



littlefire
castle^{S.L.}



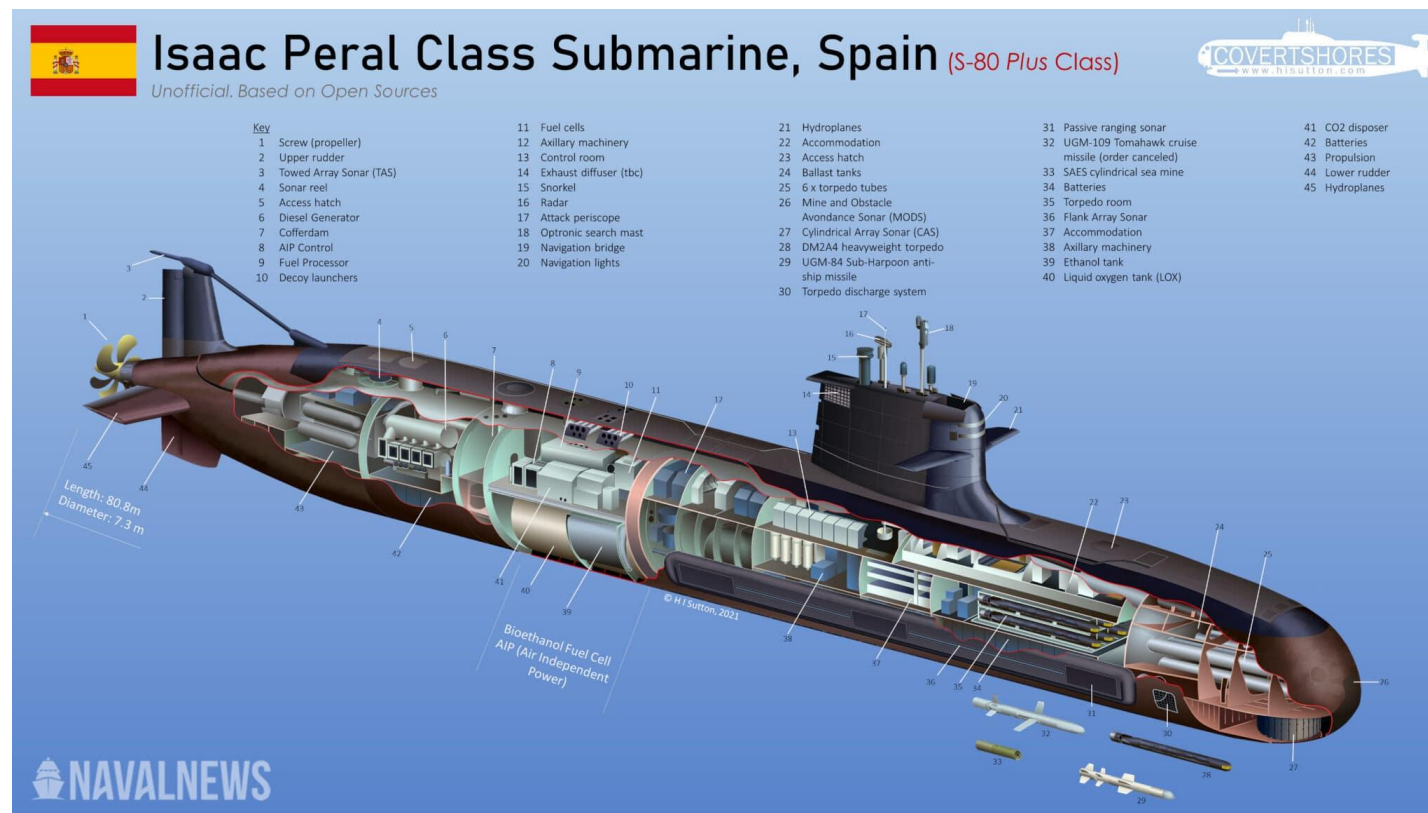
THREE AIP SUBMARINES

INITIALLY VERY DIFFERENT PERFORMANCE, CONVERGING BY THE USE OF ADVANCED BATTERIES

BY RAFAEL GUTIÉRREZ FRAILE (IN), LITTLEFIRE CASTLE SL

CLASS S80+ (ESP)

DISPLACEMENT (T)	2.700
DISPL. SUBMERGED (T)	3.000
PROP. POWER (kW)	3.500
AIP POWER (kW)	300
AIP TYPE: ETHANOL REFORMER + FC	
BATTERY TYPE: LEAD ACID	
BATTERY+AIP WEIGHT (T)	<400
U/W RANGE 4-6N (DAYS)	21



CLASS KSS-III BATCH I (SKR)

DISPLACEMENT (T)	3,358
DISPL. SUBMERGED (T)	3,750
PROP. POWER (kW)	4,500
AIP POWER (kW)	600
AIP TYPE: METAL HYDRIDE + FC	
BATTERY TYPE: LEAD-ACID	
BATTERY+AIP WEIGHT (T)	<600
U/W RANGE 4-6N (DAYS)	14



CLASS SORYU BATCH I (JPN)

DISPLACEMENT (T)	3,780
DISPL. SUBMERGED (T)	4,200
PROP. POWER (kW)	6,000
AIP POWER (kW)	300
AIP TYPE: KOCKUMS-STIRLING	
BATTERY TYPE: LEAD-ACID	
BATTERY+AIP WEIGHT (T)	<800
U/W RANGE 4-6N (DAYS)	39

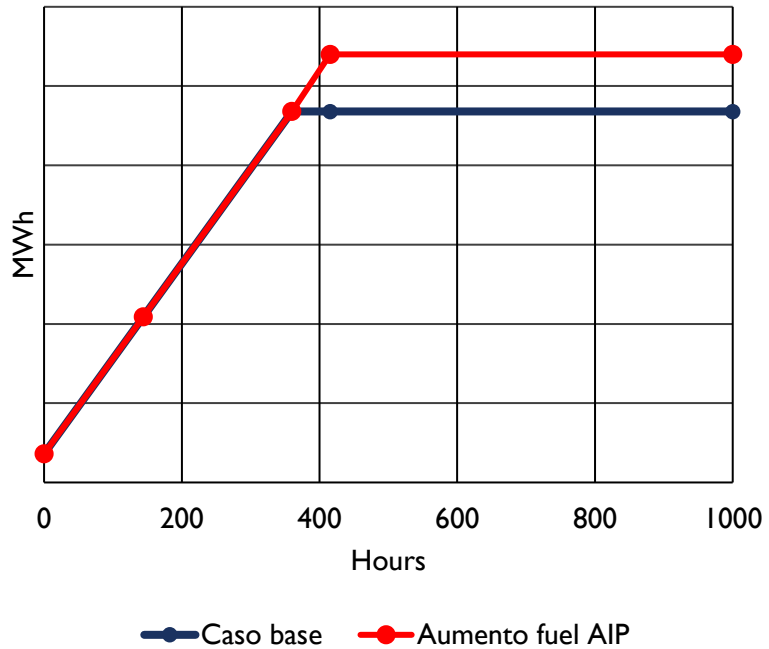
AIP Stirling Engines Soryu class submarine SS-501 ~ SS-510



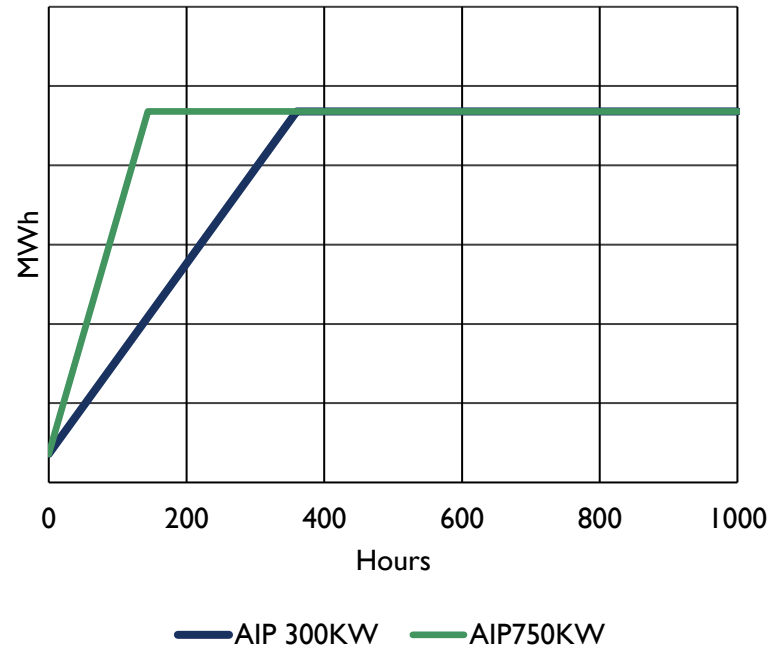
AVAILABLE ANAEROBIC ENERGY PROFILE

BATERIES + AIP

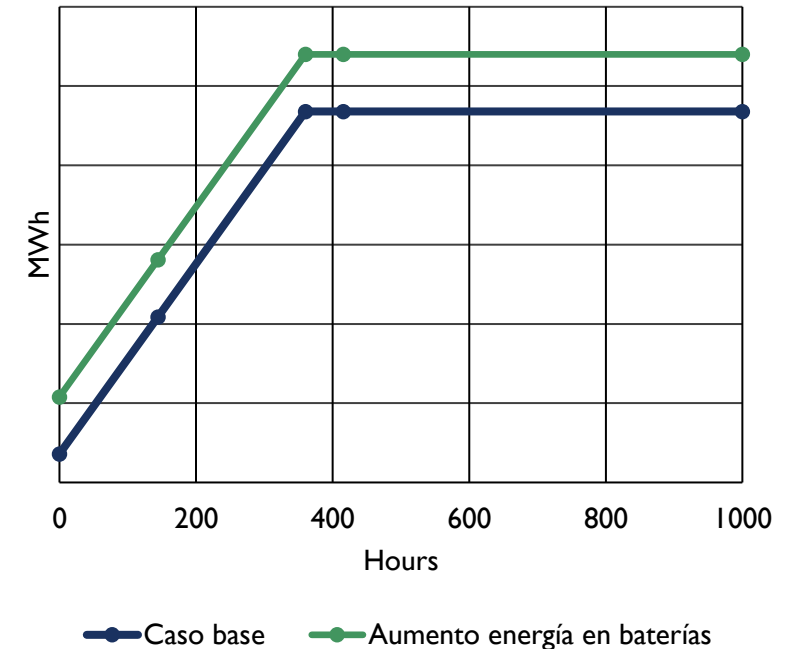
INCREASE OF AIP ENERGY



INCREASE OF AIP POWER

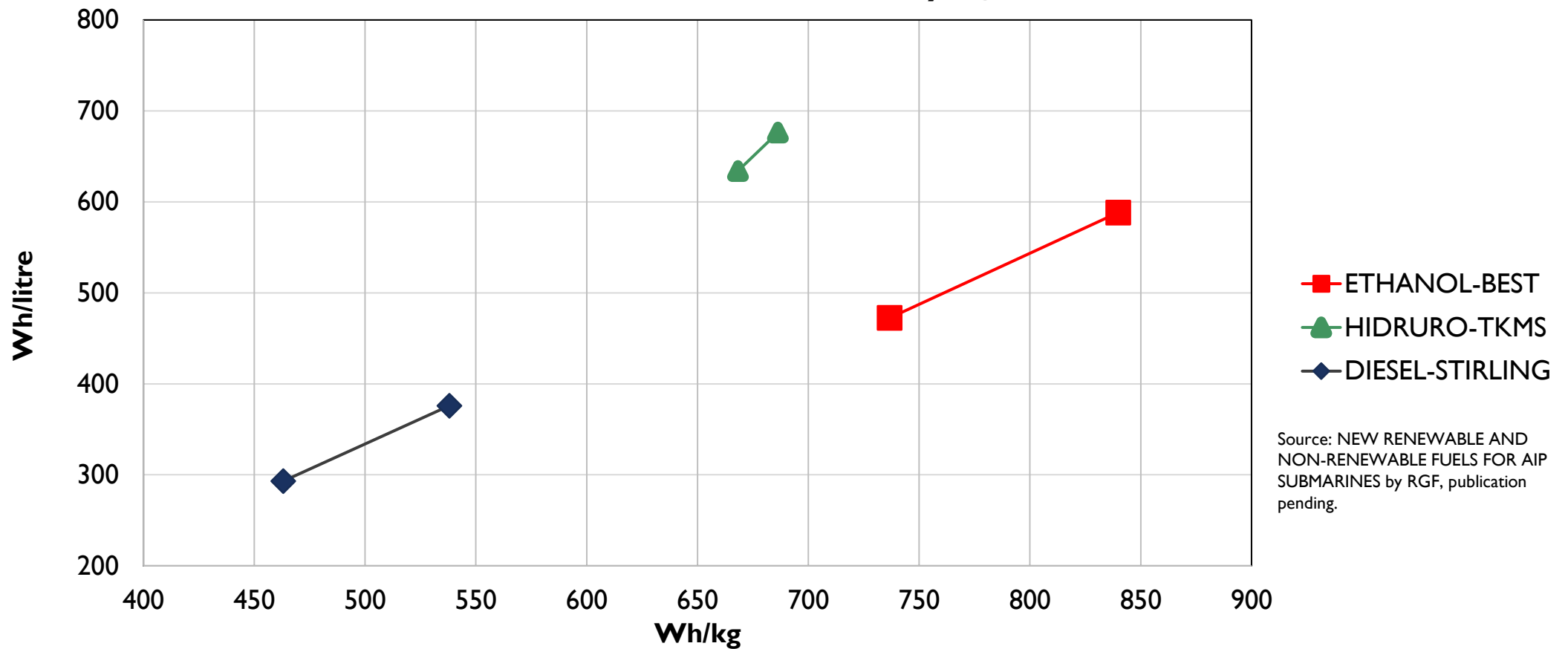


INCREASE OF BATTERY CAPACITY



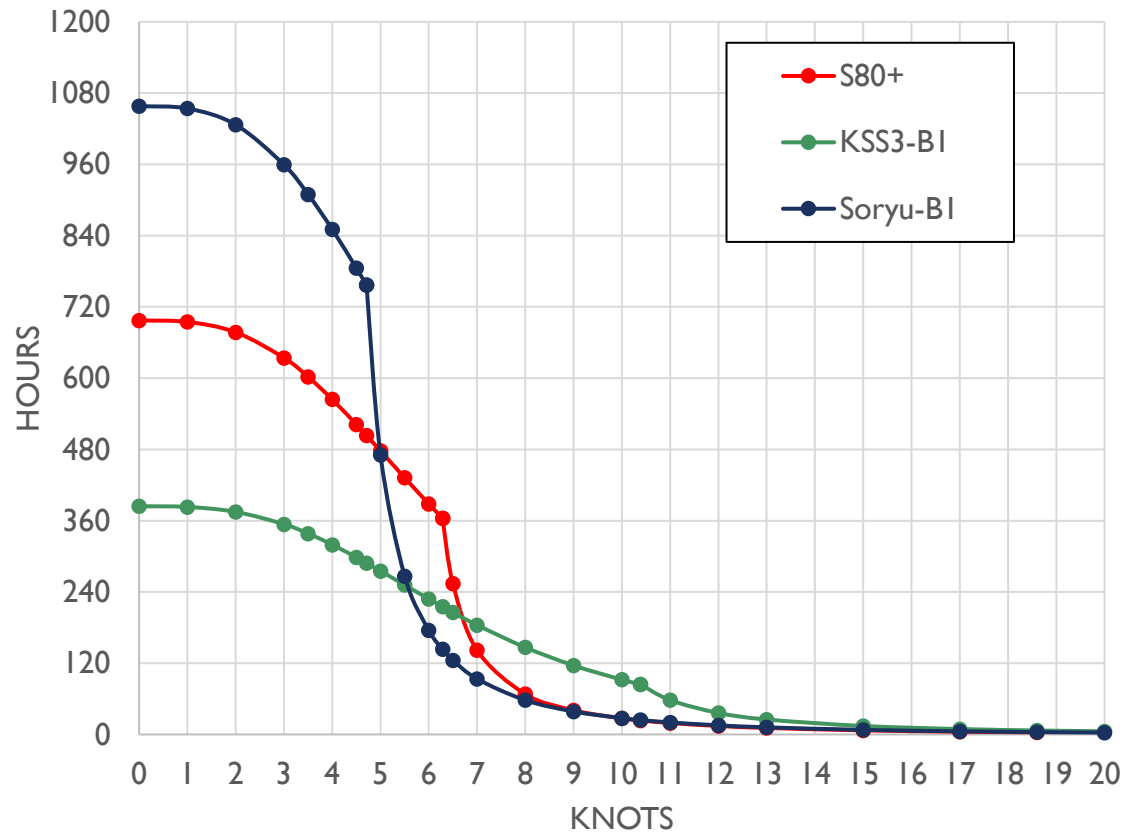
RELATIVE PERFORMANCE OF AIP SYSTEMS AND FUELS INCLUDING IMPACT OF DOUBLING AIP POWER

GRAVIMETRIC AND VOLUMETRIC CAPACITY OF VARIOUS AIP SYSTEMS
AIP 300/600kW & fuel for 15 days @ 300kW

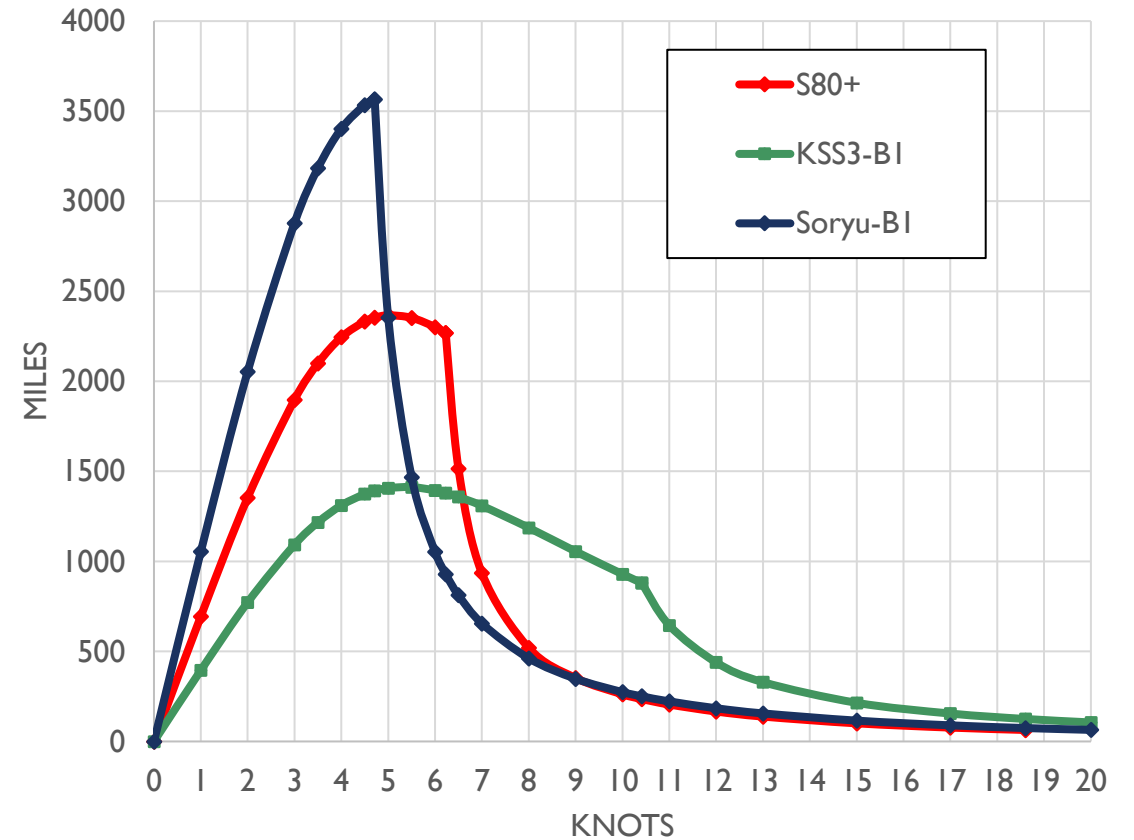


SUBMARINES BATCH I

SUBMARINES BATCH I – RANGE (EST.)



SUBMARINES BATCH I - RANGE (EST.)



NEW SUBMARINE SERIES IN S. KOREA AND JAPAN

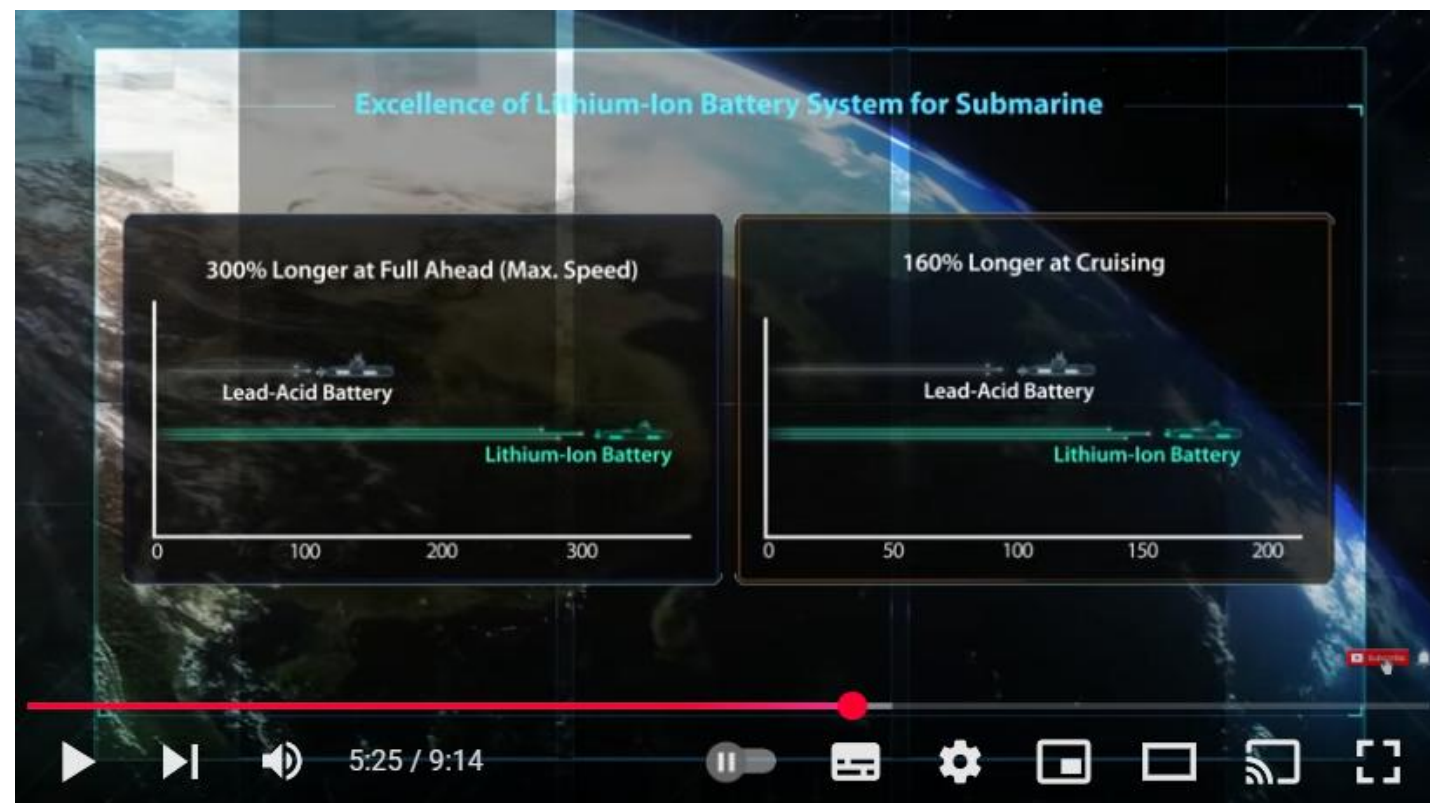
CLASS KSS-III BATCH 2: S. KOREA REPLACES LITHIUM (LFP) BATTERIES FOR LEAD-ACID ONES, TRIPLING THEIR CAPACITY (TO ABT. 150WH/KG)

CLASS SORYU BATCH 2: JAPAN ELIMINATES THE AIP SYSTEM AND REPLACES A LARGE LITHIUM-SULPHUR BATTERY SET (ABT. 300WH/KG) FOR THE LEAD-ACID ONES

CLASS TAIGEI: FROM THE THIRD SHIP, JAPAN ADDS ANOTHER 200T OF BATTERIES, INCREASING DISPLACEMENT AND RENAMING THE CLASS

CLASS KSS-III BATCH II (JPN)

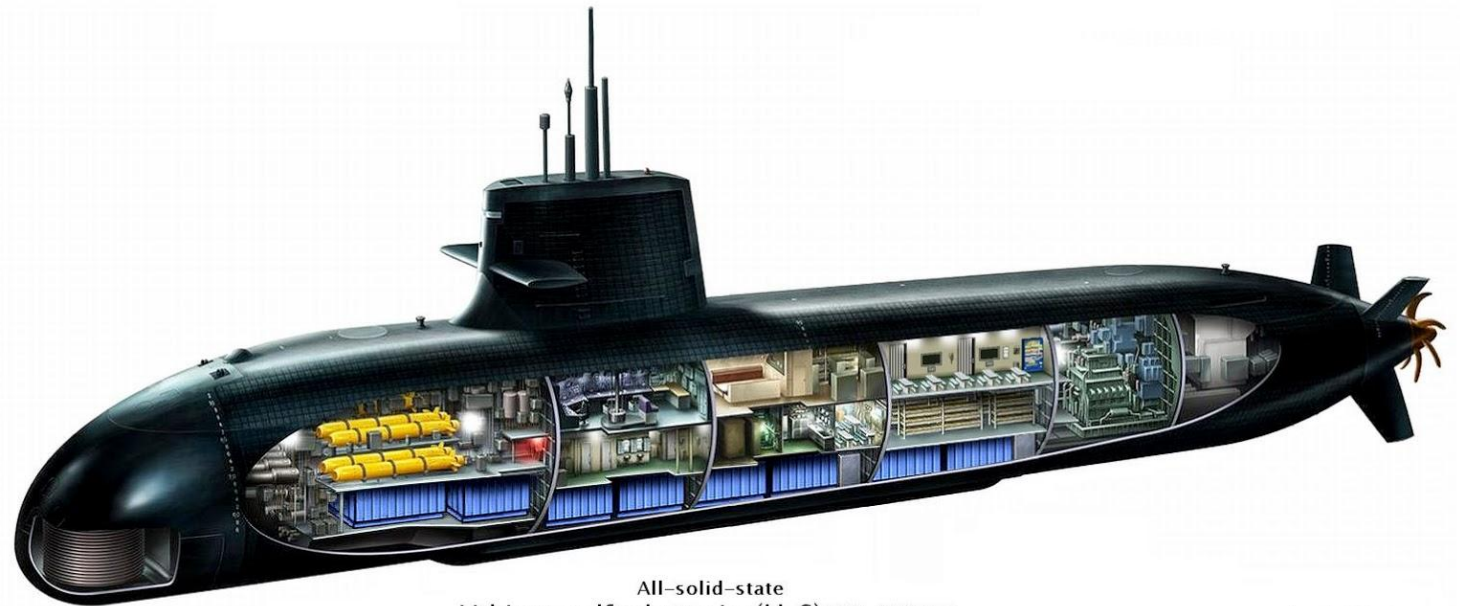
DISPLACEMENT (T)	3,358
DISPL. SUBMERGED (T)	3,750
PROP. POWER (kW)	4,500
AIP POWER (kW)	600
AIP TYPE: METAL HYDRIDE + FC	
BATTERY TYPE: LI-ION (LFC)	
BATTERY+AIP WEIGHT (T)	<600
U/W RANGE 4-6N (DAYS)	21



CLASE SORYU BATCH II (JPN)

DISPLACEMENT (T)	3,780
DISPL. SUBMERGED (T)	4,200
PROP. POWER (kW)	6,000
AIP POWER (kW)	0
AIP TYPE: NONE	
BATTERY TYPE: LITHIUM-SULPHUR	
BATTERY+AIP WEIGHT (T)	<800
U/W RANGE 4-6N (DAYS)	39

Li-S batteries Soryu class submarine SS-511 SS-512



All-solid-state
Lithium-sulfur batteries (Li-S) 230,400kWh

(Li-S) 2030 ~

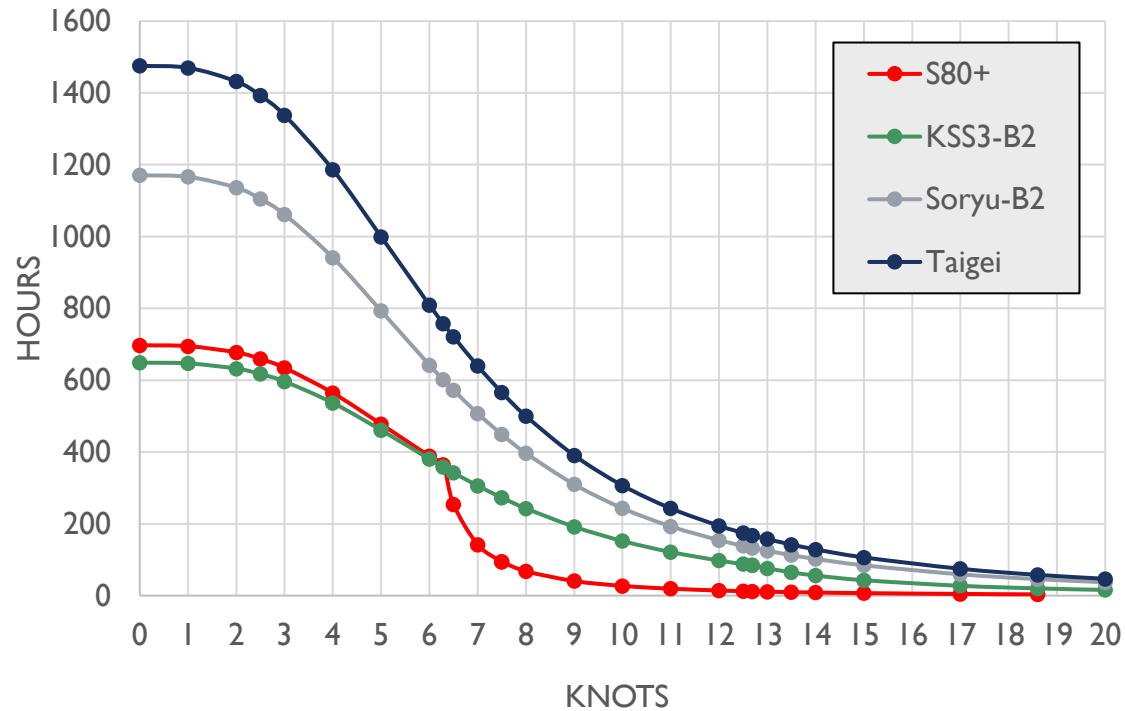
CLASS TAIGEI (JPN)

DISPLACEMENT (T)	3,780
DISPL. SUBMERGED (T)	4,200
PROP. POWER (kW)	6,000
AIP POWER (kW)	0
AIP TYPE: NONE	
BATTERY TYPE: LITHIUM-SULPHUR	
BATTERY+AIP WEIGHT (T)	<1,000
U/W RANGE 4-6N (DAYS)	49

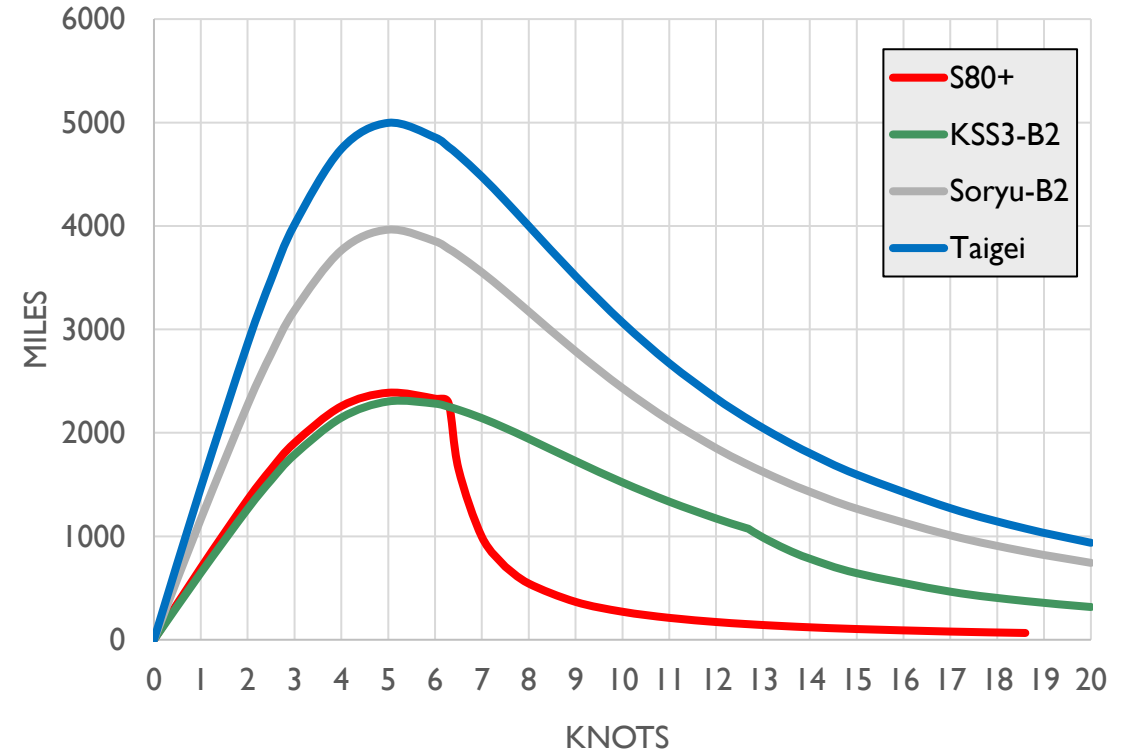


SUBMARINES BATCH II (AND S80+) ESTIMATED RANGES

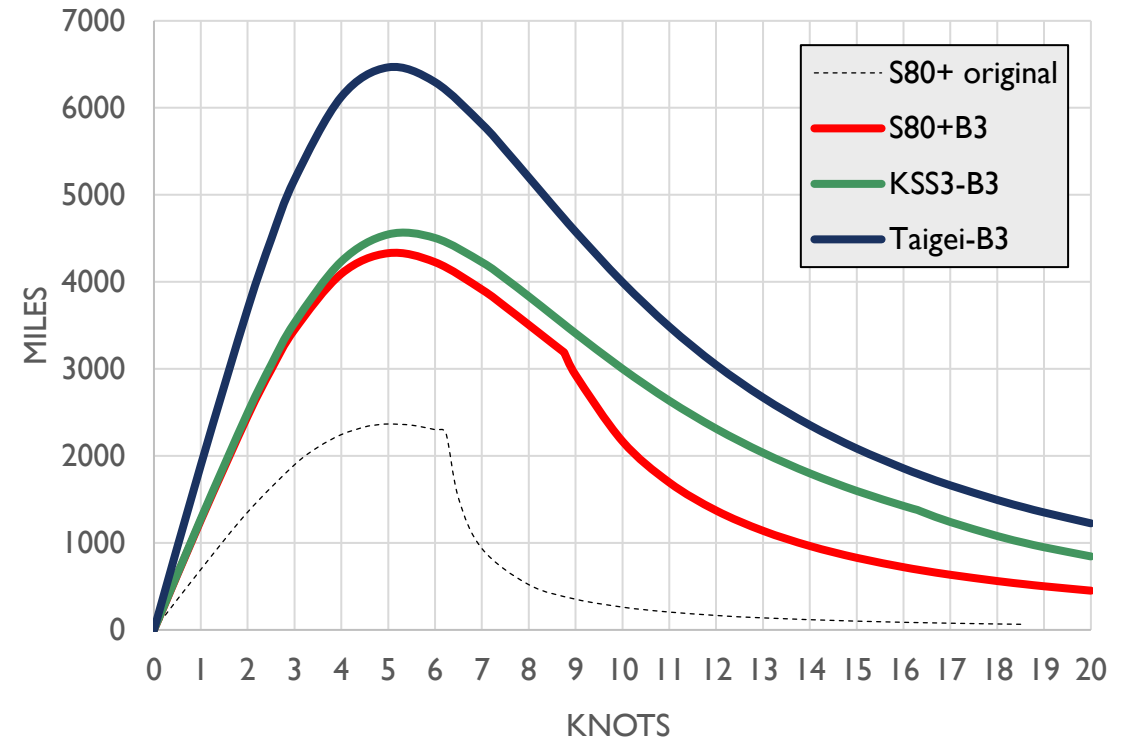
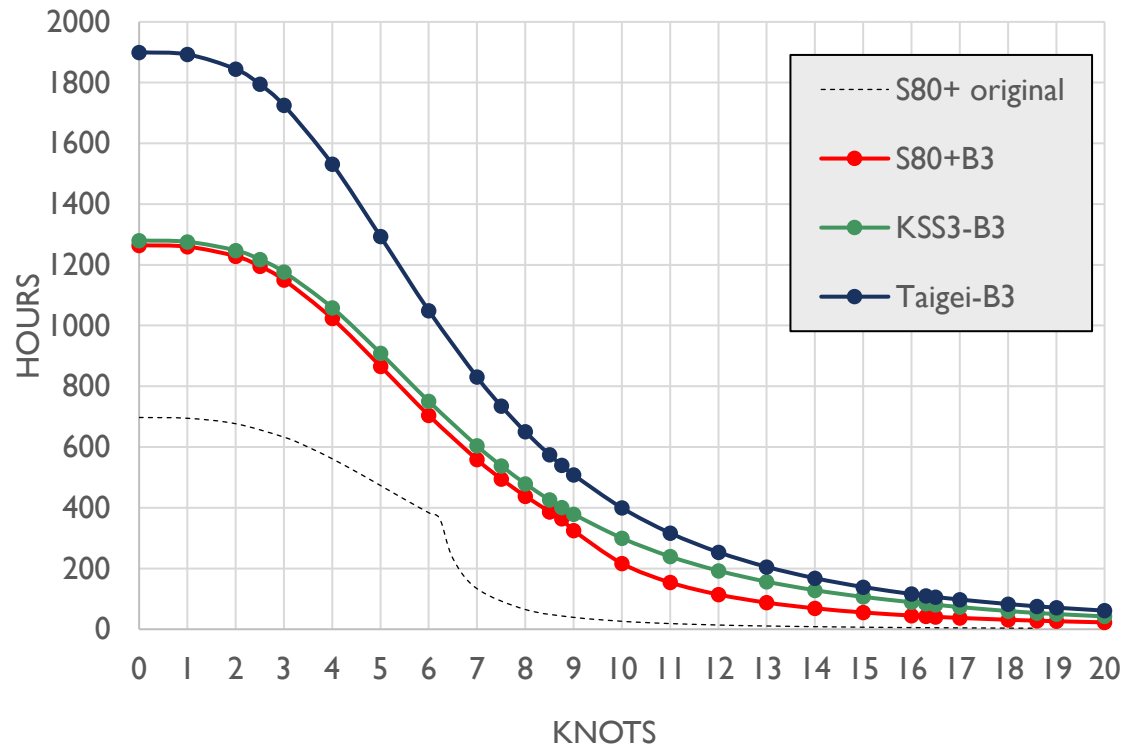
SUBMARINES BATCH 2 – RANGE (EST.)



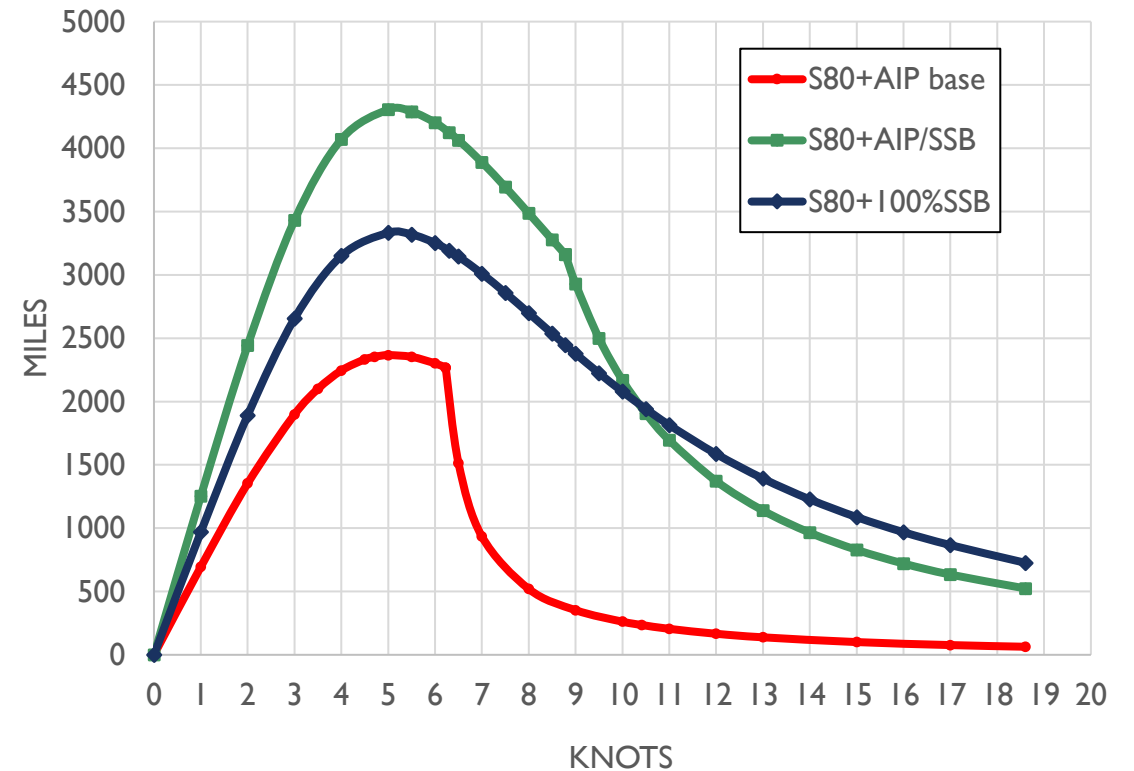
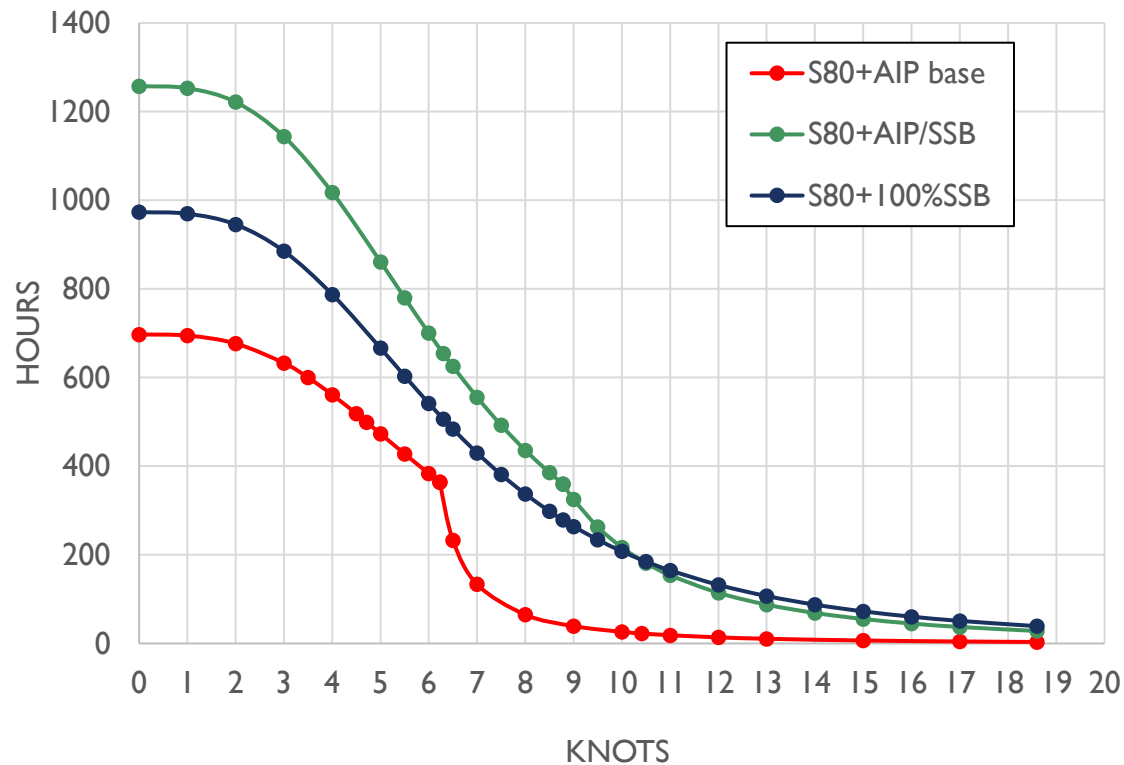
SUBMARINES BATCH 2 – RANGE (EST.)



SUBMARINES BATCH III (AND S80+) ESTIMATED RANGE WITH 400WH/KG BATTERIES



SUBMARINE S80+ BASE AND ALTERNATIVE WITH 400WH/KG BATTERIES, WITH AND W/O AIP



IN SUMMARY



NEW BATTERIES ARE DISPLACING THE LESS EFFICIENT AIP SYSTEMS

JAPANESE SUBMARINES WITH 100% BATTERIES CAN NOW REACH TRANSPACIFIC UNDERWATER RANGES

HIGHER AIP POWER IMPROVES COMPETITIVITY AND DELAYS OBSOLESCENCE OF AIP SYSTEMS

THE S80+ AIP IS THE MOST EFFICIENT AND CAN COMPETE AGAINST BATTERIES IN THE SHORT-MEDIUM PERIOD.



THANK YOU

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