
Energy System for Large Displacement Unmanned Undersea Vehicle Innovative Naval Prototype (INP)

Industry Day Briefing

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Background

- Current and future Naval UUVs¹ require longer endurance: days or months
- High Energy density batteries are insufficient
- Solutions beyond battery-only technology capabilities are required

1 – This refers to propelled vehicles, not gliders



LD UUV INP Program Research Opportunity



- Develop and demonstrate energy dense air-independent, rechargeable/refuelable energy system technologies for a 120” energy section length capable of the threshold and objective metrics outlined below
- The program is expected to employ a phased approach to achieve a Technology Readiness Level (TRL) of 6 by the end of the program

	Threshold Metrics	Objective Metrics
Energy Section Length	304.8 cm (120”)	304.8 cm (120”)
Energy Volume (liter) 106.7 cm (42.0”) (ID) x 304.8 cm (120”) (Length) <i>Note 1. Estimated available volume</i>	2043 ¹ .	2043 ¹ .
Energy Mass (kg) w/o hull & bulk	2043 (neutrally buoyant)	2043 (neutrally buoyant)
Energy (kWh) <i>Note 2. Includes ~10% reserve</i>	817 ²	1800 ²
Duration (hrs)	46 Days (1104 Hrs)	70 Days (1680 Hrs)

Program Plan

- Multiple awards are anticipated in the form of Indefinite Delivery/ Indefinite Quantity (IDIQ) contracts
- Program duration for the energy portion of the INP comprises four years- from FY12 to FY15
- Additional time (INP ends in FY16) will go towards vehicle integration and in water testing

Phase	Time Period	Metric
Phase I	24 months	Must reach TRL-4 (Component and/ or breadboard validation in laboratory environment)
Phase II	24 months	Must Reach TRL-6 (System/subsystem model or prototype demonstration in a relevant environment)

Program Eligibility

- UUV Energy is on the Militarily Critical Technologies List (MCTL), and therefore may have ITAR restrictions
 - All Key Personnel must be U.S. Citizens
- Proposers must possess an active PKI certificate (External Certificate Authority - ECA) from 30 days after contract award through the duration of the performance period
 - Will be required for access to a secure sharing web site for report and briefing materials submission

Phase I Objectives

- **Performance period 24 months in duration**
 - Conduct subscale (>40 % peak power) component and/or full-scale critical component and integration testing and analysis as a basis to meet at a minimum the THRESHOLD metrics and the THRESHOLD mission profile at a TRL 4 system level demonstration
 - Develop a preliminary Energy System 3D Solid Model demonstrating attainment of the performance specifications
 - Provide a development plan that addresses how the desired performance and environmental metrics will be met
 - Generate a table listing the weights and volumes of all the representative full-system energy section components, TRLs of the subcomponents, and necessary Balance of Plant (BOP) items
 - Conduct a Preliminary Hazards Analysis

Phase II Objectives

- **Performance period 24 months in duration**
 - Projects have at least met THRESHOLD metrics
 - Likelihood to meet OBJECTIVE metrics and OBJECTIVE mission profile
 - TRL-6 land based demonstration in a UUV energy section hull
 - A full scale UUV Energy Section hull and interface documentation will be provided by the government
 - Conduct a Critical Design Review (CDR)
 - Develop all necessary Standard Operating Procedures (SOPs), maintenance schedules, drawings, and parts list for the energy system

Program Goals

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Additional Desired Metrics

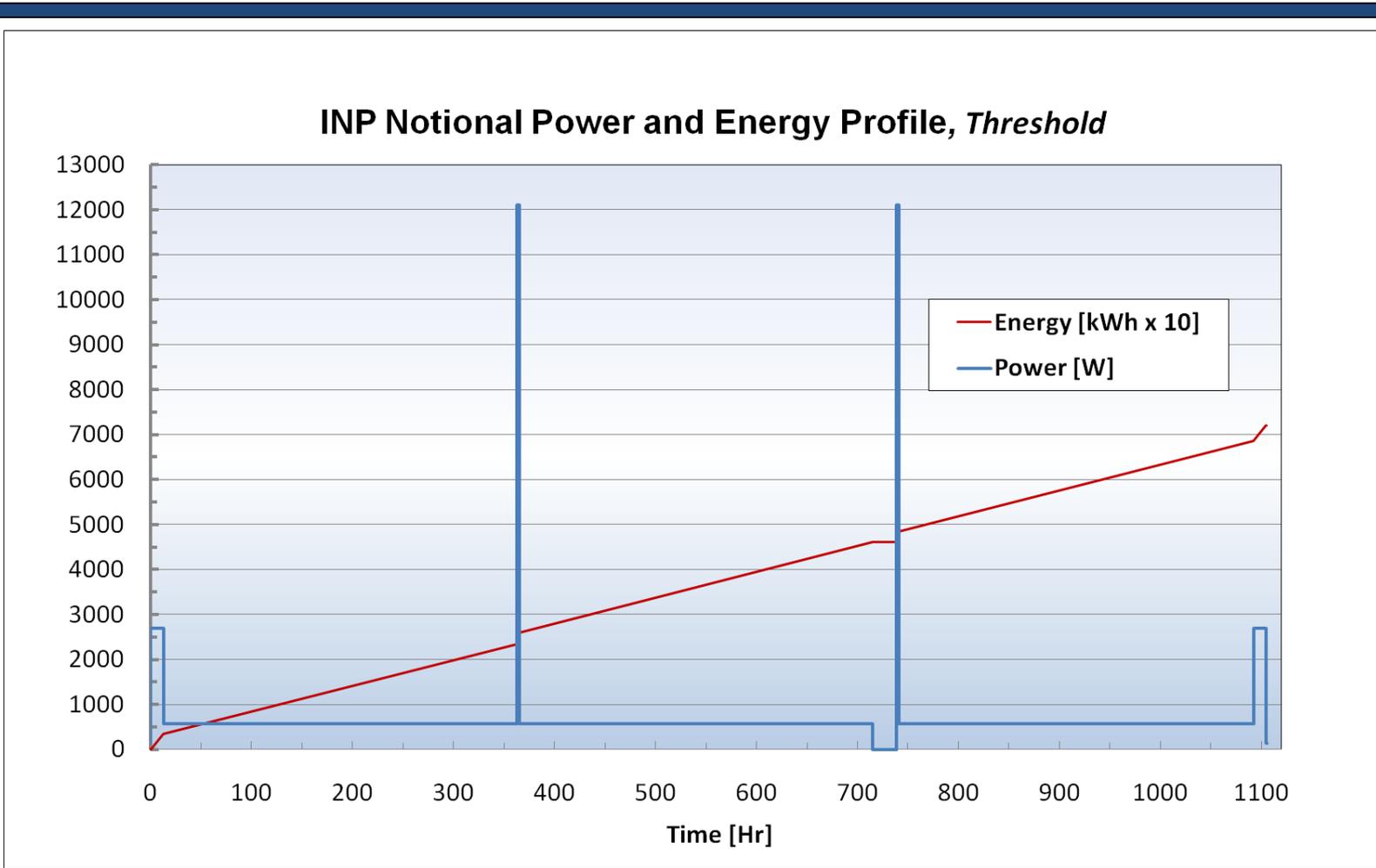


Specification	Metric
Platform Diameter Size	106.7 cm (42" ID)
Energy Density	400-900 Wh/liter, neutrally buoyant
Endurance	≥ 1000 hours
Start/Stop Cycles	5 hibernation cycles
Refuelability	Yes
Scalable	Yes, up to 152.4 cm (60") dia. And 120 days (2880 hrs) continuous operation
Open vs. Closed Cycle	Closed
Operating Depth	304.8 M (1000') (depth independent desirable)
Power Profile	To Be Provided
Power Transients	Threshold: 2 hrs continuous operation at peak power. Objective: 4 hrs continuous operation at peak power.
Safety Considerations	For demonstration commercial ship safety consideration
Peak Power	To Be Provided
Power Quality	To Be Provided
Orientation: Roll, Pitch	±45 Degrees (operation), ±90 Degrees (storage, pitch only)
Refueling Turn-around Time	24 hrs
Maintenance Specifications	To Be Provided
Safety	To Be Provided
Key Interfaces	To Be Provided

Environmental Metrics

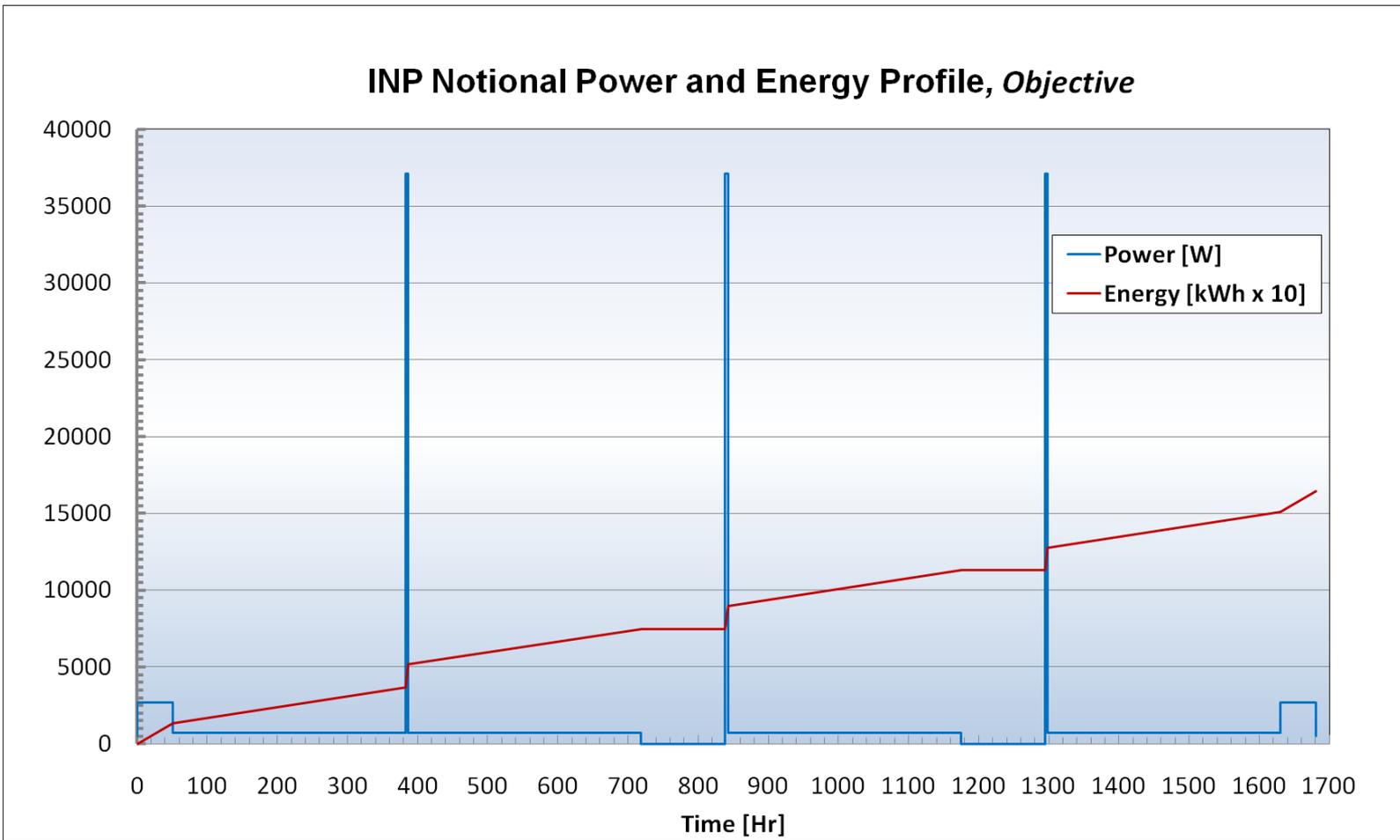
Specification	Metric
Environment (Operating Conditions)	
Salinity	0 to 50 parts per thousand (ppt)
Salinity Variation	± 10 ppt during a single sortie
Water Temperature	-1.1°C – 35.0°C (30°F to 95°F)
Air Temperature	-28.9°C to 50°C (-20°F to 122°F)
Temperature Shock	-28.9°C to 50°C (-20°F to 122°F)
Shipboard Shock	MIL-S-901D (Grade B) while secured to transportation pallet
Shipboard Vibration	MIL-STD-167-1
Humidity	0-100 % relative humidity
Salt Fog	Marine Environment
Fungus	Avoid Materials that promote fungal growth
Icing/Freezing Rain	Operate where icing may occur from sea splash/spray
Electromagnetic Environment	MIL-STD-461F (RE101, RE102, RS101, RS103)
Environment (Non Operating Conditions)	
Transportation Altitude	0 to 12,192 M(0-40,000 ft) (pressurized or non-pressurized)
Transportation & Storage Temperature	-40.0°C to 108.9°C (-40°F to 160°F)
Transportation Shock & Vibration	Withstand ground, air, rail, ship transport (MIL-STD-1366E guidance)
Storage	Long-term maintenance-free storage (minimum 6 months)

Threshold Mission Profile



- Phase I should achieve this profile at a minimum TRL-4 in a bench-top demonstration
- Tabular profile of data will also be provided

Objective Mission Profile

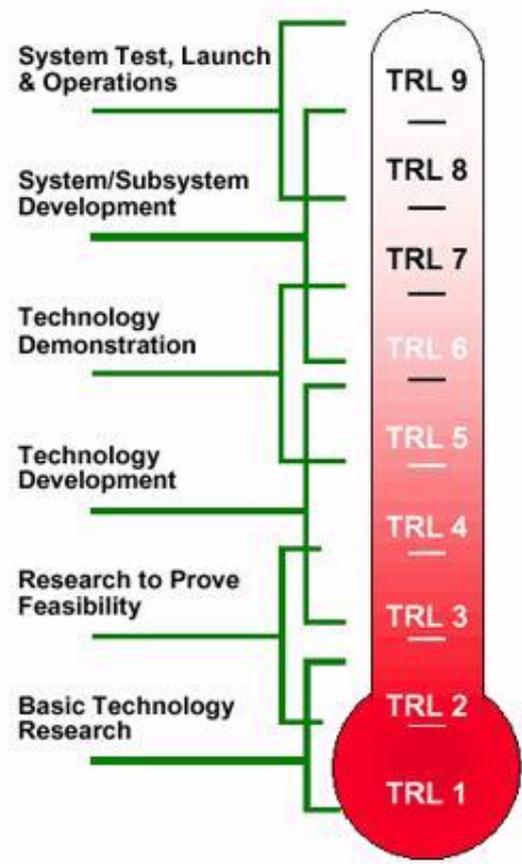


- Phase II should achieve this profile at TRL-6 in a land-based UUV energy section demonstration
 - Tabular profile of data will also be provided

Summary

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- Slides from today's briefings will be posted by noon EST 9 February 2011 on [FedBizOps](#) & the [ONR web site](#)
 - Any upcoming BAA will be posted on [FedBizOps](#) & the [ONR web site](#)
 - Industry Day questions: <https://secure.onr.navy.mil/events/regdetail.asp?cid=715>
 - MUST use template available at [FedBizOps](#) & the [ONR web site](#)
 - MUST submit to the following e-mail address: IndustryDayQuestionsUUVEnergy@ONR.navy.mil
 - Deadline for Industry Day question submittal: February 11, 2011 by 1600 EST

Technology Readiness Levels



Actual Application of the Technology in It's Final Form and Under Mission Conditions.	
TRL 9	Technology Has Been Proven to Work in It's Final Form and Under Expected Conditions.
TRL 8	Prototype Near or at Planned Operational System. Major Step From Level 6, Requiring the Demonstration of an Actual Prototype in an Operational Environment.
TRL 7	Representative Model or Prototype System, Which Is Well Beyond the Breadboard Tested 5 Is Tested in a Relevant Environment
TRL 6	Fidelity of Breadboard Technology Increases Significantly Enough to Justify Being Ready for Testing in a Simulated Environment
TRL 5	Basic Technology Components Are Integrated to Establish That the Pieces Will Work Together.
TRL 4	Active Research and Development Is Initiated. This Includes Analytical and Laboratory Studies to Physically Validate Analytical Predictions of Separate Elements of Technology.
TRL 3	Invention Begins. Once Basic Principles Are Observed, Practical Applications Can Be Invented. The Application Is Speculative and There Is No Proof of Detailed Analysis to Support the Assumption.
TRL 2	Lowest Level of Technology Readiness. Scientific Research Begins to Be Translated Into Technology's Basic Properties.
TRL 1	

Mil-Std-882D Task 202	https://assist.daps.dla.mil/docimages/A/0000/0003/6027/00000198718_000000141972_DJLKNMXRWC.PDF?CFID=24160174&CFTOKEN=97572158&jsessionid=5c30dbe089c6fbefce5740556634e187b109
DI-SAFT 80101B	https://assist.daps.dla.mil/quicksearch/basic_profile.cfm?ident_number=209470
Mil-S-901D (Grade B)	http://www.assistdocs.com/search/document_details.cfm?ident_number=2640&StartRow=1&PaginatorPageNumber=1&doc%5Fid=MIL%2DS%2D901D&status%5Fall=ON&search%5Fmethod=BASIC
Mil-STD-167-1	http://www.assistdocs.com/search/document_details.cfm?ident_number=35544&StartRow=1&PaginatorPageNumber=1&doc%5Fid=MIL%2DSTD%2D167%2D1&status%5Fall=ON&search%5Fmethod=BASIC
Mil-STD-461 (RE101,RE102,RS101,RS103)	http://www.assistdocs.com/search/document_details.cfm?ident_number=35789&StartRow=1&PaginatorPageNumber=1&doc%5Fid=MIL%2DSTD%2D461&status%5Fall=ON&search%5Fmethod=BASIC
Mil-STD-1366E	http://www.assistdocs.com/search/document_details.cfm?ident_number=35789&StartRow=1&PaginatorPageNumber=1&doc%5Fid=MIL%2DSTD%2D461&status%5Fall=ON&search%5Fmethod=BASIC