### ISS Information

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>356.4 feet</td>
</tr>
<tr>
<td>Length</td>
<td>290 feet</td>
</tr>
<tr>
<td>Mass (Weight)</td>
<td>1,005,000 pounds</td>
</tr>
<tr>
<td>Altitude</td>
<td>150 – 280 nautical miles</td>
</tr>
<tr>
<td>Inclination</td>
<td>+/- 56.0 degrees (results in +/- 75.0 degrees beta angle, without the shuttle)</td>
</tr>
<tr>
<td>Internal Pressure</td>
<td>14.25 psi</td>
</tr>
<tr>
<td>Crew Capacity</td>
<td>current 3 crew members with capability of 7 crew members after Node 3</td>
</tr>
</tbody>
</table>
ISS Node 2 & 3 Launch Schedule

Node 2 – Flight 10A: Sep. 2004

Node 3 – Flight 20A: Jul. 2006
ISS Nodes 2 & 3 Locations

Node 2 (Forward)

Flight Direction
The purpose of the Nodes is to act as building blocks to connect other system elements; provide a pressurized passageway between berthed elements; and distribute/transfer commands and data, audio and video, electrical power, atmosphere, water, and thermal energy to adjacent elements of the International Space Station (ISS).
## Nodes 2 & 3 Overview

### Both Nodes Include:
- Common Cabin Air Assembly (CCAA)
- Low and Moderate Temp Active thermal control System (ATCS)

### Node Specific

#### Node 1
- Two Avionics Racks

#### Node 2
- Four Avionics Racks
- Crew Quarters

#### Node 3
- Six Environmental Control and Life Support Systems (ECLSS) Racks

### Provides Resources to:
- Node 1 Airlock
- U.S. Habitation Module (HAB)
- Crew Return Vehicle (CRV)
- Node 3 and Node 1 Cupolas
- Multi-Purpose Logistics Module (MPLM)
Primary Space Station Thermal Requirements

Distribute Thermal Energy - the Node shall supply moderate and low temperature heat transport fluid for the purpose of heat rejection.

Physical Connectivity of Internal and External Thermal Loops - the Active Thermal Control System (ATCS) design shall define all interface fittings and connections.

Preclude Condensation - surfaces exposed to the cabin air shall preclude condensation of atmosphere moisture (Node 2&3 dewpoint is 60 °F).

Thermal Environments - an integrated thermal analysis shall be performed using System Integrated Numerical Differencing Analyzer (SINDA/FLUINT), Thermal Radiation Analyzer System (TRASYS), or Thermal Synthesizer System (TSS) thermal math models, and Node component qualification data.

Touch Temperature - internal touch temperature limits not to exceed the range between 39° and 113° F and external touch temperature limits not to exceed the range between -45° and 145° F.
ISS/Nodes 2 & 3 Thermal Control Design Overview
Nodes Thermal Control System (TCS) Overview

Internal Active TCS
Low temperature (LTL) (38 deg. F to 43 deg. F) and Moderate Temperature (MTL) (61 deg. F to 65 deg. F) coolant loops. Coolant supplied is software controlled to maximize operational flexibility.

External Active TCS
Externally mounted Ammonia/Water Heat Exchangers (6 for N2, 2 for N3); provides heat rejection for Node coolant loops. Liquid ammonia (33 deg. F to 40 deg. F) is supplied by external ISS sources in which to provide heat rejection.

Passive TCS
Multilayer insulation (MLI), thermal control coatings, insulation and heaters. Two (2) types of heaters: thermostatically controlled Launch-To-Activation phase (LTA) heaters, and software controlled On-Orbit heaters which are used following Node activation.
Passive Thermal Control Design (MLI)

Multi-Layer Insulation without Beta-Cloth
(prior to debris shield)

Multi-Layer Insulation with Beta-Cloth
General Active Thermal Control Design

Coolant

Manual Valve (set prior to launch)

Pump

Modulated Valve (controlled)

Element, Rack or Experiment (known dp)
Node 3 Active Thermal Control Design (Internal)
ISS Active Thermal Control Design (External)

Ammonia heat sink to space

Node 2 receives ammonia directly from source
ISS Active Thermal Control Design (External)

USL Forward Endcone integrated into Space Shuttle's cargo Bay

External ammonia, electrical & data connection

Meteoroid Debris Shields
Active Thermal Control Design (External)

- USL External HX
- Integrated Heater/Sensor Water Hose
- Ammonia Hose
Active Thermal Control Design (External)

Integrated Flight Heat Exchanger (Schematic)
IATCS Thermal Control Component Examples
TCS Components

International Standard Payload Rack (ISPR)

Racks are structures designed to house electronics and other subsystem equipment, and experiment payloads.

Heat rejected from equipment or experiments within the rack is transferred to the IATCS coolant loops via coldplates, heat exchangers or via direct fluid contact.

Coolant flow to the rack can be either fixed or controlled (based on flowrate or temperature).

Maximum outlet temperature is 70° F for the LT and 120° F for the MT.

Envelope: 80 in. x 40.5 in. x 40 in. (International Standard Payload Rack (ISPR))
TCS Components

Three Way Mix Valve (TWMV)

System Flow Control Assembly (SFCA)
TCS Components

Coldplate Mounting Surface

ITCS Coolant Line with Gamah Fitting
Thermo-Hydraulic Analysis Tools Overview
Thermal Analysis

- Thermal Radiation Analyzer System (TRASYS)
- System Improved Numerical Differencing Analyzer (SINDA)

Orbital Heat Flux

Radiation / Conduction
Hydraulic Analysis

System Improved Numerical Differencing Analyzer/Fluid Integrator (SINDA/Fluint)

ATCS Nodal Network

* Denotes Alenia IATCS results for time = 0.5 hrs. with NH₃ inlet = 34 °F
Thermal Analysis
Thermal Desktop

Graphical interface that develops the capacitance and conductance network for input into SINDA/FLUINT
Node 3 LCA and regenerative heat exchanger feasibility and performance study