Polar
Preliminary Concept Design Package

MARITECH 10 June, 2010

Purpose

- To provide an update on Polar Icebreaker Project.
- Presentation with take 25 minutes with questions after.

Outline

- Background
- Coast Guard Approach
- Status
- Way Ahead

Background

- The Canadian Coast Guard's (CCG) largest and most capable icebreaker, CCGS Louis St. Laurent, is nearing the end of its useful life.
- Budget 2008 provided funds to procure a new Polar Icebreaker (CCGS John G. Diefenbaker) capable of operating in Canada's Arctic farther North and for a longer period of time each year.
- CGGS John G. Diefenbaker is one of the centerpieces of the Government of Canada's high profile Northern Strategy, which focuses on strengthening Canada's Arctic sovereignty.
- The timeline for the planning, design, construction and acceptance of the Polar Icebreaker has a targeted delivery date of late 2017.

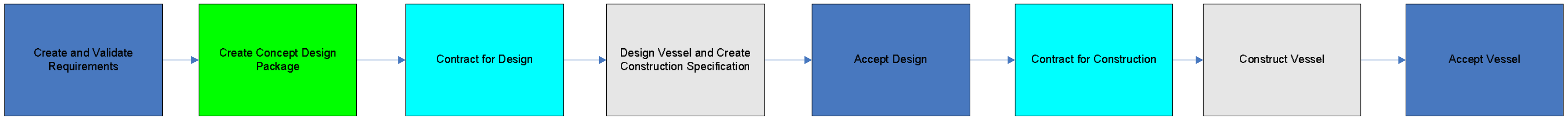
Background

- The acquisition of the Polar Icebreaker will be achieved through a two-step procurement strategy.
- The first step entails a competitive design contract for the development of a class-approved drawing package and a construction specification.
- The ship will be built in a Canadian Shipyard as an element of the National Shipbuilding Procurement Strategy.

Approach

- Be a “smart customer” by exploring and conceptualizing requirements to ensure that we both know what we want and realize what we are asking for.
- By creating a Concept Design Coast Guard will be an informed customer and become the best possible client for industry.
- The technical approach is defined in an internal document the *Polar Icebreaker Systems Engineering Management Plan (SEMP)*

SEMP



- The purpose of the SEMP is to define the engineering and technical effort required to create and transform the Polar Icebreaker requirements into the POLAR Icebreaker vessel(s).
- The SEMP defines eight engineering processes that are required to generate the key outputs.

Create & Validate Requirements

- All requirements for the Polar Icebreaker are derived from the eight missions with which the vessel will be tasked.
- Using scenarios derived from the eight missions and a series of stakeholder engagements, other governmental department consultations, operational and science working groups
  - Indicative Operational Requirements document (IOR)
  - Indicative Arctic Science Requirements document (IASR) requirement were derived.
- The IOR and the IASR were combined into a single document the Indicative Requirements Document (IRD).
- The IRD was validated and became the Baseline Requirements Document (BRD)

Eight Missions

1. Sovereignty and presence
2. Arctic science
3. Weather and ice information
4. Economic and commercial development
5. National security
6. Northern re-supply and logistics support
7. SAR, environmental and emergency response
8. Fisheries conservation and protection

Create & Validated Requirements

- To Start Most Requirements are a mixture of:
  - Requirement: The actual base requirement derived from and linkable to the mission of the vessel. The kernel of the base requirement is almost always included and just needs to be extracted.
  - Vision: An indication of how the requirement might be met in the future on the vessel. The vision is good information and is retained but as additional information to the requirement.
  - Guidance: An indication of how the requirement is currently being met and should be met in the future . The guidance is good information and is retained but as additional information to the requirement.
  - Partial Solution: A singular solution based upon comfort and knowledge set with sufficient support to determine if solution is the only one, or even correct one. The partial solution usually forms part of the guidance for a requirement.

Validate Requirements

- A "Valid" requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
  - **Affordable** (relative)
  - **Non-conflicting**
  - **Complete**
  - **Concise**
  - **Verifiable**
- **Definitions**

A Valid Requirement

- A “Valid” requirement meets the following criteria:
  - **Necessary**
    - **A requirement that is necessary is linked to a capability that is essential in supporting a CCG program or CCG supported program.**
  - **Technically Feasible**
  - **Affordable** (relative)
  - **Non-conflicting**
  - **Complete**
  - **Concise**
  - **Verifiable**

A Valid Requirement

- A “Valid” requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
    - **A requirement that is technically achievable has a solution that can be incorporated within the scope of the vessel systems and its associated constraints.**
  - **Affordable** (relative)
  - **Non-conflicting**
  - **Complete**
  - **Concise**
  - **Verifiable**

A Valid Requirement

- A "Valid" requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
  - **Affordable** (relative)
    - **A requirement that is affordable has cost that is consistent with project funding.**
  - **Non-conflicting**
  - **Complete**
  - **Concise**
  - **Verifiable**

A Valid Requirement

- A “Valid” requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
  - **Affordable** (relative)
  - **Non-conflicting**
    - **A requirement that is non-conflicting does not contradict, interfere with, or duplicate other requirements.**
  - **Complete**
  - **Concise**
  - **Verifiable**

A Valid Requirement

- A “Valid” requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
  - **Affordable** (relative)
  - **Non-conflicting**
  - **Complete**
    - **A requirement that is complete can stand on its own without further clarification or explanation and possesses no omissions or exaggerations. It can be removed from the document and read as single item.**
  - **Concise**
  - **Verifiable**

A Valid Requirement

- A “Valid” requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
  - **Affordable** (relative)
  - **Non-conflicting**
  - **Complete**
  - **Concise**
    - **A requirement that is concise has no ambiguity and is clearly and simply stated.**
  - **Verifiable**

A Valid Requirement

- A “Valid” requirement meets the following criteria:
  - **Necessary**
  - **Technically Feasible**
  - **Affordable** (relative)
  - **Non-conflicting**
  - **Complete**
  - **Concise**
  - **Verifiable**
    - **A requirement that is verifiable can have compliance confirmed by inspection, analysis, demonstration, or test.**

Create Concept Design Process

- The “Create Concept Design Package” process describes the process by which the BRD is expanded from the user (operational and science) requirements for the Polar Icebreaker to the technical requirements that will be required to enter into the Contract Design process.

Create Concept Design Process

- Essentially three steps
  - Identify and Plan Work
    - Create Work Breakdown Structure (WBS)
  - Write Concept Design Reports (CDR)
  - Create Concept Design Package (CDP)

Work Breakdown Structure

- 1.1 GENERAL PROVISIONS
- 2.1 STRUCTURE
- 2.2 PROPULSION AND MANOEUVRING MACHINERY
- 2.3 ELECTRICAL SYSTEMS
- 2.4 SHIP INFORMATION SYSTEMS
- 2.5 SHIP SYSTEMS
- 2.6 OUTFIT AND EQUIPMENT
- 2.7 MISSION SYSTEMS

1.1 General Provisions

- 1.1.1 Principal Particulars
- 1.1.2 Compliment
- 1.1.3 Speed and Power
- 1.1.4 Range
- 1.1.5 Endurance
- 1.1.6 Stability
- 1.1.7 Motion Studies
- 1.1.8 Environmental Service Conditions
- 1.1.9 Winterization
- 1.1.10 Operational Planning
- 1.1.11 Classification, Conventions and Notations

2.1 Structure

2.1.1 Hull Form
2.1.2 Stability Analysis
2.1.3 Icebreaking Systems
2.1.4 Moon Pool
2.1.5 Tank Plan
2.1.6 Sea Keeping Analysis
2.1.7 Station Keeping Analysis
2.1.8 Ice Scenarios
2.1.9 Ice Mission Analysis
2.1.10 Ice Modeling (Computer Simulation)
2.1.11 Painting and Preservation
2.1.12 Cathodic Protection

2.2 Propulsion

2.2.1 Propulsion Options Study

2.2.2 Propulsion Options Analysis

2.2.3 Prime Movers

2.2.4 Transmission Systems

2.2.5 Propulsors and Thrusters

2.2.6 Steering Systems

2.2.7 Stabilizing Systems

2.3 Electrical Systems

2.3.1 Electrical System Description

2.3.2 Power Generation

2.3.3 Power Conversion

2.3.4 Power Distribution

2.3.5 Lighting

2.4 Ship Information Systems

2.4.1 General Systems Requirements

2.4.2 Internal Data Transmission

2.4.3 External Data Transmission

2.4.4 Electronic and Acoustic Navigation Systems

2.4.5 Control and Monitoring Systems

2.5 Ship Systems

2.5.1 Raw Water Services
2.5.2 Fresh Water Services
2.5.3 Distilled Water
2.5.4 Waste Heat Recovery Systems
2.5.5 Environmental Systems
2.5.6 HVAC and Refrigeration Systems
2.5.7 Firefighting Systems
2.5.8 Fuel Oil Systems
2.5.9 Lubricating Oil Systems
2.5.10 Compressed Gas Systems
2.5.11 Hydraulic Systems

2.6 Outfitting and Equipment

2.6.1 General Arrangement
2.6.2 Coverings and Insulation
2.6.3 Domestic Spaces
2.6.4 Configurable Accommodation
2.6.5 Recreation Spaces and Lounges
2.6.6 Galley, Scullery and Messes
2.6.7 Office Spaces
2.6.8 Medical and First Aid Facilities
2.6.9 Control and Program Spaces
2.6.10 Machinery Compartments and Spaces
2.6.11 Stores Compartments and Spaces
2.6.12 Deck Machinery and Fittings
2.6.13 Towing Equipment and Fittings
2.6.14 Lifesaving Equipment and Fittings
2.6.15 Fire Safety Equipment

2.7 Mission Systems

2.7.1 Noise and Vibration

2.7.2 Organic Aviation

2.7.3 Cargo and Stowage

2.7.4 Modular Mission Fits

2.7.5 Boats

2.7.6 Science Matrices

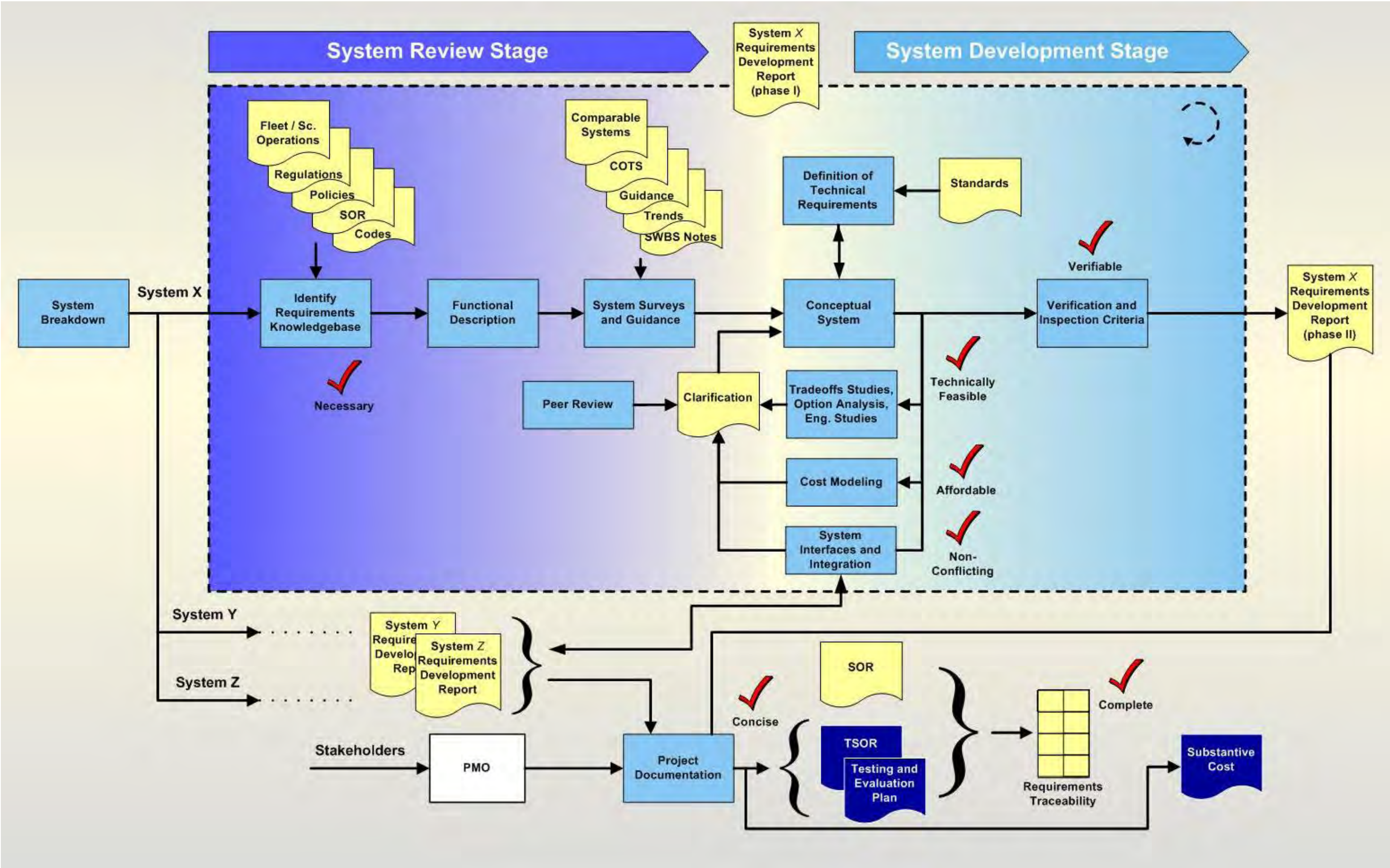
2.7.7 Armaments and Ordnance

2.7.8 Small Craft and Vehicle Storage and Workshop

Concept Design Report

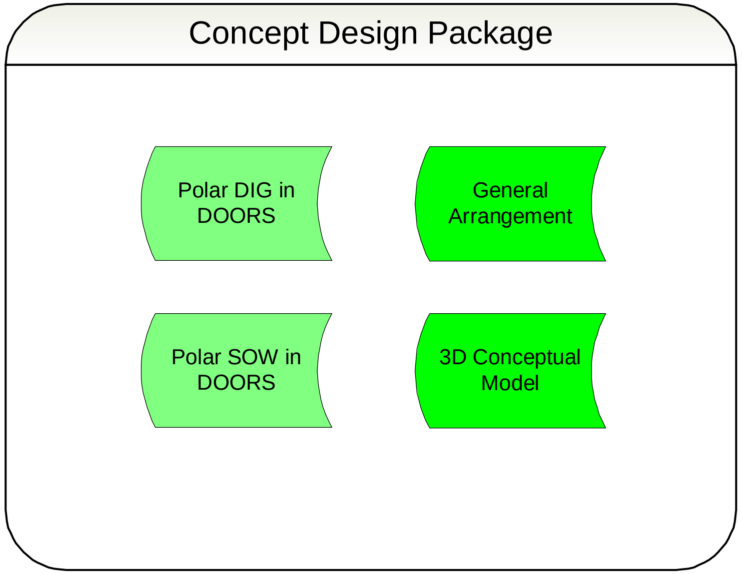
- Concept Development Report
  - Corner stone of Coast Guard concept design work
  - An engineering report that expands the operational or baseline requirements into the technical requirements .
  - Predefined format developed over the previous three projects
- Cumulative output of all the CDR’s is the Concept Design Package (CDP)

Concept Design Report



Concept Design Package

- The Concept Design Package will consist of four specific items of stored data.
  1. The Design Information and Guidance Package
  2. The Statement of Work
  3. The 3D Computer Model
  4. The General Arrangement (GA)



Engineering Team

Section	Lead Eng
1.1 – General Provisions	Michel Routhier
2.1 – Structure	Tim Fleming
2.2 – Propulsion and Manoeuvering Machinery	Jeff Neilson
2.3 – Electrical Systems	Ben Guyon
2.4 – Ship Information Systems	Mark Lukeman
2.5 – Ship Systems	Brian Carter
2.6 – Outfit and Equipment	Art Coughtry
2.7 – Mission Systems	Vince DeAngelis
n/a – X-Drive and CDR Files	Art Coughtry
n/a – Requirements Tracking	Mark Lukeman
n/a – Engineering Manager	Ken Hill

Contract for Design Process

- Process in draft form.
- Leverage of the experience from MSPV, OOSV, and OFSV
- Dependant upon procurement strategy and procurement plan.

Design & Construction Spec

- Process in draft form.
- OOSV and OFSV currently using and refining process.
- Polar will leverage off their experience

Remaining Processes

- Remaining processes
  - Accept Design
  - Contract for Construction
  - Construct Vessel
  - Accept Vessel
- Under development and will align with NSPS

The Status

- Create and Validate Requirements
  - Create Requirements: 100% complete
  - Validate Requirements: Validation of BRD is 90% complete
    - Validation of remaining requirements still being discussed with PD and PM

The Status

- Identify and Plan Work
  - 100% identified, lead Engs writing CDR Task scope
  - 75% planned initial section plans submitted, rolled up plan under development.

The Status

- Write Concept Design Reports Tasks
  - 75 “3 Digit Level” CDR’s to write, many have sublevels.
  - Work starting will take until Dec 10 to complete.
  - 21 are Key CDR’s - they not necessarily unique to the Polar Icebreaker but are required to understand and deliver the Concept Design Package. High Technical Risk
  - 15 are Unique CDR’s – they are unique to the Polar Icebreaker and are required to understand and deliver the Concept Design Package. Medium Technical Risk
  - 39 are similar to something MCP PS has written before and can update to reflect the Polar Icebreaker with little difficulty and should included to understand and deliver the Concept Design Package. Low Technical Risk

Some Key CDR's

- Principle Particulars
- Hull Form
- Propulsion Options Analysis
- Electrical System Description
- Permanent Science Fits

Some Unique CDR's

- Waste Heat Recovery
- Icebreaking Systems
- Modular Mission Fits
- Organic Aviation

Some Low Risk CDR's

- Lighting
- Internal Data Transmission
- HVAC and Refrigeration
- Recreational Spaces and Lounges
- Painting and Preservation

Principal Particulars

Notional Vessel Particulars

Principle Features

Lightship Displacement	10-12000 Tonnes
Length	120-140 m
Beam (Extreme)	25-30 m
Draft	10 m

DFO Science Equipment

- Stern A-Frame
- Coring Capability
- Water Column Sampling Capability
- Meteorological Capability
- Ice and Snow Sampling Capability
- Biological Sampling Laboratory
- Cold, Frozen and Ultra Cold Sample Freezers
- General Purpose Laboratories
- Chemical Laboratory
- Biology Laboratories
- Geology Laboratories
- Snow and Ice Laboratories
- Electronics and Computer Laboratories
- Moon pool
- Multipurpose/configurable laboratory spaces

Main Characteristics

Number of Ships	1
Range	TBD @ 12 knots
Endurance	270 days
Maximum Speed Open Water	18 Knots
In-service date	2017
First of Class	CCGS John G. Diefenbaker

Icebreaking

Thickness	2.5 meters level ice
Speed (ahead)	3 knots
Speed(astern)	making way
Endurance	35 days

Machinery

Propulsion Power	50-60 MW
Voltage	6.6-11 kV
Prime Movers	Diesel Generators
Control	Automatic Integrated Digital

Certification

Will be built and certified in accordance with Class rules.
Notations TBD

Storage and Cargo

2000 m^3 below deck
20 X TEU (5 X Refrigerated & 2 X ER)
1000 m^3 Diesel fuel oil
Modular Mission Payload Concept

CCG Equipment

Integrated Bridge System (IBS)
Dynamic Positioning System (DPS)
2 x Instrument Flight Roles (IFR) Helicopter and Hanger
Unmanned Arial Vehicle (UAV) capable
Medical Facilities
SAR Facilities
Marine Spill Response Facilities
Mission Command Center
Rapid Trim and Heeling System
Garage and Workshop
Access to snow and ice

Boats

Fast Rescue Craft (FRC)
Landing Craft Marine (LCM)
Dumb barge
Air (Skippy) Boats

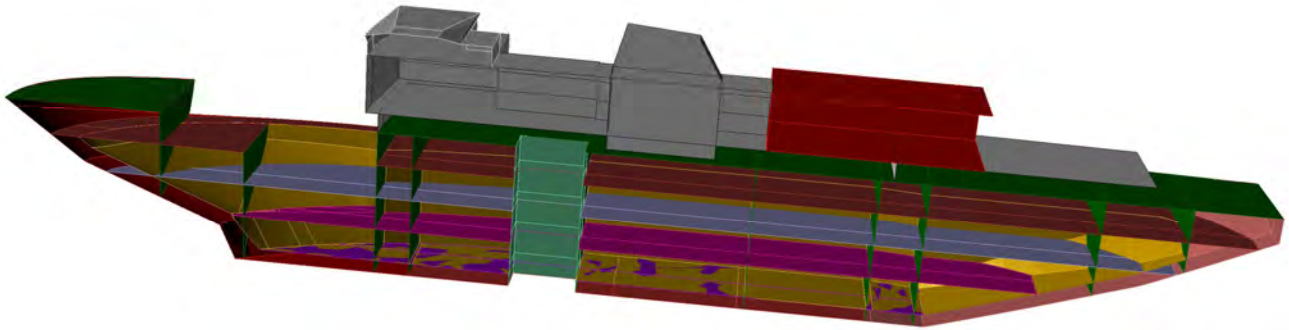
Compliment

CCG	60
Science	40
Surge	25
Total	100-125

Hull Form

Ken Hill

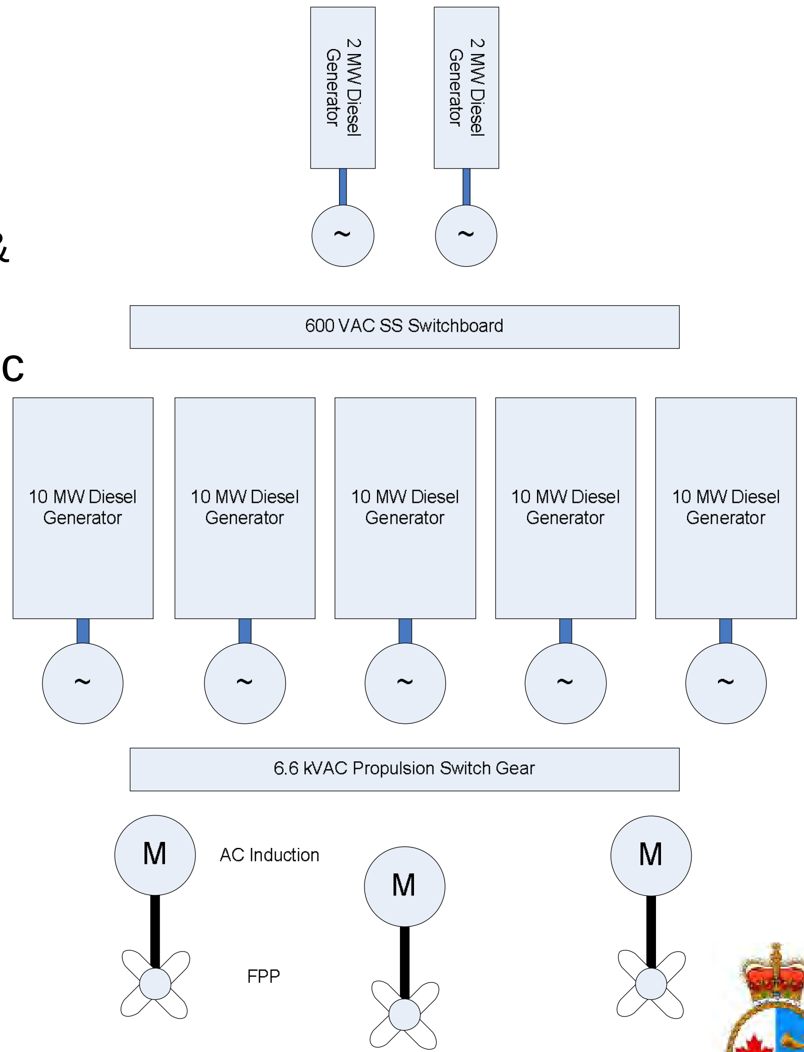
Hull Form



Propulsion Options

Propulsion Options

- Propulsion Options Include:
  - Nuclear
  - Gas Turbine
  - Diesel Mechanical
  - Diesel Electric (Integrated Propulsion & Ship Services)
- Notional Configuration is Diesel Electric
- Multiple Common Prime Movers (e.g. 5 x 10 MW plus 2 x 2 MW)
- 6.6 kV 3-Phase Propulsion Bus
- 600 V 3-Phase Ship Service Bus
- 3 Shaft (AC Induction Motors Driving Fixed Pitch Propellers

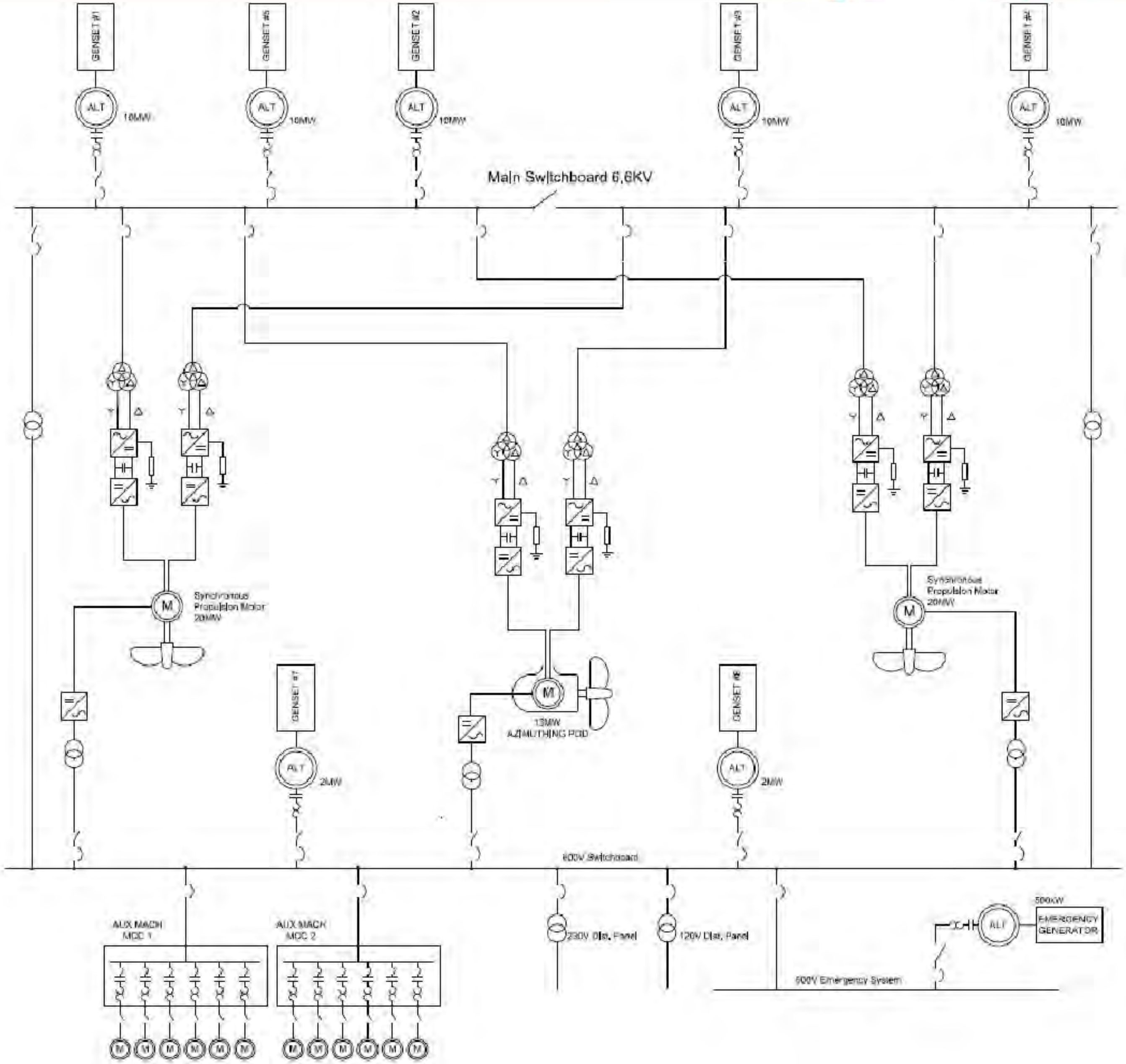


Propulsion Studies

- Propulsion trade studies being conducted to examine:
  - Optimum number and sizes of prime movers (dependant on “Time on Task”/ mission profiles and associated hull and hotel power demands)
  - AC induction versus AC synchronous versus DC propulsion motors
  - Feasibility of incorporating an ice rated podded propulsor in the centerline position (high efficiency in transit)

Electrical Systems

One Line Diagram



6.6kV vs 600V Main Switchboard

	6.6kV	600V	Impact on System
Switchboard Amperage	5000 A	55,000 A	11x reduction in Amperage
Heat Contribution ($P=I^2R$)	2.5 kW	302.5 kW	121x reduction in heat generated
Prospective Fault Currents	160 kAIC	1760 kAIC	11x reduction in fault currents

Electrical One Line Highlights

- Main Switchboard 6.6KV
  - 11x reduction in amperage compared to 600V
  - 5000 Amps compared to 55,000 Amps
- 600V Ship Service Switchboard
  - 2 x 2MW Gens
  - Operating at 4000A
- 230V Distribution Switchboard
- 120V Distribution Switchboard
- 3 AC Synchronous Motors (2 shafts + 1 POD?)
  - Larger air gap
  - Double wound motors (Redundancy)
- Complete electrical redundancy on propulsion

Permanent Science Fits

Science Equipment Process Overview

1. Identify science mission details including a description of science packages and mission requirements (e.g., ship speed, deployment depth, and cable/wire details)
2. Determine science winch and lifting equipment requirements (i.e., quantity, lift capacity, range, mass, size and power requirements)
3. Verify and validate requirements

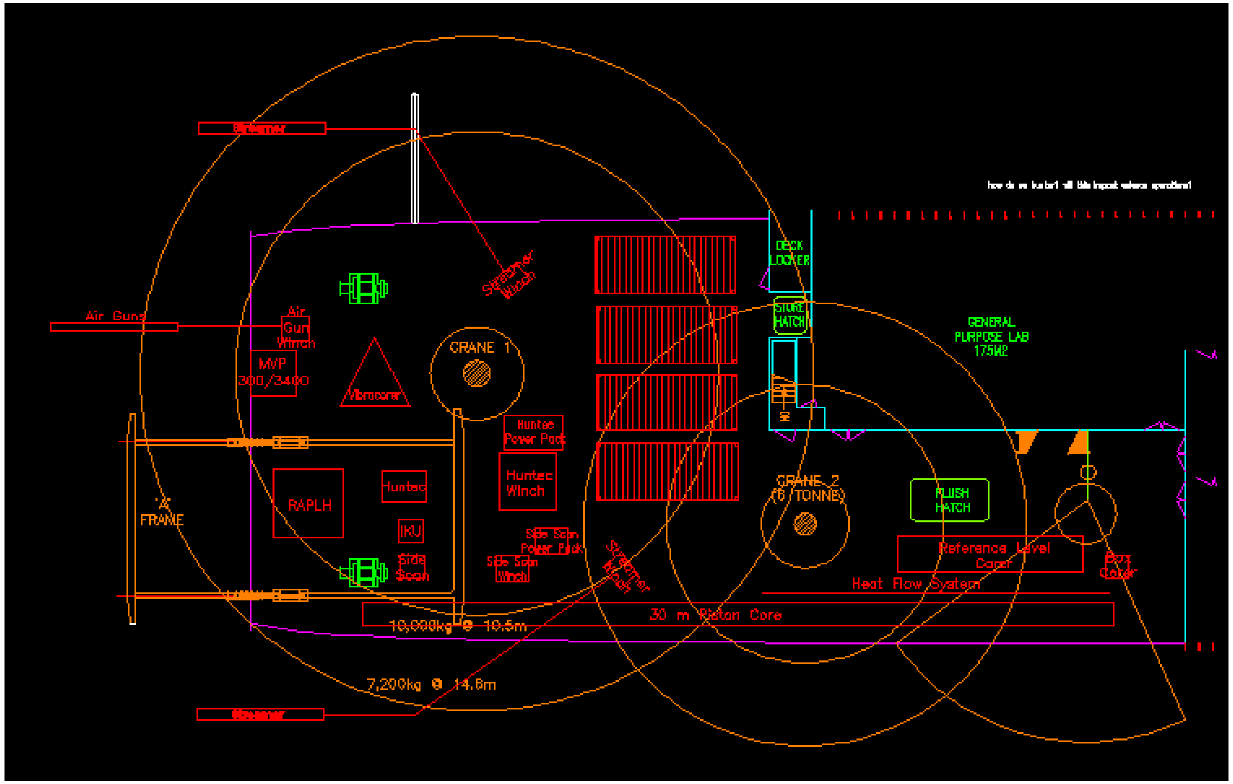
Process achieved through:

1. Talking to operators & science users to understand requirements
2. Contacting equipment manufacturers
3. Contacting other research vessel operators & science users
4. Studies (e.g., Electric versus Hydraulic Power, Motion Compensation Systems)
4. Ship visits
5. Conceptual general arrangement drawing development

Science Equipment Process Overview

Final Deliverables:

1. Science matrix
2. Concept Development Report (CDR)
3. Conceptual general arrangement drawing
4. DI&G document



Laboratory Process Overview

1. Identify laboratory requirements
2. Verify and validate requirements

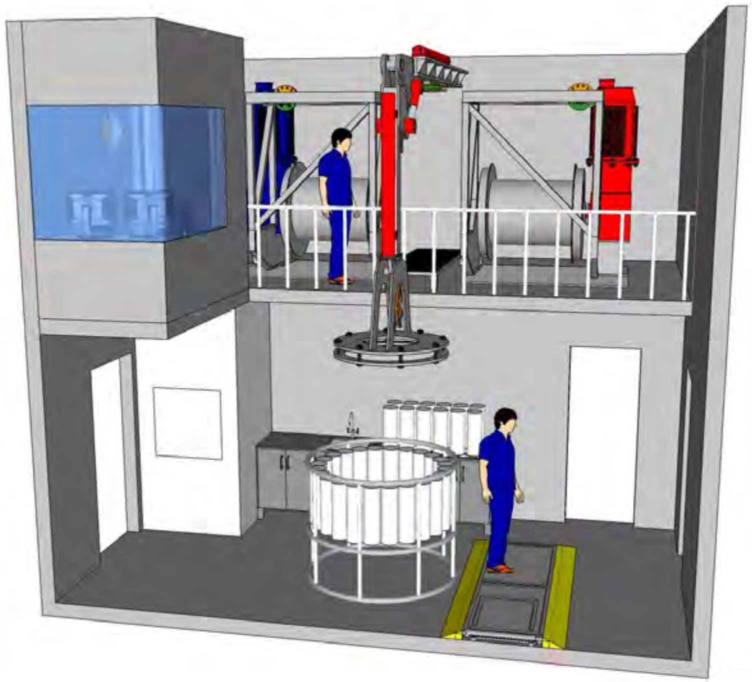
Process achieved through:

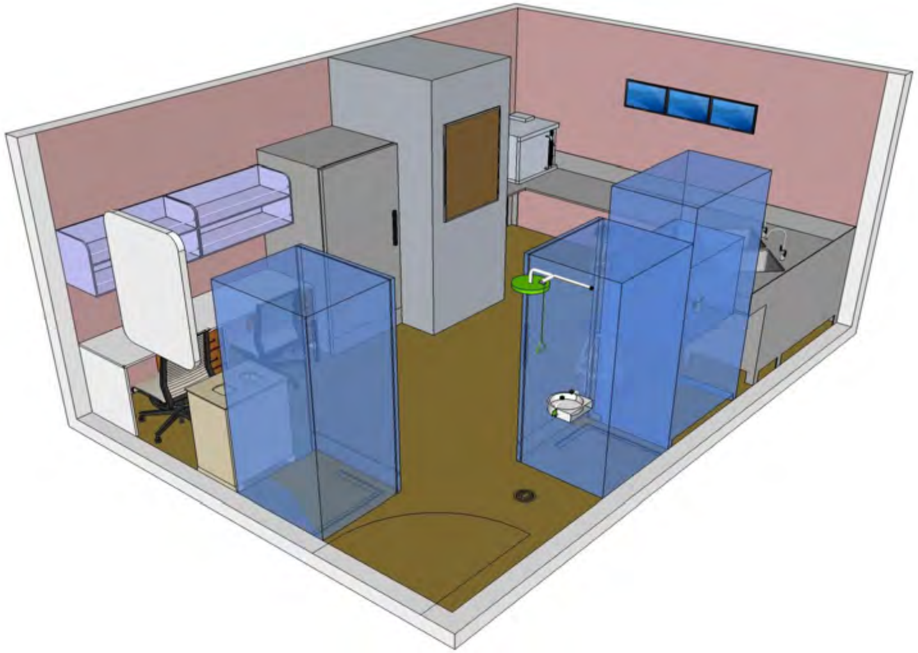
1. Talking to science users to understand requirements
2. Contacting other research vessel science users
3. Ship visits
4. Conceptual general arrangement drawing development

Laboratory Process Overview

Final Deliverables:

1. Concept Development Report (CDR)
2. Conceptual laboratory drawings
3. DI&G document





Way Ahead

- Write CDR's
- Create CDP

Conclusions

- Polar Project is now progressing as expected.

Questions?