<u>CCD Quality Control Procedures</u>

1. Objectives of CCD Quality Control Procedures.

1.1 The implimentation of procedures to measure and qualify CCD performance implies a cost of effort that must positively compensated for by the benefit of any results produced. To help evaluate these benefits and to some extent identify a limit to the costs involved in obtaining them, the following objectives are presented as a basis of discussion:

1.2 Up to date quality control information shall determine the limiting conditions of any CCD based scientific detecting system to enable users to discern its suitability and operating mode for any given purpose. This information should be freely accessable to the user comunity, possibly via the web server.

1.3 Up to date quality control data shall be used to identify any degregation of performance for each CCD at the observatory. This data should be available to technical staff and visiting astronomers in an easily accessable form, possibly via web server.

1.4 Quality control data generated while laboratory testing a CCD shall be used to evaluate the effects of modifying the operating conditions of a CCD so as to enhance the performance of the devices. The data should be available to technical staff only.

1.5 A database of historic quality control data shall be available for generating limiting conditions for any queries relating to CCDs from astronomers after leaving the observatory site. The information shall be available via petition from an astronomer on a one by one basis.

1.6 The quality control database shall provide information for the effects of aging and/or damage for each CCD, so giving qualitive data for use in evaluating the availability of each CCD to the user community and helping in the evaluation of CCD procurement plans by the observatory.

2. **Qualitive properties of a CCD detecting system**.

There are many factors involved in the performance achieved by a CCD. The measurable quantitive properties that define CCD performance can generally be divided into four groups according to the dominating factors that influence their values. These four groups are:

<u>Physical properties</u> - based on CCD design and fabrication.
<u>Operational properties</u> - based on CCD biasing and clocking.
<u>Placement properties</u> - based on the enviroment of the CCD.
<u>System properties</u> - based on the electronics used to control the CCD.

Itemized below are the relevent properties of a CCD based detecting system that must be qualified to support the intended objectives. Each property is identified for its dominating factors and membership to a performance group.

2.1 Physical Properties of the CCD.

2.1.1 Quantum Efficiency defines the ability to convert photons of any given wavelength to a measurable signal and expressed as a percentage value at discrete wavelengths. Moderately influenced by operating temperature. Long, medium and short term effects depending on surface treatment technology, storage and operational environment conditions.

2.1.2 Charge Collection Efficiency defines the ultimate spatial resolution of the device in terms of the ability of each pixel to attract charge generated by a photon at the pixel site into its potential well. Expressed by XXXX

2.1.3 Charge Transfer Efficiency is the ability of the CCD to transfer charge from one pixel to an adjacent one during the readout process. This parameter is expressed as decimal value less than unity where unity reflects perfect charge transfer without loss. Two values are measured to reflect the vertical and horizontal paths that charge must pass to arrive at the readout amplifier of the CCD. Strongly influenced by the levels and speeds of the clocking scheme used to readout the CCD. Slightly dependent on the operating temperature of the CCD.

2.1.4 Full Well Capacity measured in electrons (e-) is the point where the ability to hold and transfer the potential well charge is lost. This parameter is soft in that the operational limit is expressed as the point where the linearity of e- to photons deviates from ideal by one percent. This parameter is governed by the vertical clock bias of the integrating phase(s).

2.1.5 Dark Current Generation caused by thermally generated electrons inside the silicon of the CCD is expressed as e- / hour / pixel. Strongly influenced by the operating temperature of the CCD and the vertical clock bias values during integration (mpp mode).

2.1.6 Cosmic Ray Events caused by energetic particles interacting with the silicon lattice structure of the CCD are strongly dependent on the physical position of the CCD with respect to the radiation flux, the degree of shielding provided by the telescope and the quantum efficiency of the CCD. Expressed as events / hour / cm^2.

2.1.7 Cosmetic Quality

2.1.8 Latency of Image

2.2 Qualities of the CCD and CCD controller system.

2.2.1 Conversion factor

2.2.2 Read Noise

2.2.3 Linearity

3. Measurement Procedures.

3.1 Quantum Efficiency

3.2 Charge Collection Efficiency

3.3 Charge Transfer Efficiency

3.4 Full Well Capacity

3.5 Dark Current Generation

3.6 Cosmic Ray Events

3.7 Cosmetic Quality

3.8 Latency of Image

3.9 Qualities of the CCD and CCD controller system.

3.10 Conversion factor

3.11 Read Noise

3.12 Linearity

4. Methodology of Implimentation.