bow Extension CEP + Increased Speed by 1 knot (PMM Constant)**
 - This SHP Concept Excursion will investigate the feasibility of a ship with Integrated Propulsion System (IPS) configured to allow an alternate/lengthened bow section as a mid-life upgrade.
 - [The modification to the bow is intended to provide additional hull arrangeable area to install Block Future WSS capability, as well as improve the speed-power performance of the hullform. This excursion will evaluate an alternative to a mid-body hull extension, which requires parallel midbody and interrupts a large percentage of distributed systems running through the center of the ship. A bow modification or replacement will change all of the lines forward of full-beam section of the ship, approximately 35% aft of](#)

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forward perpendicular, however the bow section is significantly less densely populated with distributed systems and complex outfitting.

- This excursion will consist of two variants.
 - SHP 0072, a 176m LBP Base Model variant of SHP 0044 with TOP 21 and WSS 29. The machinery architecture will leverage SHP 44, and sustained speed will be calculated as a product of the reduction in Bow CEP Length.
 - SHP 0072A, a CEP variant of SHP 0044, configured with revised/enlarged bow (as described in the Hull Length section, below), to add CEP systems (WSS 30) at the forward end of the ship. The added hull section at the bow will target a sustained speed of 30 knots on the same machinery architecture as SHP 72.
- The Block 1 weapons and sensors arrangements will be based on SHP0044, and Block Future capability systems will be incorporated in the new enlarged bow section, in lieu of a amidships hull extension investigated in other excursions.
- They will not include an APU.
- **SHP0073: Single Hull + Increased Speed by 3 knot (AIM and POG Increase)**
 - This SHP Excursion will investigate the feasibility of a 'Single Hull' approach to providing increased future warfighting and speed-performance capability on an IPS ship.
 - A Single Hull concept provides the ability for WSS Block Future equipment to be backfit within the initially delivered hull, and the capability for increased sustained speed by installing additional POG+PRO equipment in a forward fit only.
 - The excursion will be delivered with single stator Advanced Induction Motors (AIM), power generation sized to accommodate Block 1 electrical loads and an initial sustained speed of 27kts. The single hull will provide Large Reservation Capacities to install additional warfighting capability, propulsion, and power generation in the Block Future variant. The advantage of this Single Hull Approach, compared to an equivalent CEP concept, is that additional POG+PRO equipment reservations can be allocated within existing machinery compartments versus alongside the WSS Block Future reservation intended in the CEP hull section.
 - Machinery arrangements will be based on SHP 0044, with sufficient separation between POG+PRO systems to achieve a minimum of VUL group 2 and potentially VUL group 3 capability. This machinery arrangement provides Improved Vulnerability capability over the midship CEP concepts, while also reducing the material cost of the added APUs.
 - This excursion will not include an APU.
 - This excursion will consist of two variants.
 - SHP 0073, a Single Hull Block 1 variant of SHP 0068B with unassigned area/volume in the same subdivision forward of MMR1, as CEP Extension Concept SHP 0071A, for meeting required Block Future capabilities. It will be configured with single stator AIM motors, and power generation in accordance

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- with ASM-SHP-005 while equipped with WSS 029. Target sustained speed is 27kts.
 - SHP 0073A, a Single Hull Block Future variant of SHP 0068 with additional warfighting capability (WSS 30) installed in the reserved space of SHP 0073. A second stator will be added to those of SHP 0073 (2 stators per shaft), and power generation will be installed to meet ASM-SHP-005 while equipped with WSS 030. Target sustained speed is 30kts.
 - It will also evaluate Affordability impact of designing a single hull with the ability to increase sustained speed by 3 knots along with significant future combat system upgrades.
- **SHP074: Mid-body CEP + Increased Speed by 3 knot (AIM and POG Increase)**
 - This SHP Concept Excursion will investigate the feasibility of an IPS ship to increase sustained speed to 30knots by installing additional POG+PRO equipment along with WSS Block Future capability within a mid-body CEP. This excursion will initially deliver single stator Advanced Induction Motors (AIMs) sized to achieve 27 knots sustained speed, and be configured to accept a second set of stators as a “Pre-Planned Extension,” to achieve 30 knots. Similarly, the power generating plant will be initially sized to meet a 27 kts sustained speed at delivery, and additional POG will be added alongside the additional AIM stators.
 - This excursion will consist of two variants
 - SHP 0074, a Base Model vessel without CEP, outfitted with single stator AIM motors, and power generation in accordance with ASM-SHP-005 while equipped with WSS 029. The target sustained speed will be 27kts.
 - SHP 0074A, a CEP variant of SHP 0074 (lengthened as described in the Hull Length section, below) with additional warfighting capability (WSS 30) outfitted in the added hull section forward of MMR1. A second set of AIM stators will be installed, in addition to those outfitted on SHP 0074 (the additional stator on each shaft will be added in the CEP hull section). These additional stators will be sized as needed to meet the sustained speed target of 30 knots. Power generation will be installed to meet ASM-SHP-005 while equipped with WSS 030.
 - This excursion will include the same APU sizing as SHP0071.

Requirement Set (REQ)

These SHP Excursions will adhere to the same Requirements as the FY20 Benchmarks, REQ-007 with some exceptions, as defined in the FY20 Benchmarking Study Guide, Ref [2]. Additionally, both the initially delivered warfare system and the future warfare system (WSS) installed along with the

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lengthened bow section will be deviations from the Initial Threshold Requirement Set. Specific WSS considerations will be discussed below in 'Approach.'

The SHP0071 and SHP0078 Concepts, designed for a mid-body hull extension, will have the following deviations from the REQ-0007:

- **Sustained Speed:** Sustained Speed will be achieved in accordance with the FY20 Benchmark requirements (30 kts) on the Block Future CEP hull variant. SHP0071 without CEP installed will be designed in accordance with the FY20 Benchmark requirements to meet 29 kts Sustained Speed.
- **Service Life Allowances (SLA):** Traditional SLAs will be provided for SHP0071A. The ability to lengthen the hull with a mid-body section will provide weight and space allowance for the initially delivered shorter Hull variant (SHP0071).
- **Energy/Time on Station:** Will be calculated for SHP0071.
- **Limiting Environmental Conditions:** The same as SHP0068A (Ref 1).
- **Vulnerability** – Same as VUL Set #1 SHPs 0065-0066 but with resized APU to 2 MW total installed power
- **Manning & Accommodations** – The total accommodations for SHP0071 will be 366, in accordance with WSS 29. The additional accommodations for the 24 Embarked Staff and Composite Warfare Commander will be added in the CEP variant.

The SHP0072 Concept, configured with an extended bow section, will have the following deviations from the REQ-0007:

- **Sustained Speed:** Sustained Speed will be achieved in accordance with the FY20 Benchmark requirements (30 kts) on the Block Future CEP hull variant. SHP0072 without CEP installed will be designed in accordance with the FY20 Benchmark requirements to meet 29 kts Sustained Speed.
- **Service Life Allowances (SLA):** Traditional SLAs will be provided for SHP0072 (representing the ship with its lengthened bow section).
- **Energy/Time on Station:** Will be calculated for SHP0072.
- **Limiting Environmental Conditions:** The same as SHP0068A Ref 1).
- **Vulnerability** – Same as Benchmark SHP0044
- **Manning & Accommodations** – The accommodations for SHP0072 will be 366, in accordance with WSS 29. The additional accommodations for the 24 Embarked Staff and Composite Warfare Commander will be added in the CEP variant.

SHP0073 and 0074 Concepts, will have the following deviations from the REQ-0007:

- **Sustained Speed:** Sustained Speed will be 27kts for the Base Model designs, with the ability to meet FY20 Benchmark requirements of 30 knots Sustained Speed on the Future LSC Hulls.

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- **Service Life Allowances (SLA):** SHP0073 should have standard SLA + WSS0030 reservations + HM&E reservation for the additional generator required in Block Future. Traditional SLAs will be provided for SHP0073A and SHP0074A. The future, lengthened mid-body section variants (SHP0074A) will provide weight and space allowance for the initially delivered shorter Hull variant (SHP0074).
- **Energy/Time on Station:** Will be calculated for SHP0073 and 0074.
- **Limiting Environmental Conditions:** The same as SHP0068A.
- **Vulnerability** – Same as SHP0071
- **Manning & Accommodations** – The accommodations for SHP0073 and SHP0074 will be 366, in accordance with WSS 29. The additional accommodations for the 24 Embarked Staff and Composite Warfare Commander will be added in the Block Future variants.

Study Approach

SHPs 0071, 0078, 0072, 0073 and 0074 will be Excursions from the FY20 LSC SHP0068 or SHP0044. SHP0071 and SHP0078 will evaluate alternative machinery arrangements compared to Vulnerability Set #1 (per VUL SHP Concept Excursions SHPs 0065-0066) as laid out for SHP0068. SHP0072 and SHP 0073 will utilize a machinery plant arrangement similar to the FY20 IPS Benchmark SHP0044 as the added length is forward of all machinery spaces and does not drive collocated machinery requirements

SHP0071-0074 and SHP0078 will use TOP 0021 for excursions fitted with WSS0029 and TOP 0022 for excursions fitted with WSS0030.

Hull Lengthening Excursions will leverage lessons learned from previous DDG 51 Extension Studies, and design to reduce re-design of shared ship components between hulls with and without the revised/lengthened bow; intending to reduce Non-Recurring Engineering (NRE) cost of incorporating the revised bow section in forward-fit construction.

Hull Sizing considerations

Hull Length

The Future Lengthened Hull variants with mid-body extension, SHP 0071A, SHP 0074A, and SHP 0078A will be initially designed to meet the identified concept requirements. The hull extension will be then be removed from SHP 0071A, SHP 0074A and SHP 0078A, to represent SHP 0071, SHP 0074, and SHP 0078. Hull sizing considerations for SHP 0074 excursions will take into account length-power studies by WBS 4.0 along with WBS 5.0 machinery database options for AIM motor sizing options to match 27kts on a single stator for SHP 0074 and 30kts on dual stators for SHP 0074A.

Length of hull extension will be taken as the length of one compartment, located directly forward of MMR1, as shown in Figure 1 below. In this figure the green hull sections represent the sections of the vessel that will be common to both the baseline variants (SHP 0071/78 and SHP 0074) and lengthened variants SHP 0071A/78A and SHP0074A, while the orange section represents the hull extension insert.

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SHP 0073 and SHP 0073A will be a single hull designs with an internal configuration similar to SHP 0071A and SHP 0074A, with the additional hull subdivision midship, forward of the aft MRR, as shown in Orange in Figure 1, below.

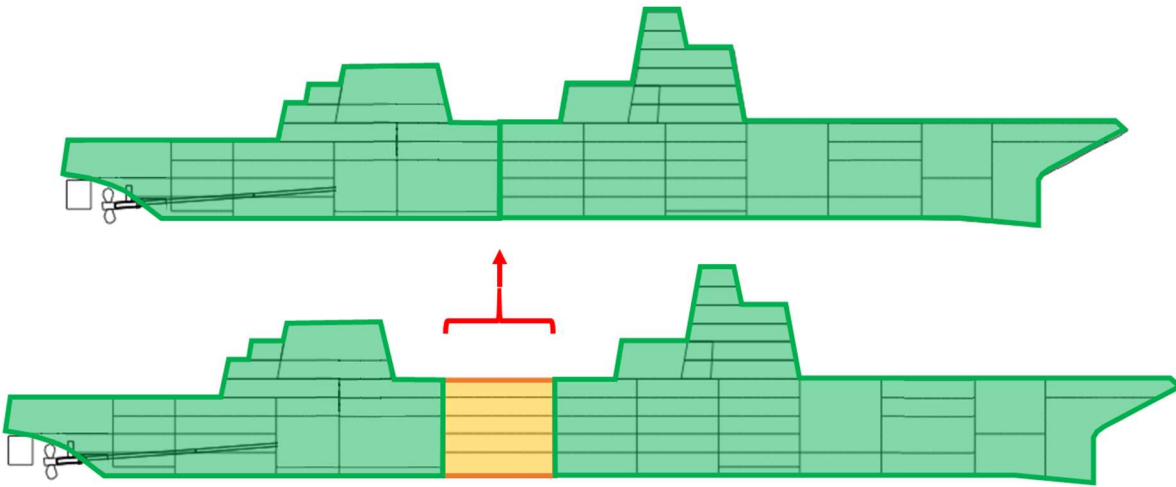


Figure 1 - Mid-Body Hull Extension Insert

The hull extension section added forward of MMR1 will be installed with Future Combat System Equipment (WSS 30), including 12x cells of MKXX CPS, Energy/Thermal storage for 2x 600 kW lasers, and full IAMD Alternate Warfare Commander capability.

The Future Lengthened Hull variants (with the revised bow section), SHP 0072A, will be designed to meet the identified concept requirements. The SHP0072A can then be compared to SHP0072 to assess the cost, feasibility (particularly for LCG/trim), and performance deltas between a mid-body hull extension and a vessel with a lengthened bow.

The lengthened bow section will incorporate one additional watertight compartment, located directly forward of the forward deck house, as shown in Figure 2 below. The ship from the forward end of the forward deck house and aft, as shown in green in the image below, will be common to both the lengthened bow variant (SHP 0072A) and original shorter hull variant (represented by SHP 0068) while the orange sections represent the alternate bow sections for each variant.

The lengthened bow section will be installed with Future Combat System Equipment, including 12x cells of MKXX CPS and full IAMD Alternate Warfare Commander capability. Energy/Thermal storage area/volume for 2x 600 kW lasers will be reserved in the deckhouse aft near the laser heads.

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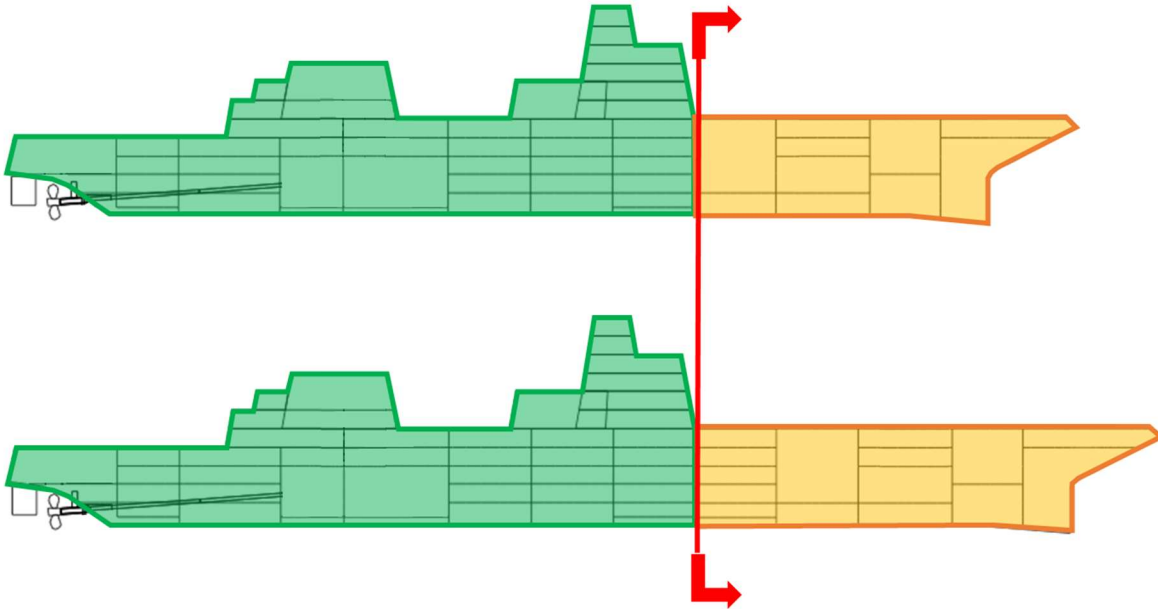


Figure 2 - Upgradeable Bow Sections

Design Displacement – will be based on SHP 0068A.

To compensate for the buoyancy added by the revised bow section, additional fuel may be added to the revised bow section. The Initial short hull variant will be designed to achieve a minimum of 6,000 nm endurance range.

Structural Considerations - Ship scantlings for SHP0071, SHP0078, SHP0072, and SHP0074 will be the same as for future variant with hull extension bending moments, to allow shared structure design between two variants, and account for structural considerations of the larger hulls. This reflects the weight impact of designing to allow installation of an extension without full redesign of structural scantlings.

Subdivision and Damage Stability

To prevent relocating watertight subdivision bulkheads when the hull extension is incorporated, subdivision for mid-body and bow hull extensions will be based on SHP 0068A to meet 15% Length of Damage, per DPC 079-1 requirements. When the lengthened hull section is removed (or replaced by a shorter length bow section for SHP 0072), the design will exceed 15% Length of Damage minimum requirement for paired subdivisions without the added length for the CEP. Bulkhead spacing will be unchanged between Future long-hull and Initial short-hull variants.

The added mid-body or revised bow section design will be set to a length that does not result in 3-compartment damage length >30% LBP for any of the short-hull variants, and will follow Naval Architecture best practices for damage stability.

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Machinery Arrangement

Machinery arrangements will be based off of SHPs 0044 and 0068A, with upgrades to improve location of several main machinery components and address LCG and vessel trim concerns.

Initial Power Generation and Propulsion architecture estimates are identified below. These may be changed throughout concept development to meet intent and defined requirements.

SHP 0071-0071A: Improved ARR from SHP 0068A

POG – 2x MT30, 2x CP PA6B

PRO – 2x 36MW PMM, 2 MW APU

SHP 0078-0078A: Improved ARR from SHP 0068A

POG – 2x MT30, 2x CP PA6B

PRO – 2x 34MW Dual Stator AIM, 2 MW APU

SHP 0072-0072A: ARR based on SHP 0044

POG – 2x LM2500+G4, 2x CP PA6B

PRO – 2x 30MW PMM

SHP 0073: ARR based on SHP 0044

POG – 2x LM2500-1A, 2x CP PA6B

PRO – 2x 20MW Single Stator AIM, 2 MW APU

SHP 0073A: ARR based on SHP 0044. Added POG in hull reservation. Added PRO in existing MMRs.

POG – 3x LM2500-1A, 2x CP PA6B

PRO – 2x 36MW (20MW + 16MW) Dual Stator AIM, 2 MW APU

SHP 0074: ARR based on SHP 0071/0078

POG – 2x LM2500-1A, 2x CP PA6B

PRO – 2x 20MW Single Stator AIM, 2 MW APU

SHP 0074A: ARR based on SHP 0071/0078. Added POG+PRO in CEP Hull Section.

POG – 3x LM2500-1A, 2x CP PA6B

PRO – 2x 40MW Dual Stator AIM, 2 MW APU

Warfare Systems - The intent for providing a lengthened bow section is to provide capacity to install more advanced warfare system equipment in the future.

SHP 0071-0074 and 0078 without CEP incorporated will be delivered with WSS0029, a reduced combat system from the FY20 Benchmark Concepts, Ref [3], and TOP 0021. WSS0029 removes 12 cells of MKXX, offboard vehicle control consoles (OBV), and Composite Warfare Commander (CWC) Capability. These reductions are intended to reduce the initial combat system to be largely equivalent with the DDG 51 FLT III FY22 Configuration and reduce the Electronics and Ordnance costs of the Initial hulls without hull extensions. Compared to the DDG 51 FLT III combat system, WSS0029 maintain the Air Defense

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Large Surface Combatant

Action Plan Technical Memorandum

Commander Capability (ADC), has additional capability from Mk 49 RAM, with a minor decrease in ASW capability by not fitting with SVTTs. Variants with CEP will be delivered with WSS0030 and TOP 0022.

The hull extension section added forward of MMR1 for SHP0071A/0078A and 0074A will include 12x cells of MKXX CPS, Energy and Services Module for 2x 600 kW lasers, berthing for a Composite Warfare Commander detachment, and planning spaces for a Composite Warfare Commander capability.

The bow length extension added for SHP0072A will be added directly forward of the deckhouse and will contain 12x cells of MKXX CPS, berthing for a Composite Warfare Commander detachment, and planning spaces for a Composite Warfare Commander capability. Energy and Services Module for 2x 600 kW lasers will be provided within the deckhouse adjacent to the laser heads.

SHP0073, as a single hull CEP variant, will only be developed at a single length, but will provide unassigned CEP area/volume in the hull and deckhouse for WSS0030 capability upgrades of 12x cells of MKXX CPS, Energy and Services Module for 2x 600 kW lasers, berthing for a Composite Warfare Commander detachment, and planning spaces for a Composite Warfare Commander capability.

The accommodations for the all Block Future ship variants (WSS 30) will be 390, which include accommodations to meet the 24 Embarked Staff Requirement.

LSC BLK 1 Affordability Baseline (Base Model)	LSC BLK Future Affordability Baseline (Base Model)
WSS0029	WSS0030
DDG FLT III - ACB 20 latest tested variant	Future Aegis Integrated Combat System (ICS)
AN/SPY-6(V)1 Air and Missile Defense Radar (AMDR) 14'	AN/SPY-6(V)1 Air and Missile Defense Radar (AMDR) 14'
AN/SPQ-9B Radar	AN/SPQ-9B Radar
AN/SPS-73 (V) 18 Next Generation Surface Search Radar (NGSSR)	AN/SPS-73 (V) 18 Next Generation Surface Search Radar (NGSSR)
KAS Feed Horn on SPG-62	KAS Feed Horn on SPG-62
SPG-62 Illuminator MK-99 [qty: 3]	SPG-62 Illuminator MK-99 [qty: 3]
Cooperative Engagement Capability (CEC) PAAA	Cooperative Engagement Capability (CEC) PAAA
UPX-29/OE-120 Identification Friend or Foe (IFF)	UPX-29/OE-120 Identification Friend or Foe (IFF)
MK 41 VLS space for 96 cells (64 cells modular to enable replacement with Large Missile Cells)	MK 41 VLS space for 96 cells (64 cells modular to enable replacement with Large Missile Cells)
NONE	MK XX Larger Cell VLS (12 cells) with [Potential Plug]
SM-2 Variants [qty: TBD]	SM-2 Variants [qty: TBD]
SM-3 Variants [qty: TBD]	SM-3 Variants [qty: TBD]
SM-6 Variants [qty: TBD]	SM-6 Variants [qty: TBD]
ESSM Variants [qty: TBD]	ESSM Variants [qty: TBD]
VLA Variants [qty: TBD]	VLA Variants [qty: TBD]
TTWCS	TTWCS ICS Integration Version
Tomahawk, SM-6 [qty: TBD]	Tomahawk, SM-6 [qty: TBD]
RAM Mk 49 GMLS [qty: 2] [360 Degree Coverage]	NONE (Mission capability replaced by DES)
MK 38 MOD 4 30mm Gun Weapon System [qty: 3]	MK 38 MOD 4 30mm Gun Weapon System [qty: 3]
NONE	NONE
MK 45 MOD 4 5"/62 Caliber Gun + MK 160 + MK 20 EOSS Electro-Optic/Infrared (EO/IR)	MK 45 MOD 4 5"/62 Caliber Gun + MK 160 + MK 20 EOSS Electro-Optic/Infrared (EO/IR)
Round Variant - Standard 5-inch HE	Round Variant: HVP - GLGP
Air Defense Commander [4 consoles] - Single Office/Planning Spaces	Air Defense Commander [4 consoles] - Single Office/Planning Spaces
ATEP Small Arms and Pyrotechnics Loadout (FLT III)	ATEP Small Arms and Pyrotechnics Loadout (FLT III)
NONE	600 kW Laser [qty: 2] [360 Degree Coverage][DES14]or[DES16] with [Potential Plug]
NONE	To be provided by 600kW laser system
AN/SIQ-32(V)17 (SEWIP Blk 3) + (SEI and HGHS)	AN/SIQ-32(V)17 (SEWIP Blk 3) + (SEI and HGHS)
SPEIR Increment II (360 Degree IR search and Track System)	SPEIR Increment II (360 Degree IR search and Track System)
MK 53 Decoy Launching System (NULKA)	MK 53 Decoy Launching System (NULKA)
AN/ALQ-248 AOEW AMP (Aviation Craft)	AN/ALQ-248 AOEW AMP (Aviation Craft)
MFTA AN/SQR-20 + Winch + handling system [qty: 2]	MFTA AN/SQR-20 + Winch + handling system [qty: 2]
AN/SIQ-25C - towed torpedo counter measures (NIXIE)	AN/SIQ-25C - towed torpedo counter measures (NIXIE)
Acoustic Surveillance SQS-53C Bow-mounted SONAR, SQQ-89A(V)15 Processing, Fluids	Acoustic Surveillance SQS-53C Bow-mounted SONAR, SQQ-89A(V)15 Processing, Fluids
AN/AQS-22 Airborne Low-Frequency Sonar (ALFS) (Aviation Craft)	AN/AQS-22 Airborne Low-Frequency Sonar (ALFS) (Aviation Craft)
Helo/Lamps - Sonobouy [qty: 16]	Helo/Lamps - Sonobouy [qty: 16]
NONE	Surface Vessel Torpedo Tube (SVTT) -MK-32 OTS System (Hull Integrated) Loaded [qty: 2]
MK-54 Torpedo [qty: 18]	MK-54 Torpedo [qty: 18]
ADC MK 2 MOD 4 [qty: TBD]	ADC MK 2 MOD 4 [qty: TBD]
MH-60R [qty: 2] or MH-60R + UAV/MALE [qty: 2]	MH-60R [qty: 2] or MH-60R + UAV/MALE [qty: 2]
7-m RHIB [qty: 2]	7-m RHIB [qty: 2]
Mission Control System (OBV) [2 consoles]	Mission Control System (OBV) (up to 4 consoles)
NONE	Combined Warfare Commander Cell [6 consoles] - OTH Targeting and Planning (SHF NMT as Surrogate)
C4I0009	C4I0009
Aviation Spare and Facilities Loadout (2 MH-60R)	Aviation Spare and Facilities Loadout (2 MH-60R)
Aviation Magazine Loadout (2 MH-60R)	Aviation Magazine Loadout (2 MH-60R)
NONE	NONE
CPS [qty: 12]	CPS and Future Large Cell Missile Variants [qty: 12]

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Topside - Topside and WSS arrangements will be developed to support the same Topside arrangements used on SHP0068. By adding ship length forward of the forward deck house in SHP 0072 it should be possible to avoid potentially expensive topsides and combat systems analyses that would otherwise be required if a hull extension were added between the deckhouses, which could impact radar reflection, weapons cut-outs and C4ISR equipment interference issues.

Additional Follow on Work Required

- Hullform Issues
 - Due to time constraints and program limitations the SHP 0072 hullform used in this analyses will fully reflect a hullform with the same aft sections of SHP 0068 but with a new lengthened bow section modeled in ASSET. Other SHPs in this study will use ASSET hullform modeled for SHP0068.
 - As such resistance characteristics of the hullform used in this analyses may vary to some degree from that of an actual hullform configured with the same stern sections of SHP0068 but with a lengthened bow section.
 - Further analyses would be required to fully assess these impacts.

Variants to Support Affordability Analysis

All variants will be assessed for 1st ship and 10th ship cost to support Affordability analysis of the trade space around the design of LSC.

SHP Assumptions

Except for items as noted in this study guide, Benchmark ASMs per Ref [2] will be used.

ASM-SHP-0005: New Design Ships Sustained Speed Assumption - Maximum sustained speed will be calculated at 80% maximum continuous rating (MCR) of the propulsion plant (geared engines, or motors) with a clean hull at full load displacement at delivery in deep water. For electric propulsion ships, sustained speed will be calculated assuming a 24 hour average electric load (at delivery) and 80% MCR of remaining power that can be supplied to the motors, if this value is less than the maximum power that can be utilized by the motors.

For SHP Concept Variants targeting 30 knot sustained speed, an ASSET speed-power prediction of 29.5 knots will be deemed acceptable. This 0.5 knot is assumed to account for the difference in IPS sustained speed conditions for Block 1 versus Block Future WSS outfitted (displacement and 24-hour average electrical load) at delivery for CEP and Single Hull concepts.

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Deliverables – “What is a SHP?”

- **LEAPS Product Model database:** ASSET 6.3 or RSDE 4.2. Includes:

- CAD model, with integrated topside model
- Stack up Diagram showing the gross layout of the major combat systems, location and size of the deckhouse, location and size of the machinery spaces with intakes and uptakes defined.

-**LSC Ship Concept Cost Form:**

- Ship Characteristics and Design Features
- 3-Digit Weight Report
- Non-Weight-Based Design Data (e.g. paintable surface area)
- Propulsion Plant + Power Generation Plant Definition (POG+PRO or SELECT) in the form of machinery equipment list with SWaP-C and cost information for each component
- Warfare System at Delivery in the form of a Combat System Equipment List with SWaP-C and cost information for each component

-**SHP Concept Placemat:** In appropriate LSC SSDM Approved Format. Ref [3]

- Includes Annual Fuel Energy Consumption, Time on Station, and Surge to Theater
- WSS Combat System Items at Delivery
- Warfare System Future
- Set Based Design serialization
- Critical Systems
- Lead and 10th Ship Acquisition Costs

-**Lethality Curve:** with SHP Concept Plotted against the LSC Tradespace and comparable US NAVY ships

References

[1] LSC_SHP 0067-0068 Ground Rules_FLX Design for Plug_Rev 4.PDF

[2]LSC_ACTION PLAN _ FY20 Concept Development and Benchmarking_Rev2.PDF

[3] 2020_05_26_WSS_Database_R33 - WSS0025-WSS0030 by Reservation.PDF

[4] Placemats_LSC_Additional Content_Rev 4.PPT

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