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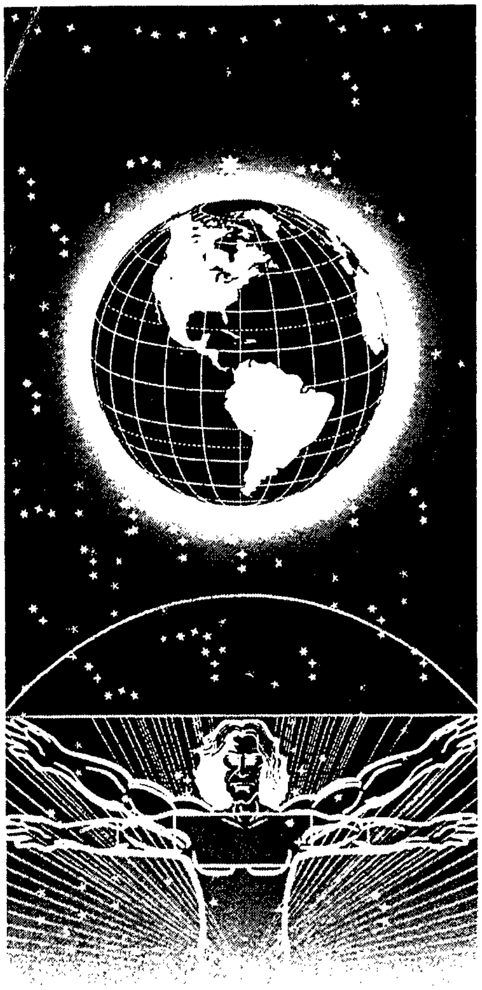

UNITED STATES AIR FORCE RESEARCH LABORATORY

LASER THREAT ANALYSIS SYSTEM (LTAS) VERSION 2.0

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This report has been reviewed and is approved for publication.

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14. ABSTRACT
LTAS is a totally integrated modeling and simulation environment designed for the purpose of ascertaining the susceptibility of Air Force pilots and air crews to optical radiation threats. Using LTAS, mission planners can assess the operational impact of optically directed energy weapons and countermeasures. Through various scenarios, threat analysts are able to determine the capability of laser threats and their impact on operational missions including the air crew's ability to complete their mission effectively. Additionally, LTAS allows the risk of laser use on training ranges and the requirement for laser protection to be evaluated. LTAS gives mission planners and threat analysts complete control of the threat environment including threat parameter control and placement, terrain mapping (line-of-site), atmospheric conditions, and laser eye protection (LEP) selection. This report summarizes the design of the final version of LTAS, and the modeling methodologies implemented to accomplish analysis.

15. SUBJECT TERMS
laser threat analysis, laser safety, directed energy bioeffects, laser threat analysis system

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1 SCOPE

1.1 IDENTIFICATION

This Software Design Document (SDD) describes the detailed software design for Version 2.0 of the Laser Threat Analysis System (LTAS) Computer Software Configuration Item (CSCI). The requirements from which this design was derived are contained in the Software Requirements Specification (SRS) for the LTAS CSCI.

1.2 SYSTEM OVERVIEW

LTAS is a totally integrated modeling and simulation environment designed for the purpose of ascertaining the susceptibility of Air Force pilots and air crews to optical radiation threats. Using LTAS, mission planners can assess the operational impact of optically directed energy weapons and countermeasures. Through various scenarios, threat analysts are able to determine the capability of laser threats and their impact on operational missions including the air crew's ability to complete their mission effectively. Additionally, LTAS allows the risk of laser use on training ranges and the requirement for laser protection to be evaluated. LTAS gives mission planners and threat analysts complete control of the threat environment including threat parameter control and placement, terrain mapping (line-of-site), atmospheric conditions, and laser eye protection (LEP) selection.

LTAS version 1.0 was initially released in mid July, 1996 with interim versions released 30 Sep 1996 (version 1.0 demo), 30 Sep 1997 (version 1.1) and 15 Nov 1997 (version 1.1a). Further LTAS enhancements are being developed and integrated by AFRL/HEDO (Air Force Research Laboratory Optical Radiation Branch) personnel and TASC, Inc. under Delivery Order 0010, entitled *Laser Threat Analysis System*. LTAS currently operates on a Sun Sparc platform using Solaris and the Common Desktop Environment (CDE). ClearCase is being used as a configuration management tool. LTAS is currently installed at AFRL/HEDO for demonstration and developmental purposes, the National Air Intelligence Center (NAIC), and the Air Force Information Warfare Center (AFIWC).

1.3 DOCUMENT OVERVIEW

This SDD describes the detailed software design of the LTAS CSCI. This document is divided into the following sections:

Section 1 - Scope
Section 2 - Referenced Documents
Section 3 - CSCI-wide Design Decisions
Section 4 - CSCI Architectural Design
Section 5 - CSCI Detailed Design
Section 6 - Requirements Traceability
Section 7 - Notes
Sections 8-12 - Appendixes

2 REFERENCED DOCUMENTS

The following documents of the exact issue shown form a part of this document to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this document, the contents of this document shall be considered a superseding requirement. However, this document shall not negate requirements of system or high-level specifications.

2.1 GOVERNMENT DOCUMENTS

1. *Software Design Document Data Item Description,* DI-MCCR-80012A, 29 February 1988.

2. *Navy Laser Safety Standard,* SPAWARINST 5100.12B.

2.2 NON-GOVERNMENT DOCUMENTS

1. *Software Requirements Specification for the Laser Threat Analysis System (LTAS),* TASC, TR-08200-10-02-1.1 Rev A, 16 April 1997.

2. *ANSI Standard Z136.1 For Safe use of Lasers, 1993.*

2.3 VENDOR DOCUMENTS

1. *ClearCase Configuration Management System Documentation.*

2. *Solaris Operating System Documentation,* Sun Microsystems.

3. *SPARC 4.0.1 C++ Compiler Documentation,* Sun Microsystems.

4. *OSF Motif 1.2 X-Windows Manager System Documentation,* Sun Microsystems.

5. *Common Desktop Environment (CDE),* Sun Microsystems.

6. *Tools ++*, Rouge Wave.

7. *Object Oriented Programming with C++ and OSF/Motif, Doug Young*

3 CSCI-WIDE DESIGN DECISIONS

LTAS is being developed as a modeling system which provides a means of calculating laser hazard and flash blindness distances, graphically displaying them as two-dimensional threat rings superimposed on terrain maps. The distance calculations are based upon user-selected and/or entered parameters, which define the context of the simulated laser threat environment. LTAS CSCI-wide design decisions have been formulated over a period of time, coinciding with software releases 1.0, 1.0 demo, 1.1, 1.1-a and 2.0. The following paragraphs describe the history of the LTAS CSCI-wide design decisions and their effect on LTAS behavior from an operator's point of view.

3.1 INITIAL LTAS DESIGN DECISIONS

When LTAS was first conceived, there were some initial goals the designers had in mind for the use of this software. The idea for LTAS initially came out of AL/OEO (recently renamed AFRL/HEDO) which was the Armstrong Laboratory Optical Radiation Division at Brooks AFB, TX. This organization has a charter to help increase USAF military personnel's effectiveness in dealing with optical radiation hazards in the battlefield. LTAS was conceived as a tool which could help mission planners and threat analysts determine the impact on missions involving laser threats to military personnel. The following list contains the design decisions implemented in the initial release of LTAS (version 1.0 released mid July, 1996).

- The user shall be able to place a laser threat on a map.
- The user shall be able to manipulate system parameters for the laser threat.
- The user shall be able to view an eye safe threat ring for the laser threat.
- The user shall be able to view a flash blindness threat ring for the laser threat.
- The user shall be able to view an irradiance/radiant exposure threat ring for the laser threat.
- The user shall be able to manipulate parameters affecting the size of the threat rings.
- The map section shall be derived from Distributed Interactive Simulation (DIS) based Semi-Automated Forces (SAF) software, allowing easy incorporation of Compact Terrain Data Base (CTDB) maps and making LTAS compatible for use within a DIS simulation. DIS customers were thought to be important during this phase.
- AVS express shall be used for its excellent visualization capabilities.
- C++ shall be used as the LTAS developmental programming language because of its availability, object orientation, and its widely accepted use in industry.
- A Sun Sparc running Solaris and Openwindows shall be used as the LTAS development platform because it's readily available at AFRL/HEDO, and it's typical of the platforms used in the forecasted customer community.
- The user shall be able to save and load data used for a Laser Threat Scenario (LTS).

3.2 LTAS 1.0 DEMO DESIGN DECISIONS

The initial release of LTAS 1.0 was developed using the design decisions described in 3.1 above. This resulted in an LTAS initial capability very much in line with the original design decisions. Once customers and impartial testers used this initial release of LTAS, several improvements were suggested. LTAS 1.0 demo was released in Dec 1996 with the intent to make LTAS more portable and cost effective. This made it more attractive for future customers to install and use at their sites. The greatest criticism of LTAS was probably the requirement to purchase an AVS express run time license to be able to run LTAS. This was an expensive piece of software and was not able to be fully utilized in its role within LTAS. The suggestions made for LTAS initial release improvements lead to the following design decisions for the LTAS 1.0 demo release:

- LTAS shall no longer use AVS express due to its prohibitive cost and overhead. Expected results are lower LTAS operating costs for customers and improved response time.
- LTAS shall not have classified information included in its releases, however, addition of classified information by a user will be supported for use in a secure environment. (LTAS 1.1 decision)
- Privacy concerns for maintenance and operation of installed LTAS software shall be up to the user.

3.3 LTAS 1.1 DESIGN DECISIONS

LTAS release 1.0 demo was successful in that it did away with AVS express. Potential users were happy to see they were no longer required to purchase an AVS express license to run LTAS. Removing AVS express also resulted in an overall improvement in response time. Further improvements were suggested for the next LTAS release due in Sep 1997 (version 1.1). LTAS 1.1 was a near-complete reengineering of the entire LTAS system. The software engineering process was started over at the requirements elicitation phase, and proceeded to design and implementation from there. The customer, the LTAS management staff, and the LTAS design team provided the requirements. These requirements led to the formulation of the following design decisions for LTAS version 1.1 release:

- Integration of the map with other user interface functions shall be done to reduce response time. Current map DIS capabilities were not fully implemented, and a conscious decision was made to make LTAS a more integrated package and improve overall response time, rather than spend resources ensuring full DIS compatibility. This was a shift away from the DIS customer base, which was now thought to be not as important as other customers for LTAS.
- The user shall be able to evaluate up to 50 simultaneous threat scenarios on the map.

- The user shall be able to view up to 5 simultaneous eye safe, flash blindness, and/or irradiance/radiant exposure threat rings associated with any placed laser system.
- The user shall be able to view up to 5 simultaneous eye damage threat rings associated with any placed laser system.
- The user shall be able to view up to 5 simultaneous eye kill threat rings associated with any placed laser system.
- The user shall be able to operate in a standard or advanced mode. Standard mode will only provide items of interest to someone who may not know (or need to know) the values behind a laser system, atmosphere, etc. Advanced mode will allow a knowledgeable operator to manipulate these values.
- Data bases shall be integrated into LTAS with the capability for user manipulation of the data.
- Users shall be able to tailor and save LTAS default settings to their preference.
- It is a design goal to make the Work Session as platform independent as possible.
- LTAS shall provide error and boundary checking for improper unit and parameter inputs by the LTAS user.

3.4 LTAS 1.1-A DESIGN DECISIONS

After LTAS version 1.1 was successfully fielded, further improvements were suggested. These suggestions lead to the following set of design decisions pertaining to LTAS version 1.1a. listed below:

- LTAS shall migrate to the Common Desktop Environment (CDE) windowing system included with new releases of Solaris. This windowing system was expected to gain wide acceptance in the user community.
- The user shall be notified of out-of-bounds and error conditions when selecting laser system parameters and map locations.
- In an attempt to keep the user well informed, special circumstances will be displayed in an "Additional Information" window.

3.5 LTAS 2.0 DESIGN DECISIONS

During testing of the LTAS 1.1a release some flaws were found and further improvements were suggested. This lead to the following design decisions associated with the LTAS 2.0 release:

- Flaws in ED50 algorithms, terrain masking, and threat ring radii computations shall be corrected.
- Streamlining of parameter and DB classes shall be implemented.
- Users shall no longer be required to press the "Calculate" button to view the results of their LTAS work session data manipulations. Threat ring displays shall change appropriately every time an option or parameter is changed in the work session.

- The user shall have the ability to convert a parameter from one allowable unit to another. The user interface shall provide a method for selecting a unit for the appropriate parameter.
- The user shall be able to select a new default when manipulating data in an object options list.
- The user shall have the option of viewing just the Map, or viewing the Map along with the other LTAS parameter panels.
- LTAS shall be capable of modeling daytime and nighttime, air-to-air, air-to-ground, and ground-to-air scenarios.
- LTAS shall have the ability to display contour lines at user specified intervals. The user shall be able to turn the display of contour lines on/off. The interval shall be in Interval Distance units, with a minimum of 10 m and a maximum of 1000 m for the range.
- LTAS shall provide the ability to put a label anywhere on the map. Also, the user shall be able to cut, copy, and/or paste the label on the map.
- For the Irradiance/Radiant Exposure threat ring, irradiance will be in irradiance units applying to continuous wave (CW) lasers, and radiant exposure will be in radiant exposure units applying to pulsed lasers.
- LTAS shall provide a more comprehensive Visual Task DB allowing for inside and outside cockpit choices with emissive or reflective values.
- LTAS shall no longer provide support for Eye Kill threat rings.
- LTAS shall provide support for Sensor Jamming and Sensor Damage threat rings.
- LTAS shall provide support for 3-D viewing of threat rings.
- The user shall be able to specify the altitude of the laser threat. Altitude shall be specified in Altitude units. The default altitude shall be 0 ft AGL (ground based). The minimum altitude shall be 0 ft AGL and the maximum 50,000 ft MSL.
- LTAS shall provide for instantainious atmospheric attenuation coefficient computation.
- LTAS 2.0 shall have the capability to generate a graphical plot of Irradiance (for CW lasers) in W/cm2 or Radiant Exposure (for Pulsed lasers) in J/cm2 versus Range in distance units.

4 CSCI ARCHITECTURAL DESIGN

This section describes the 5 main LTAS CSCIs, their main purpose, and how they relate to one another. This section also describes the 1st level CSCs for each of the 5 main LTAS CSCIs and their organizational hierarchy.

4.1 CSCI COMPONENTS

The internal organizational structure of the LTAS CSCIs is allocated into five distinct components. The five CSCIs and their functions are defined in Table 4.1-1.

Table 4.1-1 LTAS Main CSCIs

CSCI NAME	FUNCTION
User Interface	This is the main Graphical User Interface (GUI) driver. It interfaces with the Work Session CSCI to provide access to the LTAS parameters.
Work Session	Controls access to the LTAS parameters window. Interfaces with the Threat Rings Algorithm CSC to perform calculations. Calculates the threat ring distances using the specified parameters from the LTAS parameters window. It also sends the resultant information onto the map for display. (makes this info available, does not communicate with any other CSCI-tree)
Map	Displays the current CTDB map format file selected, the laser threat scenarios, laser threat rings, and their labels.
Command	Typically acts as a go-between for the UI and Work Session. There are Command CSCs associated with most UI CSCs. When a GUI action is taken by the LTAS user, the UI CSC associated with the GUI action calls a specific Command CSC to carry out the request with the Work Session.
Laser Effects Models	Stand alone algorithms used by the Work Session for calculation of Flash Blindness, Irradiance/Radiant Exposure, Eye Damage, Eye Safe, Sensor Damage and Sensor Jamming threat rings, as well as other parameters.

The LTAS CSCI interactions are shown in Figure 3.1-1. The solid red arrows indicate command action flow and the blue outlined arrows indicate sending/receiving data flow.

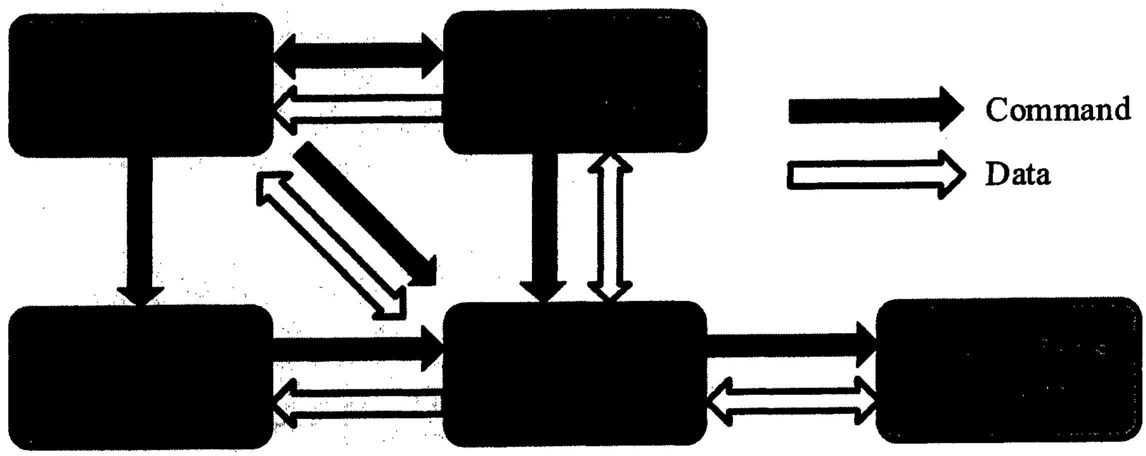

Figure 4.1-1 LTAS CSCI Interaction

4.1.1 User Interface

The purpose of the User Interface (UI) CSCI is to provide a link between LTAS and the user. The User Interface CSCs are easily identified by the user because each one is represented by a button, menu choice, parameter input, or other GUI element within the LTAS main window. The UI is made up of a series of panels for display of LTAS Work Session data. In most cases, when a User Interface CSC is selected via the GUI, a corresponding Command CSC gets executed. The 1st and 2nd level User Interface CSCs are shown in Figure 4.1.1-1 below and are described in the paragraphs that follow. . The Main Window CSC is broken out into 3 separate CSCs (Input Panel, Map, and Menu/Tool Bar) The Map is broken out as a separate CSCI and is discussed in section 4.1.4. The other two 2nd level CSCs are discussed in separate paragraphs in this section.

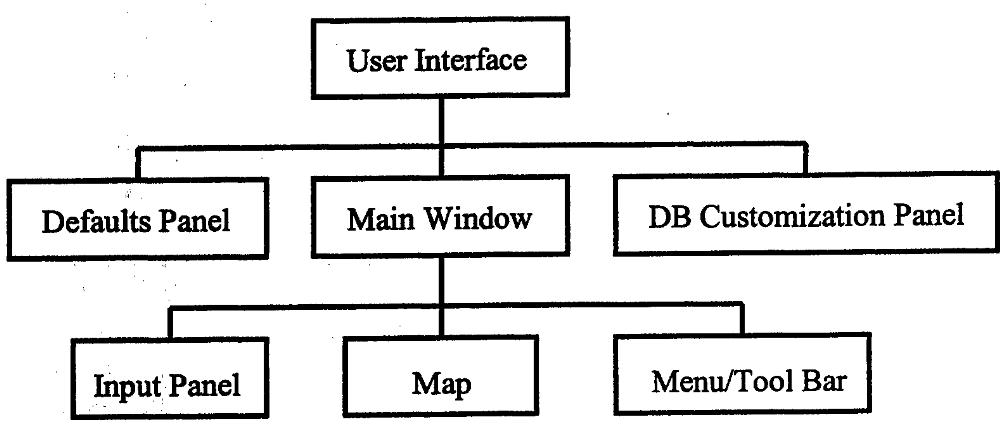

Figure 4.1.1-1 User Interface Components

4.1.1.1 Menu/Tool Bar

The Menu Bar CSCs allow quick access to primary LTAS functionality for the user. These functions include loading and saving of scenarios and work sessions, laser threat placement on the map, threat ring insertion, advanced/normal mode selection, map display zooming and parameter selection, default and global parameter adjustment, data base customization, and help. Tool Bar buttons are also provided for even easier user access to many of the functions found in the pull down menus. The tool bar is laid out across the top of the main LTAS window and has been designed to make LTAS easy to learn and use.

4.1.1.2 Default Panel

The Default Panel is a panel separate from the Main Window panel accessible via the Menu Bar "Options" pull-down. It allows manipulation of the parameters LTAS normally starts with. The LTAS default start up parameters which may be modified are Global, Laser System, Visual Task, Background, Laser's Target Altitude, Personnel Effects, Laser's Target Aircraft Type, Optics & Life Support, Laser Eye Protection, Terrain, and Laser Threat Rings.

4.1.1.3 DB Customization Panel

The DB Customization Panel, like the Default Panel, is also a separate panel from the Main Window Panel accessible via the Menu Bar "Options" pull-down. If "Advanced Mode" has been selected via the Menu Bar "Options" pull-down, data base parameters may be manipulated using this panel. The data bases which may be modified are Aircraft Type, Atmosphere, Background, Laser System, Magnifying Optics, Life Support Visors, Laser Eye Protection Spectacles and Visors, Visual Tasks, and Wavelengths.

4.1.1.4 Input Panel

The selection button just underneath the Menu/Tool Bar on the left side of the LTAS Main Window allows access to the Work Session Global Parameters Panel or a Laser Threat Scenario (LTS) Panel. Loading and saving of laser threat scenarios may also be done here. Any active LTS may be selected for parameter display. The LTS Panel is further divided up into 3 more panels; Laser System Parameters, LTS Parameters, and Threat Ring Parameters. Any of these 3 parameter panels may be displayed using the selection button appearing at the top of the LTS Panel, if an LTS has been selected.

4.1.2 Command

The Command CSCI is closely tied to the User Interface CSCI. For most User Interface actions (pushing a button, selecting a menu choice, etc.), a Command CSC is executed. The 1st level Command CSCs are shown in Figure 4.1.2-1 below. Each Command CSC is also described in the following paragraphs.

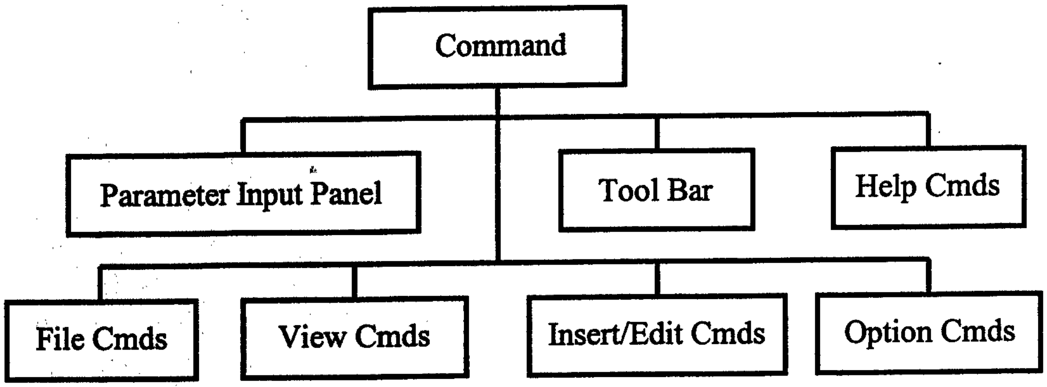

Figure 4.1.2-1 Command Components

4.1.2.1 File Commands

The File Command CSCs control what happens when a selection is made from the "File" Menu Bar pull-down. These options control saving and retrieving of LTAS work sessions, print functions, and exiting the LTAS work session.

4.1.2.2 View Commands

The View Command CSCs control what happens when a selection is made from the "View" menu bar pull-down. These options control whether or not a feature is shown on the Map display. These features include Map Zooming in and out, Map Scale, Map Elevation Units, Terrain Masking, Contour Lines, Lat/Lon Grid, and Scroll Control.

4.1.2,3 Insert/Edit Commands

The Insert and Edit Command CSCs control insertion and deletion of Laser Threat Scenarios within the LTAS work session, as well as insertion of threat rings into a selected LTS.

4.1.2.4 Option Commands

The Option Command CSCs control the LTAS Mode (advanced or not advanced) and modification of databases, Default Parameters, and Global Parameters.

4.1.2.5 Parameter Input Panel

The Parameter Input Panel Command CSCs control what happens when the user manipulates data in the input panel under the tool bar on the left side of the main LTAS window. This is the main user input area in which the user can manipulate an LTS. There are many parameters which may be manipulated within this panel, however the main options are Global Parameter manipulation, selected LTS Parameter manipulation, and saving or retrieving of LTAS Laser Threat Scenarios.

4.1.2.6 Tool Bar

The Tool Bar Command CSCs control what happens when a tool bar button is depressed. Most of these functions are also available under the Menu Bar pull-down options. The tool bar buttons provide the user quick access to various often used LTAS functions.

4.1.2.7 Help Commands

The Help Command CSCs control what happens when a selection is made from one of the Menu Bar Help pull-down options.

4.1.3 Work Session

The CSCs of the Work Session control access to the parameters input panel data. These CSCs are shown in Figure 4.1.3-1 below. Each Work Session CSC is also described in the following paragraphs.

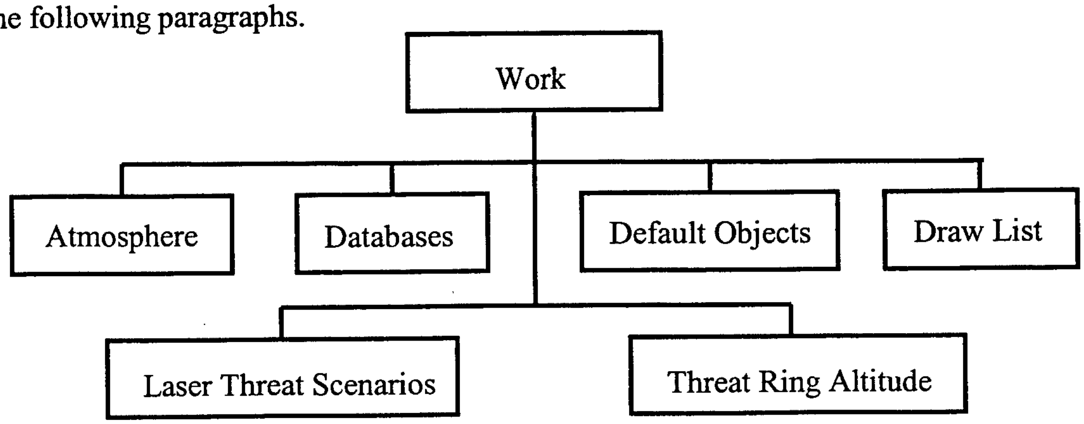

Figure 4.1.3-1 Work Session Components

4.1.3.1 Atmosphere

The Atmosphere contains a region name string, an aerosol model name string, and an atmosphere condition type. It also contains an attenuation coefficient parameter, a pointer to the atmosphere database, and an indicator showing whether the attenuation coefficient parameter matches the database value. The Atmosphere CSC provides a means of setting the region name, aerosol model name, atmospheric condition, attenuation coefficient, and the "differs from db" indicator. If a region is not in the database, the atmosphere will provide an error flag. It will also do so if the attenuation coefficient is out of range.

4.1.3.2 Databases

The Databases contain all information pertinent to the particular object data is stored for. The databases provide a means of getting a value or set of values based on certain keys.

4.1.3.3 Default Objects

The Default Object CSC provides a means for storing defaults every time a work session is created. For each possible default object, it gives a method for setting and getting the default, a way to revert the defaults back to the original system defaults, and a means for saving the default values to the local user's default file.

4.1.3.4 Draw List

The Draw List contains all information necessary for the map to display laser threats and threat rings. It provides a means to traverse itself and pull only displayable threat rings (rings which have a radius greater than 0 and have the display flag set) and all laser threat scenarios. The laser threat information includes the latitude and longitude of the laser, the label of the laser threat, and indicators showing if the altitude and atmosphere differ from the work session. The threat ring information is the same as the laser threat information with the addition of indicators showing if the altitude and atmosphere differ from the laser threat scenarios, and the size and type of threat ring being displayed.

4.1.3.5 Laser Threat Scenarios

The Laser Threat Scenario CSC handles all information about the laser threat scenario and all of its associated threat rings. It provides a means to set and get all the information for the laser threat scenario, and it provides access to functions specific to threat rings.

4.1.3.6 Threat Ring Altitude

The Threat Ring Altitude is an altitude parameter CSC containing an altitude value, ground elevation, and an Above Ground level / Mean Sea Level (AGL/MSL) indicator. The altitude CSC provides a means of setting the altitude value, ground elevation, and whether the altitude is AGL or MSL. It also provides a method for getting the altitude value in either AGL or MSL, and the indicator.

4.1.4 Map

The Map is actually part of the User Interface, however it was split into its own CSCI because it is mainly a display of the results of all the parameter selection done by the user within the rest of the UI. The map shows results of calculations. The user interface allows manipulation of the Work Session and LTS parameters. The CSC's of the Map are shown in Figure 4.1.4-1 below. Each Map CSC is also described in the following paragraphs.

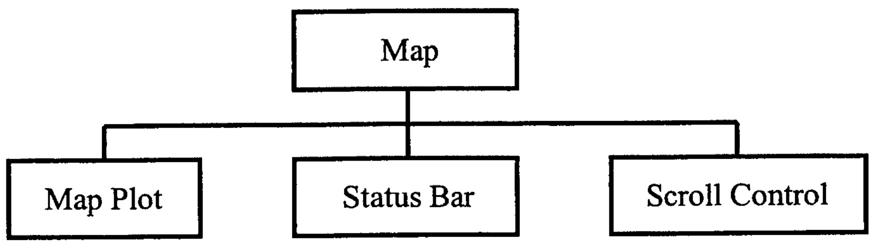

Figure 4.1.4-1 Map Components

4.1.4.1 Map Plot

The Map Plot area is the main part of the Map CSCI. It displays the current terrain and all LTS placements with their corresponding threat rings. The Map Plot is the main output results from LTAS, displaying possible laser threats to mission planners and threat analysts.

4.1.4.2 Status Bar

The Map Status Bar is displayed at the bottom of the map and shows the current scale, cursor position, and terrain masking status.

4.1.4.3 Scroll Control

The Scroll Control allows the user to display the area of the map they are interested in. Current map movements are up, down, left, right, and home/center.

4.1.5 Laser Effects Models

LTAS uses several algorithms to model various laser effects. The work session uses these algorithms to compute threat ring radii, as well as other parameters. Each algorithm CSC is shown below, and all algorithms are fully described in section 10 – Appendix C.

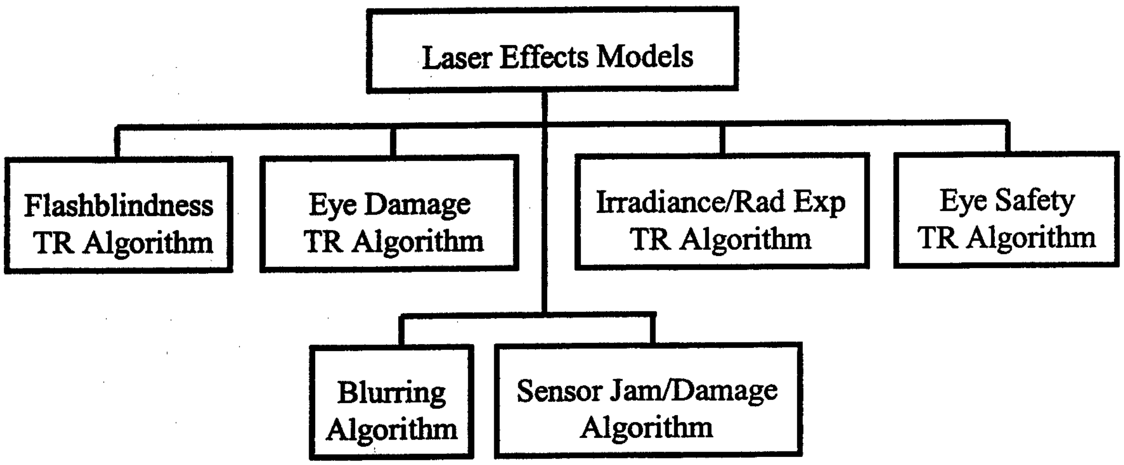

Figure 4.1.5-1 Laser Effects Models Components

The TR (Threat Ring) algorithms (Flashblindness, Eye Damage, Irradiance/Radiant Exposure, Sensor Jam/Damage, and Eye Safety or NOHD) are used by the work session to calculate the various threat ring radii displayed on the Map. The Blurring Algorithm is used to determine the degredation of the "After" display within the "Before and After" panel when viewing the Eye Damage Threat Ring Parameters.

5 CSCI DETAILED DESIGN

This section describes individual LTAS CSC functions, their main purpose, and how they are organized under the LTAS CSCI hierarchy design. Some of the information from section 4 may be repeated here briefly for the sake of clarity.

5.1 CSCI COMPONENTS

As described in section 3, the main LTAS CSCI components are the User Interface, Command, Work Session, and Map. Section 4 described the 1st level hierarchy of CSC organization under these 4 main CSCIs. This section will describe all levels below the 1st CSC hierarchy level. It is organized in the same fashion as section 4 for readability.

5.1.1 User Interface

As described in section 4, the main User Interface (UI) CSCs are the Menu/Tool Bar, Default Panel, DB Customization Panel, and Input Panel. The Map is also part of the UI, but is broken out into its own CSCI and is discussed in section 5.1.4. Almost all UI CSCs are declared in the ~LTAS/include/gui/LTAS_Panels directory within the LTAS directory hierarchy and are described in the following paragraphs.

The User Interface (UI) main window is represented by the LTASMainWindow class declared in ~LTAS/include/gui/LTAS_MainGUI/LTASMainWindow.h. It is derived from the MenuWindow class which inherits properties from the MainWindow class. MainWindow uses UIComponent as its base class. The UIComponent class in turn uses BasicComponent as its base class. All 4 of these classes are derived from Douglas Young's book (please see section 2.3 item 7) and are declared in MenuWindow.h, MainWindow.h, UIComponent.h, and BasicComponent.h in the directory ~LTAS/include/gui/LTAS_MotifApp within the LTAS directory hierarchy. The UIComponent and BasicComponent classes are basic building block classes used by Douglas Young for all C++/Motif User Interface (UI) components. MainWindow and MenuWindow were designed as sort of boilerplates good enough for use in almost any application's GUI starting point. LTASMainWindow lays out the overall LTAS GUI with placeholders for the following functionality:

- Menu Bar pull-downs for file manipulation, LTS editing, Map view manipulation, LTS and Threat Ring placement, Mode selection, and LTAS parameter & DB data manipulation.
- Tool Bar buttons for quick access to most Menu Bar functionality.
- Input Panels for manipulation of Global parameters and Laser Threat Scenario parameters.
- A Map view to display the results of the selected Laser Threat Scenarios (see 5.1.4).

5.1.1.1 Menu/Tool Bar

As described in section 4.1.1.1, the Menu Bar CSCs allow quick access to primary LTAS functionality for the user. The Menu Bar is actually built within the LTASMainWindow class, with the help of some generic Motif classes from Dave Young's book (please see section 2.3 item 7). Each Menu Bar item is tied to an LTAS Command class which actually performs the function implied by the GUI item. The LTAS Commands are duiscussed in section 5.1.2 of this document. The Menu Bar supplies the LTAS user with the following functionality:

- The "File" Menu Bar selection has the following options:
  - The "New" option allows the LTAS user to open a new terrain database.
  - The "Open" option allows the LTAS user to retrieve a previously saved LTAS Work Session.
  - The "Save" option allows the LTAS user to save changes they have made to the current LTAS Work Session.
  - The "Save As" option allows the LTAS user to save the current LTAS Work Session under a different name.
  - The "Print" option allows the LTAS user to print the current LTAS Work Session.
  - The "Exit" option terminates the LTAS program.

- The "Edit" Menu Bar selection has only one option: "Delete Current LTS" allows the LTAS user to remove a selected LTS from the Map display and LTAS Work Session.

- The "View" Menu Bar selection has the following options:
  - The "Zoom In at Center" option allows the LTAS user to zoom in on the Map display at its center.
  - The "Zoom Out at Center" option allows the LTAS user to to zoom out on the Map display at its center.
  - The "Scale" option allows the LTAS user to set the scale of the Map display.
  - The "Map Elevation Units" option allows the LTAS user to change the elevation units displayed just below the Map display in the center. Choices are meters, kilometers, feet, or kilofeet.
  - The "Terrain Masking" option allows the LTAS user to choose whether or not to have the Map terrain features influence the shape of all threat rings displayed on the Map.
  - The "Scroll Control" option allows the LTAS user to display or hide the Map scroll control.
  - The "Contour Lines" option allows the LTAS user to display or hide the Map elevation contour lines.
  - The "Lat/Lon Grid" option allows the LTAS user to display or hide the latitude and longitude lines on the Map display.

- The "Additional Information" option allows the LTAS user to view any additional information LTAS has assembled in a separate panel. The LTASOWStream and LTASOWStreamDialogManager classes are used to help funnel information to this panel. They use ostream and DialogManager as their base classes.

- The "Insert" Menu Bar selection has the following options:
  - The "Laser Threat Scenario" option allows the LTAS user to place an LTS on the Map display.
  - The "Eye Safe Threat Rings" option allows the LTAS user to add Eye Safe Threat Rings to an existing LTS on the Map display.
  - The "Flash Blindness Threat Rings" option allows the LTAS user to add Flash Blindness Threat Rings to an existing LTS on the Map display.
  - The "Eye DamageThreat Rings" option allows the LTAS user to add Eye Damage Threat Rings to an existing LTS on the Map display.
  - The "Sensor Damage Threat Rings" option allows the LTAS user to add Sensor Damage Threat Rings to an existing LTS on the Map Display.
  - The "Sensor Jam Threat Rings" option allows the LTAS user to add Sensor Jam Threat Rings to an existing LTS on the Map Display.
  - The "Irradiance/Radiant Exposure Threat Rings" option allows the LTAS user to add Irradiance/Radiant Exposure Threat Rings to an existing LTS on the Map display.

- The "Options" Menu Bar selection uses the LTASOptionMenuCmdList class to build a list providing the following options:
  - The "Advanced Mode" option allows the user to toggle between advance and standard LTAS operating mode. Advanced mode allows the experienced LTAS user much more controll over the Work Session parameters.
  - The "Customize Databases" option allows the LTAS user to manipulate the LTAS databases in advanced mode. This is discussed further in section 5.1.1.3.
  - The "Set Default Parameters" option allows the LTAS user to change the default values utilized by LTAS when a new LTAS Work Session is started. This is discussed further in section 5.1.1.2.
  - The "Set Global Parameters" option allows the LTAS user to change the overall Threat Ring Altitude and Atmospheric conditions for an LTAS Work Session.

- The "Help" Menu Bar selection uses the HelpCmdList class to build a list providing the following options:
  - The "On Line Help" option gives the LTAS user access the the LTAS User's Guide.
  - The "Help About" allows the LTAS user to open a help window on any GUI item.
  - The "About LTAS" displays the current LTAS version.

Tool Bar buttons are also provided for even easier user access to many of the functions found in the pull down menus. The LTASToolBarCmdList class, using CmdList as its base class, is used to help build the Tool Bar buttons laid out across the top of the main LTAS window. These have LTAS Command classes associated with each one of them to actually carry out the functionality implied by the buttons. Please see section 5.1.2 for an explanation of the LTAS Commands. The Tool Bar is built using the LTASToolBar, LTASMainWindow, and LTASToolBarButtonInterface classes. These classes are located in the ~LTAS/include/gui/LTAS_MainGUI directory whithin the LTAS directory hierarchy. These classes use pixmaps from the ~LTAS/src/gui/LTAS_MainGUI/pixmaps directory to display the icons on the Tool Bar buttons.

5.1.1.2 Default Panel

The Default Panel is accessible from the LTAS main window Menu Bar "Options" pull down. When the "Set Default Parameters" option is selected, an LTAS Command CSC starts the job of displaying the Default Panel. This panel is represented by the classes LTASSetDefaultsPanel and LTASSetDefaultsDialogManager. They use LTASPanel and DialogManager as their base classes respectively. There are 3 main sections to this panel as shown in Figure 5.1.1.2-1 below. The Parameter Input Panel CSC is further broken out into its sub-components.

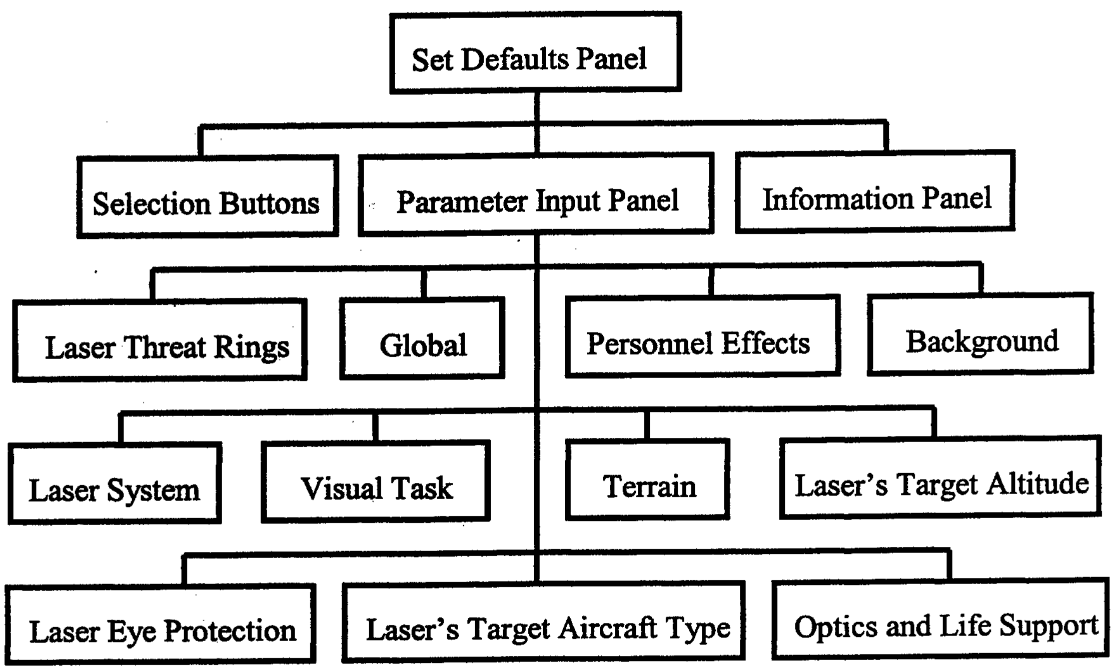

Figure 5.1.1.2-1 Set Defaults Panel Components

The Selection Buttons and Information Panel widgets are built within the class LTASSetDefaultsDialogManager, with the help of some generic Motif classes. They supply the LTAS user with the following functionality:

- Allow the LTAS user to change default parameters applied to a new Work Session for the current parameters displayed in the Set Defaults Parameter Input panel by selecting the "Apply These" button.
- Allow the LTAS user to change default parameters applied to a new Work Session for all parameters which have been modified in the Set Defaults Parameter Input panel by selecting the "Apply All" button.
- Allow the LTAS user to reset the current parameters displayed in the Set Defaults Parameter Input panel by selecting the "Reset These Parameters" button.
- Allow the LTAS user to reset the all parameters which have been modified in the Set Defaults Parameter Input panel by selecting the "Reset All Parameters" button.
- Allow the LTAS user to reset the current parameters displayed in the Set Defaults Parameter Input panel to System Defaults by selecting the "Revert These to System Defaults" button.
- Allow the LTAS user to reset the all parameters which have been modified in the Set Defaults Parameter Input panel to System Defaults by selecting the "Revert All to System Defaults" button.
- Allow the LTAS user to view the Information panel for a history of changes they have made to the Set Defaults Input Parameter panels.
- Allow the LTAS user to select from a list of default parameter categories to modify.

There are several default parameter categories the LTAS user may select from. Once a selection has been made, the proper parameters are displayed in the Set Defaults Parameter Input panel. The following paragraphs describe each of the different Parameter Input panel types.

5.1.1.2.1 Set Global Defaults Panel

The Set Global Defaults panel is represented by the LTASGlobalSetDefaultsPanel class which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDAtmosphereSubPanel and LTASSDThreatRingAltitudeSubPanel classes providing the functionality listed below:

- The LTASSDTRAAltitudeAugmentedParameterFieldSubPanel class provides an input field for the LTAS user to change the default Threat Ring Altitude.
- The LTASSDTRAMSL_AGLParameterFieldAugmentationSubPanel class provides radio buttons for the LTAS user to choose the default reference for Threat Ring Altitude to be MSL or AGL.
- Select Atmospheric data usage default to be on or off.
- Customize the Atmosphere data base.

- Select a default atmospheric condition from the "Atmospheric Condition" button list generated by the Work Session.
- Select a default aerosol model from the "Aerosol Model " button list generated by the Work Session.
- Select a default region from the "Region" button list generated by the Work Session.

5.1.1.2.2 Set Laser Defaults Panel

The Set Laser System Defaults panel is represented by the LTASLaserSetDefaultsPanel class which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDLaserParametersSubPanel class providing the functionality listed below:

- Allow the LTAS user to select the default laser system from the "Laser System" button list generated by the Work Session.
- Allow the LTAS user to customize the Laser System data base.

5.1.1.2.3 Set Visual Task Defaults Panel

The Set Visual Task Defaults panel is represented by the class LTASVisualTaskSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDVisualTaskPanel class providing the functionality listed below:

- Allow the LTAS user to select a default visual task from the "Visual Task" button list generated by the LTAS Work Session.
- Allow the LTAS user to customize the Visual Task database.
- The LTASSDVTViewDistParameterFieldSubPanel class allows the LTAS user to view/change the default "Distance From Viewer" parameter.
- The LTASSDVTAltitudeAugmentedParameterFieldSubPanel class allows the LTAS user to view/change the default "Altitude" parameter.
- The LTASSDVTMSL_AGLParameterFieldAugmentationSubPanel class allows the LTAS user to select MSL or AGL as the default altitude reference.

5.1.1.2.4 Set Background Defaults Panel

The Set Background Defaults panel is represented by the class LTASBackgroundSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDBackgroundPanel class providing the functionality listed below:

- Allow the LTAS user to select the default condition of the sky from the "Sky Condition" button list generated by the LTAS Work Session.
- Allow the LTAS user to select default terrain type from the "Terrain" button list generated by the LTAS Work Session.

5.1.1.2.5 Set Laser's Target Altitude Defaults Panel

The Set Laser's Target Altitude Defaults panel is represented by the class LTASLasersTargetSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDLasersTargetPanel class providing the functionality listed below:

- The LTASSDLTAltitudeAugmentedParameterFieldSubPanel class allows the LTAS user to view/change the default Laser's Target Altitude.
- The LTASSDLTMSL_AGLParameterFieldAugmentationSubPanel class allows the LTAS user to select MSL or AGL as the default Laser's Target Altitude reference.

5.1.1.2.6 Set Personnel Effects Defaults Panel

The Set Personnel Effects Defaults panel is represented by the class LTASPersonnelEffectsSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDPersonnelEffectsPanel class providing the functionality listed below:

- The LTASSDObsLevelParameterFieldSubPanel class allows the LTAS user to view/change the default Obscuration Level value.
- The LTASSDTimeAfterExpParameterFieldSubPanel class allows the LTAS user to view/change the default Time After Exposure value.

5.1.1.2.7 Set Laser's Target Aircraft Type Defaults Panel

The Set Laser's Target Aircraft Type Defaults panel is represented by the class LTASLasersTargetATSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDLasersTargetATPanel class providing the functionality listed below:

- Allow the LTAS user to select a default aircraft from the"Aircraft Type" button selection list generated by the Work Session.
- Allow the LTAS user to customize the Optics database.

5.1.1.2.8 Set Optics and Life Support Defaults Panel

The Set Optics and Life Support Defaults panel is represented by the class LTASOpticsAndLifeSupportSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the class LTASSDOpticsAndLifeSupportPanel, providing the functionality listed below:

- Allow the LTAS user to select a default optic from the "Magnifying Optic" button selection list generated by the Work Session.
- Allow the LTAS user to select a default visor from the "Life Support Visor" button selection list generated by the Work Session.
- Allow the LTAS user to customize the Optics database.

5.1.1.2.9 Set Laser Eye Protection Defaults Panel

The Set Laser Eye Protection Defaults panel is represented by the class LTASLaserEyeProtectionSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDLaserEyeProtectionPanel class providing the functionality listed below:

- Allow the LTAS user to select a default visor from the LEP "Visor" button selection list generated by the Work Session.
- Allow the LTAS user to select a default spectacle from the LEP "Spectacle" button selection list generated by the Work Session.
- Allow the LTAS user to customize the Optics database.

5.1.1.2.10 Set Terrain Defaults Panel

The Set Terrain Defaults panel is represented by the class LTASTerrainSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDTerrainSubPanel class (which uses LTASTerrainSubPanel as its base class), providing the functionality listed below:

- The LTASSDTerrainParameterFieldSubPanel class allows the LTAS user to view/change the default terrain data base.
- Allows the LTAS user to browse for a default terrain file by selecting the "Select File" button.
- The LTASSDTerrainMaskingStepSizeParameterFieldSubPanel class allows the LTAS user to view/change the default step size used for terrain masking.

5.1.1.2.11 Set Laser Threat Rings Defaults Panel

The Set Laser Threat Rings Defaults panel is represented by the class LTASThreatRingsSetDefaultsPanel which uses LTASSetDefaultsPanel as its base class. This class builds this panel with the help of the LTASSDThreatRingsSubPanel class providing the functionality listed below:

- The LTASSDNumNOHDParameterFieldSubPanel class allows the LTAS user to view/change the default number of Eye Safe threat rings associated with an LTS.
- The LTASSDNumFBParameterFieldSubPanel class allows the LTAS user to view/change the default number of Flashblindness threat rings associated with an LTS.
- The LTASSDNumIREParameterFieldSubPanel class allows the LTAS user to view/change the default number of Irradiance/Radiant Exposure threat rings associated with an LTS.
- The LTASSDNumEDParameterFieldSubPanel class allows the LTAS user to view/change the default number of Eye Damage threat rings associated with an LTS.
- The LTASSDNumSDParameterFieldSubPanel class allows the LTAS user to view/change the default number of Sensor Damage threat rings associated with an LTS.
- The LTASSJNumSDParameterFieldSubPanel class allows the LTAS user to view/change the default number of Sensor Jam threat rings associated with an LTS.
- The LTASSDED50MultParameterFieldSubPanel class allows the LTAS user to view/change the default ED50 multiplier.
- The LTASSDIRExpParameterFieldSubPanel class allows the LTAS user to view/change the default Irradiance/Radiant Exposure value.

5.1.1.3 DB Customization Panel

The DB Customization Panel is accessible from the LTAS main window Menu Bar "Options" pull down, if advanced mode is turned on. When the "Customize Databases" option is selected, another pull-down menu is revealed displaying 10 database choices for modification. This is all handled within the LTASMainWindow class. Once a choice has been selected, a corresponding LTAS Command CSC starts the job of displaying the Database Customization Panel. This panel is represented by the classes LTASCustomizeDBPanel and LTASCustomizeDatabaseDialogManager. They use LTASPanel and DialogManager as their base classes respectively. There are 3 main sections to this panel as shown in Figure 5.1.1.2-1 below. The Parameter Input Panel is also broken out into its sub-components.

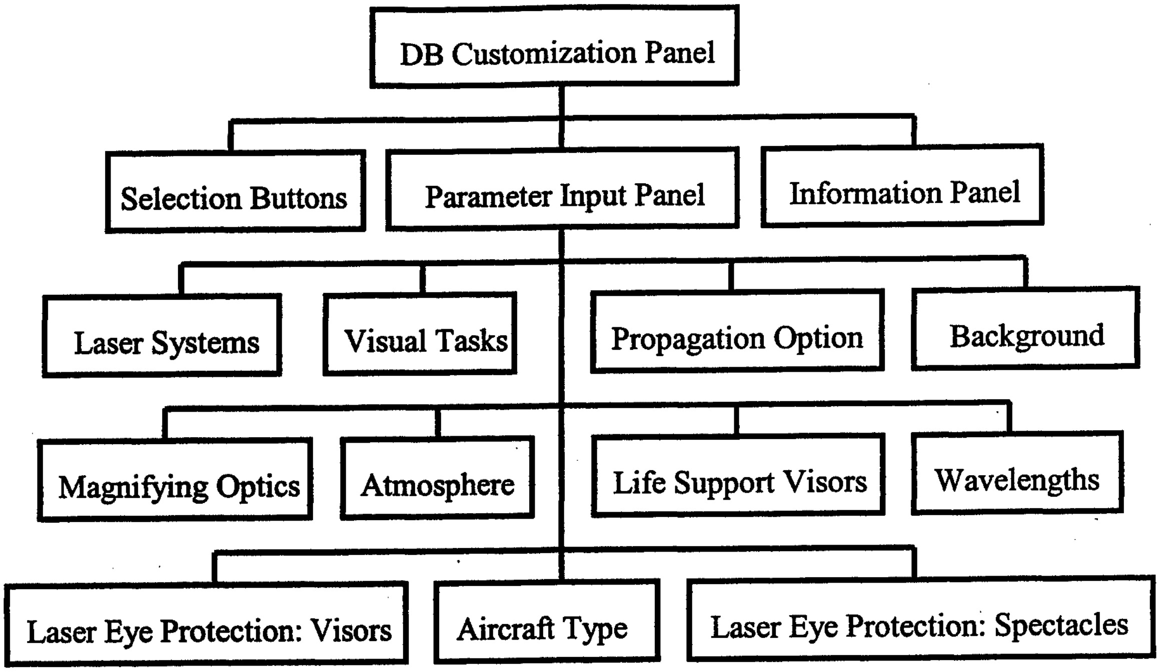

Figure 5.1.1.3-1 DB Customization Components

The Selection Buttons are built using the LTASCustomizeDBButtonPanel class which uses LTASPanel as its base class. This supplies the LTAS user with the following functionality:

- Allow the LTAS user to add a new local entry to the current data base by selecting the "Add to Local" button.
- Allow the LTAS user to add a new system entry to the current data base by selecting the "Add to System" button.
- Allow the LTAS user to modify a new entry to the current data base by selecting the "Modify" button.
- Allow the LTAS user to delete a new entry to the current data base by selecting the "Delete" button.

The Information panel allows the LTAS user to view the Information panel for a history of changes they have made to the Set Defaults Input Parameter panels.

5.1.1.3.1 Modify Aircraft Type DB Panel

The Modify Aircraft Type DB panel is represented by the class LTASAcftTransmissionODCDBPanel which uses LTASCustomizeDBPanel as its base class. The LTASCDBAcftTransmissionODPanel class helps build this panel, using LTASTransmissionODPanel as its base class, providing the functionality listed below:

- Allow the LTAS user to select an existing aircraft type from the selection button. Current choices are Generic – No Canopy, A-10, AH-1S, F-111, F-16, and UH-60.
- Allow the LTAS user to enter a new aircraft type into the "Aircraft Type" input parameter field.
- The LTASCDBAcftTransmissionParamMatrixSubPanel class allows the LTAS user to view/change the wavelength and OD transmission entries for a selected aircraft type.
- Allow the LTAS user to load a new entry into the database from a file by selecting the "Load from File" button.

5.1.1.3.2 Modify Atmosphere DB Panel

The Modify Atmosphere DB panel is represented by the LTASAtmosphereCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the class LTASCDBAtmosphereSubPanel, providing the functionality listed below:

- Allow the LTAS user to select an existing region from the "Region" selection button.
- The LTASCDBRegionNameParameterFieldSubPanel class allows the LTAS user to enter a new region into the "Region" input parameter field.
- Allow the LTAS user to select an existing aerosol model from the "Aerosol Model" selection button.
- Allow the LTAS user to select an existing wavelength from the "Wavelength" selection button.
- The LTASCDBWavelengthNameParameterFieldSubPanel class allows the LTAS user to enter a new wavelength into the "Wavelength" input parameter field.
- The LTASCDBAttenuationCoeffParameterMatrixSubPanel class allows the LTAS user to view the different atmospheric condition attenuation coefficients for existing atmospheric models. It also allows the LTAS user to manipulate the data for new atmospheric models being added to the database.
- The LTASAtmosphereCDBChooseDeleteDialogManager class allows the LTAS user to delete an entire atmospheric model region from the LOCAL or SYSTEM database, or to delete only a selected table from an atmospheric model.

5.1.1.3.3 Modify Background DB Panel

The Modify Background DB panel is represented by the LTASBackgroundCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the class LTASCDBBackgroundPanel, providing the functionality listed below:

- Allow the LTAS user to select an existing terrain type from the selection button.

- The LTASCDBBGTerrainNameParameterFieldSubPanel class allows the LTAS user to enter a new terrain type into the "Terrain" input parameter field.
- The LTASCDBBGTerrainReflectanceParameterFieldSubPanel class allows the LTAS user to view/change the reflectance parameter for a selected terrain type.

5.1.1.3.4 Modify Laser System DB Panel

The Modify Laser System DB panel is represented by the LTASLaserCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the class LTASCDBLaserParametersSubPanel, providing the functionality listed below. (Note: All "...OneOverEParameterFieldAugmentationSubPanel" classes use LTASOneOverEParameterFieldAugmentationSubPanel as their base class and all "...Divergence..." or "...Aperture..." "...AugmentedParameterFieldSubPanel" classes use LTASAugmentedParameterFieldSubPanel as their base class.)

- Allow the LTAS user to select an existing laser system from the "Laser System" selection button.
- The LTASCDBLPLaserNameParameterFieldSubPanel class allows the LTAS user to enter a new laser system for addition to the database.
- Allow the LTAS user to select an exsisting wavelength from the "Wavelength" selection button.
- The LTASCDBLPWavelengthParameterFieldSubPanel class displays the Wavelength input parameter field for viewing and modification by the LTAS user.
- Allow the LTAS user to select a laser type: pulsed or continuous wave.
- Allow the LTAS user to select a beam profile: circular, eliptical, or rectangular.
- The LTASCDBLPPowerParameterFieldSubPanel class displays the Power input parameter field for viewing and modification by the LTAS user if a laser of Type "CW" (Continuous Wave) has been selected.
- The LTASCDBLPEnergyParameterFieldSubPanel class displays the Energy input parameter field for viewing and modification by the LTAS user if a laser of Type "Pulsed" has been selected.
- The LTASCDBLPPRFParameterFieldSubPanel class displays the PRF (Pulse Repetition Frequency) input parameter field for viewing and modification by the LTAS user if a laser of Type "Pulsed" has been selected.
- The LTASCDBLPPulseWidthParameterFieldSubPanel class displays the Energy input parameter field for viewing and modification by the LTAS user if a laser of Type "Pulsed" has been selected.
- The LTASCDBLPApertureAugmentedParameterFieldSubPanel class displays the Output Aperture input parameter field for viewing and modification by the LTAS user if a "Circular" Beam Profile has been selected.
- The LTASCDBLPAOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Output Aperture input parameter field if a "Circular" Beam Profile has been selected.

- The LTASCDBLPDivergenceAugmentedParameterFieldSubPanel class displays the Divergence input parameter field for viewing and modification by the LTAS user if a "Circular" Beam Profile has been selected.
- The LTASCDBLPDOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Divergence input parameter field if a "Circular" Beam Profile has been selected.
- The LTASCDBLPXApertureAugmentedParameterFieldSubPanel class displays the X Axis Aperture input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPXAOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the X Axis Aperture input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPXDivergenceAugmentedParameterFieldSubPanel class displays the X Axis Divergence input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPXDOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the X Axis Divergence input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPYApertureAugmentedParameterFieldSubPanel class displays the Y Axis Aperture input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPYAOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Y Axis Aperture input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPYDivergenceAugmentedParameterFieldSubPanel class displays the Y Axis Divergence input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASCDBLPYDOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Y Axis Divergence input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.

5.1.1.3.5 Modify Magnifying Optics DB Panel

The Modify Magnifying Optics DB panel is represented by the class LTASMagnifyingOpticsCDBPanel which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the class LTASCDBMagnifyingOpticsPanel, providing the functionality listed below:

- Allow the LTAS user to select an existing magnifying optic from the selection button.
- The LTASCDBMOMagnifyingOpticParameterFieldSubPanel class allows the LTAS user to enter a new magnifying optic name into the "Magnifying Optic" input parameter field for addition to the database.

- The LTASCDBMOMagnificationParameterFiledSubPanel class allows the LTAS user to view/change the magnification for a selected magnifying optic.
- The LTASCDBMOObjectiveApertureParameterFiledSubPanel class allows the LTAS user to view/change the objective aperture for a selected magnifying optic.
- The LTASCDBMOWavelengthTransParamMatrixSubPanel class allows the LTAS user to view/change the wavelength and OD transmission entries for a selected magnifying optic.
- Allow the LTAS user to load a new entry into the database from a file by selecting the "Load from File" button.

5.1.1.3.6 Modify Life Support Visors DB Panel

The Modify Life Support Visors DB panel is represented by the class LTASLifeSupportCDBPanel which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the class LTASCDBLifeSupportPanel, providing the functionality listed below:

- Allow the LTAS user to select an existing life support visor from the selection button.
- The LTASCDBLSVNameParameterFieldSubPanel class allows the LTAS user to enter a new life support visor name into the "Life Support Visor" input parameter field for addition to the database.
- The LTASCDBLSVWavelengthTransParamMatrixSubPanel class allows the LTAS user to view/change the wavelength and OD transmission entries for a selected life support visor.
- Allow the LTAS user to load a new entry into the database from a file by selecting the "Load from File" button.

5.1.1.3.7 Modify LEP Spectacles DB Panel

The Modify Laser Eye Protection Spectacles DB panel is represented by the class LTASLEPSpectacleCDBPanel which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the LTASCDBLEPSpectaclePanel class providing the functionality listed below:

- Allow the LTAS user to select an existing LEP spectacle from the selection button.
- The LTASCDBLEPSpectacleNameParameterFieldSubPanel class allows the LTAS user to enter a new LEP spectacle name into the "LEP Spectacle" input parameter field for addition to the database.
- The LTASCDBLEPSpectacleWavelengthTransParamMatrixSubPanel class allows the LTAS user to view/change the wavelength and OD transmission entries for a selected LEP spectacle.
- Allow the LTAS user to load a new entry into the database from a file by selecting the "Load from File" button.

5.1.1.3.8 Modify LEP Visors DB Panel

The Modify Laser Eye Protection Visors DB panel is represented by the class LTASLEPVisorCDBPanel which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the LTASCDBLEPVisorPanel class providing the functionality listed below:

- Allow the LTAS user to select an existing LEP visor from the selection button.
- The LTASCDBLEPVisorNameParameterFieldSubPanel class allows the LTAS user to enter a new LEP visor name into the "LEP Visor" input parameter field for addition to the database.
- The LTASCDBLEPVisorWavelengthTransParamMatrixSubPanel class allows the LTAS user to view/change the wavelength and OD transmission entries for a selected LEP visor.
- Allow the LTAS user to load a new entry into the database from a file by selecting the "Load from File" button.

5.1.1.3.9 Modify Visual Tasks DB Panel

The Modify Visual Tasks DB panel is represented by the LTASVisualTaskCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the LTASCDBVisualTaskPanel class providing the functionality listed below:

- Allow the LTAS user to select an existing visual task from the selection button.
- The LTASCDBVTVisualTaskParameterFieldSubPanel class allows the LTAS user to enter a new visual task into the "Visual Task" input parameter field for addition to the database.
- The LTASCDBVTSizeParameterFieldSubPanel class allows the LTAS user to enter a visual task object dimension into the "Size" input parameter field for a new visual task.
- The LTASCDBVTReflectanceParameterFieldSubPanel class allows the LTAS user to enter a reflectance value into the "Reflectance" input parameter field for a new visual task.

5.1.1.3.10 Modify Wavelength DB Panel

The Modify Wavelength DB panel is represented by the LTASWavelengthCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of LTASCDBWavelengthPanel (which uses LTASWavelengthPanel as its base class), providing the following functionality:

- Allow the LTAS user to select an existing wavelength from the selection button.
- The LTASCDBWLWavelengthParameterFieldSubPanel class allows the LTAS user to enter a new wavelength into the "Wavelength" input parameter field for addition to the database.
- Allow the LTAS user to select the "Customize Atmosphere" button for modification of the atmosphere database for the selected wavelength.
- Allow the LTAS user to select the "Customize Optics" button for modification of the optics database for the selected wavelength.
- Allow the LTAS user to select the "Customize Aircraft Type" button for modification of the visual task database for the selected wavelength.

Selection of one of the 3 "Customize ..." buttons displays one of 3 panels. These panels are discussed in the following paragraphs.

5.1.1.3.10.1 Customize Atmosphere Panel

This panel is very similar to the Modify Atmosphere DB panel and is represented by the LTASAtmosphereCDBWLPanel class, which uses LTASCustomizeDBPanel as its base class. The LTASCDBWLAtmosphereSubPanel class also helps build this panel, providing the functionality listed below:

- Allow the LTAS user to select an existing region from the "Region" selection button.
- Allow the LTAS user to enter a new region into the "Region" input parameter field.
- Allow the LTAS user to select an existing aerosol model from the "Aerosol Model" selection button.
- The LTASCDBWLWavelengthNameParameterLabelSubPanel class allows the LTAS user to view the current wavelength.
- Allow the LTAS user to view the different atmospheric condition attenuation coefficients for existing atmospheric models. The LTAS user may also manipulate the data for new atmospheric models being added to the database.
- Allow the LTAS user to return to the main Customize Wavelength DB panel by selecting the "Return to Customize Wavelength" button
- Allow the LTAS user to load a new entry into the database from a file by selecting the "Load from File" button.
- Allow the LTAS operator to view the FASCODE panel by selecting the "Run FASCODE" button.

If the "Run FASCODE" button is selected, a FASCODE panel appears. This panel is represented by the LTASRunFASCODEPanel class which uses LTASPanel as its base class. This class builds this panel with the help of LTASRunFASCODEDialogManager class, providing the following functionality:

- Allow the LTAS user to select a region and aerosol model from a push button list.
- Allow the user to select a default or user specified HITRAN database. If "User Specified" is selected the LTAS user may enter the database (with full path) or browse for one by pressing the "Select Databasae" button.
- Allow the LTAS user to select an existing wavelength from the selection button.
- The LTASRunFASCODEWavelengthParameterFieldSubPanel. Class allows the LTAS user to enter a new wavelength in the "Wavelength" input parameter field for addition to the database.

5.1.1.3.10.2Customize Optics Panel

This panel is represented by the LTASOpticsTransmissionODCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the LTASCDBOpticsTransmissionODPanel class (using LTASTransmissionODPanel as its base class) providing the functionality listed below:

- The LTASCDBOpticsTransmissionParameterMatrixSubPanel class allows the LTAS user to enter new optics transmission values at the specified wavelength for addition to the database.
- Allow the LTAS user to return to the main Customize Wavelength DB panel by selecting the "Return to Customize Wavelength" button

5.1.1.3.10.3Customize Aircraft Type Panel

This panel is represented by the LTASLasersTargetCDBPanel class which uses LTASCustomizeDBPanel as its base class. This class builds this panel with the help of the LTASCDBLasersTargetPanel class providing the functionality listed below:

- The LTASCDBLTAircraftNameParameterFieldSubPanel class allows the LTAS user to enter a new target into the "Aircraft Name" input parameter field for addition to the database.
- The LTASCDBLTWavelengthTransParamMatrixSubPanel class allows the LTAS user to view/change the wavelength and OD transmission entries for a selected target.
- Allow the LTAS user to return to the main Customize Wavelength DB panel by selecting the "Return to Customize Wavelength" button

5.1.1.3.11 Proagation Option Panel

The Choose Propagation Option panel is displayed if the current LTAS Work Session is using an item the LTAS user has decided to remove from its database. This panel is represented by the LTASCustomizeDatabaseModifyDeleteChooseDialogManager class, useing DialogManager as its base class. This panel provides the following functionality:

- Warn the LTAS user by displaying the work session items which will be effected by the database changes they are making.
- Allow the LTAS user to select how the database change will effect the work session with a series of radio button choices.
- Allow the LTAS user to cancel the database change by selecting the "Cancel" button.

5.1.1.4 Input Panel

Almost all UI Input Panel classes inherit properties from the LTASPanel or LTASSubPanel class. These 2 classes are the basis on which most of the Input Panel CSCs are derived. LTASPanel and LTASSubPanel are declared in LTASPanel.h and LTASSubPanel.h in the ~LTAS/include/gui/LTAS_Panels directory within the LTAS directory hierarchy. LTASSubPanel inherits from LTASPanel and LTASPanel's base class is UIComponent. The UIComponent class in turn uses BasicComponent as its base class. These "Component" classes are derived from Douglas Young's book (please see section 5.1.1 and section 2.3 item 7). The basic hierarchy of some of the more common LTAS Input Panel types is shown in figure 5.1.1.4-1 below. Please see Appendix D for a detailed description of the entire LTAS class hierarchy, including all Panel classes.

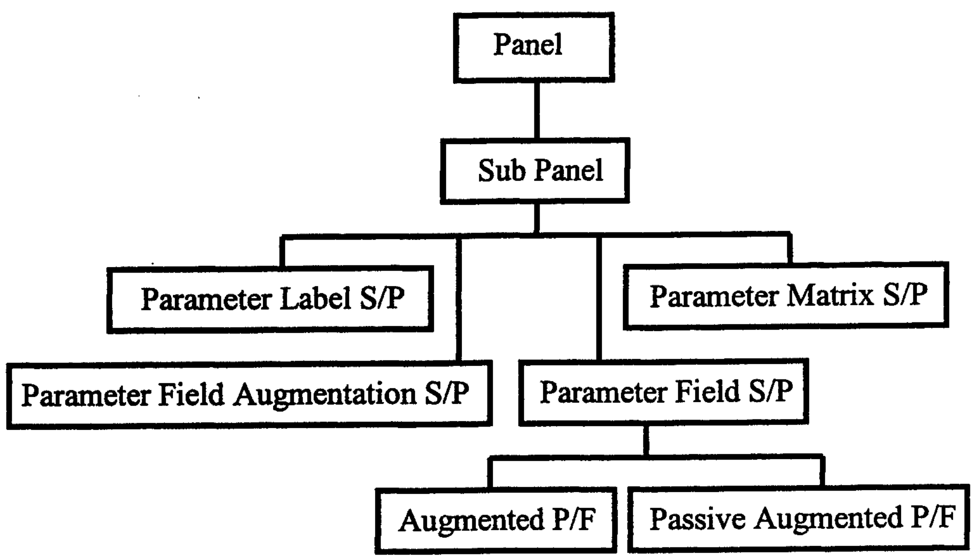

Figure 5.1.1.4-1 LTAS Panel Hierarchy

Each of these panels represent a unique Input Panel GUI segment allowing the LTAS user access to a particular portion of the LTAS Work Session data. Many panels use the LTASAdjRowCol class to help manipulate how the panel will look to the LTAS user. If a panel uses a selection button, the OptionMenu class is used to help build its selection list. The 3 main types of Sub Panels are Parameter Label, Parameter Field, and Parameter

Matrix. An Augmented Parameter Field panel is the same as a Parameter Field panel with a Parameter Field Augmentation panel attached to it. All UI Input Panel CSCs are declared in the ~LTAS/include/gui/LTAS_Panels directory in various .h files within the LTAS directory hierarchy. The lower level UI Input Panel CSC hierarchy is shown in Figure 5.1.1.4-2 below.

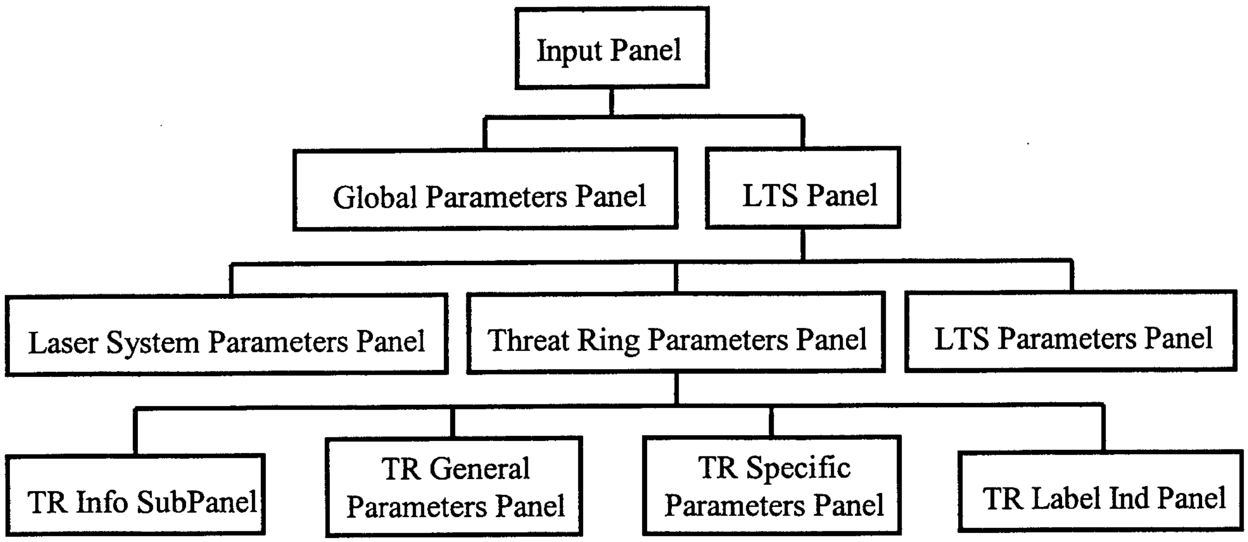

Figure 5.1.1.4-2 Input Panel Components

This panel is represented by the class LTASInputPanel which uses LTASPanel as its base class. LTASInputPanel has functionality to display a selection button at the very top of the panel allowing the LTAS user to select one of the following options:

- Global Parameters for manipulation of global Threat Ring Altitude and Atmospheric conditions.
- Laser Threat Scenario (LTS) selection for manipulation of an LTS's parameters.
- Load or Save an LTS.

5.1.1.4.1 Global Parameter Panel

The Global Parameters panel is represented by the LTASGlobaParametersPanel class declared in LTASGlobalParameters.h. Its base class is LTASPanel and it has object pointers to LTASWSThreatRingAltitudeSubPanel and LTASWSAtmosphereSubPanel which use LTASThreatRingAltitudeSubPanel and LTASAtmosphereSubPanel as their base classes.
The LTASWSThreatRingAltitudeSubPanel class, along with the help of 2 other classes listed below provide Threat Ring Altitude parameter viewing and manipulation within the Global Parameters panel:

- The LTASWSTRAltitudeAugmentedParameterFieldSubPanel class provides an input field for the LTAS user to change the Threat Ring Altitude.
- The LTASWSTRAMSL_AGLParameterFieldAugmentationSubPanel class, which uses the LTASParameterFieldAugmentationSubPanel class as its base class, provides radio buttons for the LTAS user to choose between MSL or AGL.

The LTASWSAtmosphereSubPanel class makes use of object pointers to the LTASParameterFieldSubPanel and LTASParameterLabelSubPanel classes to create the Atmosphere selection panel, allowing the LTAS operator to manipulate the following data:

- Select Atmospheric data usage to be on or off.
- Customize the Atmosphere data base.
- Select an atmospheric condition from the "Atmospheric Condition" button list generated by the Work Session.
- Select an aerosol model from the "Aerosol Model" button list generated by the Work Session.
- Select a region from the "Region" button list generated by the Work Session.
- The LTASWSAttenCoefParameterFieldSubPanel allows the LTAS user to view/change the Atmospheric Attenuation Coeficient.

5.1.1.4.2 LTS Panel

All UI Laser Threat Scenario (LTS) Input Panel classes begin with "LTASLTS..." and are declared in .h files beginning in the same manner. The UI LTS CSCs provide the LTAS user with displays for data display and manipulation in the main parameter input panel involving anything to do with an LTS. The user must select an LTS from the main parameter input panel selection popup in order to view the LTS CSC panels.

The main UI LTS class is LTASLTSPanel which is declared in LTASLTSPanel.h. This class represents the main LTS parameter input panel in the LTAS main window when an LTS is selected from the main parameter input panel selection popup. LTASLTSPanel uses LTASPanel as its base class and has member functions which supply the following functionality:

- Selection of Laser System Parameters panel for data display and manipulation.
- Selection of Laser Threat Scenario Parameters panel for data display and manipulation.
- Selection of a Threat Ring Parameters panel for data display and manipulation.
- The LTASLTSCBPNeedsUpdateFlagLabelSubPanel class is used to notify the LTAS user they have made modifications to the LTS but haven't yet recalculated the results.

- A "Calculate" button which when selected will display the results of any data manipulation on the Map display (This button is actually created by invoking the LTASLTSCalculateButtonPanel class constructor).

5.1.1.4.2.1 Laser Threat Scenario (LTS) Parameters Panel

The LTS Parameters Panel allows the LTAS operator to view and manipulate general LTS data having to do with any Laser Threat Scenario displayed on the Map. This panel is represented by the class LTASLTSParametersPanel which uses LTASPanel as its base class. Other classes used to help build this panel are LTASLTSAtmosphereSubPanel, LTASLTSLabelIndicatorsPanel and LTASLTSTRRadiusDisplayLabelIndPanel which use LTASLabelIndicatorsPanel and LTASPanel as their base classes respectively. This panel allows the LTAS operator to maintain separate control of the following parameters for each LTS on the Map display:

- The LTASLTSTRAAltitudeAugmentedParameterFieldSubPanel class provides an input field for the LTAS user to view/change the Threat Ring Altitude.
- The LTASLTSTRAMSL_AGLParameterFieldAugmentationSubPanel class provides radio buttons for the LTAS user to choose between MSL or AGL.
- Select Atmospheric data usage to be on or off.
- Customize the Atmosphere data base.
- Select an atmospheric condition from the "Atmospheric Condition" button list generated by the Work Session.
- Select an aerosol model from the "Aerosol Model" button list generated by the Work Session.
- Select a region from the "Region" button list generated by the Work Session.
- The LTASLTSAttenCoeffParameterFieldSubPanel class allows the LTAS user to view/change the Atmospheric Attenuation Coeficient.
- View the radius of each Threat Ring (TR) associated with the LTS (TR possibilities are NOHD, Flashblindness, EyeDamage, Eye Kill, and Irradiance/Radiant Exposure).
- Set the location (N, N/E, E, S/E, S, S/W, W, N/W) of the LTS label on the Map display.
- Select whether or not to show the LTS label and indicator on the Map display.
- Select whether or not to show each TR and/or its label and indicator on the Map display.

5.1.1.4.2.2 Laser System Parameters Panel

The LTS Laser System Parameters Panel allows the LTAS operator to view and manipulate data about an LTS's laser parameters and location. The LTS parameter panel is represented by the LTASLTSLaserSystemPanel class which uses LTASPanel as its base class. The Laser system panel is split into 2 distinct parts; The LTS system parameters and the LTS location. The LTS laser parameters panel is represented by the LTASLTSLaserParametersSubPanel class using LTASLaserParametersSubPanel as its base class. The LTS location panel is represented by the LTASLocationSubPanel class which uses LTASSubPanel as its base class. Each of these classes use other classes to build the panels seen by the LTAS operator. The location portion of the Laser System Parameters panel is represented by the LTASLTSLaserLocationSubPanel class. It uses LTASLocationSubPanel as its base class and uses other classes to provide the following functionality:

- The LTASLTSLatParameterFieldSubPanel class which displays LTS Latitude location from the Map display.
- The LTASLTSLonParameterFieldSubPanel class which displays LTS Longitude location from the Map display.

The laser system portion of the Laser System Parameters panel combines several classes and methods to build the panel displayed to the operator. The panel is very simple if Advanced mode is not selected, allowing only Laser System selection. However, if Advanced mode is selected, a host of Laser System parameters may be manipulated by the LTAS operator. The LTASLTSLaserParametersSubPanel class has set and get methods which display the proper information on the button selection widgets in this panel for Laser System, Wavelength, Type, and Beam Profile. Other classes used to help build this panel are listed below:

- The LTASLTSLPWavelengthParameterFieldSubPanel class displays the Wavelength input parameter field for viewing and modification by the LTAS user.
- The LTASLTSLPPowerParameterFieldSubPanel class displays the Power input parameter field for viewing and modification by the LTAS user if a laser of Type "CW" (Continuous Wave) has been selected.
- The LTASLTSLPEnergyParameterFieldSubPanel class displays the Energy input parameter field for viewing and modification by the LTAS user if a laser of Type "Pulsed" has been selected.
- The LTASLTSLPPRFParameterFieldSubPanel class displays the PRF (Pulse Repetition Frequency) input parameter field for viewing and modification by the LTAS user if a laser of Type "Pulsed" has been selected.
- The LTASLTSLPPulseWidthParameterFieldSubPanel class displays the Energy input parameter field for viewing and modification by the LTAS user if a laser of Type "Pulsed" has been selected.
- The LTASLTSLPApertureAugmentedParameterFieldSubPanel class displays the Output Aperture input parameter field for viewing and modification by the LTAS user if a "Circular" Beam Profile has been selected.
- The LTASLTSLPAOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Output Aperture input parameter field if a "Circular" Beam Profile has been selected.

- The LTASLTSLPDivergenceAugmentedParameterFieldSubPanel class displays the Divergence input parameter field for viewing and modification by the LTAS user if a "Circular" Beam Profile has been selected.
- The LTASLTSLPDOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Divergence input parameter field if a "Circular" Beam Profile has been selected.
- The LTASLTSLPXApertureAugmentedParameterFieldSubPanel class displays the X Axis Aperture input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPXAOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the X Axis Aperture input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPXDivergenceAugmentedParameterFieldSubPanel class displays the X Axis Divergence input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPXDOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the X Axis Divergence input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPYApertureAugmentedParameterFieldSubPanel class displays the Y Axis Aperture input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPYAOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Y Axis Aperture input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPYDivergenceAugmentedParameterFieldSubPanel class displays the Y Axis Divergence input parameter field for viewing and modification by the LTAS user if a "Rectangular" or "Eliptical" Beam Profile has been selected.
- The LTASLTSLPYDOneOverEParameterFieldAugmentationSubPanel class displays the 1/e radio button selections just to the right of the Y Axis Divergence input parameter field if a "Rectangular" or "Eliptical" Beam Profile has been selected.

5.1.1.4.2.3 Threat Ring Parameter Panels

The LTS Threat Ring (TR) Parameters panel allows the LTAS user to manipulate data concerning anything to do with a particular threat ring. There are 6 types of threat rings which can be displayed in LTAS; NOHD or Eye Safe TR, Flash Blindness TR, Eye Damage TR, Sensor Damage TR, Sensor Jam TR, and Irradiance/Radiant Exposure TR. The main TR parameter panel is represented by the LTASThreatRingParametersPanel class which uses the LTASPanel class as its base class. This class has object pointers to 4 other classes which help build a specific TR parameter panel depending on which TR is selected. Some Threat Rings use more panels than others, and some panels belong to a specific Threat Ring. The paragraphs which follow describe the classes used by the LTASThreatRingParametersPanel class to help build any of the 6 types of TR panels.

5.1.1.4.2.3.1 TR Information Subpanel

All Threat Rings use this class to help build their TR panels. The LTASTRInfoSubPanel class provides an information subpanel at the top of all TR panels. This class uses LTASPanel as its base class and has object pointers to other classes which provide the following functionality for the TR information portion of a TR panel:

- The LTASTRAssumptionsMadeFlagLabelSubPanel class provides the LTAS operator with a small display on the upper right side of this panel listing assumptions made, if any, by LTAS.
- The LTASTRRadiusParameterLabelSubPanel class provides the LTAS operator a display of the TR radius in the upper laeft corner of this panel.
- The LTASTRODRequiredParameterLabelSubPanel class provides the LTAS operator with a display showing the OD required for Laser Eye Protection (LEP) equipment.
- The LTASTRInfoSubPanel class provides a "Recommended Optics" button for the LTAS operator to select if they wish to view a list of recommended LEP equipement.
- The LTASShowRecommendedOpticsDialogManager class handles displaying the LEP list after the "Recommended Optics" button has been selected.

5.1.1.4.2.3.2 TR Specific Parameters Subpanel

If a Threat Ring has specific parameters associated with it, they will be displayed just below the TR information subpanel. The LTASTRSpecificParametersSubPanel class represents this panel and uses the LTASPanel class as its base class. The Threat Rings which use this panel are Flash Blindness, Irradiance/Radiant Exposure, and Eye Damage. Each of these Threat Rings, and the classes used to build their respective TR Specific panels will be discussed here in separate paragraphs.

5.1.1.4.2.3.2.1 Flash Blindness TR Specific Parameters Subpanel

The Flash Blindness TR Specific parameter subpanel is represented by the class LTASTRFBSpecificPanel, which uses LTASPanel as its base class. This panel allows the LTAS user to view and manipulate data with respect to Visual Task, Background, Laser's Target, and Personnel Effects, as they effect the Flash Blindness Threat Ring. Each of these 4 sections are described in the following paragraphs.

The LTASTRVisualTaskPanel class represents the Visual Task portion of the Flash Blindness TR Specific Parameters Subpanel and uses LTASVisualTaskPanel as its base class. This 1st portion of the TR Flashblindness Specific Parameters panel has data which may influence a "Visual Task" such as distance from the viewer, altitude, size, reflectance, and luminance. This class uses methods and other classes to provide the following functionality to the LTAS user:

- Allow the LTAS user to select a visual task to perform from the "Visual Task" button list generated by the LTAS Work Session.

- Allow the LTAS user to customize the Visual Task database.
- The LTASTRVTViewDistParameterFieldSubPanel class allows the LTAS user to view/change the "Distance From Viewer" input parameter field.
- The LTASTRVTAltitudeAugmentedParameterFieldSubPanel class allows the LTAS user to view/change the "Altitude" input parameter field.
- The LTASTRVTMSL_AGLParameterFieldAugmentationSubPanel class allows the LTAS user to select between MSL and AGL for the Altitude reference.
- The LTASTRVTSizeParameterFieldSubPanel class allows the user to view/change the "Size" of object being viewed.
- The LTASTRVTReflectanceParameterFieldSubPanel class allows the LTAS user to view/change the "Reflectance" of the object being viewed, if an object was chosen from the "Visual Task" selection button.
- The LTASTRVTLuminanceParameterFieldSubPanel class allows the LTAS user to view/change the "Luminance" of the symbol being viewed. If a symbol was chosen from the "Visual Task" selection button.

The LTASTRBackgroundPanel class represents the next portion of the Flash Blindness TR Specific Parameters Subpanel and uses LTASBackgroundPanel as its base class. This portion of the panel has data regarding the "Background" of a visual task. This class uses methods and other classes to provide the following functionality for this panel:

- Allow the LTAS user to select the condition of the sky from the "Sky Condition" button list generated by the LTAS Work Session.
- The LTASTRBGSourceIlluminanceParameterFieldSubPanel class allows the LTAS user to view/change the Source Illuminance value.
- Allow the LTAS user to select from a variety of different types of terrain from the "Terrain" button list generated by the LTAS Work Session.
- Allow the LTAS Operator to customize the Terrain database.
- The LTASTRBGTerrainReflectanceParameterFieldSubPanel class allows the LTAS user to view/change the Background Reflectance value.

The 3rd portion of the Flash Blindness TR Specific Parameters panel is represented by the LTASTRFBLasersTargetSubPanel class which uses LTASLasersTargetSubPanel as its base class. This section of the panel provides altitude information about the target being viewed. This class uses other classes to provide the following functionality for this panel:

- The LTASTRLTAltitudeAugmentedParameterFieldSubPanel class allows the LTAS user to view/change the Laser's Target Altitude.
- The LTASTRLTMSL_AGLParameterFieldAugmentationSubPanel class allows the LTAS user to select between MSL or AGL for the Laser's Target Altitude reference.

The final section of the Flash Blindness TR Specific Parameters panel is called Personnel Effects. It is represented by the LTASTRPersonnelEffectsSubPanel class wich uses LTASPersonnelEffectsSubPanel as its base class. This section of the panel provides information about the personnel being effected by the laser. The following classes are used to help build this section of the panel:

- The LTASTRObsLevelParameterFieldSubPanel class allows the LTAS user to view/change the Obscuration Level value.
- The LTASTRTimeAfterExpParameterFieldSubPanel class allows the LTAS user to view/change the Time After Exposure value.

5.1.1.4.2.3.2.2 Irradiance/Radiant Exposure TR Specific Parameters Subpanel

The Irradiance/Radiant Exposure TR Specific parameter subpanel is represented by the class LTASTRIRESpecificPanel, which uses LTASPanel as its base class. This panel allows the LTAS user to view and manipulate Radiant Exposure data, as it effects the Irradiance/Radiant Exposure Threat Ring. The following classes and methods provide the functionality displayed to the LTAS user in this panel:

- The LTASTRIREParameterFieldSubPanel class allows the LTAS user to view/change the Radiant Exposure value.

5.1.1.4.2.3.2.3 Eye Damage TR Specific Parameters Subpanel

The Eye Damage TR Specific parameter subpanel is represented by the class LTASTREDSpecificPanel, which uses LTASPanel as its base class. This panel allows the LTAS user to view and manipulate Eye Damage and Visualization data as effected by the Eye Damage Threat Ring. The LTASTREDSpecificPanel uses methods and other classes to provide the functionality displayed to the LTAS user in this panel as described below:

- Allow the LTAS user to select an Eye Damage Level.
- The LTASTRED50MultParameterFieldSubPanel class allows the LTAS user to view/change the ED50 Multiplier value.
- Allow the LTAS user to display a picture of what a selected target would look like before and after current LTAS eye damage levels.
- Allow the LTAS user to select from a list of pictures for displaying Before/After Eye Damage effects.

5.1.1.4.2.3.3 TR Label Indicators Subpanel

All Threat Rings use this class to help build their TR panels. This panel is represented by the LTASTRLabelIndicatorsPanel class and provides TR label and indicator information at the bottom of all TR panels. This class uses LTASLabelIndicatorsPanel as its base class and has methods which provide the following functionality:

- Select to show or hide the TR label on the Map Display.
- Select to show or hide the TR indicator on the Map display.
- Select to show or hide the Threat Ring on the Map display.
- Delete the Threat Ring from the LTS.

5.1.1.4.2.3.4 TR General Parameters Subpanel

All Threat Rings use this class to help build their TR panels. This panel is represented by the LTASTRGeneralParametersPanel class and provides general TR information used by all Threat Rings just above the Label Indicators Subpanel at the bottom of all TR panels. This class has LTASPanel as its base class and uses other classes to help build the TR general parameters portion of a TR panel. The LTASTRThreatRingAltitudeSubPanel and LTASTRAtmosphereSubPanel classes create the first part of the TR General Parameters panel with the help of the classes listed below. This portion of the TR General Parameters panel looks just like the Global Parameters panel. This panel allows the LTAS operator to manipulate Threat Ring Altitude and Atmospheric conditions for each LTS Threat Ring independently. There are several classes used in this panel which use LTASAssumedFlagLabelSubPanel as their base class, which in turn uses LTASFlagLabelSubPanel as its base class. These are used in case assumptions had to be made to calculate the value displayed in their respective fields. The ParameterFieldSubPanels assiciated with each of these AssumedFlagLabelSubPanels use LTASPassiveAugmentedParameterFieldSubPanel as their base class.

- The LTASTRTRAAltitudeAugmentedParameterFieldSubPanel class provides an input field for the LTAS user to change the Threat Ring Altitude for the selected TR.
- The LTASTRTRAMSL_AGLParameterFieldAugmentationSubPanel class provides radio buttons for the LTAS user to choose between MSL or AGL for the selected TR.
- Allow the LTAS user to select Atmospheric data usage to be on or off, customize the Atmosphere data base, select the Atmospheric Condition., Aerosol Model, and Region.
- The LTASTRAttenCoeffParameterFieldSubPanel class allows the LTAS user to view/change the Atmospheric Attenuation Coeficient.
- The LTASTRAttenCoeffAssumedFlagLabelSubPanel class sets a flag if any assumptions had to be made to calculate the value displayed in the Attenuation Coefficient field.

The next portion of the TR General Parameters panel is the Laser's Target section. This is represented by the LTASTRLasersTargetSubPanel class. LTASLasersTargetSubPanel is used as its base class and it uses methods and other classes to supply the following functionality:

- Allow the LTAS user to select an aircraft from the"Aircraft Type" button selection list generated by the Work Session.
- Allow the LTAS user to customize the Optics database.

- The LTASTRCanopyTransParameterFieldSubPanel class allows the LTAS user to view/change the Canopy Transmission field.
- The LTASTRCanopyTransAssumedFlagLabelSubPanel class sets a flag if any assumptions had to be made to calculate the value displayed in the Canopy Transmission field.

The 3rd portion of the TR General Parameters panel is Optics and Life Support Equipment. This section is represented by the LTASTROpticsAndLifeSupportSubPanel class which uses LTASOpticsAndLifeSupportSubPanel as its base class. This class uses methods and other classes to help build this portion of the TR General Parameters panel with the following functionality:

- Allow the LTAS user to select an optic from the "Magnifying Optic" button selection list generated by the Work Session.
- Allow the LTAS user to select a visor from the "Life Support Visor" button selection list generated by the Work Session.
- Allow the LTAS user to customize the Optics database.
- The LTASTRMagnificationParameterFieldSubPanel class allows the LTAS user to view/change the Magnifying Optic Magnification field.
- The LTASTRMagOpticTransParameterFieldSubPanel class allows the LTAS user to view/change the Transmission field.
- The LTASTRMagOpticTransAssumedFlagLabelSubPanel class sets a flag if any assumptions had to be made to calculate the value displayed in the Magnifying OpticTransmission field.
- The LTASTRObjApertureParameterFieldSubPanel class allows the LTAS user to view/change the Magnifying Optic Object Aperture field.
- The LTASTRLSVTransParameterFieldSubPanel class allows the LTAS user to view/change the Life Support Visor Transmission field.
- The LTASTRLSVTransAssumedFlagLabelSubPanel class sets a flag if any assumptions had to be made to calculate the value displayed in the Life Support Visor Transmission field.

The final portion of the TR General Parameters panel is Laser Eye Protection (LEP). This section is represented by the LTASTRLaserEyeProtectionSubPanel class which uses LTASLaserEyeProtectionSubPanel as its base class. This class uses methods and other classes to help build this portion of the TR General Parameters panel with the following functionality:

- Allow the LTAS user to select a visor from the "LEP Visor" button selection list generated by the Work Session.
- Allow the LTAS user to select a spectacle from the "LEP Spectacle" button selection list generated by the Work Session.
- Allow the LTAS user to customize the Optics database.
- The LTASTRVisorTransParameterFieldSubPanel class allows the LTAS user to view/change the LEP Visor Transmission field.

- The LTASTRVisorTransAssumedFlagLabelSubPanel class sets a flag if any assumptions had to be made to calculate the value displayed in the LEP Visor Transmission field.
- The LTASTRSpectacleTransParameterFieldSubPanel class allows the LTAS user to view/change the LEP Spectacle Transmission field.
- The LTASTRSpectacleTransAssumedFlagLabelSubPanel class sets a flag if any assumptions had to be made to calculate the value displayed in the LEP Spectacle Transmission field.

5.1.2 Command

As described in section 4, the main Command CSCs are the Tool Bar, Parameter Input Panel, Help Commands, File Commands, View Commands, Insert/Edit Commands, and Option Commands. The Command CSCI is tied very closely to the UI CSCI. The UI CSCs display information to the LTAS user. When an action such as a button bush or menu choice is made using a UI CSC, a Command CSC is executed to perform the action requested. All Command classes use the Cmd class as their base class unless otherwise noted. The Cmd class is derived from Douglas Young's book (please see section 2.3 item 7) and is declared in cmd.h in the ~LTAS/include/gui/LTAS_MotifApp directory within the LTAS directory hierarchy. This class is a basic building block class used by Douglas Young for all C++/Motif commands. All Command CSCs are declared in the ~LTAS/include/gui/LTAS_Cmds directory within the LTAS directory hierarchy and are described in the following paragraphs.

5.1.2.1 File Commands

The File Command CSCs are executed when the LTAS user selects an option from the UI Menu Bar File pulldown. There is a corresponding Command CSC executed for each pulldown option as described below. The main purpose of these CSCs are for saving, retreiving, and printing of LTAS work sessions, opening terrain databases, and exiting LTAS.

- The LTASFileNewCmd class, which uses LTASFileSave as its base class, executes when the LTAS user selects the "New" option of the UI Menu Bar File pulldown. This class opens a new terrain database selected by the LTAS user for display on the Map.
- The LTASFileOpenCmd class, which uses LTASFileSaveCmd as its base class, executes when the LTAS user selects the "Open" option of the UI Menu Bar File pulldown. This class opens a previously saved LTAS Work Session with all its corresponding parameters.
- The LTASFileSaveCmd class, which uses LTASFileSaveAsCmd as its base class, executes when the LTAS user selects the "Save" option of the UI Menu Bar File

pulldown. This class saves any modifications made to the current work session to disk under its old filename.

- The LTASFileSaveAsCmd class executes when the LTAS user selects the "Save As" option of the UI Menu Bar File pulldown. This class saves any modifications made to the current work session to disk, allowing the LTAS user to select a new filename.
- TheLTASFilePrintCmd class executes when the LTAS user selects the "Print" option from the UI Menu Bar File pulldown. This class prints user selected itmes from the current work session.
- TheLTASFileExitCmd class, which uses LTASFileSave as its base class, executes when the LTAS user selects the "Exit" option from the UI Menu Bar File pulldown. This class terminates the LTAS program.

5.1.2.2 View Commands

The View Command CSCs are executed when the LTAS user selects an option from the UI Menu Bar View pulldown. There is a corresponding Command CSC executed for each pulldown option as described below. The main purpose of these CSCs are for manipulating what is shown on the Map display.

- The LTASViewZoomCenterInCmd class executes when the LTAS user selects the "Zoom In At Center" option of the UI Menu Bar View pulldown. This class causes the Map display to zoom in at its center point. It is also used for the Zoom In At Center Tool Bar button.
- The LTASViewZoomCenterOutCmd class executes when the LTAS user selects the "Zoom Out At Center" option of the UI Menu Bar View pulldown. This class causes the Map display to zoom out from its center point. It is also used for the Zoom Out At Center Tool Bar button.
- The LTASViewScaleCmd class executes when the LTAS user selects the "Scale" option of the UI Menu Bar View pulldown. This class allows the LTAS user to change the scale of the Map display via a Map Scale panel. A scale may be entered in this panel's Scale input parameter field, which is represented by the scaleField class. This class uses LTASParameterField as its base class.
- The LTASViewMapElevationUnitsCmd class executes when the LTAS user selects the "Map Elevation Units" option of the UI Menu Bar View pulldown. This class allows the LTAS user to change the elevation units displaed just under the Map display via a Map Elevation Units panel.
- The LTASViewTerrainMaskingCmd class, which uses ToggleCmd as its base class, executes when the LTAS user selects the "Terrain Masking" option of the UI Menu Bar View pulldown. This class causes Threat Rings shown on the Map display to use or ignore terrain elevations.
- The LTASViewScrollControlCmd class, which uses ToggleCmd as its base class, executes when the LTAS user selects the "Scroll Control" option of the UI Menu Bar View pulldown. This class hides or displays the Map scroll control.

- The LTASViewContourLinesCmd class, which uses ToggleCmd as its base class, executes when the LTAS user selects the "Contour Lines" option of the UI Menu Bar View pulldown. This class hides or displays elevation contour lines on the Map.
- The LTASViewLatLonGridCmd class, which uses ToggleCmd as its base class, executes when the LTAS user selects the "Lat/Lon Grid" option of the UI Menu Bar View pulldown. This class hides or displays the latitude and longitude grid on the Map.
- The LTASViewAdditonalInformationCmd class executes when the LTAS user selects the "Additional Information" option of the UI Menu Bar View pulldown. This class allows the LTAS user to view any additional information LTAS has compiled via an Additional Information panel.

5.1.2.3 Insert and Edit Commands

The Insert and Edit Command CSCs are executed when the LTAS user selects an option from the UI Menu Bar Insert or Edit pulldown. There is a corresponding Command CSC executed for each pulldown option as described below. The main purpose of these CSCs are for manipulation of LTSs on the Map display.

- The LTASInsertLTSCmd class executes when the LTAS user selects the "Laser Threat Scenario" option of the UI Menu Bar Insert pulldown. This class inserts a new LTS into the current work session and displays it on the Map. It is also used for the Insert LTS Tool Bar button.
- The LTASInsertEyeSafeTRCmd class executes when the LTAS user selects the "Eye Safe Threat Rings" option of the UI Menu Bar Insert pulldown. This class inserts an Eye Safe Threat Ring into the current LTS. It is also used for the Insert NOHD Threat Ring Tool Bar button.

- The LTASInsertFlashBlindnessTRCmd class executes when the LTAS user selects the "Flashblindness Threat Rings" option of the UI Menu Bar Insert pulldown. This class inserts a Flashblindness Threat Ring into the current LTS. It is also used for the Insert Flashblindness Threat Ring Tool Bar button.
- The LTASInsertEyeDamageTRCmd class executes when the LTAS user selects the "Eye Damage Threat Rings" option of the UI Menu Bar Insert pulldown. This class inserts an Eye Damage Threat Ring into the current LTS. It is also used for the Insert Eye Damage Threat Ring Tool Bar button.
- The LTASInsertSensorDamageTRCmd class executes when the LTAS user selects the "Sensor Damage Threat Rings" option of the UI Menu Bar Insert pulldown. This class inserts a Sensor Damage Threat Ring into the current LTS. It is also used for the Insert Sensor Damage Threat Ring Tool Bar button.
- The LTASInsertSensorJamTRCmd class executes when the LTAS user selects the "Sensor Jam Threat Rings" option of the UI Menu Bar Insert pulldown. This class

inserts a Sensor Jam Threat Ring into the current LTS. It is also used for the Insert Sensor Jam Threat Ring Tool Bar button.

- The LTASInsertIrradRadExpTRCmd class executes when the LTAS user selects the "Irradiance/Radiant Exposure Threat Rings" option of the UI Menu Bar Insert pulldown. This class inserts an Irradiance/Radiant Exposure Threat Ring into the current LTS. It is also used for the Insert Irradiance/Radiant Exposure Threat Ring Tool Bar button.
- The LTASEditDeleteCmd class executes when the LTAS user selects the "Delete Current LTAS" option of the UI Menu Bar Edit pulldown. This class deletes the current LTS from the work session.

5.1.2.4 Option Commands

The Option Command CSCs are executed when the LTAS user selects an option from the UI Menu Bar Option pulldown. There is a corresponding Command CSC executed for each pulldown option as described below. The main purpose of these CSCs are for setting of overall LTAS parameters and database manipulation.

- The LTASOptionsSwitchModeCmd class, which uses ToggleCmd as its base class, executes when the LTAS user selects the "Advanced Mode" option of the UI Menu Bar Option pulldown. This class tells the current work session to switch from the mode its in (Advanced or Normal) to the other mode.
- The LTASOptionsSetDefaultsCmd class executes when the LTAS user selects the "Set Default Parameters" option of the UI Menu Bar Option pulldown. This results in the display of the LTAS Set Defaults panel, allowing the LTAS user to manipulate the default parameters a new work session uses.
- The LTASOptionMenuResetButtonCmd class executes when the LTAS user selects the "Reset These Parameters" or "Reset All Parameters" buttons in the Set Default Parameters panel. This resets the parameters previously modified by the LTAS user.
- The LTASOptionsSetGlobalParametersCmd class executes when the LTAS user selects the "Set Global Parameters" option of the UI Menu Bar Option pulldown. This results in the Global Parameter panel being displayed, allowing the LTAS user to manipulate the Threat Ring Altitude and Atmospheric Condition parameters for the current work session.

There is a Command CSC associated with each selection under the "Customize Database" option. They all use LTASCustomizeDBCmd as their base class. There are also Command CSCs associated with the selection buttons on the various "Customize Database" panels. These Command CSCs are described in the following paragraphs.

5.1.2.4.1 Customize Aircraft Type DB Commands

- The LTASOptionsCustomizeAircraftTypeCmd class executes when the LTAS user selects the “Aircraft Type” option of the UI Menu Bar Option (Customize Databases…) pulldown. This results in the LTAS Customize Database panel being displayed with Aircraft Type parameters.
- The LTASLasersTargetSubPanelSetAircraftTypeNameCmd class executes when the LTAS user selects an option from the “Aircraft Type” selection button in the LTAS Customize Database panel. This changes the laser’s target aircraft being manipulated in the database. This class is also used to change the aircraft type in the Threat Ring General Parameters panel within the LTS panel.
- The LTASLoadFromFileCmd class executes when the LTAS user selects the “Load From File” button in the LTAS Customize Database panel. This displays the Load From File panel allowing the LTAS user to browse for a file to load into the database.

5.1.2.4.2 Customize Atmosphere DB Commands

- The LTASOptionsCustomizeAtmosphereCmd class executes when the LTAS user selects the “Atmosphere” option of the UI Menu Bar Option (Customize Databases…) pulldown. This results in the LTAS Customize Database panel being displayed with Atmosphere parameters.
- The LTASAtmosphereSubPanelSetRegionNameCmd class executes when the LTAS user selects an atmospheric region from the "Region" Atmosphere panel selection button within the Customize Database panel. This changes the atmospheric region being manipulated in the database. This class is also used to change the region name in other Atmosphere subpanels contianed within the Global Defaults, LTS, and General Threat Ring panels.
- The LTASAtmosphereSubPanelSetAerosolModelNameCmd class executes when the LTAS user selects a model from the "Aerosol Model" Atmosphere panel selection button within the Customize Database panel. This changes the aerosol model being manipulated in the database. This class is also used to change the aerosol model in other Atmosphere subpanels contianed within the Global Defaults, LTS, and General Threat Ring panels.
- The LTASAtmosphereSubPanelSetWavelengthNameCmd class executes when the LTAS user selects a wavelength from the "Wavelength" Atmosphere panel selection button within the Customize Database panel. This changes the wavelength being manipulated in the database.
- The LTASLoadFromFileCmd class executes when the LTAS user selects the "Load From File" button in the LTAS Customize Database panel. This displays the Load From File panel allowing the LTAS user to browse for a file to load into the database.

5.1.2.4.3 Customize Background DB Commands

- The LTASOptionsCustomizeBackgroundCmd class executes when the LTAS user selects the "Background" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with Background parameters.
- The LTASBackgroundPanelSetTerrainCmd executes when the LTAS user selects a background from the "Terrain" Background selection button within the Customize Database panel. This changes the terrain being manipulated in the database. This class is also used to change the terrain in the Flashblindness Threat Ring Specific Parameters panel within the LTS panel.

5.1.2.4.4 Customize Laser Systems DB Commands

- The LTASOptionsCustomizeLaserSystemCmd class executes when the LTAS user selects the "Laser Systems" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with Laser System parameters.
- The LTASLaserPanametersSubPanelSetLaserNameCmd class executes when the LTAS user selects a laser from the "Laser System" LTAS Customize Database panel selection button. This changes the laser system being manipulated in the database. This class is also used to change the laser name in the Laser System Parameters panel within the LTS panel.
- The LTASLaserPanametersSubPanelSetLaserWavelengthCmd class executes when the LTAS user selects a wavelength from the "Wavelength" LTAS Customize Database panel selection button. This changes the laser system's wavelength being manipulated in the database. This class is also used to change the laser wavelength in the Laser System Parameters panel within the LTS panel.
- The LTASLaserPanametersSubPanelSetLaserTypeCmd class executes when the LTAS user selects a type (Pulsed or Continuous) from the "Type" LTAS Customize Database panel selection button. This changes the laser system type being manipulated in the database. This class is also used to change the laser type in the Laser System Parameters panel within the LTS panel.
- The LTASLaserPanametersSubPanelSetLaserBeamProfileCmd class executes when the LTAS user selects a beam profile (Circular, Eliptical, or Rectangular) from the "Beam Profile" LTAS Customize Database panel selection button. This changes the laser system's beam profile being manipulated in the database. This class is also used to change the laser beam profile in the Laser System Parameters panel within the LTS panel.

5.1.2.4.5 Customize Magnifying Optics DB Commands

- The LTASOptionsCustomizeMagnifyingOpticsCmd class executes when the LTAS user selects the "Magnifying Optics" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with Magnifying Optic parameters.
- The LTASOpticsAndLifeSupportSubPanelSetMagnifyingOpticsNameCmd class executes when the LTAS user selects an option from the "Magnifying Optic" selection button in the LTAS Customize Database panel. This changes the magnifying optic being manipulated in the database. This class is also used to change the magnifying optic in the General Threat Ring Parameter panel within the LTS panel.
- The LTASLoadFromFileCmd class executes when the LTAS user selects the "Load From File" button in the LTAS Customize Database panel. This displays the Load From File panel allowing the LTAS user to browse for a file to load into the database.

5.1.2.4.6 Customize Life Support Visors DB Commands

- The LTASOptionsCustomizeLifeSupportVisorsCmd class executes when the LTAS user selects the "Life Support Visors" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with Life Support Visor parameters.
- The LTASOpticsAndLifeSupportSubPanelSetLSVNameCmd class executes when the LTAS user selects an option from the "Life Support Visor" selection button in the LTAS Customize Database panel. This changes the life support visor being manipulated in the database. This class is also used to change the life support visor in the General Threat Ring Parameters panel within the LTS panel.
- The LTASLoadFromFileCmd class executes when the LTAS user selects the "Load From File" button in the LTAS Customize Database panel. This displays the Load From File panel allowing the LTAS user to browse for a file to load into the database.

5.1.2.4.7 Customize Laser Eye Protection: Spectacles DB Commands

- The LTASOptionsCustomizeLEPSpectaclesCmd class executes when the LTAS user selects the "Laser Eye Protection: Spectacles" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with LEP Spectacle parameters.
- The LTASLaserEyeProtectionSubPanelSetSpectacleNameCmd class executes when the LTAS user selects an option from the "Spectacle" selection button in the LTAS Customize Database panel. This changes the LEP spectacle being manipulated in the database. This class is also used to change the LEP spectacle in the General Threat Ring Parameters panel within the LTS panel.

- The LTASLoadFromFileCmd class executes when the LTAS user selects the "Load From File" button in the LTAS Customize Database panel. This displays the Load From File panel allowing the LTAS user to browse for a file to load into the database.

5.1.2.4.8 Customize Laser Eye Protection: Visors DB Commands

- The LTASOptionsCustomizeLEPVisorsCmd class executes when the LTAS user selects the "Laser Eye Protection: Visors" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with LEP Visor parameters.
- The LTASLaserEyeProtectionSubPanelSetVisorNameCmd class executes when the LTAS user selects an option from the "Visor" selection button in the LTAS Customize Database panel. This changes the LEP visor being manipulated in the database. This class is also used to change the LEP visor in the General Threat Ring Parameters panel within the LTS panel.
- The LTASLoadFromFileCmd class executes when the LTAS user selects the "Load From File" button in the LTAS Customize Database panel. This displays the Load From File panel allowing the LTAS user to browse for a file to load into the database.

5.1.2.4.9 Customize Visual Tasks DB Commands

- The LTASOptionsCustomizeVisualTaskCmd class executes when the LTAS user selects the "Visual Tasks" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with Visual Task parameters.
- The LTASVisualTaskPanelSetVisualTaskNameCmd class is executed when the LTAS user makes a selection from the "Visual Task" selection button in the LTAS Customize Database panel. This changes the visual task object used in the current threat ring. This class is also used to change the visual task in the Flashblindness Specific Threat Ring Parameters panel within the LTS panel.
- The LTASVisualTaskPanelSetVisualTaskLocationCmd class executes when the LTAS user selects an option from the "Location" selection button in the LTAS Customize Database panel. This sets the location (Air or Ground) for the visual task being manipulated in the database.

5.1.2.4.10 Customize Wavalengths DB Commands

- The LTASOptionsCustomizeWavelengthCmd class executes when the LTAS user selects the "Wavelengths" option of the UI Menu Bar Option (Customize Databases...) pulldown. This results in the LTAS Customize Database panel being displayed with Wavelength parameter modification choices.

- The LTASWavelengthPanelSetWavelengthCmd class executes when the LTAS user selects an option from the "Wavelength" selection button in the LTAS Customize Database panel. This changes the wavelength of the data being manipulated in the database.
- The LTASRunFASCODECmd class executes when the LTAS user selects the "RunFASCODE" button in the LTAS Customize Database panel. This causes the Run FASCODE panel to appear.
- The LTASRunFASCODESetWavelengthCmd class executes when the LTAS user makes a selection from the "Wavelength" selection button in the Run Fascode panel.
- The LTASRunFASCODEGetHitranFileLocCmd class executes when the LTAS user selects the "Select Database" button in the Run Fascode panel. This causes the Select HITRAN Database panel to appear, allowing the LTAS user to browse for a HITRAN database to load.

5.1.2.5 Parameter Input Panel Commands

The Parameter Input Panel Command CSCs are executed when a panel button is selected which exists within the main LTAS Parameter Input panel. There are 4 selection which can be made from the main selection button which appears at the very top of the parameter input panel. The Command CSCs associated with these selection are discussed below. Commands associated with subpanels of this panel are described in the following subparagraphs.

- The LTASLoadLTSCmd class executes when the LTAS user selects the "Open Laser Threat Scenario" option from the main LTAS Parameter Input panel selection button. This allows the LTAS user to load a previously saved LTS into the current work session.
- The LTASSaveLTSAsCmd class executes when the LTAS user selects the "Save Laser Threat Scenario" option from the main Parameter Input panel selection button. This allows the LTAS user to save the current LTS to disk.
- The LTASShowGlobalParametersPanelCmd class executes when the LTAS user selects the "Global Parameters" option from the main Parameter Input panel selection button. This displays the Global Parameters panel within the main LTAS Parameter Input panel.
- The LTASShowLTSPanelCmd class executes when the LTAS user selects an LTS from the main parameter input panel selection button. This displays the LTS panel within the main LTAS Parameter Input panel.

5.1.2.5.1 Global Parameters Panel Commands

If the Global Paramters panel is displayed within the main LTAS Parameter Input panel, Atmosphere panel selection buttons will be shown. The Command CSCs associated with these selection buttons are described below:

- The LTASAtmosphereSubPanelSetRegionNameCmd class executes when the LTAS user selects an atmospheric region from the "Region" Atmosphere panel selection button. This changes the atmospheric region used in the current work session.
- The LTASAtmosphereSubPanelSetAerosolModelNameCmd class executes when the LTAS user selects a model from the "Aerosol Model" Atmosphere panel selection button. This changes the aerosol model parameter used in the current work session.
- The LTASAtmosphereSubPanelSetAtmosphericConditionNameCmd class executes when the LTAS user selects an atmospheric condition from the "Atmospheric Condition" Atmosphere panel selection button. This changes the atmospheric condition parameter used in the current work session.

5.1.2.5.2 LTS Panel Commands

If the LTS panel is displayed within the main LTAS Parameter Input panel, a selection button is displayed at the top of this panel. This button would appear to be just below the main LTAS Parameter Input panel selection button. There are 3 types of selections which can be made from the LTS panel selection button which are desribed below. The Command CSC for the Calculate button is also described.

- The LTASLTSPanelShowLTSLaserSystemPanelCmd class executes when the LTAS user selects the "Laser System Parameters" option from the LTS panel selection button. This displays the Laser System Parameters panel within the LTS panel.
- The LTASLTSPanelShowLTSParametersPanelCmd class executes when the LTAS user selects the "Laser Threat Scenario" option from the LTS panel selection button. This displays the LTS Parameter panel within the LTS panel.
- The LTASLTSPanelShowLTSThreatRingParametersPanelCmd class executes when the LTAS user selects one of the Threat Rings from the LTS panel selection button. This displays a Threat Ring panel within the LTS panel.
- The LTASCurrentLTSCalculateCmd class executes when the LTAS user selects the "Calculate" button in the LTS panel. This class interfaces with the work session to recalculate the placement of Threat Rings on the Map display due to any LTS panel modifications made by the LTAS user.

5.1.2.5.2.1 Laser System Parameters Panel Commands

If the Laser System Parameters panel is displayed within the LTS panel, 4 selection buttons are shown on the panel. The Command CSCs associated with these selection buttons are desribed below:

- The LTASLaserPanametersSubPanelSetLaserNameCmd class executes when the LTAS user selects a laser from the "Laser System" Laser System Parameters panel selection button. This changes the laser system parameters used in the current LTS.

This class is also used to change the laser name in the LTAS Customize Database panel.

- The LTASLaserPanametersSubPanelSetLaserWavelengthCmd class executes when the LTAS user selects a wavelength from the "Wavelength" Laser System Parameters panel selection button. This changes the laser system's wavelength used in the current LTS. This class is also used to change the laser wavelength in the LTAS Customize Database panel.
- The LTASLaserPanametersSubPanelSetLaserTypeCmd class executes when the LTAS user selects a type (Pulsed or Continuous) from the "Type" Laser System Parameters panel selection button. This controls the laser system type used in the current LTS. This class is also used to change the laser type in the LTAS Customize Database panel.
- The LTASLaserPanametersSubPanelSetLaserBeamProfileCmd class executes when the LTAS user selects a beam profile (Circular, Eliptical, or Rectangular) from the "Beam Profile" Laser System Parameters panel selection button. This changes the laser system's beam profile used in the current LTS. This class is also used to change the laser beam profile in the LTAS Customize Database panel.

5.1.2.5.2.2 Laser Threat Scenario Parameters Panel Commands

If the Laser Threat Scenario Parameters panel is displayed within the LTS panel, selection buttons are shown on the panel. The Command CSCs associated with these selection buttons are desribed below:

- The LTASSetLabelCurrentLTSCmd class, which uses LTASSSetLabelCmd as its base class, executes when the LTAS user selects the "Set" button next to the "Label" toggle button on the LTS Parameter panel. This causes a Set Current LTS Label panel to appear, allowing the LTAS user to place the current LTS's label on the Map display.

5.1.2.5.2.3 Threat Ring Parameters Panel Commands

If the LTS Threat Ring Parameters panel is displayed within the LTS panel, selection buttons are shown on the panel. The Command CSCs associated with these selection buttons are desribed below:

- The LTASSetLabelCurrentTRCmd class, which uses LTASSetLabelCmd as its base class, executes when the LTAS user selects the "Set" button next to the "Label" toggle button on the Threat Ring Parameter panel. This causes a Set Current Threat Ring Label panel to appear, allowing the LTAS user to place the current threat ring's label on the Map display.

There are general threat ring parameters which apply to any threat ring, and there are some specific threat ring parameters which apply only to specific threat rings. These are described in the following paragraphs.

5.1.2.5.2.3.1 General Threat Ring Parameters Panel Commands

- The LTASLasersTargetSubPanelSetAircraftTypeNameCmd class executes when the LTAS user selects an option from the "Aircraft Type" selection button in the Laser's Target subpanel of the General Threat Ring Parameter panel. This changes the laser's target aircraft used for the current threat ring. This class is also used to change the aircraft type in the Customize Database panel.
- The LTASOpticsAndLifeSupportSubPanelSetMagnifyingOpticsNameCmd class executes when the LTAS user selects an option from the "Magnifying Optic" selection button in the Optics and Life Support subpanel of the General Threat Ring Parameter panel. This changes the magnifying optic used in the current threat ring. This class is also used to change the magnifying optic in the LTAS Customize Database panel.
- The LTASOpticsAndLifeSupportSubPanelSetLSVNameCmd class executes when the LTAS user selects an option from the "Life Support Visor" selection button in the Optics and Life Support subpanel of the General Threat Ring Parameter panel. This changes the life support visor used in the current threat ring. This class is also used to change the life support visor in the LTAS Customize Database panel.
- The LTASLaserEyeProtectionSubPanelSetVisorNameCmd class executes when the LTAS user selects an option from the "Visor" selection button in the Laser Eye Protection subpanel of the General Threat Ring Parameter panel. This changes the LEP visor used in the current threat ring. This class is also used to change the LEP visor in the LTAS Customize Database panel.
- The LTASLaserEyeProtectionSubPanelSetSpectacleNameCmd class executes when the LTAS user selects an option from the "Spectacle" selection button in the Laser Eye Protection subpanel of the General Threat Ring Parameter panel. This changes the LEP spectacle used in the current threat ring. This class is also used to change the LEP spectacle in the LTAS Customize Database panel.

5.1.2.5.2.3.2 Specific Threat Ring Parameters Panel Commands

- The LTASVisualTaskPanelSetVisualTaskNameCmd class is executed when the LTAS user makes a selection from the "Visual Task" selection button in the Flashblindness Specific Threat Ring Parameters panel within the LTS panel. This changes the visual task object used in the current threat ring. This class is also used to change the visual task in the LTAS Customize Database panel.
- The LTASBackgroundPanelSetSkyConditionCmd executes when the LTAS user selects a condition from the "Sky Condition" selection button in the Flashblindness Specific Threat Ring Parameters panel within the LTS panel. This changes the sky condition used in the current threat ring.
- The LTASBackgroundPanelSetTerrainCmd executes when the LTAS user selects a background from the "Terrain" selection button in the Flashblindness Specific Threat Ring Parameters panel within the LTS panel. This changes the terrain used in the

current threat ring. This class is also used to change the terrain in the LTAS Customize Database panel.

- The LTASTREDSpecificPanelSetDamageLevelCmd executes when the LTAS user selects a damage level from the "Level" selection button in the Eye Damage Specific Threat Ring Parameters panel within the LTS panel. This changes the eye damage level used in the current threat ring.
- The LTASTREDSpecificPanelSetPictureCmd executes when the LTAS user makes a selection from the "Pictures" selection button in the Eye Damage Specific Threat Ring Parameters panel within the LTS panel. This changes the picture displayed in the "Before and After" visual acuity panel.
- The LTASEyeDamageBeforeAfterCmd executes when the LTAS user selects the "Display" button in the Eye Damage Specific Threat Ring Parameters panel within the LTS panel. This results in the display of the "Before and After" visual acuity panel.

5.1.2.6 Tool Bar Commands

The Tool Bar Command CSCs are executed when the LTAS user selects a Tool Bar button. These buttons provide easier access to many of the same functions provided in the Menu Bar Command CSCs. As a matter of fact, for some of the Tool Bar buttons, the same command CSCs are executed as for the Menu Bar options. There is a corresponding Command CSC executed for each Tool Bar button as described below.

- The LTASFileNewCmd class, which uses LTASFileSave as its base class, executes when the LTAS user selects the Tool Bar button with the map icon on it. This action displays a Terrain panel, allowing the LTAS user to browse for a new terrain file. The LTASTerrainSubPanelGetTerrainFilenameCmd class executes when the LTAS user has highlighted a terrain database file and selects the "OK" button on the Terrain panel. This action opens a new terrain database selected by the LTAS user for display on the Map.
- The LTASFileOpenCmd class, which uses LTASFileSave as its base class, executes when the LTAS user selects the Tool Bar button with the open file icon it. This class opens a previously saved LTAS Work Session with all its corresponding parameters.
- The LTASFileSaveCmd class, which uses LTASFileSaveAs as its base class, executes when the LTAS user selects the Tool Bar button with the floppy disk icon on it. This class saves any modifications made to the current work session to disk under its old filename.
- TheLTASFilePrintCmd class executes when the LTAS user selects the Tool Bar button with the printer icon on it. This allows the LTAS user to print selected itmes from the current work session via a Print panel. A printer may be entered into this panel's Printer input parameter field, which is represented by the printerField class. This class uses LTASParameterField as its base class.

- The LTASViewZoomCenterInCmd class executes when the LTAS user selects the Tool Bar button with the magnifying glass and plus sign on it. This class causes the Map display to zoom in at its center point.
- The LTASViewZoomCenterOutCmd class executes when the LTAS user selects the Tool Bar button with the magnifyint glass and minus sign on it. This class causes the Map display to zoom out from its center point.
- The LTASToolBarZoomCursorCmd class executes when the LTAS user selects the Tool Bar button with the magnifying glass and pointer icon on it. This class causes the Map display to zoom in around a point selected by the LTAS user.
- The LTASToolBarInsertLTSCmd class executes when the LTAS user selects the Tool Bar button with the laser icon on it. This class then allows the LTAS user to select a point on the Map display to place a new LTS. The LTASMapInsertLTSCmd class then executes, adding the new LTS to the current work session and displaying it on the Map.
- The LTASToolBarInsertEyeSafeTRCmd class executes when the LTAS user selects the Tool Bar button with the green circle on it. This class then allows the LTAS user to select an LTS on the Map to add an Eye Safe Threat Ring to. The LTASMapInsertNOHDTRCmd class then executes, inserting an Eye Safe Threat Ring into the selected LTS.
- The LTASToolBarInsertFlashBlindnessTRCmd class executes when the LTAS user selects the Tool Bar button with the yellow circle on it. This class then allows the LTAS user to select an LTS on the Map to add a Flashblindness Threat Ring to. The LTASMapInsertFBTRCmd class then executes, inserting a Flashblindness Threat Ring into the selected LTS.
- The LTASToolBarInsertEyeDamageTRCmd class executes when the LTAS user selects the Tool Bar button with the red circle on it. This class then allows the LTAS user to select an LTS on the Map to add an Eye Damage Threat Ring to. The LTASMapInsertEDTRCmd class then executes, inserting an Eye Damage Threat Ring into the selected LTS.
- The LTASToolBarInsertSensorDamageTRCmd class executes when the LTAS user selects the Tool Bar button with the black circle on it. This class then allows the LTAS user to select an LTS on the Map to add a Sensor Damage Threat Ring to. The LTASMapInsertSDTRCmd class then executes, inserting a Sensor Damage Threat Ring into the selected LTS.
- The LTASToolBarInsertSensorJamTRCmd class executes when the LTAS user selects the Tool Bar button with the gray circle on it. This class then allows the LTAS user to select an LTS on the Map to add a Sensor Jam Threat Ring to. The LTASMapInsertSJTRCmd class then executes, inserting a Sensor Jam Threat Ring into the selected LTS.
- The LTASToolBarInsertIrradRadExpTRCmd class executes when the LTAS user selects the Tool Bar button with the red circle on it. This class then allows the LTAS user to select an LTS on the Map to add an Irraniance/Radiant Exposure Threat Ring to. The LTASMapInsertIRETRCmd class then executes, inserting an Irradiance/Radiant Exposure Threat Ring into the selected LTS.

- The LTASToolBarReturnToNormalCmd class executes when the LTAS user selects the Tool Bar button with the pointer icon on it. This class returns the mouse pointer to a normal state.
- The LTASHelpHelpAboutCmd class executes when the LTAS user selects the Tool Bar button with the question mark and pointer icons on it. This action changes the cursor to a question mark. The LTAS user may then select any GUI item they are interested in getting information about. Once a GUI item has been selected, a help panel is displayed with the information the LTAS user requested.

5.1.2.7 Help Commands

The Help Command CSCs are executed when the LTAS user selects an option from the UI Menu Bar Help pulldown. There is a corresponding Command CSC executed for each pulldown option as described below. The main purpose of these CSCs are to supply information to help the user run LTAS.

- The LTASHelpHelpAboutCmd class executes when the LTAS user selects the "Help About" option of the UI Menu Bar Help pulldown. This action changes the cursor to a question mark. The LTAS user may then select any GUI item they are interested in getting information about. Once a GUI item has been selected, a help panel is displayed with the information the LTAS user requested.
- The LTASHelpAboutLTASCmd class executes when the LTAS user selects the "About LTAS" option of the UI Menu Bar Help pulldown. This results in the display of an LTAS version information panel.
- The LTASHelpOnLineHelpCmd class executes when the LTAS user selects the "On Line Help" option of the UI Menu Bar Help pulldown. This results in the display of an LTAS help information panel.
- The LTASHelpOnLineHelpBackCmd class executes when the LTAS user selects the "Back" button of the On Line Help panel. This causes the text display in the panel to revert to the previously displayed text.
- The LTASHelpOnLineHelpHomeCmd class executes when the LTAS user selects the "Home" button of the On Line Help panel. This causes the text display in the panel to revert to the default beginning help text.
- The LTASHelpOnLineHelpExitCmd class executes when the LTAS user selects the "Exit" button of the On Line Help panel. This action terminates On Line Help.
- The LTASHelpDialog class is used with the OnLineHelp classes to present the On Line Help panel to the LTAS user.
- The gifReader class is used by the LTASHelpDialog class to read the help files.

5.1.3 Work Session

As described in section 4, the first level Work Session CSCs are Atmosphere, Databases, Default Objects, Draw List, Laser Threat Scenarios, Threat Ring Altitude, and Threat

Ring Algorithms. The main Work Session CSC is represented by the class LTAS_Work_Session declared in ~LTAS/include/ltas_work_session/work_session.h within the LTAS directory hierarchy. This class controls parameters in an LTAS work session. It uses various other classes, or objects, to keep track of these parameters. All functionality for these CSCs are described in the following paragraphs.

5.1.3.1 Atmosphere Object

The LTAS_Atmosphere class represents the atmospheric conditions applied to an LTAS Work Session. An LTS takes its default atmospheric conditions from the instantiation of the LTAS_Atmosphere class belonging to the Global LTAS parameters, however, each LTS may also have independent atmospheric conditions. Each threat ring takes its default atmospheric conditions from the instantiation of the LTAS_Atmosphere class belonging to its LTS, however, each threat ring may also have its own independent atmospheric conditions.

5.1.3.2 Database Objects

The lower level CSCs of the Work Session Databases are shown in Figure 5.1.3.2-1 below. All Work Session Database CSCs are declared in various files in the ~LTAS/include/database directory within the LTAS directory hierarchy and are described in the following paragraphs. Database formats are shown in Appendix B. The class LTAS_Convert_Name_To_Filename is used to convert a name with spaces into a filename with underscores.

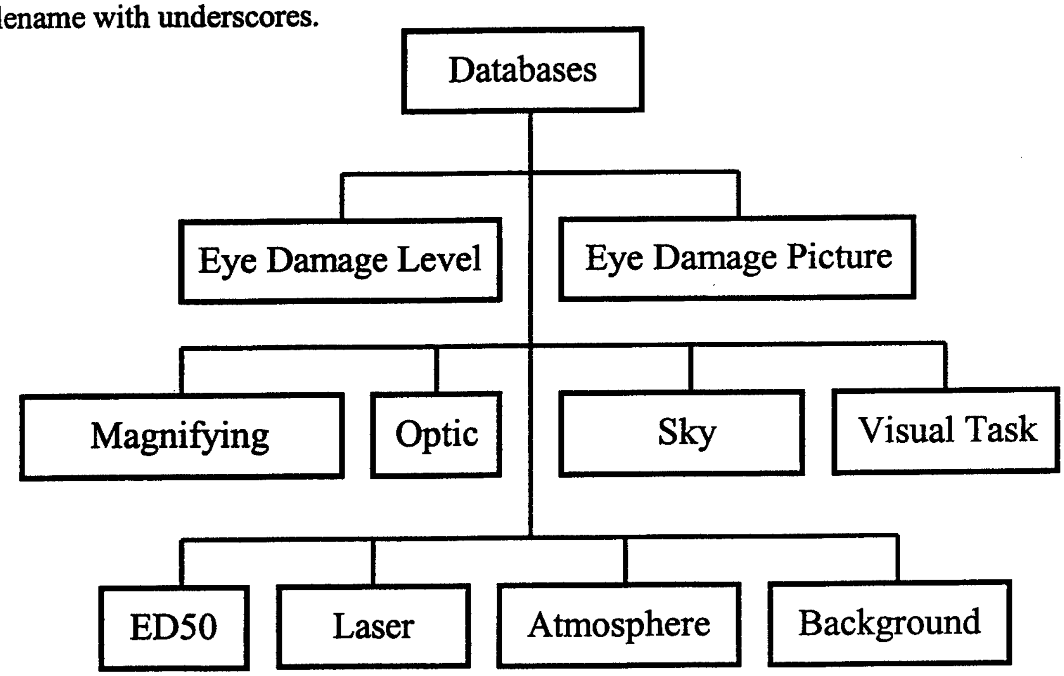

Figure 5.1.3.2-1 Work Session Database Components

5.1.3.2.1 Atmosphere DB

The Atmosphere database has a large list of atmospheric attenuation coefficients corresponding to several different atmospheric parameters. The parameters used in this database are region, aerosol model, laser wavelength, atmospheric condition and altitude. There is a specific atmospheric attenuation coefficient associated with each combination of unique parameter values. Currently, the unique parameter values contained in this database are as follows:

- Region: 1976 US Standard, Midlatitude Summer, Midlatitude Winter, and Tropical.
- Aerosol Model: Desert, Maritime, Rural, and Urban.
- Wavelength: 532nm, 550nm, 633nm, 633nm, 670nm, 693nm, 825nm, 1064nm, 1540nm, and 10600nm.
- Atmospheric Condition: Medium Haze, Light Haze, Clear, Very Clear, and Exceptionally Clear.
- Altitude: 50 unique values ranging from 1000ft to 50,000ft in 1000ft increments.

The following classes are used by the LTAS Work Session when interfacing with the Atmosphere database:

- The LTAS_Atmosphere_DB class represents the LTAS Atmosphere database during an LTAS Work Session. It is loaded with the part of the Atmosphere database upon LTAS startup.
- The LTAS_Atmosphere_Tape5_Container class is used to hold values for 1 record from the Atmosphere database during an LTAS Work Session.
- An instance of the LTAS_Atmos_Att_Coeff_Cache_Container class is used to hold values from the Atmosphere database for each time FASCODE is run with contrasting parameters. Wavelengths within 5nm and altitudes within 1m are considered the same value.
- The LTAS_Attenuation_Param class handles attenuation units (meters^{-1}) used by the atmosphere object. Allowable units are km^{-1}, m^{-1}, and cm^{-1}.
- The LTAS_Tuple template class handles ordered pair parameters such as altitude and attenuation for the Atmosphere DB.

5.1.3.2.2 Background DB

The Background database contains reflectance values for several different types of terrain, or background parameters. Currently, the unique background parameter values contained in this database are as follows:

- Terrain: Bay, Deep Ocean, Green Fields, Jungle Forrest, Ocean, Blacktop, Bay & River, Wheat Fields, Open Forrest, Ground with Some Trees, Inland Waters, Very White Ground, Wet Sand, Bare Ground, Dry Plowed Fields, Dry Grass, Rock, Dry Sand, Concrete, Thin Clouds, Nearly Opaque Clouds, Opaque Dense Clouds, and White Field Snow.

The following classes are used by the LTAS Work Session when interfacing with the Background database:

- The LTAS_Background_DB class represents the Background database during an LTAS Work Session. It is loaded with the Background database upon LTAS startup.
- The LTAS_Background_Container class is used to hold values for 1 record from the Background database during an LTAS Work Session. Multiple instances of this class are arranged in background name order.
- The LTAS_Background_Container_OBV class is used to hold values for 1 record from the Background database during an LTAS Work Session. Multiple instances of this class are arranged in reflectance value order.

5.1.3.2.3 ED50 DB

The ED50 database contains many parameters pertaining to eye damage data. The main parameters used by LTAS from this database are irradiance, hemorrage, and wavelength. The following classes are used by the LTAS Work Session when interfacing with the ED50 database:

- The LTAS_ED50_DB class represents the ED50 database during an LTAS Work Session. It is loaded with part of the ED50 database upon LTAS startup.
- The LTAS_ED50_Container class is used to hold values for 1 record from the ED50 database during an LTAS Work Session. Multiple instances of this class are arranged in wavelength order.
- The LTAS_ED50_Sec_Container class is used to hold values for 1 record from the ED50 database during an LTAS Work Session. Multiple instances of this class are arranged in an order defined by the ED50 algorithms.

5.1.3.2.4 Eye Damage Level DB

The Eye Damage Level database contains ED50 multipliers pertaining to eye damage levels. The multiplier values in the database range from 1 to 50, with LTAS selectable values (Low, Medium, and High) corresponding to ED50 multiplier values of 1, 5, and 50. The following classes are used by the LTAS Work Session when interfacing with the Eye Damage Level database:

- The LTAS_Eye_Damage_Level_DB class represents the Eye Damge Level database during an LTAS Work Session. It is loaded with the Eye Damage Level database upon LTAS startup.
- The LTAS_Eye_Damage_Level_Container class is used to hold values for 1 record from the Eye Damage Level database during an LTAS Work Session. Multiple instances of this class are arranged in ED50 multiplier value order.

5.1.3.2.5 Eye Damage Picture DB

The Eye Damage Picture database contains names of pictures for the "Before and After" display. There are currently 4 choices in this database; Bomber, Fighter, Sam Site, and Urban Area. The following classes are used by the LTAS Work Session when interfacing with the Eye Damage Picture database:

- The LTAS_Eye_Damage_Picture_DB class represents the Eye Damage Picture database during an LTAS Work Session. It is loaded with the Eye Damage Picture database upon LTAS startup.
- The LTAS_Eye_Damage_Picture_Container class is used to hold values for 1 record from the Eye Damage Picture database during an LTAS Work Session. Multiple instances of this class are arranged in object name order.

5.1.3.2.6 Laser DB

The Laser System database contains laser parameter data for many different lasers. The laser parameters include Wavelength, Type, Beam Profile, Power, Energy, PRF, Pulse Width, Output Aperture, and Divergance. Currently, there are 36 unique laser systems contained in the database. The following classes are used by the LTAS Work Session when interfacing with the Laser database:

- The LTAS_Laser_DB class represents the Laser database during an LTAS Work Session. It is loaded with the Laser database upon LTAS startup. LTAS_Laser_DB also maintains a list of laser wavelengths used by the work session for generation of wavelength options lists.
- The LTAS_Laser_Container class is used to hold values for 1 record of the Laser database during an LTAS Work Session. Multiple instances of this class are arranged in laser name order.

5.1.3.2.7 Magnifying Optics DB

The Magnifying Optics database contains magnification, objective aperture, wavelength, and tramsmission/OD data for specific magified optics. The magnified optics choices currently available in this database are Binocular 5X, Binocular 7X, Binocular 8X, and None. The following classes are used by the LTAS Work Session when interfacing with this database:

- The LTAS_Magnifying_Optics_DB class represents the Magnifying Optics database during an LTAS Work Session. It is loaded with the Magnifying Optics database upon LTAS startup.
- The LTAS_Magnifying_Optics_Container class is used to hold values for 1 record from the Magnifying Optic database during an LTAS Work Session. Multiple instances of this class are arranged in magnified optic name order.
- The LTAS_Wavelength_Range class handles the wavelength range field.
- The LTAS_Tuple template class handles ordered pair parameters such as wavelength and transmission for the Magnifying Optics DB.

5.1.3.2.8 Optics DB

The Optics database contains wavelength and tramsmission/OD data for specific non-magified optics. Currently, there are 3 Life Support Visor, 7 LEP Spectacle, and 10 LEP Visor choices available in the Optics database. The following classes are used by the LTAS Work Session when interfacing with this database:

- The LTAS_Optics_DB class represents the Optics database during an LTAS Work Session. It is loaded with the Optics database upon LTAS startup.
- The LTAS_Optics_Container class is used to hold values for 1 record of the Optic database during an LTAS Work Session. Multiple instances of this class are arranged in optic name order.
- The LTAS_Wavelength_Range class handles the wavelength range field.
- The LTAS_Tuple template class handles ordered pair parameters such as wavelength and transmission for the Optics DB.

5.1.3.2.8.1 Required OD Algorithm

The Required OD (Ocular Density) Algorithm works with the Optics DB and calculates the OD required to nullify a laser threat using the parameter settings entered by the user for the laser threat and current threat ring. The OD required is always displayed in the threat ring panel and is updated when any laser threat parameter effecting its value is modified by the operator. This algorithm is further described in Appendix C – Section 10.1.5.

5.1.3.2.9 Sky Condition DB

The Sky Condition database contains source illuminance data for specific sky conditions. Currently, there are 4 choices available in the Sky Condition database; Overcast Day at

Sunset, Heavily Overcast day, Overcast Day, and Clear. The following classes are used by the LTAS Work Session when interfacing with this database:

- The LTAS_Sky_Condition_DB class represents the Sky Condition database during an LTAS Work Session. It is loaded with the Sky Condition database upon LTAS startup.
- The LTAS_Sky_Condition_Container class is used to hold values for 1 record of the Sky Condition database during an LTAS Work Session. Multiple instances of this class are arranged in sky condition name order.
- The LTAS_Sky_Condition_Container_OBV class is used to hold values for 1 record of the Sky Condition database during an LTAS Work Session. Multiple instances of this class are arranged in source illuminance value order.

5.1.3.2.10 Visual Task DB

The Visual Task database contains reflectance data for specific objects a pilot may have to identify while/after being exposed to a laser. There is also a field for object size. Currently, there are 9 object choices available in the Visual Task database; Air to Air Refueling, Bomber Aircraft, Building in Urban Area, Fighter Aircraft, HDD Symbol, HUD Symbol Letter, HUD Symbol Pipper, SAM Site/Tank, and Small Object in Desert. There are also 7 choices the operator has to model the visual task object as. These choices are HUD SYMBOL PIPPER, HUD SYMBOL LETTER, HDD SYMBOL, REFLECTIVE OUTSIDE COCKPIT ON GROUND, REFLECTIVE OUTSIDE COCKPIT IN AIR, EMISSIVE OUTSIDE COCKPIT ON GROUND, and EMISSIVE OUTSIDE COCKPIT IN AIR. The following classes are used by the LTAS Work Session when interfacing with this database:

- The LTAS_Visual_Task_DB class represents the Visual Task database during an LTAS Work Session. It is loaded with the Visual Task database upon LTAS startup.
- The LTAS_Visual_Task_Container class is used to hold values for 1 record of the Visual Task database during an LTAS Work Session. Multiple instances of this class are arranged in object name order.

5.1.3.3 Default Objects

When an LTAS Work Session is started, there are many default values established. This is handled by the LTAS_Defaults class. All default values which are established at the startup of an LTAS session are performed by this class. There is a default set for virtually every LTAS parameter.

5.1.3.4 Draw List

The Draw List is represented by the LTAS_Draw_List class. This class, along with 2 other classes described below, contain all the information necessary for the map to display laser threats and threat rings. LTAS_Draw_List provides a means to traverse itself and pull only displayable threat rings (rings which have a radius greater than 0 and have their display flag set) and all laser threat scenarios. It also contains global atmosphere and TR altitude information from the work session.

- The LTAS_Drawable_Container class supplies the draw list with information about an LTS, including laser location, label, and indicators showing if the altitude and atmosphere differ from the work session.
- The LTAS_TR_Drawable_Container class supplies TR information to the draw list. This is the same as the LTS information with the addition of the size and type of threat ring being displayed, and indicators showing if the altitude and atmosphere differ from the LTS.

5.1.3.5 Laser Threat Scenarios

An LTAS Work Session Laser Threat Scenario (LTS) is represented by the class LTAS_Laser_Threat_Scenario. All parameters for a single LTS are contained in an instance of this class. This class uses other classes, or objects, which are part of every LTS. Instatiations of these objects are used as defaults for all threat rings, although each threat ring can set its own values for any object contained within it. Some of the main LTS objects are described below. Other objects are discussed in the following paragraphs, where the object parameters may be modified at their lowest level.

- The LTAS_Lat_Coord_Param and LTAS_Lon_Coord_Param classes, which use the LTAS_Coord_Param as their base class, represent the location of the LTS.
- The LTAS_Atmosphere class is used to represent the atmospheric conditions applied to a particular LTS. An LTS takes its default atmospheric conditions from the instantiation of the LTAS_Atmosphere class belonging to the Global LTAS parameters, however, each LTS may also have independent atmospheric conditions.
- The LTAS_TR_Indicator_Container, which uses LTAS_Info_Container as its base class, holds information about an LTS's indicators for the Map display.

5.1.3.5.1 Threat Rings

All of the threat ring objects are declared in the ~LTAS/include/ltas_tr_lts directory within the LTAS directory hierarchy. Of all the objects used by the 5 different types of threat rings, there are several used by all of them. This main group of threat ring objects is represented by the LTAS_Threat_Ring class, which is also the base class used by all other threat ring classes. These generic threat ring lower level CSCs are shown in figure 5.1.3.5.1-1. Specific threat ring lower level CSCs are shown in figures 5.1.3.5.1-2 through 5.1.3.5.1-4.

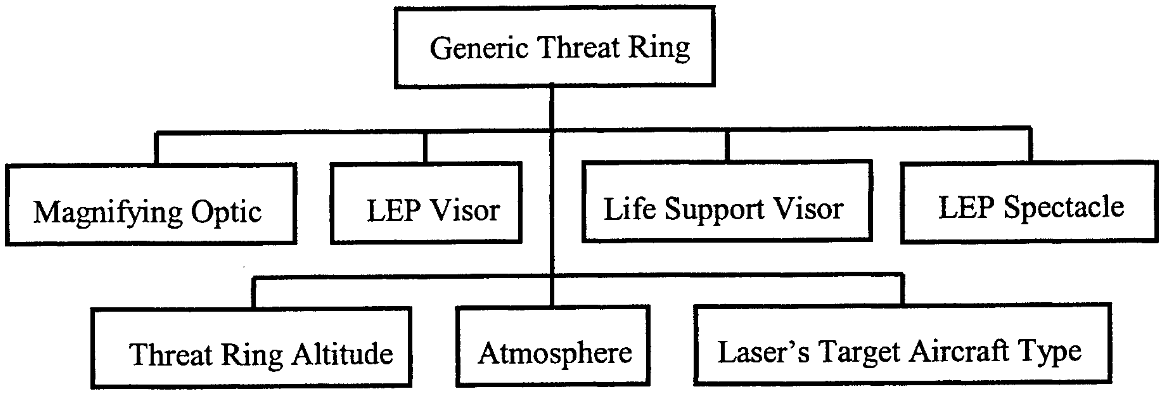

Figure 5.1.3.5.1-1 Generic Threat Ring Components

The group of objects used by the generic threat ring class are declared in the various .h files within the ~LTAS/include/ltas_objects directory and are described below. The NOHD threat ring class uses only this object and is represented by the LTAS_NOHD_Threat_Ring class. Threat rings using other objects are described in the following paragraphs.

- The LTAS_Altitude_Param class, declared in ~LTAS/include/base_parameters, handles whether the threat ring altitude is based on MSL (Mean Sea Level) or AGL (Above Ground Level).
- The LTAS_Atmosphere class is used to represent the atmospheric conditions applied to a particular threat ring within an LTS. Each threat ring may have completely independent atmospheric conditions, however the default values are taken from the instantiation of the LTAS_Atmosphere class belonging to the LTS. An LTS takes its default atmospheric conditions from the instantiation of the LTAS_Atmosphere class belonging to the Global LTAS parameters, however, each LTS may also have independent atmospheric conditions.
- The LTAS_Single_Unit_Param class is used to handle parameters with a single allowable unit.
- The LTAS_Lasers_Target and LTAS_Aircraft_Optics classes represent the laser's target aircraft canopy and its transmisivity.
- The LTAS_Magnifying_Optics class, which uses LTAS_Optics as its base class, represents the magnification, transisivity, and objective aperture of a magnified optic.
- The LTAS_LSV_Optics class, which uses LTAS_Optics as its base class, represents a life support visor and its transmisivity.
- The LTAS_LEPS_Optics class, which uses LTAS_Optics as its base class, represents an LEP spectacle and its transmisivity.

- The LTAS_LEPV_Optics class, which uses LTAS_Optics as its base class, represents an LEP Visor and its transmisivity.
- The LTAS_Transmission_Param class is used to handle parameters such as Transmission. Allowable units are % and OD.
- The LTAS_TR_Info_Container class, which uses LTAS_Info_Container as its base class, holds information about a threat ring not contained in any other threat ring object.

The Irradiance/Radiant Exposure threat ring specific objects are shown below. This threat ring is represented by the LTAS_IRE_Threat_Ring class.

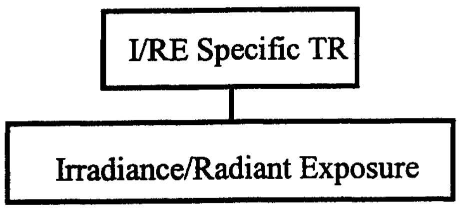

Figure 5.1.3.5.1-2 Irradiance/Radiant Exposure Specific Threat Ring Components

The LTAS_Radiant_Exp_Param class holds the radiant exposure resulting from the parameters set up for this threat ring for a pulsed laser system. The LTAS_Irradiance_Param class holds the irradiance resulting from the parameters set up for this threat ring for a continuous wave laser system. The LTAS_IRE_Threat_Ring class determines which of these parameters to use.

The Flashblindness threat ring specific objects are shown below. This threat ring is represented by the LTAS_FB_Threat_Ring class.

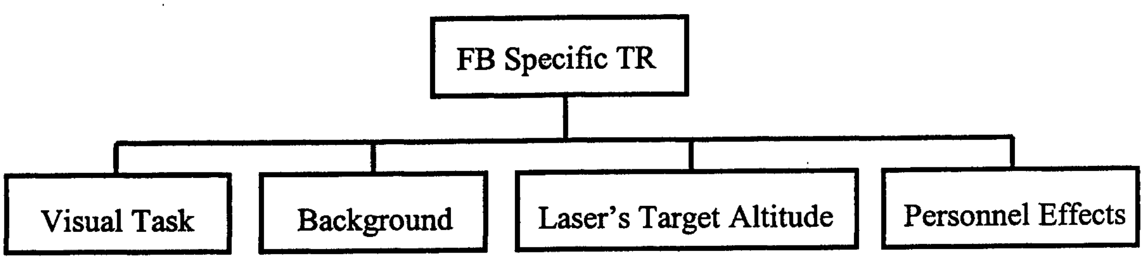

Figure 5.1.3.5.1-3 Flashblindness Specific Threat Ring Components

The group of objects used by the flashblindness specific threat ring class are declared in various .h files within the ~LTAS/include/ltas_objects directory and are described below.

- The LTAS_Visual_Task class represents the visual task object associated with the flashblindness threat ring. It includes parameters for the viewing object, viewing distance, altitude, object size, and object reflectance.
- The LTAS_Background class represents the background conditions for the flashblindness threat ring. It includes sky condition and terrain reflectance information.
- The LTAS_Altitude_Param class, declared in ~LTAS/include/base_parameters, handles whether the laser's target altitude is based on MSL (Mean Sea Level) or AGL (Above Ground Level).
- The LTAS_Personnel_Effects class represents the obscuration level and time after exposure from a laser exposure.

The Eye Damage threat ring specific objects are shown below. This threat ring is represented by the LTAS_ED_Threat_Ring class.

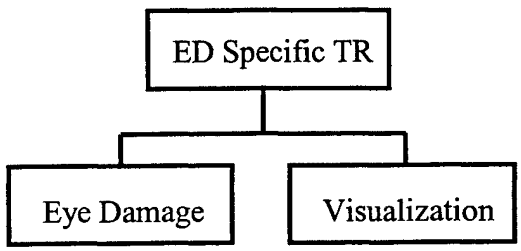

Figure 5.1.3.5.1-4 Eye Damage Specific Threat Ring Components

The LTAS_Eye_Damage_Model class represents the Eye Damage CSC. The algorithm for this model is described in Appendix C - Section 10.1.3. The Visualization CSC results in a "Before and After" picture displayed to the LTAS user to indicate how much vision impairment would be caused by the parameter conditions used in the current LTAS ED50 threat ring. To determine the degredation required in the after picture, a blurring algorithm is used. CMI designed and implemented this algorithm which blurs an image based on the lesion size on the retina. The blurring algorithm employs a biological center-surround receptive field model and is further described in Appendix C – Section 10.1.6.

5.1.3.5.2 Laser Object

The LTAS Laser object is represented by the LTAS_Laser class declared in laser.h of the ~LTAS/include/ltas_objects directory within the LTAS directory hierarchy. This class holds all the parameters of a laser object for an LTS. The laser object is made up of the following items:

- Latitude and longitude location of the laser system on the Map display.
- Laser Name.
- Wavelength.

- Laser Type (Pulsed or Contiuous).
- Laser Beam Profile (Circular, Eliptical, or Rectangular).
- Power (for a "Contiuous" Laser Type).
- Energy (for a "Pulsed" Laser Type).
- PRF (for a "Pulsed" Laser Type).
- Pulse Width (for a "Pulsed" Laser Type).
- Output Aperture (one value for a "Circular" Beam Profile, otherwise x and y values).
- Divergence (one value for a "Circular" Beam Profile, otherwise x and y values).

The Laser object uses other classes declared in the ~LTAS/include/base_parameters directory to handle unit conversions for its parameters as follows:

- The LTAS_Dist_Param class is used to handle distance units used by laser parameters such as Wavelength and Output Aperture. Allowable units are km, m, cm, mm, um, nm, kft, ft, and in.
- The LTAS_Aperture_Param class is used with the Output Aperture parameters to identify whether they are 1/e or $1/e^2$.
- The LTAS_Divergence_Param class is used with the Divergence parameters to identify whether they are 1/e or $1/e^2$. It is also used to handle angular units (radians) used by laser parameters such as Divergence. Allowable units are rad, mrad, and urad.
- The LTAS_Power_Param class is used to handle power units (watts) used by laser parameters such as Power, for contiuous wave lasers. Allowable units are kw, w, mw, uw, and nw.
- The LTAS_Energy_Param class is used to handle energy units (joules) used by laser parameters such as Energy, for pulsed lasers. Allowable units are kj, j, mj, uj, and nj.
- The LTAS_Time_Param class is used to handle time units used by laser parameters such as Pulse Width. Allowable units are s, ms, us, ps, fs, and min.
- The LTAS_Base_Param class is used to set boundary conditions for the parameters used in the laser object.

5.1.3.6 Threat Ring Altitude

The atmospheric conditions used in determining the attenuation properties for threat ring altitudes in LTAS are taken into account by using the atmospheric attenuation coefficient tables generated under FASCODE. See Brian Lund's "Laser Atmospheric Attenuation Tables for LTAS." In the event that an attenuation coefficient for a particular case does not exist, the user has the option to run an off-line guided session of FASCODE. An assumption made here is that, as far as the atmospheric attenuation is concerned, the laser system is at 0 ft MSL in altitude.

Atmospheric Attenuation Coefficient tables are 5x50 matrices containing attenuation coefficients for 5 sky conditions (visibilities) over 50 altitudes (from 0 to 50,000 ft MSL in 1000 ft increments), for a specific wavelength, region, and aerosol model.

5.1.3.7 Threat Ring Algorithms

LTAS calculates six different types of threat rings: Flashblindness, Eye Safety (NOHD), Eye Damage, Irradiance/Radiant Exposure, Sensor Damage, and Sensor Jamming. The algorithms involved in calculating each type of threat ring are defined in Appendix C – Section 10.1.

5.1.4 Map

As described in section 4, the first level Map CSCs are Map Plot, Status Bar, and Scroll Control. All Map CSCs are declared in the .h files of the ~LTAS/include/gui/ltas_map directory within the LTAS directory hierarchy.

The Map CSCI is represented by the LTASMap class declared in ltasmap.h. LTASMap and all three 1st level Map CSCs use UIComponent as their base class. The UIComponent class in turn uses BasicComponent as its base class. These 2 classes are derived from Douglas Young's book (please see section 2.3 item 7) and are declared in UIComponent.h and BasicComponent.h in the ~LTAS/include/gui/LTAS_MotifApp directory within the LTAS directory hierarchy. The UIComponent and BasicComponent classes are basic building block classes used by Douglas Young for all C++/Motif User Interface (UI) components.

The LTASMap class has over 40 public member functions including its constructor and destructor. These functions primarily provide control and information of Map states to other Map CSCs as described below:

- Control of terrain file checking and loading.
- Control of Map scale and zooming in/out on the Map display.
- Control of scrolling on the Map display.
- Control of latitude/longitude grid lines and terrain masking state.
- Control of location information for an LTS, Map center, and last mouse click on the Map display.
- Control of Map modes and printing of Map display area.

The LTASMap class also has private members which are primarily object pointers to objects defined in other Map and Command CSCs. Map 1st level CSCs and lower level CSCs are described in the following paragraphs.

5.1.4.1 Map Plot

The Map Plot CSC is represented by the LTASMapPlot class declared in LTASMapPlot.h. Its base class is UIComponent as described in section 5.1.4. Map Plot has 2 lower level CSC classes associated with it; ltsOnScreen which is also declared in

LTASMapPlot.h and LTASTerrain which is declared in LTASTerrain.h. These classes will be discussed in the following subparagraphs.

The LTASMapPlot class has over 40 public member functions which interface primarily with functions from the LTASMap class and Command CSCs providing initialization functionality as described below:

- Initiate terrain file checking and loading.
- Initiate zooming in/out on the Map display.
- Initiate scrolling on the Map display.
- Initiate display of latitude/longitude grid lines, terrain contour lines, and terrain masking effects.
- Getting location information for an LTS, Map center, and last mouse click on the Map display.
- Invoke selected Map modes.

The LTASMapPlot class also has many private members providing the following functionality:

- Handles for various Map GUI widgets.
- Object pointers for LTASTerrain, LTASMapStatusBar, LTASMainWindow, and LTAS_Work_Session objects.
- Status flags for various Map display user choices.
- Control of colors used on the Map display for threat rings, contour lines, terrain features, etc.
- Map image display control.
- Coordinate Conversion.

5.1.4.1.1 ltsOnScreen Class

The ltsOnScreen class is used to represent the location of an LTS displayed on the Map. It has no base class. The ltsOnScreen constructor includes variables for a unique ID and label for each LTS. Variables for location, elevation and definition of the LTS icon's x/y boundaries on the Map are also supplied.

5.1.4.1.2 LTASTerrain Class

The LTASTerrain class is used to implement required Compact Terrain Data Base (CTDB) functionality. LTAS uses a CTDB for its Map plot in the display area. The LTASTerrain class defines several member functions which interact with other MAP CSCs to perform the following:

- Check for a valid CTDB file.

- Load a CTDB file for use within the LTAS Map display area.
- Provide elevations for given lat/lon or x/y points within the terrain map.
- Provide coordinate conversion between x/y and lat/lon.
- 2-D terrain contour generation for the Map display.
- Provide CTDB boundary parameters.

5.1.4.2 Status Bar

The Status Bar CSC is represented by the LTASMapStatusBar class declared in LTASMapStatusBar.h. Its base class is UIComponent as described in section 5.1.4. The LTASMapStatusBar class has 4 public member functions which control what is displayed on the status bar directly under the Map display in the LTAS main window, as described below:

- Terrain masking state (ON or OFF).
- Latitude, longitude and elevation of last mouse click location made on the Map display, or "OFF MAP" if last mouse click was outside the displayed terrain.
- Terrain map Scale.

The LTASMapStatusBar class also has a few private members relating to various widgets within the status bar display area.

5.1.4.3 Scroll Control

The Scroll Control CSC is represented by the LTASMapScrollControl declared in LTASMapScrollControl.h. Its base class is UIComponent as described in section 5.1.4. The LTASMapScrollControl class has 1 public member function which sets a pointer to an LTASMapPlot object and a few private member functions which control scrolling of the terrain on the Map display. These functions allow terrain on the Map display to be shifted to the right, left, up, down, or centered.

6 REQUIREMENTS TRACEABILITY

Requirements Paragraph Number xxx	Requirement Title	Software Design Document Paragraph Numbers
3.1	Required Modes	3.3, 4.1.1.1, 4.1.2.4, 5.1.1.1, 5.1.1.3, 5.1.2.4
3.2.1	User Interface	4.1, 0, 5.1.1
3.2.1.1	Default Parameters	4.1.2.4, 5.1.1.2
3.2.1.2	Modifying Parameters	3.4, 5.1.1.2
3.2.1.3	Saving and Loading Parameters	3.1, 4.1.1.1, 4.1.1.4, 5.1.1.4, 5.1.2.5
3.2.1.4	Adding Options to Object Options List	4.1.1.3, 5.1.1.3
3.2.2	Laser Threat Scenarios and Work Sessions	3.3, 4.1.3.5
3.2.3	Terrain	3.1
3.2.3.1	Latitude/Longitude/Elevation Display	5.1.4.2
3.2.3.2	Zoom In/Zoom Out	5.1.1.1, 5.1.2.2, 5.1.2.6
3.2.3.3	Scale	4.1.4.2, 5.1.1.1, 5.1.2.2
3.2.3.4	Grid Lines	5.1.4
3.2.4	Laser Threat Rings	3.3, 4.1.3.5, 5.1.1.1, 5.1.1.4.2.3
3.2.4.1.1	Laser Threat Ring Diameter	5.1.1.4.2
3.2.4.1.2	Optical Density Required	5.1.1.4.2.3.1
3.2.4.1.3	Laser Threat Ring Altitude	4.1.3.6, 5.1.3.6
3.2.4.2	Laser Threat Ring Types	5.1.1.4.2.3
3.2.4.2.1	Flashblindness Threat Ring	5.1.3.5.1, 5.1.1.4.2.3.2.1
3.2.4.2.2	Eye Safe (NOHD) Threat Ring	5.1.3.5.1, 5.1.1.4.2.3.2
3.2.4.2.3	Eye Damage Threat Ring	5.1.3.5.1, 5.1.1.4.2.3.2.3
3.2.4.2.4	Irradiance/Radiant Exposure Threat Ring	5.1.3.5.1, 5.1.1.4.2.3.2.2
3.2.4.2.7	Sensor Damage Threat Ring	5.1.3.5.1, 5.1.1.4.2.3.2
3.2.4.2.6	Sensor Jam Threat Ring	5.1.3.5.1, 5.1.1.4.2.3.2
3.2.4.3	Terrain Masking	5.1.1.1; 5.1.1.2.10
3.2.5	Laser System	5.1.1.2.2, 5.1.1.3.4, 5.1.1.4.2.2
3.2.5.1	Laser Position	5.1.1.4.2.2
3.2.5.2	Laser Name	5.1.2.4.4, 5.1.2.5.2.1, 5.1.3.5.2
3.2.5.3	Laser Type	5.1.1.3.4, 5.1.2.4.4 , 5.1.2.5.2.1, 5.1.3.5.2
3.2.5.3.1	CW Laser Parameters	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.3.1.1	Laser Power	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.3.2	Pulsed Laser Parameters	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.3.2.1	Laser Energy	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2

3.2.5.3.2.2	Laser Pulse Repetition Frequency (PRF)	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.3.2.3	Laser Pulse Width	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4	Laser Profile	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4.1	Circular Profile Parameters	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4.1.1	Laser Output Aperture	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4.1.2	Laser Divergence	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4.2	Rectangular and Elliptical Profile Parameters	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4.2.1	X and Y Axis Output Apertures	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.4.2.2	X and Y Axis Divergences	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.5.5	Laser Wavelength	5.1.1.3.4, 5.1.1.4.2.2, 5.1.3.5.2
3.2.6	Background	5.1.1.3.3, 5.1.1.4.2.3.2.1, 5.1.3.2.2
3.2.6.1	Sky Condition	5.1.1.2.4, 5.1.1.4.2.3.2.1, 5.1.3.2.9
3.2.6.2	Terrain Reflectance	5.1.1.3.3, 5.1.1.3.9, 5.1.3.2.2, 10.1.1
3.2.7	Atmosphere	5.1.1.4.2.3.4, 5.1.3.2.1
3.2.7.1	Region	5.1.3.2.1
3.2.7.2	Aerosol Model	5.1.3.2.1
3.2.7.3	Atmospheric Condition	5.1.3.2.1
3.2.7.4	Atmospheric Attenuation Coefficient	5.1.3.2.1
3.2.7.5	Customization	5.1.1.3.2
3.2.7.6	FASCODE Off-Line	5.1.1.3.10.1
3.2.8	Laser's Target	5.1.1.2.5
3.2.8.1	Aircraft Altitude	5.1.1.2.5, 5.1.3.2.1
3.2.8.2	Aircraft Type	5.1.1.3.1
3.2.9	Optics & Life Support Equipment	5.1.1.2.8, 5.1.1.4.2.3
3.2.9.1	Magnifying Optics	5.1.3.2.7
3.2.9.1.1	Magnifying Optics Parameters	5.1.3.2.7
3.2.9.1.1.1	Magnification	5.1.3.2.7
3.2.9.1.1.2	Transmission	5.1.3.2.7
3.2.9.1.1.3	Objective Aperture	5.1.3.2.7
3.2.9.2	Life Support Visor	5.1.3.2.8
3.2.9.3	Laser Eye Protection: Visor	5.1.1.3.6 5.1.3.2.8
3.2.9.4	Laser Eye Protection: Spectacle	5.1.1.3.7 5.1.3.2.8
3.2.10	Visual Task	5.1.1.3.9, 5.1.1.4.2.3.2.1
3.2.10.1	Visual Tasks Type	5.1.1.3.9, 5.1.1.4.2.3.2.1
3.2.10.1.1	Visual Tasks Inside Cockpit	5.1.3.2.10
3.2.10.1.2	Visual Tasks Outside Cockpit	5.1.3.2.10
3.2.10.1.2.1	Ground-Based Visual Tasks Outside Cockpit	5.1.3.2.10
3.2.10.1.2.2	Airborne Visual Tasks Outside Cockpit	5.1.3.2.10

3.2.10.2	Visual Task Parameters	5.1.1.3.9, 5.1.3.2.10
3.2.10.2.1	Visual Task Size	5.1.1.4.2.3.2.1
3.2.10.2.2	Visual Task Reflectance	5.1.1.4.2.3.2.1
3.2.10.2.3	Visual Task Luminance	5.1.1.4.2.3.2.1
3.2.10.2.4	Visual Task Distance From Viewer	5.1.1.4.2.3.2.1
3.2.10.2.5	Visual Task Altitude	5.1.1.4.2.3.2.1
3.2.11	Personnel Effects Criteria	5.1.1.2.6, 5.1.1.4.2.3.2.1
3.2.11.1	Visual Task Obscuration Level	5.1.1.2.6, 5.1.1.4.2.3.2.1
3.2.11.2	Time After Exposure	5.1.1.2.6, 5.1.1.4.2.3.2.1
3.2.12	Eye Damage Pictures	5.1.1.4.2.3.2.3, 5.1.2.5.2.3.2, 5.1.3.2.5
3.2.13	Work Session Specifiable Parameters	5.1.1.4.1
3.2.14	On-line Help	5.1.1.1, 5.1.2.7
3.2.15	Software Version and Contact Information Display	5.1.1.1, 5.1.2.7
3.2.16	Printing	5.1.1.1, 5.1.2.1, 5.1.2.6

7 NOTES

7.1 LIST OF ACRONYMS

AGL	Above Ground Level
CDE	Common Desktop Environment
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CTDB	Compact Terrain Database
DIS	Distributed Interactive Simulation
DoG	Difference of Gaussian
FQT	Formal Qualification Testing
GUI	Graphical User Interface
LEP	Laser Eye Protection
LTAS	Laser Threat Analysis System
LTS	Laser Threat Scenario
MSL	Mean Sea Level
NOHD	Nominal Ocular Hazard Distance
OD	Optical Density
PRF	Pulse Repetition Frequency
SAF	Semi-Automated Forces
SRS	Software Requirements Specification
STP	Software Test Plan
UI	User Interface

8 APPENDIX A - TABLES

Table 8-1 V_λ

Wavelength (nm)	Photopic Conditions	Scotopic Conditions
380.0	4.0e-5	0.00059
385	0.0001	0.00111
390	1.2e-4	0.00221
395	0.0002	0.00453
400	0.0004	0.00929
405	0.0006	0.0185
410	0.0012	0.03484
415	0.0022	0.0604
420	0.004	0.0966
425	0.0073	0.1436
430	0.0116	0.1998
435	0.0168	0.2625
440	0.023	0.3281
445	0.0298	0.3931
450	0.038	0.455
455	0.048	0.5129
460	0.06	0.5672
465	0.0739	0.6205
470	0.091	0.6756
475	0.1126	0.7337
480	0.139	0.793
485	0.1693	0.8509
490	0.208	0.9043
495	0.2586	0.9491
500	0.323	0.9817
505	0.4073	0.9984
510	0.503	0.9966
515	0.6082	0.975
520	0.71	0.9352
525	0.7932	0.8796
530	0.862	0.811
535	0.9149	0.7332
540	0.954	0.6497
545	0.9803	0.5644
550	0.995	0.4808
555	1.0002	0.4015
560	0.995	0.3288
565	0.9786	0.2639
570	0.952	0.2076
575	0.9154	0.1602
580	0.87	0.1212
585	0.8163	0.0899
590	0.757	0.0655

Wavelength (nm)	Photopic Conditions	Scotopic Conditions
595	0.6949	0.0469
600	0.631	0.03325
605	0.5668	0.02312
610	0.503	0.01593
615	0.4412	0.01088
620	0.381	0.00737
625	0.321	0.00497
630	0.265	0.003335
635	0.217	0.002235
640	0.175	0.001497
645	0.1382	0.001005
650	0.107	0.000677
655	0.0816	0.000459
660	0.061	0.0003129
665	0.0446	0.0002146
670	0.032	0.000148
675	0.0232	0.0001026
680	0.017	0.0000716
685	0.0119	0.0000502
690	0.0082	0.00003533
695	0.0057	0.00002502
700	0.0041	0.0000178
705	0.0029	0.00001273
710	0.0021	0.00000914
715	0.0015	0.0000066
720	0.001	0.00000478
725	0.0007	3.48E-06
730	0.0005	2.55E-06
735	0.0004	0.00000187
740	0.0003	1.38E-06
745	0.0002	1.02E-06
750	0.0001	0.00000076
755	0.0001	5.67E-07
760	6.0e-5	4.25E-07
765	0	0.00000032
770	0	2.41E-07
775	0	1.83E-07
780	0	1.39E-07

9 APPENDIX B - DATABASE FORMATS

The following lists the databases within LTAS and an example of their formats.

9.1 Atmosphere

Tropical	# Region
Rural	# Aerosol Model
0.532 um	# Wavelength
1	# Number of Conditions Defined
Medium Haze	# Condition Name
5	# Number of Alt/Att Coeff Tuples
1000 ft MSL 0.8174 km-1	# Altitude/Attenuation Coeff
2000 ft MSL 0.8176 km-1	# Altitude/Attenuation Coeff
3000 ft MSL 0.8176 km-1	# Altitude/Attenuation Coeff
4000 ft MSL 0.7888 km-1	# Altitude/Attenuation Coeff
6000 ft MSL 0.7047 km-1	# Altitude/Attenuation Coeff

9.2 Laser Object

AIM-1/EXL	# Name
825 nm	# Wavelength
0.000100 rad	# Divergence
0.000300 rad	# X Divergence
0.000300 rad	# Y Divergence
0.100000 cm	# Aperture
0.320000 cm	# X Aperture
0.610000 cm	# Y Aperture
0.016200 W	# Power
0.000375 J	# Energy
8.000000 hz	# PRF
1.000000 ns	# Pulse Width
RECTANGULAR	# Profile
CW	# Type

9.3 Background (Terrain)

Bay	# Terrain
4.0%	# Terrain Reflectance

9.4 ED50

193 nm	# Wavelength
2.5e-08 s	# Pulse Width
0 Hz	# PRF
'rabbit'	# Species
133690.1522 w/cm2	# Irradiance
0	# Eye Kill Flag

9.5 Magnifying Optics

Binocular 5X	# Name
1	# Number of Wavelength/Tx Tuples
532 nm 93.0 %	# Wavelength/Transmission
0.050 m	# Objective Aperture
5.0X	# Magnification

9.6 Optics

* Note the "to" which indicates the range of wavelengths

KG 3 Flight Glasses	# Name
LEPS	# Type
6	# Number of Wavelength/Tx Tuples
200 nm to 950 nm 0.01%	# Wavelength/Transmission
960 nm 0.188452%	# Wavelength/Transmission
970 nm 0.135021%	# Wavelength/Transmission
980 nm 0.081433%	# Wavelength/Transmission
990 nm 0.04042%	# Wavelength/Transmission
1000 nm to 10600 nm 0.01%	# Wavelength/Transmission

9.7 Visual Task

HDD Symbo	# Name
HDD_SYMBOL	# Type
0.01 m	# Size
0.0 %	# Reflectance
8565.0 Cd/m2	# Luminance
1.0 m	# Distance

9.8 Eye Damage Level Database

0.2 deg	22.5	NO_UNITS
0.6 deg	27.5	NO_UNITS
1.04 deg	33	NO_UNITS
1.5 deg	38.75	NO_UNITS
1.84 deg	43	NO_UNITS
2.12 deg	46.5	NO_UNITS
2.38 deg	49.75	NO_UNITS
2.56 deg	52	NO_UNITS
2.8 deg	55	NO_UNITS
2.94 deg	56.75	NO_UNITS
3.14 deg	59.25	NO_UNITS
3.32 deg	61.5	NO_UNITS
3.46 deg	63.25	NO_UNITS
3.64 deg	65.5	NO_UNITS
3.8 deg	67.5	NO_UNITS
4 deg	70	NO_UNITS
4.14 deg	71.75	NO_UNITS
4.28 deg	73.5	NO_UNITS
4.42 deg	75.25	NO_UNITS
4.56 deg	77	NO_UNITS
4.7 deg	78.75	NO_UNITS
4.84 deg	80.5	NO_UNITS
4.98 deg	82.25	NO_UNITS
5.12 deg	84	NO_UNITS
5.26 deg	85.75	NO_UNITS
5.4 deg	87.5	NO_UNITS
5.54 deg	89.25	NO_UNITS
5.68 deg	91	NO_UNITS
5.82 deg	92.75	NO_UNITS
5.94 deg	94.25	NO_UNITS
6.06 deg	95.75	NO_UNITS
6.2 deg	97.5	NO_UNITS
6.3 deg	98.75	NO_UNITS
6.4 deg	100	NO_UNITS
6.5 deg	101.25	NO_UNITS
6.6 deg	102.5	NO_UNITS
6.7 deg	103.75	NO_UNITS
6.8 deg	105	NO_UNITS
6.9 deg	106.25	NO_UNITS
7 deg	107.5	NO_UNITS
7.1 deg	108.75	NO_UNITS
7.2 deg	110	NO_UNITS
7.3 deg	111.25	NO_UNITS

7.4 deg	112.5	NO_UNITS
7.5 deg	113.75	NO_UNITS
7.6 deg	115	NO_UNITS
7.7 deg	116.25	NO_UNITS
7.8 deg	117.5	NO_UNITS
7.9 deg	118.75	NO_UNITS
8 deg	120	NO_UNITS

9.9 Eye Damage Picture Database

```
Fighter          # Picture Name
FIGHTER.PGM      # Picture Filename
```

9.10 Sky Condition

```
Clear           # Name
10000 cd/m2  #  Sky Condition
```

10 APPENDIX C – ALGORITHMS

The following paragraphs describe the algorithms used for different purposes within LTAS. These algorithms are referenced within section 5 of this document.

10.1 Threat Ring Algorithms

LTAS calculates 6 different types of threat rings: Flashblindness, Eye Safety (NOHD), Eye Damage, Irradiance/Radiant Exposure, Sensor Damage and Sensor Jam. The following describes the algorithms involved in calculating each type of threat ring.

10.1.1 Flashblindness Threat Ring Algorithm

The Flashblindness Hazard Distance computation comes from the Menendez Flashblindness model represented by the LTAS_Flash_Blindness_Model class. This model computes the size of the flashblindness/glare given certain environment conditions. Here, the environment conditions and the size of the flashblindness/glare are given, and the hazard distance to obtain the desired flashblindness is calculated. The scenario involves a pilot in an aircraft looking at a particular object to perform a task. This object is called the visual task. LTAS accommodates four types of visual task. Three of the visual tasks are symbols inside the aircraft's cockpit (HUD Letter, HUD Pipper, and HDD Symbol). The last visual task is an aircraft outside the cockpit.

The following describes the calculations.

The size of the flashblindness is given as an obscuration level in percentages, meaning that a percentage of the visual task's circular area is to be obscured by the flash scotoma. The obscuration angle, φ, that obscures the visual task's visual angle is,

$$\varphi = \arctan\left(\left(V_r \sqrt{O_L / 100}\right) / V_d\right) \qquad \text{Eq. 10.1.1-1}$$

where,

V_r = visual task's radius in meters
V_d = distance between visual task and viewer in meters
O_L = obscuration level in percent

and φ is in degrees.
The background luminance, L_B in Cd/m^2, is given by,

$$L_B = L_S \cdot R_F \qquad \text{Eq. 10.1.1-2}$$

where,

L_S = source luminance in Cd/m^2, which depends on the sky condition
(see Table 2.2-7 in the Camouflage Handbook)

and,

R_F = reflectance factor, which is dependent on the background terrain
(see Table 1.3-5 in the Camouflage Handbook).

In the case of the visual tasks inside the cockpit, the background luminance then determines the reduced target contrast threshold, C_{RT} required to obtain the given flashblindness scotoma. The following tables and equations determine C_{RT}:

The following table gives the CRT interpolation points for HUD Symbol Pipper, HUD Symbol Letter, and HDD Symbol:

Table 10.1.1-1 CRT Interpolation Points for HUD Symbol Pipper

L_B (Cd/m^2)	px1	px2	py1	py2
< 34.00 *	3.4	34.0	0.22	0.10
>= 34.00, but < 340.0	34.0	340.0	0.10	0.063
>= 340.0, but < 1700	340.0	1700	0.063	0.054
> 1700	1700	1E+06	0.054	0.050

* minimum background Luminance for this visual task must be 3.40 Cd/m^2. Set it equal to 3.40 if it's less (Contrast threshold is not defined for background luminances < 3.4).

Table 10.1.1-2 CRT Interpolation Points for HUD Symbol Letter

L_B (Cd/m^2)	px1	px2	py1	py2
< 34.00 *	3.4	34.0	0.090	0.040
>= 34.00, but < 340.0	34.0	340.0	0.040	0.033
>= 340.0, but < 1700	340.0	1700	0.033	0.030
> 1700	1700	1E+06	0.030	0.026

* minimum background Luminance for this visual task must be 3.40 Cd/m^2. Set it equal to 3.40 if it's less (Contrast threshold is not defined for background luminances < 3.4).

Table 10.1.2-3 CRT Interpolation Points for HDD Symbol

L_B (Cd/m^2)	px1	px2	py1	py2
< 34.00 *	3.4	34.0	0.300	0.110
>= 34.00, but < 340.0	34.0	340.0	0.110	0.073
>= 340.0, but < 1700	340.0	1700	0.073	0.064
> 1700	1700	1E+06	0.064	0.060

* minimum background Luminance for this visual task must be 3.40 Cd/m^2. Set it equal to 3.40 if it's less (Contrast threshold is not defined for background luminances < 3.4).

C_{RT} is then given by,

$$C_{RT} = 10^{m \cdot \log(L_B) + b} \qquad \text{Eq. 10.1.1-3}$$

where,

$$m = \frac{\log (py2/py1)}{\log (px2/px1)} \qquad \text{Eq. 10.1.1-4}$$

and,

$$b = \log(py1) - m \cdot \log(px1) \qquad \text{Eq. 10.1.1-5}$$

If the visual task is an aircraft, the reduced target contrast threshold is given by,

$$C_{RT} = 0.0352 \cdot \varphi^{0.24} + (0.584 \cdot \varphi^{1.6} / \phi^2) \qquad \text{Eq. 10.1.1-6}$$

where the visual task's visual angle, ϕ, is,

$$\phi = \arctan(V_r / V_d) \qquad \text{Eq. 10.1.1-7}$$

and, again,

V_r = visual task's radius in meters
V_d = distance between visual task and viewer in meters

and ϕ should be in minutes.

Now, the Equivalent Background Luminance is calculated. This parameter also varies with the type of visual task involved. For a HUD Symbol (Pipper or Letter), the Equivalent Background Luminance, or EBL in Cd/m^2 is,

$$EBL = |(L_V / C_{RT}) - L_B| \qquad \text{Eq. 10.1.1-8}$$

where, L_V is the visual task's luminance in Cd/m^2. For a HDD Symbol,

$$EBL = |((L_V - L_B) / C_{RT}) - L_B| \qquad \text{Eq. 10.1.1-9}$$

And for an aircraft, EBL depends on several variables. But mainly, it depends on the look angle, or the angle between the pilot in the aircraft and its visual task outside the cockpit. The look angle is defined in Figure 10.1-1,

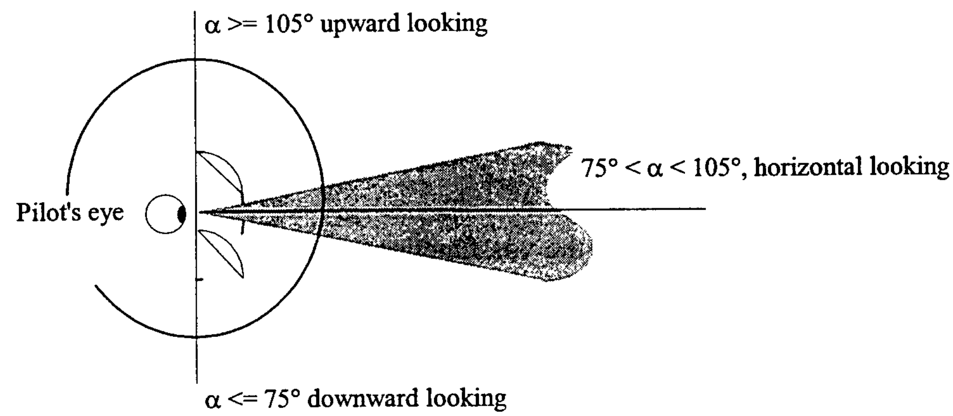

Figure 10.1.1-1 Flashblindness TR Algorithm Look Angle

The equivalent Background Luminance, EBL, is

$$EBL = \left| \frac{(L_A - L_T)}{C_{RT} \cdot \{1 - k \cdot (1 - \exp[\mu \cdot d \cdot (h_o / h) \cdot (1 - e^{-h/ho})])\}} - L_T \right|$$

Eq. 5.2.1-10

where,

$$k = \frac{L_S}{L_T \cdot e^{-\mu \cdot d} + (L_S \cdot (1 - e^{-\mu \cdot d}))} \qquad \text{for downward looking cases,}$$

$$EBL = \left| \left[\frac{(L_A - L_S)}{C_{RT}} \cdot \exp[-\mu \cdot d] \right] - L_S \right| \qquad \text{for horizontal looking cases,}$$

and,

$$EBL = \left| \left[\frac{(L_A - L_S)}{C_{RT}} \cdot \exp[-\mu \cdot d \cdot (9200 / h) \cdot (1 - e^{-h/9200})] \right] - L_S \right|$$

for upward looking cases,
Eq. 5.2.1-11

where,

$h_o = 21{,}700$ ft
h = Aircraft (Visual Task) Elevation in feet
I_{SUN} = Sun Illuminance
I_S = Sky Illuminance = $L_S \cdot \pi$
L_A = Aircraft Luminance = $R_A \cdot (I_{SUN} + I_S)$
L_T = Terrain Luminance = $R_F \cdot (I_{SUN} \cdot I_S)$
d = Distance From Viewer To Visual Task
R_A = Aircraft Reflectance

Once the EBL is determined, the vos function is calculated. This depends on the Time After Exposure parameter. The time after exposure is the time in seconds after the flash. If time equals zero, it represents the actual instant of the flash, called glare. Anytime after the flash, the phenomenon is called flashblindness. The vos is then,

$vos = EBL$, for time = 0,

$vos = 4 \cdot 10^{Ir} / (\pi \cdot P_d^2)$, for time > 0, Eq. 5.2.1-12

where,

I_r = retinal illuminance = (log(EBL) + log(time) + 6.33)/1.75
Eq. 5.2.1-13

in log-troland seconds, and,

$$P_d = (10^{(2.1442 + (0.000401 \cdot temp))}) \cdot 1000 \qquad \text{Eq. 5.2.1-14}$$

is the pupil diameter in millimeters, and

$$temp = (7.6 + \log(L_B))^3 \qquad \text{Eq. 5.2.1-15}$$

Note, that retinal illuminance has limits between 0 and 7.6 log-troland seconds. Also, vos cannot be less than the EBL. If it is, then vos should be set equal to EBL.
Now, the corneal illuminance, I_c, is calculated in lux-seconds,

$$I_c = \frac{Vos}{10.0} \cdot \frac{1}{\frac{1}{(|\varphi| + 0.02)^2} + \frac{1}{(|\varphi| + 0.02)^3}} \qquad \text{Eq. 5.2.1-16}$$

From this, the power per area, PPA, required can be calculated,

$$PPA = \frac{I_c}{10000 \cdot V_\lambda \cdot 683} \quad \text{in Watts/m}^2 \qquad \text{Eq. 5.2.1-17}$$

where V_λ, is defined for the laser wavelength in accordance to Table 1 (See Appendix A). This is the power per area at the cornea required to observe the given flashblindness/ glare. Now, given the laser parameters, one can calculate the distance that degrades the output power density of the laser to the one calculated above, given the atmospheric conditions and other peripheral optics in between the laser and the line of sight.

To account for collecting optics, the gain, G, is computed as described in the ANSI book, page 84, as follows,

$$G = D_o^2 / d_e^2 \qquad \text{for } d_e \geq D_e$$

$$G = D_o^2 / D_e^2 = M^2 \qquad \text{for } d_e \leq D_e \qquad \text{Eq. 5.2.1-18}$$

where D_o and D_e are the diameters of the objective and exit pupil of the optical system ($D_e = D_o / M$, where M is the optical system magnification), respectively, and d_e is the pupil diameter of the eye. This is for objective diameters smaller than the diameter of the beam at range.

All collecting and transmissive optics in LTAS are factored in and taken into account here,

$$\text{factor} = T \cdot G \cdot \text{canopy transmission} \qquad \text{Eq. 5.2.1-19}$$

where T is the transmission through the optics between the pilot and the laser. The output laser energy (E) or power (P) (depending on whether the laser is CW or Pulsed) are then adjusted,

$$\text{Adjusted Energy} = E_a = E \cdot \text{factor}$$
$$\text{Adjusted Power} = P_a = P \cdot \text{factor} \qquad \text{Eq. 5.2.1-20}$$

The laser spot area, A_S should then be,

$A_S = E_a \cdot PRF / PPA$ for Pulsed lasers
$A_S = P_a / PPA$ for CW lasers Eq. 5.2.1-21

From here on, the calculations for the hazard distance depend on the laser profile (circular, elliptical, or rectangular). Also, because the distance depends on the atmospheric attenuation, and the atmospheric attenuation depends on the distance, an iteration calculation is needed. For the purposes of the software programming, a binary search iteration method is used. The formulas are based on the range equation, which is equation B11, page 82 of the ANSI standard.

The equation under the radical in the range equation is,

$$\text{radical} = (4 \cdot A_S / \pi) - A_L^2 \quad \text{for circular lasers}$$
$$\text{radical} = (\text{sqrt}(\text{cross}^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - (4 \cdot A_S / \pi)^2)) - \text{cross}) / 2 \quad \text{for elliptical lasers}$$
$$\text{radical} = (\text{sqrt}(\text{cross}^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - A_S^2)) - \text{cross}) / 2 \quad \text{for rectangular lasers}$$

Eq. 5.2.1-22

where A_L is the output aperture diameter of the laser in meters for circular lasers, and A_{LX} and A_{LY} are the x and y axis apertures in elliptical and rectangular lasers. And

$$\text{cross} = A_{LX}^2 \cdot \beta_Y^2 + A_{LY}^2 \cdot \beta_X^2 \qquad \text{Eq. 5.2.1-23}$$

To initialize the iteration process, the hazard distance, r, is initialize to be,

$$r = \sqrt{\text{radical}} / \tan(\beta) \quad \text{for circular lasers}$$

$$r = \sqrt{\text{radical}} / \beta_X \cdot \beta_Y \quad \text{for elliptical or rectangular lasers}$$

Eq. 5.2.1-24

where β = laser divergence for circular lasers
and β_X = x-axis laser divergence
β_Y = y-axis laser divergence for elliptical and rectangular lasers

The iteration solver used here keeps track of the minimum and maximum values of the oscillations and uses the average of these values as the seed for each successive computation. The initial minimum value, rFloor will be zero. The maximum value, rCeil, will have the following value, which will take the atmospheric attenuation coefficient, μ, into account,

$$\text{rCeil} = \log((A_L^2 \cdot \pi) / (4 \cdot A_S)) / -\mu \quad \text{for circular lasers}$$
$$\text{rCeil} = \log(\text{sqrt}(A_{LX}^2 \cdot A_{LY}^2) \cdot \pi / (4 \cdot A_S)) / -\mu \quad \text{for elliptical lasers}$$

$$rCeil = \log(\mathrm{sqrt}(A_{LX}^2 \cdot A_{LY}^2) / A_S) / -\mu$$ for rectangular lasers

Eq. 5.2.1-25

The current value of r is then used to compute the atmospheric transmissivity,

$$T_A = e^{-\mu \cdot r}$$ Eq. 5.2.1-26

radical is then recomputed, taking T_A into account,

$$radical = (4 \cdot A_S \cdot T_A / \pi) - A_L^2$$ for circular lasers

$$radical = (\mathrm{sqrt}(cross^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - (4 \cdot A_S \cdot T_A / \pi)^2)) - cross) / 2$$ for elliptical lasers

$$radical = (\mathrm{sqrt}(cross^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - A_S^2 \cdot T_A^2)) - cross) / 2$$ for rectangular lasers

Eq. 5.2.1-27

rPrime is now the new estimate

$$rPrime = \sqrt{radical} / \tan(\beta)$$ for circular lasers

$$rPrime = \sqrt{radical} / \beta_X \cdot \beta_Y$$ for elliptical or rectangular lasers

Eq. 5.2.1-28

If necessary, rCeil and/or rFloor are adjusted to this new estimate to keep track of the min/max values, i.e., if r is less than rPrime and greater than rFloor, rFloor gets the value of r; if r is greater than or equal to rPrime and r is less than rCeil, rCeil gets then value of r. In any case, the new seed (the new r) will be the average of rCeil and rFloor,

$$r = (rCeil + rFloor) / 2$$ Eq. 5.2.1-29

This process continues until the r delta between successive evaluations falls below some predefined level. The final r is returned as the Flashblindness Hazard Distance or the radius of the Flashblindness Threat Ring.

10.1.2 Eye Safety (NOHD) Threat Ring Algorithm

The Nominal Ocular Hazard Distance or Eye Safety Threat Ring is determined per ANSIZ136.1-1993, or the American National Standard for Safe Use of Lasers. This is represented by the LTAS_NOHD_Model class. First, Maximum Permissible Exposures, or MPEs, are computed from Tables 5 and 6, and Sections 8.2.2.1 - 8.2.2.3, page 33.

Then, the Range Equation iterative range solver is applied. The range equation is derived from Eq.B11, page 82 of the ANSI standard. The important observation to make in Eq. B11 is that the RANGE (r) appears in two different expressions in the equation. Solving for the r-squared term in the denominator leaves the r term in the exponentiation. This makes the equation incompletely specified, requiring an iterative technique to solve for the actual range.

The approach to the iterative solver is to keep track of the min/max values of the oscillations and use the average of these values as the seed each successive computation. This technique is still subject to the problem of the value under the radical going negative. This is handled by fixing, via conditional assignment of new values for max and min, the min value to 0.0. Since the average is (max + min)/2 this has the effect of halving the max each time through the loop, e.g. a binary search. This is done until the value under the radical goes positive, at which time the min value can be modified.

Finally, the efficiency of the loop can be improved by seeding rCeil with the value of r which just causes the radical to go negative. This value is arrived at by setting the expression under the radical to zero and solving for r.

This algorithm first checks to see if the attenuation coefficient has been set. If it has not, the unattenuated NOHD is returned. If it has, the algorithm then checks to see if a hazard exists (nohd > 0.0). If there is no hazard, 0.0 is returned, otherwise the iterative solver is applied.

The range equation is Eq B12, page 83. (The constant 1.27 is $4/\pi$) This equation assumes no viewing optics, and no protective eyewear. The complete equation used here is:

$$\text{range} = \frac{1}{\text{divergence}} * \frac{(4*Q*\exp(-\text{attnCoeff}*R)*ODT*G - A**2)^{1/2}}{(\pi*MPE)^{1/2}} \qquad \text{Eq. 10.1.2-1}$$

where Q is the source energy
R is the range (in centimeters) (the same range being solved for)
ODT is the transmittance of protective eyewear
G is the gain of viewing optics (NOT the magnification)
A is the aperture diameter of the laser system

The above equation assumes intrabeam viewing, which corresponds to worst case viewing conditions. If the viewing distance and divergences are large enough that off axis viewing of the beam is possible, replace the divergence term in the equation with the viewing angle. The above equation is also only for circular beams.

To start the NOHD calculation, the equation under the radical in the range equation is,

$$\text{radical} = (4 \cdot A_S / \pi) - A_L^2 \qquad \text{for circular lasers}$$

$$radical = (sqrt(cross^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - (4 \cdot A_S / \pi)^2)) - cross) / 2$$

for elliptical lasers

$$radical = (sqrt(cross^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - A_S^2)) - cross) / 2$$

for rectangular lasers

Eq. 10.1.2-2

where $A_S = Q \cdot ODT \cdot G \cdot T / MPE$, A_L is the output aperture diameter of the laser in meters for circular lasers, A_{LX} and A_{LY} are the x and y axis apertures in elliptical and rectangular lasers, T is any other transmission losses through optics, and

$$cross = A_{LX}^2 \cdot \beta_Y^2 + A_{LY}^2 \cdot \beta_X^2$$

Eq. 10.1.2-3

To initialize the iteration process, the hazard distance, r, is initialize to be,

$r = \sqrt{radical} / \tan(\beta)$ for circular lasers

$r = \sqrt{radical} / \beta_X \cdot \beta_Y$ for elliptical or rectangular lasers Eq. 10.1.2-4

where β = laser divergence for circular lasers
and β_X = x-axis laser divergence
β_Y = y-axis laser divergence for elliptical and rectangular lasers

The iteration solver used here keeps track of the minimum and maximum values of the oscillations and uses the average of these values as the seed for each successive computation. The initial minimum value, rFloor will be zero. The maximum value, rCeil, will have the following value, which will take the atmospheric attenuation coefficient, μ, into account,

$rCeil = \log((A_L^2 \cdot \pi) / (4 \cdot A_S)) / -\mu$ for circular lasers
$rCeil = \log(sqrt(A_{LX}^2 \cdot A_{LY}^2) \cdot \pi / (4 \cdot A_S)) / -\mu$ for elliptical lasers
$rCeil = \log(sqrt(A_{LX}^2 \cdot A_{LY}^2) / A_S) / -\mu$ for rectangular lasers

Eq. 10.1.2-5

The current value of r is then used to compute the atmospheric transmissivity,

$$T_A = e^{-\mu \cdot r}$$

Eq. 10.1.2-6

radical is then recomputed, taking T_A into account,

$radical = (4 \cdot A_S \cdot T_A / \pi) - A_L^2$ for circular lasers

$$\text{radical} = (\text{sqrt}(\text{cross}^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - (4 \cdot A_S \cdot T_A / \pi)^2)) - \text{cross}) / 2$$

for elliptical lasers

$$\text{radical} = (\text{sqrt}(\text{cross}^2 - 4 \cdot \beta_X^2 \cdot \beta_Y^2 \cdot (A_{LX}^2 \cdot A_{LY}^2 - A_S^2 \cdot T_A^2)) - \text{cross}) / 2$$

for rectangular lasers

Eq. 10.1.2-7

rPrime is now the new estimate

$$\text{rPrime} = \sqrt{\text{radical}} / \tan(\beta) \qquad \text{for circular lasers}$$

$$\text{rPrime} = \sqrt{\text{radical}} / \beta_X \cdot \beta_Y \qquad \text{for elliptical or rectangular lasers}$$

Eq. 10.1.2-8

If necessary, rCeil and/or rFloor are adjusted to this new estimate to keep track of the min/max values, i.e., if r is less than rPrime and greater than rFloor, rFloor gets the value of r; if r is greater than or equal to rPrime and r is less than rCeil, rCeil gets then value of r. In any case, the new seed (the new r) will be the average of rCeil and rFloor,

$$r = (\text{rCeil} + \text{rFloor}) / 2 \qquad \text{Eq. 10.1.2-9}$$

This process continues until the r delta between successive evaluations falls below some predefined level. The final r is returned as the NOHD.

10.1.3 Eye Damage Threat Ring Algorithm

The computation of the eye damage threat ring distance is estimated from a value taken to be a multiple of ten of the MPE parameter. If the laser is CW, the irradiance has to be converted to a radiant exposure in J/cm^2. To do this, the entered Irradiance in W/cm^2 is multiplied by the exposure duration. For pulsed lasers, the radiant exposure is already in J/cm^2.

10.1.4 Irradiance/Radiant Exposure Threat Ring Algorithm

The calculation of the Irradiance/Radiant Exposure Threat Ring, or hazard distance, follows the same algorithm as the one for the Eye Safety (NOHD) Threat Ring, where the irradiance (if laser is CW) or the radiant exposure (if laser is Pulsed) takes the place of the MPE parameter. If the laser is CW, the irradiance has to be converted to a radiant exposure in J/cm^2. To do this, the entered Irradiance in W/cm^2 is multiplied by the exposure duration. For pulsed lasers, the radiant exposure is already in J/cm^2.

10.1.5 Required OD Algorithm

If any of the other threat rings has a radius smaller than an Eye Safe threat ring defined with identical parameters (i.e., the maximum permissible exposure (MPE) of the laser source is less than the irradiance or radiant exposure at the threat ring's radius from the source), the user is notified of the amount of optical density (OD) required in units of OD, to reduce the irradiance or radiant exposure of the laser source at that distance (radius of threat ring) to the MPE, as defined in ANSI Z136.1-1993. Utilizing the required OD would then make the current threat ring's radius an eye safe distance from the laser source. The following describes how to calculate this value.

First the laser's radiant exposure, R_e, in J/cm^2 shall be calculated:

a) For the Flashblindness Threat Ring:

$R_e = PPA / PRF$	for Pulsed lasers
$R_e = PPA \cdot \text{Exposure Duration}$	for CW lasers

where PPA is the Power per Area calculated in equation 5.1-17, and PRF is the laser's Pulse Repetition Frequency.

b) For the Eye Damage and Eye Kill Threat Ring:
If the threat ring turned out to be equal to zero,

$R_e = PPA / PRF$	for Pulsed lasers
$R_e = PPA \cdot \text{Exposure Duration}$	for CW lasers

Otherwise,

$R_e = I_C / PRF$	for Pulsed lasers
$R_e = I_C \cdot \text{Exposure Duration}$	for CW lasers,

where I_C, is the irradiance that was selected from the ED50 database.

c) For the Irradiance/Radiant Exposure Threat Ring:

R_e = Radiant Exposure entered by user	for Pulsed lasers
R_e = Irradiance entered by user $\cdot$ Exposure Duration	for CW lasers

The laser's MPE, or Maximum Permissible Exposure should be calculated just as described in the Eye Safety Threat Ring procedure (paragraph 5.1.3.2), or Table 5 and 6 of the ANSIZ136-1993. The OD required is then,

$$OD = \log_{10} (R_e / MPE)$$

10.1.6 Blurring Algorithm

The blurring algorithm takes a viewing distance, a lesion size, an image size, and an image as input. The viewing distance has a unit of meters and a storage type of float. The lesion size has a unit of degrees of visual angle and a storage type of float. The input image is an 8-bin grayscale which is stored in a one-dimensional array of type char or an XImage structure which is specified in the <X11/Xlib.h> directory. The output image is a filtered, blurred, version of the input image in an 8-bit grayscale format of type char or an XImage structure, which is specified in the <X11/Xlib.h> directory. The algorithm assumes that the lesion size is circular and center about the fovea. The algorithm also assumes that the observer is fixating at the center of the image. Figure 10.1.6-1 below depicts the relationship of the all the classes required for the blurring algorithm.

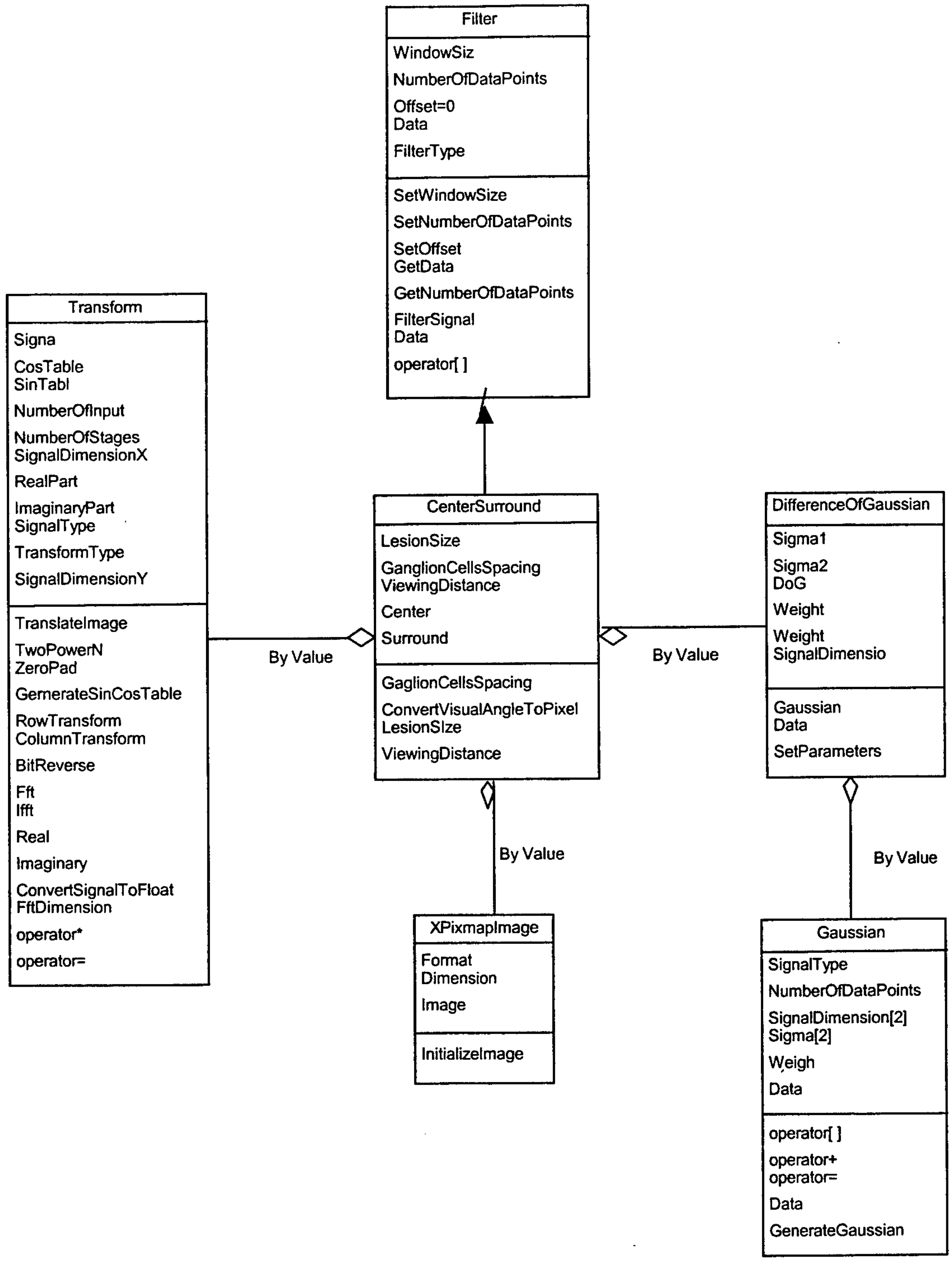

Figure 10.1.6-1. Blurring Algorithm Static Class Relationship

The Filter class is a base class used for different filter types. It has the ability to process standard built-in data types, i.e., char, unsigned int, short, int, float, and double. This class has features common to many filter types, which include the filter window size and the offset to the location of the signal to begin filtering.

The Gaussian class generates a gaussian signal based on the specified standard deviation and weights. The gaussian signal is generated based on the following equation:

$$g(x,y) = \frac{1}{2\sigma_x\sigma_y\pi} e^{-\left[\frac{(x-x_o)^2+(y-y_o)^2}{2\sigma_x\sigma_y}\right]}$$

where x_o and y_o are the localization of the gaussian space.

The DifferenceofGaussian class performs a difference of two gaussian signals:

$$DoG(x,y) = w_a g_a(x,y) - w_b g_b(x,y)$$

where w_a and w_b are weighting constant. The two gaussian signals are generated based on the standard deviations attributes.

The Transform class is a class that performs two-dimensional FFT and IFFT transforms. The class employs a power of 2 (radix-2) decimation-in-frequency algorithm.

The CenterSurround class is a filter which utilizes the Difference of Gaussian (DoG) to model the receptive field of the visual system. The DoG is the difference of two Gaussians with different values for standard deviation (σ):

$$f(x) = 1\frac{1}{\sqrt{2\pi}}\left[\frac{w_c}{\sigma_c} e^{\frac{-(x-\mu)^2}{2\sigma_c^2}} - \frac{w_s}{\sigma_s} e^{\frac{-(x-\mu)^2}{2\sigma_s^2}}\right]$$

This class uses an input lesion size and visual angle to determine (lookup) a corresponding linear spacing of the center-receptive field for the retinal ganglion cells. If the specified lesion size does not exist in the table a corresponding linear spacing will be interpolated. The linear spacing of the center is represented by σ_c in the DoG equation. The linear spacing of the surround is obtained by weighting the center by a factor of 6. The linear spacing of the surround is represented by σ_s in the DoG equation. Once the DoG is obtained, an FFT transform is performed on the generated DoG signal. The frequency domain DoG is utilized as a filter by weighting the FFT transformed image with the FFT transformed DoG. The result is a filtered image in the frequency domain. An IFFT is then performed to obtain a filtered image in space domain.

The XPixmapImage class is used to to convert various image formats, i.e., BMP, JPG, TIFF, etc., to the X PixMap, XPM, image format. Currenty, it will only convert an 8-bit gray scale image into the XPM image format.

Figure 10.1.6-2 below is the flow diagram for implementation of the blurring algorithm.

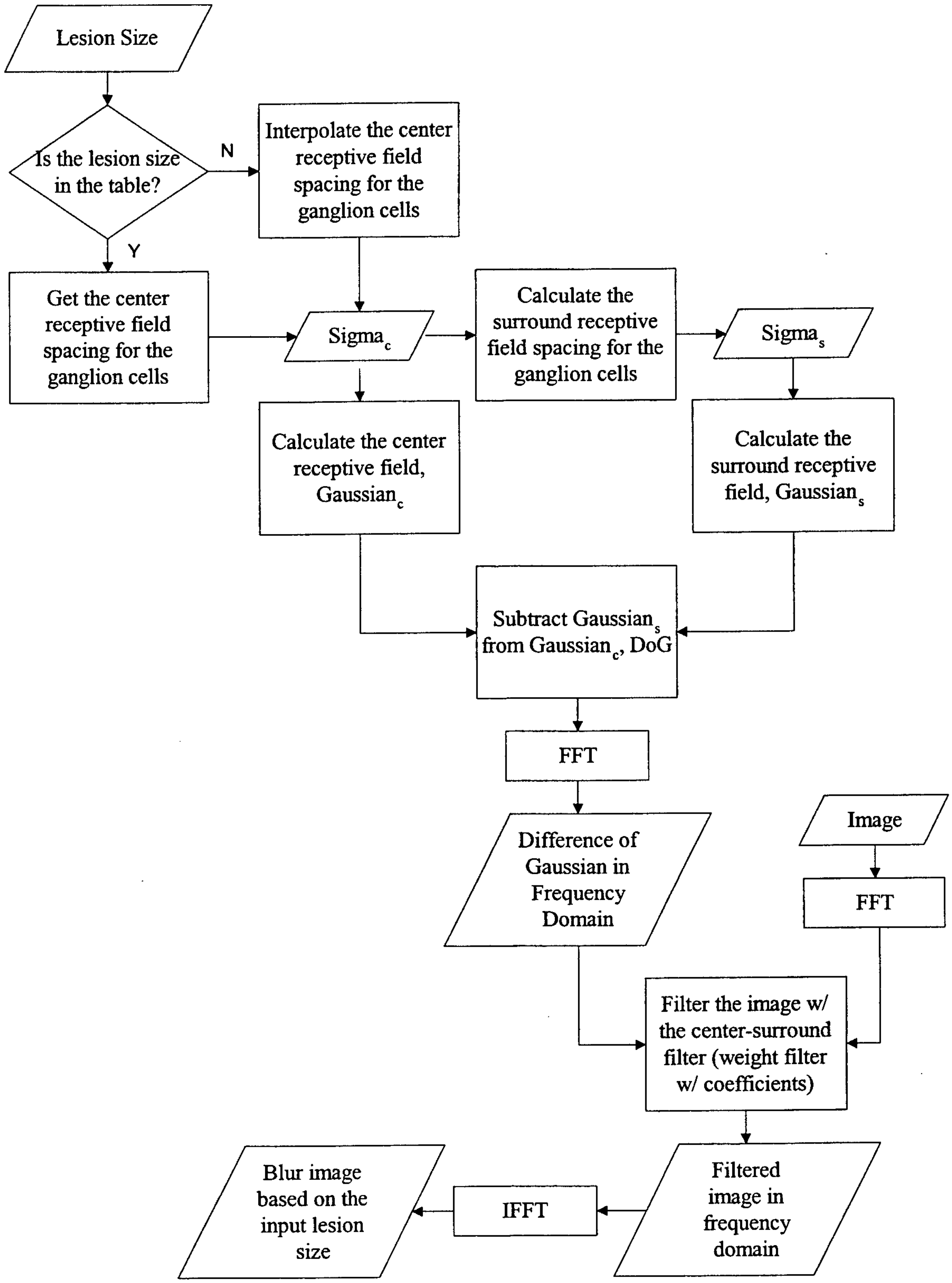

Figure 10.1.6-2 Blurring Algorithm Flow Diagram

11 APPENDIX D – LTAS CLASS CROSS-REFERENCE

This appendix lists all LTAS classes in alphabetical order, and the file in which they are declared within the LTAS directory structure. The page number within this document that the class is referenced is also listed. For the purposes of this appendix, it is assumed that each directory listing starts with "~LTAS/include/". It is also assumed, unless otherwise noted, that the file a class' member functions are defined in is similar to the directory listing in this appendix with the following exceptions:

- The directory listing starts with "~LTAS/src/".
- The file extension changes from .h to .c, .cc, or .cxx.

LTAS Class Definition and Cross-Reference Table

LTAS Class	Directory (~LTAS/include/)	Page
CenterSurround	blurring_algorithm/CenterSurround.h	10-15 12-11
DifferenceofGaussian	blurring_algorithm/DifferenceOfGaussian.h	10-15 12-11
Filter	blurring_algorithm/filter.h	10-14 12-11
Gaussian	blurring_algorithm/gaussian.h	10-15 12-12
gifReader	image_readers/gifReader.h	5-43 12-12
HelpCmdList	gui/LTAS_Cmds/HelpCmdList.h	5-3 12-9
LTAS_Aircraft_Optics	ltas_objects/acft_optics.h	5-51 12-13
LTAS_Altitude_Param	base_parameters/altitude_units.h	5-51 5-53
LTAS_Angle_Param	base_parameters/angle_units.h	12-12
LTAS_Aperture_Param	base_parameters/aperture_units.h	5-54 12-12
LTAS_Atmos_Att_Coeff _Cache_Container	database/atmosphere_cache_container.h	5-45 12-12
LTAS_Atmosphere	ltas_objects/atmosphere.h	5-44 5-50 5-51 12-12
LTAS_Atmosphere_DB	database/atmosphereDB.h	5-45 12-12
LTAS_Atmosphere_Tape5_Container	database/atmosphere_tape5_container.h	5-45 12-12
LTAS_Attenuation_Param	base_parameters/attenuation_units.h	5-45

LTAS Class	Directory (~LTAS/include/)	Page
LTASFileSaveCmd	gui/LTAS_Cmds/LTASFileSaveCmd.h	5-29 5-41 12-9
LTASFlagLabelSubPanel	gui/LTAS_Panels/LTASFlagLabelSubPanel.h	5-27 12-5
LTASGlobalParametersPanel	gui/LTAS_Panels/LTASGlobalParametersPanel.h	5-19 12-2
LTASGlobalSetDefaultsPanel	gui/LTAS_Panels/LTASGlobalSetDefaultsPanel.h	5-5 12-3
LTASHelpAboutLTASCmd	gui/LTAS_Cmds/LTASHelpAboutLTASCmd.h	5-43 12-10
LTASHelpCmdList	gui/LTAS_Cmds/Help_CmdList.h	5-3 12-9
LTASHelpDialog	gui/LTAS_MotifApp/LTASHelpDialog.h	5-43 12-1
LTASHelpHelpAboutCmd	gui/LTAS_Cmds/LTASHelpHelpAboutCmd.h	5-43 5-43 12-10
LTASHelpOnLineHelpBackCmd	gui/LTAS_Cmds/LTASHelpOnLineHelpBackCmd.h	5-43 12-10
LTASHelpOnLineHelpCmd	gui/LTAS_Cmds/LTASHelpOnLineHelpCmd.h	5-43 12-10
LTASHelpOnLineHelpExitCmd	gui/LTAS_Cmds/LTASHelpOnLineHelpExitCmd.h	5-43 12-10
LTASHelpOnLineHelpHomeCmd	gui/LTAS_Cmds/LTASHelpOnLineHelpHomeCmd.h	5-43 12-10
LTASInputPanel	gui/LTAS_Panels/LTASInputPanel.h	5-19 12-2
LTASInsertEyeDamageTRCmd	gui/LTAS_Cmds/LTASInsertEyeDamageTRCmd.h	5-31 12-10
LTASInsertEyeSafeTRCmd	gui/LTAS_Cmds/LTASInsertEyeSafeTRCmd.h	5-31 12-10
LTASInsertFlashblindnessTRCmd	gui/LTAS_Cmds/LTASInsertFlashblindnessTRCmd.h	5-31 12-10
LTASInsertIrradRadExpTRCmd	gui/LTAS_Cmds/LTASInsertIrradRadExpTRCmd.h	5-32 12-10
LTASInsertSensorDamageTRCmd	gui/LTAS_Cmds/LTASInsertSensorDamageTRCmd.h	5-31
Error! Bookmark not defined.		
LTASInsertSensorJamTRCmd	gui/LTAS_Cmds/LTASInsertSensorJamTRCmd.h	5-31
Error! Bookmark not defined.		
LTASInsertLTSCmd	gui/LTAS_Cmds/LTASInsertLTSCmd.h	5-31 12-10
LTASLabelIndicatorsPanel	gui/LTAS_Panels/LTASLabelIndicatorsPanel.h	5-21 12-2
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\- LTASAugmentedParameterFieldSubPanel
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     |-- LTASCDBLPXApertureAugmentedParameterFieldSubPanel
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|-- LTASLoadFromFileCmd
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|-- LTASLTSPanelShowLTSLaserSystemPanelCmd
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|-- LTASOpticsAndLifeSupportSubPanelSetMagnifyingOpticNameCmd
|-- LTASOptionMenuResetButtonCmd
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|-- LTASRunFASCODECmd
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|-- LTASSetLabelCmd
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|-- LTASToolBarInsertEyeDamageTRCmd
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