“Using classic craftsmanship and advanced technology to fathom new possibilities”
About C3I

C3I Inc. specializes in engineering critical communications, controls, lighting, instruments, and systems for the marine industry.

Located in Hampton, New Hampshire, a coastal New England town in a region with a rich shipbuilding tradition, our experienced team has worked together solving marine challenges for over 20 years, with an average of 25 years of individual experience.

We produce reliable, high-quality products and have depth of experience and breadth of offerings with volume to support full naval market demand. We know how ships work and understand how the Mariner uses them.

Our expertise includes real time, embedded systems using COTS platforms, as well as software development, energy management technology, shipboard control and navigation equipment, and directed thrust control systems.

We have designed and manufactured precision, critical controls and instruments in four major products lines: Advanced Lighting Systems, Interior Communications, Distributed Data Acquisition, and Bridge Display Systems.

Our equipment and systems support submarines, surface ships, gas turbine and nuclear power plants, autonomous vehicles, and passenger ferries. We offer a range of products, from individual instruments through complex systems.

C3I, Inc. has the scientific, engineering, and manufacturing resources to provide you with highly cost effective, advanced communications and control systems.
Advanced Lighting System (ALS) Overview

C3I, Inc. produces Advanced Lighting System (ALS) control systems and equipment that represent a new generation of integrated lighting specifically beneficial in large and/or complex marine applications.

Our Advanced Lighting System provides lighting, monitoring, and control of individual lights, lighting groups, and ship wide lighting systems. Our system architecture is comprised of a control system, communication networks, and various lighting technologies and provides real benefits in lowered shipbuilding costs with significant improvement in capability and function and ease of maintenance. The technology is platform and mission independent, and is tailorable without programming.

We can architect a system to meet your needs.

Advanced Lighting System (ALS)

The Advanced Lighting System (ALS) is an architecture designed, developed, and manufactured by the companies of the Advanced Lighting Team (ALT).

ALS technology is currently being installed on the DDG-51 class, is part of the LPD-17 lighting upgrade, is being incorporated into the design specifications of the DDX, and is currently being manufactured for installation on the ONR XCraft. New ALS technologies, including select illuminated indicators, are under development for the VLA (Visual Landing Areas—flight decks) of Navy ships.

Advanced Lighting Team (ALT) Areas of Expertise

Each company of the Advanced Lighting Team brings state-of-the-art design and manufacturing capabilities in its area of contribution.

- **C3I, Inc.**, Center Centre Square D4, 11 Merrill Industrial Drive, Hampton NH 03842 USA – System architect, hardware and software for communication and controls.
- **RSL Fiber Systems, LLC**, 90 W. Broadway, Salem NJ, 08079 USA – Advanced fiber optics and illumination technology including full-function light engines and luminaires.
Elements of an Advanced Lighting System

The Advanced Lighting System equipment we produce fulfills three major functions:

- control
- communications
- lighting

Control System Equipment

The ALS control system includes the hardware and software that make the integrated control of lighting possible. The control system provides signals and processing for the ALS and is capable of managing remote, group, sub-group, and local control of shipboard lighting. Lighting control includes dimming levels, color, switching functions, and variable lighting technologies (incandescent, LED, fiber-optic) through user-friendly interfaces at single or multiple control stations.

The ALS addressing architecture allows the ship naval architect, shipbuilder, and ship’s crew the ability to easily and readily configure, troubleshoot, and manage the lighting system. It includes switches that are set to define the lighting-technology address and function without the use of special equipment. Four switches are provided on each lighting technology device to effect this: Super Group, Group, Sub-Group, and Lighting Technology Function.

The Group, Sub-Group, and Lighting Technology Function settings allow the device to be assigned to any control page within the ALSGUI at any time, from installation to operation. The Super-Group setting provides the unique capability to operate the light technology remotely even before the group assignment is made. This ability is particularly valuable during ship construction and as a troubleshooting aid during in-service support.

Communication Networks

The ALS communication networks integrate the ALS into ship systems. Our networks enable the lighting technology to be located anywhere in the ship and be remotely controlled from the locations of your choosing. The Advanced Lighting Local Area Network (ALLAN) of the ALS can integrate into an installed, ship-wide network or can be used as a stand-alone network.

Lighting Technologies

The ALS incorporates various lighting technologies including conventional incandescent, conventional fluorescent, LED, and Fiber-Optic. It also includes special function switches such as the Emergency Lighting Override Switch (ELOS), Local Lighting Control Switch (LLCS), and Darken Ship Door Interlock (DSDI) switches.

Building a System to Address Your Needs

We’ve created a flexible Advanced Lighting System architecture to simplify the design process for you. We have done the software development, so that after you define your system requirements and specify the hardware you need, the user interface and embedded software maintenance tests and setup controls are in place to configure your lighting system.

C3I, Inc. can help you define your shipboard lighting system requirements and develop a system to address your specific lighting needs.

We can guide you through the following four steps in designing your system:

- Step 1: Define the System Requirements
- Step 2: Specify Hardware Types, Quantities, and Locations
- Step 3: Tailor the Software to the Requirements
- Step 4: Perform the Shipboard Installation
### Step 1: Define the System Requirements

Developing the lighting system requirements is the first step in determining the specific shipboard lighting system architecture. The options to be considered in developing the lighting system requirements include the following:

| Level of Automation: | Ship Manning Level  
| Ship Mission Profile |
|----------------------|-------------------|
| Unique Lighting Requirements: | Hazardous Applications: hazardous area lighting such as for magazines, wet areas such as well decks, fuel tanks, mastheads, and difficult weather deck locations  
| Unique Functional Applications such as Flight Deck Lights: Status Lights, Wave Off Lights, Night Vision Device Compatibility requirements  
| Unique Control Applications: Multiple Control Stations, Divisible Control Stations, Emergency Control Stations |
| Types of Lighting: | Conventional Incandescent Lights: quantity and locations  
| Conventional Fluorescent Lights: quantity and locations  
| LED Lighting: types, quantity and locations  
| Fiber-Optic Lighting: types, quantity and locations  
| Darken Ship Door Interlocks: quantity and locations |
| Type of Control: | Integrated Control: integrated into other systems  
| Divisible Control: ability to assign groups and sub-groups to various distributed controls  
| Control Panel Functions: NVD compatible screens, panel dimming, indoor/outdoor locations, etc.  
| Special Control Functions: emergency lighting override controls, coordinated sub-group responses |
| Type of Communications | Integrated into existing shipboard networks  
| Separate Stand-Alone Installation (ALLAN)  
| Hybrid Installations: combination of shipboard integration and stand-alone Local Area Networks (ALLAN) |
| Type of Maintenance & Support: | Configuration Management Policy, etc.  
| Test Equipment |
| Documentation | System Architecture Drawings  
| Operation and Maintenance technical manuals |
Step 2: Specify Hardware Types, Quantities, and Locations

The Advanced Lighting System control system created by C3I is comprised of many assemblies and software programs, each serving an important function. The equipment required for your system may vary depending on your needs. As you layout your system, choose the Control Hardware, the Communication System Hardware, and the Lighting Technologies to fulfill your ship system requirements.

Table 1: Hardware and Software of the Advanced Lighting System

<table>
<thead>
<tr>
<th>Control System Equipment</th>
<th>Description</th>
<th>Part Number</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALS Control Panels (ALSCPs)</td>
<td>LCD flat-panel touch screen provides control over the Advanced Lighting System Application Program (ALSAP) for the command and control of the lighting system equipment. Includes Darken Ship and NVD compatible screen &amp; wide viewing angle and embedded UPS. May include the ALS Processor Module (ALSPM).</td>
<td>AY-03400-014</td>
<td>(Software has separate part number)</td>
</tr>
<tr>
<td>Local Lighting Control Switches (LLCS)</td>
<td>Provides local switching function: on/off/network. Color selection: red/white.</td>
<td>AY-04200-008</td>
<td></td>
</tr>
<tr>
<td>Emergency Override Control Switches (EOCS)</td>
<td>Provides local emergency control of designated lighting technology.</td>
<td>AY-04200-009</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Conventional Lighting Integrated Control Module (CLICM)</td>
<td>Under development, this device integrates the functions of the circuit breaker, health monitoring, circuit monitoring, on/off control, dimming control, and system communication interface into one package.</td>
<td>AY-04200-012</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Variable Transformer Power Control Module (VTPCM)</td>
<td>This rack unit provides ALS-compatible control of incandescent dimming using a motorized variable transformer. Available in three sizes.</td>
<td>AY-04200-013 (10 amp) AY-04200-014 (22 amp) AY-04200-015 (30 amp)</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Darken Ship Door Interlock (DSDI)</td>
<td>Provides door position status to the ALS.</td>
<td>AY-04200-016</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>ALS Test Equipment Suite</td>
<td>Hardware and software test equipment for all ALS instruments.</td>
<td>AY-04200-016</td>
<td></td>
</tr>
</tbody>
</table>
### Advanced Lighting System Software (ALSS)

- **Advanced Lighting System Application Program (ALSAP)**
  - Performs all the detailed lighting control functions and performs the machine outer control loop functions. Customizable without programming. Includes the Advanced Lighting System Installation & System Maintenance Software for installation and maintenance of the system.
  - SOF-04012

- **Advanced Lighting System Graphical User Interface (ALSGUI)**
  - Provides the main access point for users to interact with the system. Customizable without programming.
  - SOF-04011
  - Sample GUI screens:

### Communication Network Hardware

- **Digital Interface Module Ethernet to RS485 (DIMER)**
  - Provides the ability to interface the various ship WAN/LAN networks to the standard ALS hardware modules, allowing them to be used on virtually any ship. DIMER provides the communications interface to support a single channel Ethernet interface to the ships fiber-optic network or copper network.
  - AY-04200-002

- **Lighting Interface Network Controllers (LINC)**
  - Embeddable module to provide other technology with compatibility to the ALS.
  - AY-04200-012

### Lighting Technologies

- **Fiber-Optic Light Engines**
  - High-intensity light engine, with dimming adjustable through a full range from 0% (full on) to 100% (full blackout). Internal lamps with optical filters (red, amber, NVD blue).
  - RSLFS P/N 38011

- **Integrated Control Module (ICM)**
  - An embedded circuit board that provides control of the Fiber-Optic Light Engine. It is adaptable to multiple light control applications and technologies. Available with or without LCD readout.
  - SA-04400-001
### Table 1: Hardware and Software of the Advanced Lighting System (Continued)

<table>
<thead>
<tr>
<th><strong>Fiber-Optic Luminaires for Flight Deck and Navigation</strong></th>
<th>OH Flood</th>
<th>RSLFS P/N 38033</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck Surface Wash</td>
<td>RSLFS P/N 38034</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Structure Wash</td>
<td>RSLFS P/N 38035</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Deck Boundary</td>
<td>RSLFS P/N 38036</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Drop Line or Line Up</td>
<td>RSLFS P/N 38038</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Obstruction</td>
<td>RSLFS P/N 38039</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Homing Beacon</td>
<td>RSLFS P/N 38040</td>
<td>Available April 2005</td>
</tr>
<tr>
<td>Forward Anchor</td>
<td>RSLFS P/N 38027</td>
<td></td>
</tr>
<tr>
<td>Aft Anchor</td>
<td>RSLFS P/N 38030</td>
<td></td>
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<tr>
<td>Masthead</td>
<td>RSLFS part 37000</td>
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<tr>
<td>Stern</td>
<td>RSLFS P/N 38032</td>
<td></td>
</tr>
<tr>
<td>Port (Red)</td>
<td>RSLFS P/N 38030</td>
<td></td>
</tr>
<tr>
<td>Starboard (Green)</td>
<td>RSLFS P/N 38031</td>
<td></td>
</tr>
<tr>
<td>Task/NUC (360 Red)</td>
<td>RSLFS P/N 38029</td>
<td></td>
</tr>
<tr>
<td>Waterline Security</td>
<td>RSLFS P/N 38026</td>
<td></td>
</tr>
</tbody>
</table>

**Task lighting**

**LED Lighting**

Various LED-based lighting options

**Conventional lighting**

Incandescent and fluorescent Commercially available.

**Documentation**

A full range of Technical Documentation for the software and maintenance of the ALS is available.
Step 3: Tailor the Software to the Requirements

Our system can be tailored to your vessel using the embedded tools that come with our software programs. This tailoring can be performed in-house by your engineering department, or it can be performed by our engineering consultants to provide you with a turn-key system package.

The software in the ALS control system provides communication and processing for the ALS and is capable of managing remote, group, sub-group, and local control of shipboard lighting. The applications are platform and mission independent, and are tailorable so you can customize them without programming.

There are two main software programs that provide lighting system control. Features and custom capabilities built into each application are listed here.

ALS Application Program Features

The ALS Application Program (ALSAP) performs all the detailed lighting control functions, and performs the machine outer control loop functions. These functions include: equipment polling, output message queuing, message priority scheduling, status message receipt and analysis, command message formatting, message transmission, error checking, fault tolerant computation algorithms, embedded maintenance programming, lighting configuration management schedules, arbitration logic, fault alarming, alarm acknowledgement, and watchdog functions.

The ALS Application Program has a flexible architecture that enables installations to manage changes in illumination type and configuration without altering the code.

- Complete lamp and illuminator editing control over configuring lamp types, field of illumination, location, capability, and address
- Excel-format compatible configuration file loads facilitate off-hull configuration control of illumination layouts
- Assignable/divisible illumination control allows control of specified lighting groups to be transferred to alternate control stations
- Hierarchical illumination control (ship-wide, group-wide or individual) allows lighting to be changed ship-wide, group-wide or by individual lamp
- Capable of multiple shipboard illumination configuration settings, allows pre-set illumination configurations (i.e. Normal, Darken Ship Condition, NVD Condition)

ALS Graphical User Interface (ASLGUI)

The ALS Graphical User Interface (ASLGUI) provides the main access point for users to interact with the system.

- Bit map background graphics allow custom layouts without impact on operating programs
- Random access page tabs (no menu hierarchy)
- Darken Ship (Red) and NVD (Blue) compatible graphics
- ICON-driven light editing capability
- Program health monitoring
- Error messaging
- Lamp-fault locating features
- Hierarchical lighting control layout
- Pop-up individual illuminator controls

Step 4: Perform the Shipboard Installation

Shipboard installation of the equipment or system entails several levels. We can help you with any of these levels and have specialized test equipment available.

- Installation and checkout of equipment
- Testing and support
- Supply and spares
Remote Source Lighting Technology Overview

The remote source lighting (RSL) technology consists of transmitting light generated by a high intensity light engine (illuminator) through a length of fiber optic cable and emitting it at a distance from a light diffusing device (Luminaire). This technology has been widely used in applications ranging from illumination for medical procedures, automotive instrumentation lighting, and architectural illumination. The RSL technology provides several benefits when compared to conventional lighting.

### Advantages of Remote Source Lighting

- Ability to place the light engine (illuminator) in an area where maintenance functions will be facilitated, such as closets, basements, or ship compartments
- Ability to remote the illuminator from the light emitter (luminaire) by up to 200 meters
- Elimination of potentially damaging infra-red and ultra-violet emissions via the use of filters in the illuminator
- Ability to place small, maintenance free luminaires in hard to reach locations
- Ability to change light color and intensity instantaneously via filter wheels and light dimmers in the illuminator
- Ability to switch instantaneously from white light to Night Vision Imaging System (NVIS) friendly lighting via the use of filters in the illuminator
- Utilization of a single light source for multiple luminaires
- Improved illumination pattern distribution through optics in the luminaire

While conventional RSL systems utilize plastic (PMMA) optical fibers, RSL Fiber Systems, LLC utilizes cables manufactured using high purity silica based optical fibers, providing lower optical losses (<20 dB/Km vs. > 200 dB/Km for PMMA), virtually no chromaticity shift, and allowing for long distances between illuminator and luminaires.

Testing performed at RSL Fiber Systems indicated that the new, silica based RSL systems can provide up to 16 times the luminous output of equivalent PMMA based systems!

### Illuminators

The illuminator is the light engine containing the high intensity light source(s) providing luminous power to the RSL system.

<table>
<thead>
<tr>
<th>Illuminator Type &amp; Application</th>
<th>Typical Applications</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-Function</strong>&lt;br&gt;The illuminator needs to provide a wide range of functions, have no down time, and rapidly switch modes of operation (Ex: white to NVIS blue)**</td>
<td>Navigation Lights&lt;br&gt;Flood Lights&lt;br&gt;Flight Deck Lighting&lt;br&gt;Well Deck Lighting&lt;br&gt;Visual Landing Aids</td>
<td>- 2 (redundant) Lamps&lt;br&gt;- Up to 4 colors (White, Red, Amber, Green, NVIS Blue)&lt;br&gt;- Flashing&lt;br&gt;- Fully linear dimming form 0 to 100%</td>
</tr>
<tr>
<td><strong>Single Function</strong>&lt;br&gt;The illuminator provides lighting to a non-critical application where only one color is required</td>
<td>Waterline Security&lt;br&gt;Passageways&lt;br&gt;Interiors</td>
<td>- Single Lamp&lt;br&gt;- One color (White, red, Amber, Green, or NVIS Blue)</td>
</tr>
<tr>
<td><strong>Portable, Weather Resistant Illuminator</strong></td>
<td>Brow Lighting&lt;br&gt;Temporary Lights</td>
<td>- Single Lamp&lt;br&gt;- One color&lt;br&gt;- Small size, light weight (&lt; 30 lbs)</td>
</tr>
</tbody>
</table>
Optical Cable and Assemblies

The light from the illuminator is coupled into a highly efficient RSL fiber optic cable consisting of several silica core fibers, helically stranded for optimal flexibility.

The RSL fiber optic cable uses low loss silica core fibers, stranded, reinforced with Aramid yarns, and encased in a low-smoke, zero-halogen jacket. The cable has been tested and has met the applicable mechanical, environmental, and safety requirements of the MIL-PRF-85045 and MIL-C-24643 specifications. The RSL silica glass cable represents a quantum improvement in areas of optical losses, size, chromatic response, and ease of handling over conventional RSL cables built utilizing plastic (PMMA) fibers.

Luminaires

The luminaires receive and emit the light generated by the illuminator and transmitted via the RSL fiber optic cable. Optical components internal to the luminaires shape the light beam into the desired pattern. The luminaires are hermetically sealed and Nitrogen charged to prevent the entry of moisture.

NVIS “Friendly” and “Compatible”

NVIS compatibility is determined by several factors, not only by the specific wavelength of the light being emitted. NVIS compatibility needs to be evaluated from the entire lighting system standpoint. Some of the factors affecting the NVIS compatibility of a system include:

■ Type (Generation) of Night Vision Imaging System used
■ Wavelength of the light emitted and spectral width of the monochromatic component(s)
■ Total number of lights and distance of the light source(s) from the NVIS equipped personnel

The ALS can address the multi-faceted requirements for NVIS compatibility through a combination of optics and control capabilities.

Example: Once the “NVIS MODE” is selected from the Flight Deck control panel, a series of tasks are initiated through control signals sent to each illuminator (the tasks described are for illustrative purpose only - the actual tasks will be determined by the actual NVIS requirements as defined by the user):

1. Switch all the illuminators to NVIS mode;
2. Switch any other NVIS capable lighting device (example: LED Deck Edge Lights) to NVIS mode;
3. Determine the number of lighting devices that are on, calculate the total light output intensity, and dim the output as required;
4. Determine if any non-NVIS capable lights are on (example: hangar lights) and fully dim the lights (full blackout).