Appendix 1

3.3 Compliance Matrix for Requirements

A compliance matrix for the Cassegrain ADC requirements document, revision 1.3 is presented in the following pages. The matrix lists in each row the referenced requirements by section number where applicable, and subsidiary requirements within a section indented in subsequent table rows. Note that the first occurrence of a new section is shown in bold face. In the interest of brevity the major section headings (7.2 Implementation Requirements for example) are not always listed if the first occurrence of a subsection within that section is clear enough.

The third column of the matrix, "Compliance", indicates the level of compliance, and the manner of compliance. An example is shown in figure x below.

Reference	Requirement	Compliance	Verify	Notes
6.1.1.1	Operating Environment	100%, by design	T	

Figure x: example compliance matrix row

The level of compliance is shown as a value from 0% to 100% in steps of 25%. The manner of compliance indicates where in the development process the compliance will be achieved. Recommendations for describing the manner of compliance are as follows:

> "**by design**": indicates that the compliance will be achieved in the detail design phase of development
>
> "**by fabrication**": indicates that the compliance will be achieved in the full scale development phase of development
>
> "**by configuration**": indicates that the compliance will be achieved when the instrument is configured with other systems not part of these requirements
>
> "**by test**": indicates that compliance will be achieved during testing, this includes the selection of component values to meet specific parametric performance requirements for example
>
> "**by procedure**": indicates that compliance will be achieved by establishing and documenting an operational procedure for the instrument at installation

"**by documentation**": indicates that compliance will be achieved by documentation provided with the instrument at installation

The verify column indicates the manner in which compliance will ultimately be verified, the values used are as follows:

T = verify by test
I = verify by inspection
D = verify by demonstration

The last column is used to provide notes that explain compliance values of less than 100%.

Section 6 – Overall System Requirements

Reference	Requirement	Compliance	Verify	Notes
6.1	**Performance Requirements**			
6.1.1.1	Operating Environment	100% by Design	T	Will cool to about 0C and run for at least one LN2 fill cycle. -Will not test below 0C due to concerns about icing. -Cannot test at other than ambient humidity -Cannot test at altitude
6.1.1.2	Air Borne Contaminants	100% by Design	I	
6.1.1.3	Shock and Vibration	100% by Design	I	Review of calculations/analysis
6.1.1.4	Audible Noise			
6.2.1	**Feature Implementation Requirements**			
	Two components – optics module and electronics module	100% by Design	I	
	20 arc minute FOV when located in front of Keck I Cassegrain position	100% by Design	I	Review of analysis
	2 prism linear configuration	100% by Design	I	
	Optics module installed in Keck I tertiary tower using Keck I transfer module	100% by Design	I	Review of design and compliance to ICD
	Single axis of motion control via electronics module	100% by Design	T	Will test at Lick Observatory
6.2.3.1	Shipping Containers	100% by Design	I	Review of Design
6.2.4	Regulatory Implementation Requirements			

	OSHA compliance			
6.3	**Design Requirements**			
6.3.1.1	Materials Suitability and Safety	100% by Design	I	Review of Design

Section 7 – Optical Requirements

Reference	Requirement	Compliance	Verify	Notes
7.1	**Performance Requirements**			
7.1.1.1	Typical Parameters			
	FOV	100% by Design	I	Review of design
	Working zenith distance	100% by Design	I	Review of design
	Nominal design wavelength range	100% by Design	I	Review of design
7.1.1.2	Goal Parameters			
	Dispersion correction	100% by Design	I	Review of design. Assumes reference of image average position rather than 0.45 microns as stated in Req. Doc. Compliance is 95% of goal value.
	Peak dispersion	100% by Design	I	Review of design. Assumes reference of image average position rather than 0.45 microns as stated in Req. Doc. One-half of peak-to-peak residual is 78% of goal.
	Correction non-uniformity	100% by Design	I	Review of design
	Transmission	100% by Design	I	Review of design; compliance is 99% of goal at all wavelengths.
	Transmission non-uniformity	100% by Design	I	assumes uniform coating quality
	Effect on image quality	100% by Design	I	Review of design; measured at the LRIS slitmask. With LRIS-R, complies with goal at 90%.

	Image quality non-uniformity	100% by Design	I	Review of design; based on average image sizes at 5 field orientations.
	Ghost images	100% by Design	I	Review of design
	Differential Distortion	100% by Design	I	Review of design; measured across LRIS slitmask field only. Exceeds goal everywhere.
	Differential Rotation	100% by Design	I	Review of design; in worst case (0.008-deg) only meets 25% goal but meets maximum by factor of 6.
7.1.2	Operational Performance Requirements			
	ADC Module Optical Adjustments	100% by Design	I	Review of design
	Dispersion Correction	100% by Design	I	Review of design
	Rotation	100% by Design	I	Review of design
	Centering	100% by Design	I	Review of design
	Focus Position Offset	100% by Design	I	Review of design
	Tilt	100% by Design	I	Review of design

7.2.1	**Feature Implementation Requirements**			
	Required focus and pointing corrections as a function of zenith angle identified	100% by Design	I	Review of design
7.3.1	**Technological Design Requirements**			
	Image quality	100% by Design	I	Review of design
	Optical materials maximize throughput and stability	100% by Design	I	Review of design
	Optical materials and coatings durability	100% by Design	I	Review of design
	Baffling	100% by Design	I	Review of design
	Interior finish	100% by Design	I	Review of design
7.3.3	Standards Related Design Requirements			

	Optical drawings			
	ANSI/ASME Y14.18M-1986	100% by Design	I	On a best effort basis
7.3.4	Integration Related Design Requirements			
	Cassegrain focal position vignetting	100% by Design	I	Review of Design
	LRIS science field vignetting	100% by Design	I	Review of Design

Section 8 – Mechanical Requirements

Reference	Requirement	Compliance	Verify	Notes
8.1	**Design Requirements**			
8.1.1	Parametric Performance Requirements			
	ADC module weight	100% by Design	D	We will weight it
	ADC electronics module weight	100% by Design	D	We will weight it
	Dispersion position repeatability	100% by Design	T	At Lick Observatory
	Dispersion position, absolute accuracy	100% by Design	T	At Lick Observatory
	Full separation travel time	100% by Design	T	
8.1.2.1	Operating Temperature Range	100% by Design	T	As 6.1.1.1
8.1.2.2	Impact and Shock	100% by Design	I	Review of Design
8.1.2.3	Vibration	Not Specified		
8.2	**Implementation Requirements**			
8.2.1.1	ADC Module			
	Cassegrain ADC module a single unit	100% by Design	I	Review of Design/ICD
	For installation in the tertiary mirror tower of Keck I	100% by Design	I	Review of Design/ICD
	ADC module dimensions	100% by Design	I	Review of Design/ICD
	Compatible with installation in the	100% by Design	I	Review of Design/ICD

	tertiary mirror tower of Keck I			
	Compatible with the existing Keck I tertiary transfer module.	100% by Design	I	Review of Design/ICD
8.2.1.2	Defining Points	100% by Design	I	Review of Design/ICD
8.2.1.3	ADC Module Structure	100% by Design	I	Review of Design/ICD
8.2.1.4	Prism Separation Mechanism	100% by Design	I	Review of Design/ICD
8.2.1.5	Optical Mounts	100% by Design	I	Review of Design/ICD
8.2.1.6	Access and Covers	100% by Design	I	Review of Design
8.2.1.7	Handling	100% by Design	I	Review of Design
8.2.1.8	Glycol Cooling	100% by Design	I	Review of Design
8.2.2.1	Fit and Finish	25% Design 75% by Fabrication	I	Inspection of hardware
8.2.2.2	Continuity of Shielding and Grounding	25% by design, 75% by fabrication	none	Cables will all have overall shield which will be tied to the electronics chassis
8.2.2.3	Corrosion resistance	50% by Design 50% Fab	I	Review of Design/Hardware
8.2.2.4	Fasteners	100% by Design	I	Review of hardware
8.2.2.5	Lubricants	100% by Design	I	Review of Maintenance Proceedure
8.2.2.6	Lubricated Components	100% by Design	I	Review of Maintenance Proceedure
8.2.3	Standards Implementation Requirements			
	Seismic zone 4 earthquake survival requirements	100% by Design	I	Review of Design
8.3	**Design Requirements**			
8.3.1.1	Drive Couplings	100% by Design	I	Review of Design
8.3.1.2	Component Ratings	100% by Design	I	Review of Design
8.3.1.3	Enclosure	100% by Design	I	Review of Design
8.3.3	Standards Related Design Requirements			

	UL 508	100% Fab	I	
	ADC electronics module enclosure NEMA type 4	100% Design	I	
	Mechanical drawings			
	ANSI Y14.5M-1982 (R1988)	100% Design	I	To the best of our abilities
	ASME Y14.100M-2000-2001	100% Design	I	To the best of our abilities

Section 9 - Electronic/Electrical Requirements

Reference	Requirement	Compliance	Verify	Notes
9.1	**Performance Requirements**			
9.1.1.1	Power Dissipation	100% by design	T	
9.1.1.2	Compatibility			
9.1.1.3	Temperature and Humidity			
9.1.1.4	Power Supply	100% by design	T	
9.1.1.4.1	ADC Electronics Module			
9.1.1.4.2	ADC Module			
9.1.1.5	Cable and Wire Ratings	100% by design	None	We will use cabling practices that have proven to be effective and reliable in various instruments that have been built for Keck.
9.2.1	**Feature Implementation Requirements**			
	ADC Electronics Module			
	Local control and safety features operate without a networked data communications connection or remote computer connection	100% by design	D	
	Equipped with a local terminal	100% by design	D	This will be provided for only if

	connection (RS-232) for test and diagnostic purposes			our equipment complement includes a terminal server.
	If the "ADC target computer" is a PC type computer	100% by design	D	
	Diskless computer running CARA approved version of the Linux operating system			
	Local terminal connection (RS-232) or monitor/mouse and keyboard connections for test and diagnostic purposes			See above

	If a remote computer is used the computer should be a Sun workstation or server running a CARA approved version of the Solaris operating system.			
	Local control switch	100% by design	D	
	Motion stop switch	100% by design	D	
	Plug-in printed circuit boards			No idea what this refers to. The circuit board designs and fabrication will follow practices that have proven to be effective and reliable in various instruments that have been built for Keck.
	Positive retention features			Will apply where needed.
	Extractors			Will apply where needed.
9.2.2	Common Practices Implementation Requirements			
	No stray light			

	No LED or lamp indicators on exterior of ADC module or ADC electronics module	100% by design	D	
9.2.3	Standards Implementation Requirements			
9.2.3.1	Electrical Safety	75% by design, 25% by fabrication	D	
9.2.3.2	Electromagnetic Compatibility			None
9.2.4.1	AC Line Connections	50% by design, 50% by fabrication	I	Verify by documentation
9.2.4.2	Covers			
9.2.4.3	Wiring	100% by design	I	Verify by documentation
9.2.4.4	Overcurrent Protection	100% by design	I	Verify by documentation
9.2.4.5	Grounding and Shielding	100% by design	I	Verify by documentation
9.2.4.6	Terminations	100% by design	I	Verify by documentation
9.2.4.7	Altitude Derating			

9.3	**Design Requirements**			
9.3.1.1	Motion Controller	100% by design	I	We will use a suitable motion controller as determined by us.
9.3.1.2	Power Ratings	100% by design	I	
9.3.1.3.1	Connector and Cable Mounting	100% by design	I	Verify by documentation
9.3.1.3.2	Cable and Wire Routing	100% by design	I	Verify by documentation
9.3.1.3.3	Interconnections	100% by design	I	Verify by documentation
9.3.1.3.4	Data communications – connectors & formats	100% by design	I	Verify by documentation
9.3.3	Standards Related Design Requirements			
	Connectors used for low voltage AC and DC equivalent to MIL-C-38999 series IV.			We will use a suitable connnectors as determined mutually.

Section 10 – Safety Requirements

Reference	Requirement	Compliance	Verify	Notes
10.1	**Performance Requirements**			
10.1.2	Operational Performance Requirements	100% Fab	I	
10.2	**Implementation Requirements**			
10.2.1.1	Local Control	100% by design	D	
10.2.1.2	Mechanical		D	
10.2.1.3	Electrical	100% by design		
10.3.1	**Technological Design Requirements**			
	No mechanism motion when AC power applied to or removed			If possible
	All inhibited motion during a power on/reset.			If possible
	No servo “wind up”			If possible
	Limit switches closed when not actuated			If possible
	Disconnected limit switch will appear to be active			If possible
	Movement away from an active limit switch is restricted to a reasonable distance past the limit switch	100% by design	D	
	Position encoder status loop	100% by design	D	
10.3.2	Regulatory Design Requirements			

Section 11 – Software Requirements

Reference	Requirement	Compliance	Verify	Notes
11.1	**Performance Requirements**			

11.1.1	Parametric Performance Requirements			
	Tracking mode accuracy	100% Design	T	
	Repeatability	100% Design	T	
11.1.2	Operational Performance Requirements			
	Network connection disconnect recovery	100% Design	T	
	Network connection timeouts and error recovery	100% Design	T	
	Execution speed and command latency	100% Design	T	
11.1.2.2.1	ADC Keyword Service	100% Design	I	
11.1.2.2.2	Motion Control System	100% Design	I	
11.1.2.2.3	DCS Client	100% Design	I	
11.1.2.2.4	DCS	100% Design	I	
11.1.2.2.5	Boot Host (if required)	100% Design	I	
11.1.2.2.6	Operating Modes			
	Manual Mode	100% Design	T	
	Tracking Mode	100% Design	T	
	Slew and tracking speed	100% Design	T	
11.2.1	**Feature Implementation Requirements**			
	C/C++	100% Design	I	
	Auto-boot and auto-execute at power on/reset.	100% Design	T	
	Test Mode	100% Design	I	
	Reliability	100% Design	T	

11.2.3	Standards Implementation Requirements			
	KSD 201	100% Design	I	
	KSD 210	100% Design	I	

	Communications via keywords (KSD 8)	100% Design	I	
11.3	**Design Requirements**			
11.3.1.1	Target Software			
	C/C++	100% Design	I	
	Communications via TCP/IP and the Keck Keyword Interface	100% Design	I	
	Keyword support analogous to Tables 9 and 10 of KSD 46a	100% Design	I	
11.3.3	Standards Related Design Requirements			
	KSD 50	100% Design	I	
	KSD 210	100% Design	I	

Section 13 - Reliability Requirements

Reference	Requirement	Compliance	Verify	Notes
13	10 year lifetime.	**100% Design**	**I**	**We will show expected lifetime of major moving components**

Section 15 – Service and Maintenance Requirements

Reference	Requirement	Compliance	Verify	Notes
15.1	Cleaning of Optics	100% Design	I	

Section 16 - Documentation Requirements

Reference	Requirement	Compliance	Verify	Notes
16.1	**Drawings**			
	Electronic form and printed	**100% Design**	**I**	**On a best effort basis**

	ANSI Y14.1-1995	**100% Design**	**I**	**On a best effort basis**
	ANSI Y14.34M-1996	**100% Design**	**I**	**On a best effort basis**
	ANSI Y14.5M-1982 (R1988)	**100% Design**	**I**	**On a best effort basis**
	ANSI Y14.3M-1994	**100% Design**	**I**	**On a best effort basis**
	ANSI Y14.17-1966	**100% Design**	**I**	**On a best effort basis**
	ANSI 14.5M-1982 (R1988)	**100% Design**	**I**	**On a best effort basis**
	ANSI 14.5M-1982 (R1988)	**100% Design**	**I**	**On a best effort basis**
16.2	**Manuals**			
16.2.1	Operating Manuals	**100% Design**	**I**	
16.2.2	Maintenance Manuals	**100% Design**	**I**	
16.3	**Software**			
	KSD-3	**100% Design**	**I**	
16.4	**Test Data**			
	Test data report	**100% Test**	**I**	
	Raw test data	**100% Test**	**I**	