

APO DESIGN GUIDELINES

1. LIGHTNING PROTECTION.

APO is very prone to lightning strikes, there are an average of 1-2 strikes per week during July and August within 1/4 mile of the site.

APO protects existing systems by:

- reducing copper wire runs to electronic equipment to less than 20 ft. inside buildings;
- not allowing any copper wire except for power between buildings;
- maintaining strict lightning protection designs for buildings including outside down conductors, counterpoise and radials;
- optical isolation of copper input/outputs;
- power panel surge protection; and,
- UPS power with isolation transformers and/or double conversion.

2. ENVIRONMENTAL CONDITIONS.

Equipment must be designed to operate at:

- 10,000 ft MSL
- ambient temperature range of -10 degrees to 90 degrees F
- 5 to 100% condensing RH
- winds to 100 mph
- snow loads to 40"
- LN2 systems must be designed for 77 Deg K with frozen condensate and icing
- peak dust levels:
 - 10,000,000 .1 micron particles
 - 1,000,000 .5 micron particles

Adverse events may occur several times a year and last 4-8 hours each time.

3. RODENT AND INSECTS.

APO has severe issues with miller moths, mice and rats.

ALL equipment should be sealed and air inlets and outlets fine-screened for insects. Cabling should be sheathed and protected from gnawing insects.

4. SPARES.

Sufficient spares should be purchased at the time of the initial purchase to ensure parts are available and compatible for 2x the expected lifetime. Items with a high cost that

prohibit keeping spares in stock should be listed as a risk factor. Spares should be provided as complete assemblies, where applicable, to allow for quick swap-out and minimize lost sky time.

Spares parts should be carefully packed for storage and labeled.

Power supplies should be fully spared and easily swapped.

5. HARDWARE DOCUMENTATION.

Documentation should be provided to include, but not limited to, the following:

- AS-BUILT Mechanical and Optical CAD drawings (prefer format compatible with SolidWorks)
- AS-BUILT Mechanical and CAD drawings in PDF format
- AS-BUILT Schematics in CAD format and PDF
- AS-BUILT optical Zemax drawings
- Design notes in rational and easy-to-understand terms
- Testing data
- Design reviews presentations, notes, comments, and actions
- Hazard analysis
- Parts list, including vendor and cost, where applicable
- Manufacturer design, operation and maintenance manuals
- Spares list
- Design specifications
- System operations and maintenance manuals
- Any calibration procedures
- Special test/assembly/maintenance tools and equipment
- Troubleshooting procedures including easily understood fault codes, waveforms, voltages
- Equipment should be labeled appropriately for function, switches, indicators, and manual controls

6. SOFTWARE/FIRMWARE/EPROM DOCUMENTATION.

Software must include version control and repository, operations manual, source code, compiling software requirements, and compiling/burning and operations hardware requirements.

7. SAFETY ISSUES.

- All hazards should be clearly identified and mitigated by design where possible. Items not able to be mitigated shall include any required PPE, training and controls.
- All chemicals shall be identified before coming to APO, and MSDS (Material

Safety Data Sheets) provided.

- Power distribution should be grounded for personal safety.
- High voltage systems should be properly labeled and protected.
- Hazardous analysis should be included in documentation and provided before delivery.
- Handling of heavy items should be included as part of design.
- Items greater than 50 lbs. should include some type of lifting fixture provisions.
- Components should be designed as fail-safe.

8. INDICATORS.

Status indicators are highly desired. All indicators should be easily identifiable, clearly labeled and not emit any light during normal operations. Fault indicators should be red when faulted. Absent of light should NOT be used to indicate a fault.

9. MAINTAINABILITY.

Maintainability should be built into all designs to:

- enable easy installation, handling, access, test-points, and adjustments;
- avoid high density pin connectors when possible; and,
- utilize color-coded wiring.

Engineering and/or maintenance modes should be incorporated and allow the individual working on the item to perform basic operation at the device.

Do not utilize connectors that can be misconnected or hooked up to the wrong function. All custom tools needed to repair/assemble/disassemble must be provided.