IMAGINEERING WITH LASERS

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February 15, 2001

Dockets Management Branch (HFA-305)
Food and Drug Administration
5630 Fishers Lane, Room 1081
Rockville, MD 20857

Dear Sir/Madam,

I request that our variance (No. 79P-0055, effective 5/11/98 from 21 CFR 1040.11 [c] of the performance standard from laser products) to be extended for the maximum possible time period. We plan to manufacture, produce, and assemble laser light shows as specified in our Initial Report and Supplements (CDRH Accession No. 79A0118-12,-13,-14). Our current variance is due to expire on May 19, 2001.

I look forward to your response. Please contact me if you have any questions.

Sincerely,

Ward Davis
President

WD:ts

7 9P-0055

EXP 7

DEPARATMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION

APPLICATION FOR A VARIANCE FROM 21 CFR 1040.11(c) FOR A LASER LIGHT SHOW, DISPLAY, OR DEVICE

Form Approved: 0910-0025
Expiration Date: August 31, 1988

DOCKET NUMBER
79P-0055

NOTE: No laser light show, projection system, or device may vary from compliance with 21 CFR 1040.11(c) in design or use without the approval of this application in accordance with 21 CFR 1010.4.

INSTRUCTIONS 6345 01 FEB 26 A10 :45

1. Check all applicable boxes and type or print the requested information.
2. Submit an original and four (4) copies.
3. Mail your application to the Dockets Management Branch (HFA-305), Food and Drug Administration, Room J-62. 5600 Fishers Lane. Rockville, MD 20857.
4. Enter Document Number if assigned.

1. NAME OF COMPANY
AUDIO VISUAL IMAGINEERING, INC.

2. ADDRESS OF COMPANY (*Include ZIP CODE*) (*If P.O. Box is used, include actual street address also.*)
10801 Cosmonaut Blvd., Orlando, Florida 32824

3. NAME AND TITLE OF RESPONSIBLE PERSON
Ward Davis, President

4. TELEPHONE NO. (*Include area code*)
407-859-8166

5 DATE OF SUBMISSION
02/12/2001

6. The applicant requests the variance to be in effect for a period of ______ years from the date of issue.
(*In general, the Agency will approve a variance for only two years. If a longer period is requested, a justification must be attached as part of the application.*)

7. **PRODUCT DESCRIPTION AND USE**

a. LIST NAME AND/OR MODEL NUMBER(S) FOR THE LASER LIGHT SHOW(S) AND PROJECTOR(S)
AVI Laser Projection System - S/B Series (CDRH Accession No. 790118-12,-13,14,16)
Omniscan Laser Projection System Model Series 2000

b. PRODUCT FOR WHICH A VARIANCE IS REQUESTED
- ☐ A LASER DISPLAY DEVICE
- ☒ A PROJECTOR FOR A LASER LIGHT SHOW
- ☒ A LASER LIGHT SHOW
- ☒ OTHER (*Specify*) Laser Video Projection

c. ☒ PROJECTORS ARE INTENDED FOR SALE, LEASE, OR LOAN TO OTHER LASER LIGHT SHOW PRODUCERS

d. PRODUCT IS INTENDED FOR USE IN A
- ☒ PLANETARIUM OR OTHER DOME PROJECTION STRUCTURE
- ☒ THEATER
- ☒ HOTEL/MOTEL BALLROOM OR MEETING ROOM
- ☐ STORE DISPLAYS
- ☒ TRADE SHOW OR CONVENTION
- ☒ DISCOTHEQUE OR NIGHT CLUE
- ☒ PAVILION
- ☒ INDOOR ARENA
- ☒ OUTDOOR ARENA
- ☒ MUSEUM
- ☒ OUTDOOR UNENCLOSED AREA
- ☐ OTHER (*Specify*) ______

e. PRODUCT IS INTENDED TO BE USED
- ☒ AT ONLY ONE (*fixed*) LOCATION
- ☒ AT A VARIETY OF (*tour*) LOCATIONS
- ☐ OTHER (*Specify*) ______

f. PRODUCT IS INTENDED TO BE USED AT ANY ONE LOCATION
- ☒ MORE THAN 15 DAYS
- ☒ MORE THAN 5 BUT NOT MORE THAN 15 DAYS
- ☒ LESS THAN 5 DAYS

g. TOUR IS INTENDED TO RUN FOR
- ☐ MORE THAN 6 MONTHS
- ☐ 1-6 MONTHS
- ☐ LESS THAN 1 MONTH
- ☒ NOT APPLICABLE (*not a tour*)
- ☐ OTHER (*Specify*) ______

h. PRODUCT UTILIZES THE FOLLOWING LASER EFFECTS
- ☒ FRONT SCREEN PROJECTIONS
- ☒ REAR SCREEN PROJECTIONS
- ☐ HOLOGRAPHIC DISPLAYS
- ☒ MULTIPLE REFLECTION/DIFFRACTION EFFECTS
- ☐ AUDIENCE SCANNING (*Also includes scanning any accessible uncontrolled areas.*)
- ☒ REFLECTIONS FROM STATIONARY MIRRORS OR MIRRORED SURFACES (*Beam Matrices.*)
- ☐ STATIONARY IRRADIATION OF ROTATING MIRROR BALLS, ETC.
- ☐ SCANNING IRRADIATION OF ROTATING MIRROR BALLS, ETC.
- ☐ FIBER OPTIC PROJECTIONS
- ☒ FOG, SMOKE, OR OTHER SCATTERING ENHANCEMENT EFFECTS
- ☐ OTHER (*Specify*) ______

8. **LASER RADIATION LEVELS**

LASER MEDIUM (*Ar, He-Ne, etc.*)	WAVE LENGTHS (nm)	PEAK POWER (*Watts*)
HELIUM NEON	632 8 nm	.05 watts
KRYPTON	488' - 647.1 nm	9 watts
ARGON	457.9 - 514.5 nm	25 watts
ARGON-KRYPTON	457.9 - 676.4 nm	28 watts
DIODE-PUMPED SOLID STATE	532 nm	11 watts
DIODE-PUMPED Nd:YV04	446 - 628 nm	19 watts

9. IF ANY LASER RADIATION IS PULSED OR SCANNED. GIVE THE PULSE DURATION AND RATE AND SCANNING FREQUENCY AND AMPLITUDE

PLEASE REFER TO SECTION 14 AND ATTACHMENTS

0. REASON FOR REQUESTING VARIANCE
- ☒ COMPLIANCE WITH THE LIMITS OF 21 CFR 1040.11(c) WOULD RESTRICT THE INTENDED USE OF THE PRODUCT BECAUSE COMPLIANCE WOULD LIMIT THE OUTPUT POWER TO THE EXTENT THAT THE DESIRED EFFECTS WOULD NOT BE SUFFICIENTLY VISIBLE
- ☐ OTHER OR ADDITIONAL EXPLANATION (*Specify*)

11. MANNER IN WHICH IT IS PROPOSED TO DEVIATE FROM THE REQUIREMENTS OFTHEAPPLICABLE STA-NDARD

- [X] IT IS PROPOSED TO DEVIATE FROM THE PROVISIONS OF 21 CFR 1040.11(c) IN THAT THE ACCESSIBLE EMISSION LEVEL'WOULD EXCEED THE ACCESSIBLE EMISSION LIMITS SPECIFIED IN 21 CFR 1040.11(c).
- [ ] IT IS PROPOSED TO DEVIATE FROM THE PROVISION OF 21 CFR 1040.11(c) AS FOLLOWS:

PLEASE REFER TO ATTACHMENTS

12. ADVANTAGES TO BE DERIVED FROM SUCH DEVIATION

- [X] LASER LIGHT SHOWS AND DISPLAYS ARE ACCEPTED POPULAR MEDIA IN ENTERTAINMENT AND THE ARTS. USE OF POWER'LEVELS IN EXCESS OF THE LIMITS IMPOSED BY 21 CFR 1040.11(c) IS NECESSARY TO ACHIEVE THE REQUIRED EFFECTS IN THESE MEDIA.
- [ ] OTHER OR ADDITIONAL ADVANTAGES (describe and explain)

PLEASE REFER TO ATTACHMENTS

13. EXPLAIN THE ALTERNATE MEANS OF RADIATION PROTECTION TO BE PROVIDED. (Check as many boxes as apply. In Item 14 "Remarks," justify any boxes not checked, using additional sheets as necesssary. State any other means of radiation protection that will be used.)

a. [X] ALL LASER PRODUCTS, SYSTEMS, SHOWS, AND PROJECTORS WILL BE CERTIFIED TO COMPLY WITH 21 CFR 1040.10 AND THE CONDITIONS OF THIS VARIANCE AND WILL BE REPORTED AS REQUIRED BY 21 CFR 1002.10 AND 1002.12 USING THE REPORTING GUIDES PROVIDED FOR SUCH PURPOSE. THESE ACTIONS WILL BE ACCOMPLISHED PRIOR TO ANY INTRODUCTION INTO COMMERCE.

b. [X] EFFECTS NOT SPECIFICALLY INDICATED IN THIS VARIANCE APPLICATION WILL NOT BE PERFORMED. NO OTHER EFFECTS WILL BE ADDED UNTIL AN AMENDMENT TO THE VARIANCE HAS BEEN OBTAINED AND THE REQUIRED REPORTS OR SUPPLEMENTS, AS APPLICABLE, HAVE BEEN SUBMITTED.

c. [X] SCANNING, PROJECTION, OR REFLECTION OF LASER AND COLLATERAL RADIATION (LIGHT SHOW RADIATION) INTO AUDIENCE OR OTHER ACCESSIBLE UNCONTROLLED AREAS WILL NOT BE PERMITTED EXCEPT FOR DIFFUSE REFLECTIONS PRODUCED BY THE ATMOSPHERE, ADDED ATMOSPHERIC SCATTERING MEDIA, AND TARGET SCREENS.

d. [X] LASER RADIATION LEVELS IN EXCESS OF THE LIMITS OF CLASS I WILL NOT BE PERMITTED AT ANY POINT LESS THAN 3.0 METERS ABOVE ANY SURFACE UPON WHICH PERSONS OTHER THAN OPERATORS, PERFORMERS, OR EMPLOYEES ARE PERMITTED TO STAND OR 2.5 METERS BELOW OR IN LATERAL SEPARATION FROM ANY PLACE WHERE SUCH PERSONS ARE PERMITTED To BE. OPERATORS, PERFORMERS, AND EMPLOYEES WILL NOT BE REQUIRED OR ALLOWED TO VIEW RADIATION ABOVE THE LIMITS OF CLASS I OR BE EXPOSED TO RADIATION ABOVE THE LIMITS SPECIFIED IN 21 CFR 1040.11(c).

e. [X] ANY PRODUCT WHICH RELIES ON SCANNING TO MEET ACCESS, EXPOSURE, OR PRODUCT CLASS LIMITS WILL INCORPORATE A SCANNING SAFEGUARD SYSTEM WHICH DIRECTLY SENSES SCANNER MOTION AND WHICH WILL REACT FAST ENOUGH TO PRECLUDE EXCEEDING THE APPLICABLE LIMIT.

f. [X] ALL LASER LIGHT SHOWS SHALL BE UNDER THE DIRECT AND PERSONAL CONTROL OF TRAINED, COMPETENT OPERATOR(S). THE OPERATOR(S) WILL:

(1) IMMEDIATELY TERMINATE THE EMMISSION OF LIGHT SHOW RADIATION IN THE EVENT OF ANY UNSAFE CONDITION;

(2) BE LOCATED WHERE ALL BEAM PATHS CAN BE DIRECTLY OBSERVED AT ALL TIMES; AND

(3) BE AN EMPLOYEE OF THE VARIANCE HOLDER WHO WILL BE RESPONSIBLE FOR THE TRAINING AND CONDUCT OF THE OPERATOR.

g. [X] THE MAXIMUM LASER PROJECTOR OUTPUT POWER WILL NOT EXCEED THE LEVEL REQUIRED TO OBTAIN THE INTENDED EFFECTS.

h. [X] THE PROJECTION SYSTEM (I.E., THE PROJECTOR AND ALL OTHER COMPONENTS USED TO PRODUCE THE LIGHTING EFFECTS) WILL BE SECURELY MOUNTED OR IMMOBILIZED TO PREVENT UNINTENDED MOVEMENT OR MISALIGNMENT. BEAM LIMITERS WILL BE PROVIDED AS AN INHERENT PART OF THE SYSTEM DESIGN TO PREVENT OVERFILLING OF SCREENS, BEAM STOPS; TARGETS, ETC.

i. [X] LASER PROJECTORS WILL NOT BE DELIVERED TO ANY OTHER PARTY UNDER AN AGREEMENT OF SALE, LEASE, OR LOAN UNLESS'AND UNTIL THE RECIPIENT DEMONSTRATES THAT THEY HAVE A VARIANCE IN EFFECT AT THE TIME OF DELIVERY THAT'PERMITS'THEM TO PRODUCE LASER LIGHT SHOWS INCORPORATING SUCH PROJECTOR.

j. [X] IN ADDITION TO THE REQUIREMENTS OF 21 CFR 1040.10(h), THE MANUFACTURER OF LASER PROJECTORS/SYSTEMS WILL PROVIDE TO PARTIES WHO PURCHASE, LEASE, OR BORROW THE EQUIPMENT, ADEQUATE USER'S INSTRUCTIONS FOR SAFE INSTALLATION AND OPERATION AND WHICH EXPLAIN THE RESPONSIBILITY OF THE RECIPIENT AS AN INDEPENDENT LIGHT SHOW MANUFACTURER TO SUBMIT THE REQUIRED REPORTS AND APPLY FOR AND OBTAIN A VARIANCE FROM CDRH PRIOR TO INTRODUCTION INTO COMMERCE OF ANY LASER LIGHT SHOWS.

k. [X] THE REQUIREMENTS OF 21 CFR 1002.30(a)(l) AND (2) WILL BE ACCOMPLISHED THROUGH THE USE OF WRITTEN PROCEDURES FOR SETUP, ALIGNMENT, TESTING, AND PERFORMANCE OF EACH SHOW. THESE PROCEDURES WILL BE IN SUFFICIENT DETAIL TO ENSURE COMPLIANCE WITH 21 CFR 1040.10, THE CONDITIONS OF THIS VARIANCE, AND THE CONTROL OF ACCESS TO RADIATION AREAS USING THE PROCEDURES DESCRIBED IN THE ANSI 2136.1 STANDARD FOR THE SAFE USE OF LASERS (AMERICAN NATIONAL STANDARDS INSTITUTE, 1430 BROADWAY, NEW YORK, NY 10018) OR ANY OTHER EQUIVALENT USER CONSENSUS STANDARD AND, WHERE APPLICABLE, STATE OR LOCAL REQUIREMENTS. LASER RADIATION AREAS WHICH CAN CONTAIN RADIATION LEVELS ABOVE THE LIMITS SPECIFIED IN 21 CFR 1040.11(c), WILL BE CLEARLY IDENTIFIED BY THE POSTING OF WARNING SIGNS AND/OR RESTRICTING ACCESS THROUGH PHYSICAL MEANS (SUCH AS PRESSURE SWITCHES, PHOTOCELLS, BARRIERS, GUARDS, ETC.). THESE REQUIREMENTS APPLY TO TEMPORARY AREAS (SUCH AS DURING SET-UP AND ALIGNMENT PROCEDURES) AND TO FINAL OR PERMANENT AREAS. THE VARIANCE HOLDER WILL RETAIN THE RECORDS OF THESE PROCEDURES AND THE RESULTS OF ALL TESTS AS REQUIRED BY'21 CFR 1002.31. A COPY OF THE VARIANCE APPLICATION, THE APPROVAL LETTER, CURRENT PROCEDURES, AND RECORDS RELATING TO EACH PARTICULAR SHOW WILL BE WITH THE OPERATOR OR OTHER RESPONSIBLE INDIVIDUAL AND WILL BE MADE AVAILABLE FOR INSPECTION BY FDA AND OTHER RESPONSIBLE AUTHORITIES.

I. [X] ADVANCE WRITTEN NOTIFICATION WILL BE MADE AS EARLY AS POSSIBLE TO APPROPRIATE FEDERAL, STATE, AND LOCAL AUTHORITIES PROVIDING SHOW ITINERARY WITH DATES AND LOCATIONS CLEARLY AND COMPLETELY IDENTIFIED, AND A BASIC DESCRIPTION OF PROPOSED EFFECTS INCLUDING A STATEMENT OF THE MAXIMUM POWER OUTPUT INTENDED. SUCH NOTIFICATIONS WILL BE MADE, BUT NOT NECESSARILY BE LIMITED, TO:

(1) THE CENTER FOR DEVICES AND RADIOLOGICAL HEALTH, OFFICE OF COMPLIANCE (HFZ-312), 8757 GEORGIA AVE., SILVER SPRING, MD 20910, PROVIDING THE INITIAL AND CLOSING DATES FOR FIXED INSTALLATIONS AND THE ITINERARY FOR MOBILE SHOWS. IN ADDITION, UNLESS ALL ASPECTS OF EACH SHOW HAVE BEEN REPORTED AND THE ACCESSION NUMBERS CLEARLY REFERENCED, EACH NOTICE WILL INCLUDE DETAILED DESCRIPTIONS OF EACH SHOW AND A LISTING OF ALL EFFECTS TO BE PERFORMED IN SUFFICIENT DETAIL TO CONFIRM COMPLIANCE WITH THE REGULATIONS AND THIS VARIANCE.

(2) THE FEDERAL AVIATION ADMINISTRATION (FAA) FOR ANY PROJECTIONS INTO OPEN AIRSPACE AT ANY TIME (I.E.. INCLUDING SET-UP, ALIGNMENT, REHEARSALS, PERFORMANCES, ETC.). IF THE FAA OBJECTS TO ANY LASER EFFECTS, THE OBJECTIONS WILL BE RESOLVED AND ANY CONDITIONS REQUESTED BY FAA WILL BE ADHERED TO. IF THESE CONDITIONS CAN NOT BE MET, THE OBJECTIONABLE EFFECTS WILL BE DELETED FROM THE SHOW.

(3) STATE AND LOCAL RADIATION CONTROL OFFICES/AGENCIES FOR ALL SHOWS TO BE PERFORMED WITHIN THEIR JURISDICTIONS. ALL REQUIREMENTS OF STATE AND LOCAL LAW WILL BE SATISFIED AND ANY OBJECTIONS RAISED BY LOCAL AUTHORITIES WILL BE RESOLVED OR THE EFFECTS DELETED. (LISTS OF FEDERAL AND STATE OFFICES ARE AVAILABLE FROM THE CENTER FOR DEVICES AND RADIOLOGICAL HEALTH UPON REQUEST.)

14. REMARKS

Our laser projector is designed to scan (i.e. reflect from mirrors attached to galvanomic scanners) laser beams direclty onto a screen surface to form patterns in such a way that laser and collateral radiation, measured where the audience is located, does not exceed the limits of Class I during operation. Each of the laser projector scanners has frequency range of: 60 cycles per second (minimum) to 4000 cycles per second (maximum). The amplitude (i.e. angle of laser beam deflection from each scanner) is: 0 degrees (minimum) to 180 degrees (maximum).

Diode-pumped solid state laser using an optical parametric oscillation to produce 446 - 628 nm wavelengths.
Peak pulse power: 34 kwatts
Avg. pulse power: 19 watts
Rep. rate: 80 MHZ, width: 7ps

Please also refer to attachments G-K.

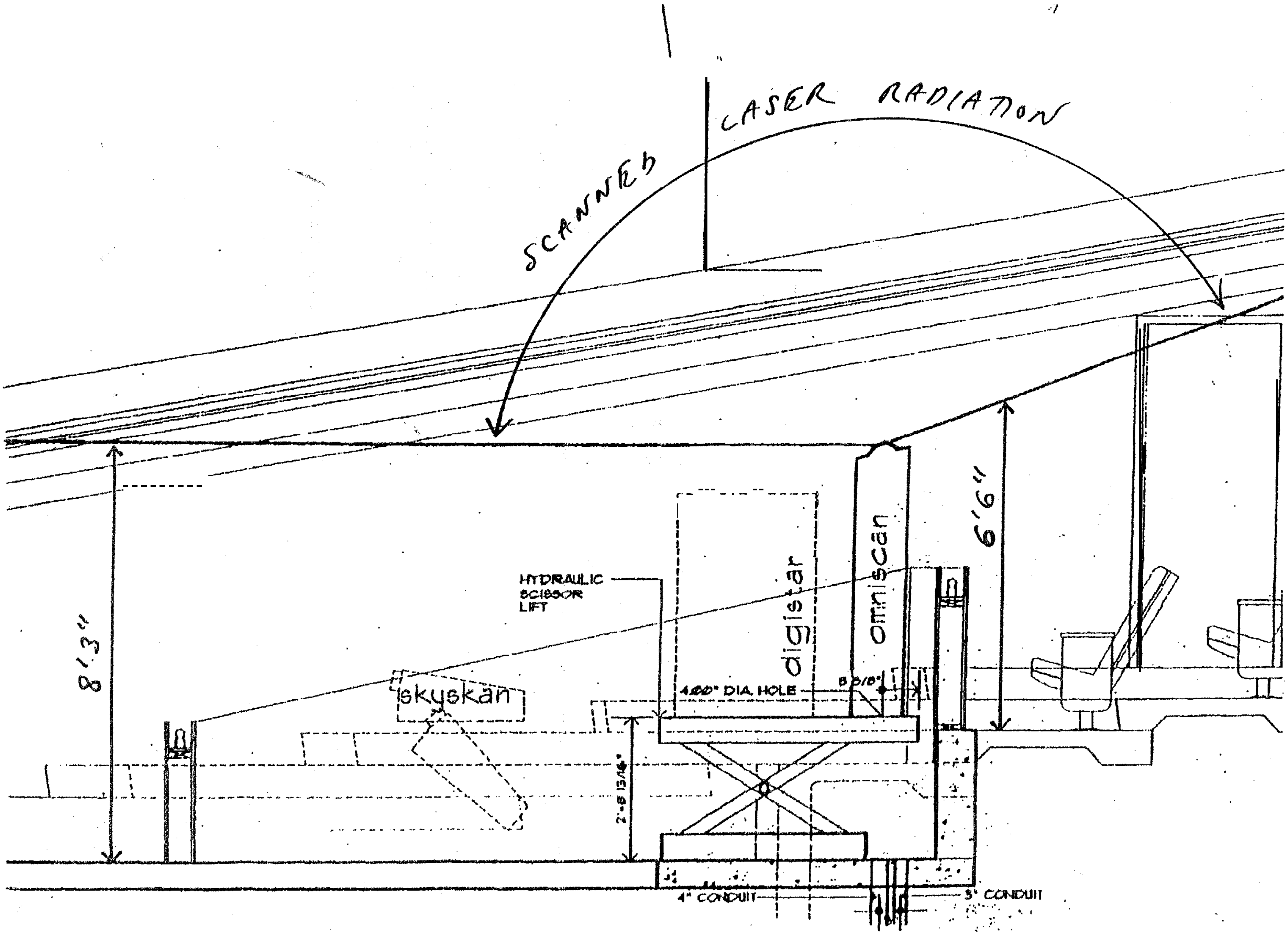
CERTIFICATION

I CERTIFY that all of the above information and statements are true, complete, and correct to the best of my knowledge and acknowledge that my variance application may be denied or my variance may be revoked if this application is found to be false, misleading, or incorrect in any material way. I have submitted and will submit all reports required by 21 CFR 1002.10 and 1002.12 on the laser equipment and show(s). I further understand that I may be required by regulation or by the Director, Center for Devices and Radiological Health, to supply such other information as may be necessary to evaluate and act on this application.

15. SIGNATURE	16. NAME (Type or Print)	17. TITLE
[signature]	Ward Davis	President

☆ U.S. GOVERNMENT PRINTING OFFICE:1987-185-695/69119 Dk: 7m

ATTACHMENT G



BLUEPRINT OF OMNISCAN INSTALLATION FOR OMNISPHERE THEATER

Attachment H

Request for Modification of Access Limits for Special Applications of the Omniscan™ Projection System

The Omniscan™ Projection System is a new, proprietary invention (Patent No. 5,546,139) incorporating breakthroughs in laser display technology. Omniscan™ is designed to superimpose (via laser projection) computergraphic imagery upon the starfield of a planetarium theater. The primary use is for the dynamic display of astronomical phenomena in educational shows. In order to achieve its intended function, the Omniscan™ is designed to project a single, full-color vectorgraphic image 360” x 180” upon the curvilinear screen of a planetarium theater. To achieve this novel (i.e., extremely wide) 360” projection angle, the Omniscan™ must be located near the center of the dome adjacent to the star projector.

Please note that in the 1970s, when laser shows first were displayed in planetarium theaters, the maximum possible scan angle was 40” optical and the laser projector was located at the perimeter of the dome. Since that time, there have been very few changes in the way laser shows have been displayed in planetarium theaters. However, planetarium theaters have undergone a significant architectural change whereby the newer theaters feature tilted domes (approximately 20-30°) with unidirectional, tiered (i.e. raked) seating. These newer style planetarium theaters are generally referred to as omnitheaters.

It is our assertion that the novel developments of both the Omniscan™ projector (i.e. 360” x 180” scan angle) and omnitheaters (i.e. 20-30° tilted domes) were not anticipated by the laser safety standards when they were initially formulated. Consequently, in order to achieve the intended function of our product and be able to safely introduce it into the marketplace, we have designed the Omniscan™ with uniquely redundant safety features, which will both prevent and preclude exposure to unacceptable laser radiation levels in the event of a performance failure in the system.

In lieu of meeting the three meter vertical clearance, these alternative safety features have been employed by which acceptable exposure levels will be maintained:

1) **Safety Interlocks** - with gravity-fed mechanical shutter to terminate emission in the event of power failure, signal interruption, removal of protective housing, etc.

2) **Software Protection** - to suppress the level of radiation below the three meter limit; determines the velocity and size (i.e., power levels) of an image **prior** to signal transmission (i.e., X, Y, Z coordinates and intensity levels) to the projector.

3) **Internal Fixed Iris** - to preclude audience exposure under "worst case scenario" of total system failure.

4) **Acousto-Optic Modulator** - with scan-fail sensing circuitry to immediately terminate emission in the event that energy levels are exceeded. Please note that only the first order beam from the PCAOM is emitted from the projector and in the event of any failure, no zero order beam can be emitted.

5) **Mechanical Scanner-Type Shutter** - with dedicated scan-fail sensing circuitry similar to that used in conjunction with the PCAOM above.

6) **External Physical Masking** - to prevent any "stray beams" (under worst case scenario) from exceeding vertical distance limits.

Attachment I

Request For Modification of Scan Failure Limits For the Omniscan™ Projector

Currently, during scan failure conditions, a scan failure safeguard system must limit the total exposure possible to Class I limits. To comply with these limits, the safeguard system in the Omniscan™ projector would need to have a response time of approximately 67nS in order to shutter a 3W beam before Class I limits are exceeded. This response time is unobtainable using current accessible technology. It is the goal of this request to demonstrate to the Office of Compliance that, given the Omniscan's™ intended function, its operational environment and the current safeguards that can be installed in the Omniscan™, that scan failure response limits may be relaxed but would still maintain reasonable safety margins.

Intended Function of the Product:
The Omniscan™ projector projects vector-scanned laser images onto a hemispherical projection surface, such as a planetarium dome. The unique and key selling point of the Omniscan™ projector is that it is capable of scanning an image over the entire hemispherical projection surface. In no way is the Omniscan™ projector intended for any type of audience scanning.

The Operating Environment:
The primary target use of the Omniscan™ projector is in planetariums. Its normal use is to augment typical star shows/talks. During these shows, which last anywhere from 20 minutes to an hour, the audience remains seated, viewing the graphics projected onto the planetarium dome. Most of the images projected onto the dome will be centered and will only occasionally fill the entire size of the dome. In most planetariums, even when the laser image is filling the dome, the beam is above the three-meter height requirement. However, in certain tilted domes, when very large images are scanned, the three-meter height requirement may be abrogated, and it is possible that an audience member could have access to the scanned beam. It should be pointed out, however, that an audience member would have to stand up in order for this to happen, and that a standing position is not normal for viewing a show.

Current Safeguards Installed:
The Omniscan™ projector has all required safety labels attached which are clearly visible. In addition, the projector housing has redundant interlocks that shut down the laser should one of the housing panels be removed. As required, an operator keyswitch is provided which is easily accessible in order to stop laser emission should the need arise. (It should be noted that an operator will be at the Omniscan™ controls at all times during a show.) Both an accousto-optic modulator and a mechanical shutter are used in series for blanking/shuttering the laser beam. When required, a physical beam block mask will prevent the laser beam from scanning accessible areas.

Scanning Safeguard System:

In installations that might abrogate the three-meter rule, redundant hardware and software-based safeguard systems will be included in the Omniscan™ that would shutter the beam preventing dangerous exposures should a scan failure or other condition be detected that would cause accessible limits to rise above Class II levels. The hardware and software safeguard systems are separate systems acting together to prevent and preclude hazardous emission levels.

The software safeguard system which is integral to the main image computer supplying image data to the Omniscan™ precludes hazardous emission levels by not allowing image data to be transmitted to the Omniscan™ that would cause the scan velocity or beam dwell time to exceed Class II levels. For more information on the software safeguard system refer to the "Theory and Operation of the Software Protection" document.

While the software safeguard system acts to prevent images/signals that would cause high emission levels, the hardware system will prevent high emission levels by directly monitoring the scanner mirror position. Obviously, the hardware safeguard system in the Omniscan™ does not respond quickly enough to limit accessible emissions to Class I limits should a scan failure condition occur. (If it did, there would be no need for this request.) The ANSI 1mW for ¼ second aversion response limit was chosen for the accessible limit for the Omniscan™ because it is an obtainable goal that provides an adequate margin of safety and does not limit the intended function of the product. In practice, the actual hardware safeguard system shuts off the beam before the 1mW for ¼ second level is reached. For a more detailed explanation of the scanning safeguard system used in the Omniscan™, refer to the "Omniscan™ Scan Failure Safeguard" document.

* * *

It is understood that the current scanning safeguard system in the Omniscan™ limits accessible emissions to 1.9×10^{-4} J and that the 1mW for ¼ second (2.5×10^{-4} J) ANSI standard on which the Omniscan™ limit is based is an average limit. However, because of the following circumstances, it is felt that this limit provides a reasonable and safe operating environment given that:

1) While the beam is occasionally below the three-meter height requirement, its lowest point is 6½ feet (2 meters) above the floor. The beam will always be above eye level, even for above-average height persons. A physical beam block mask on the Omniscan™ prevents the beam from going any lower than two meters.

2) People will remain seated during a show. The only reason that an audience member may be standing during a show is to exit the planetarium. It should be noted that most planetariums have a non re-admittance policy which prevents people from entering and exiting the planetarium during a show.

3) The planetarium is a controlled environment. Operator(s) are present and nearby the Omniscan™ controls at all times.

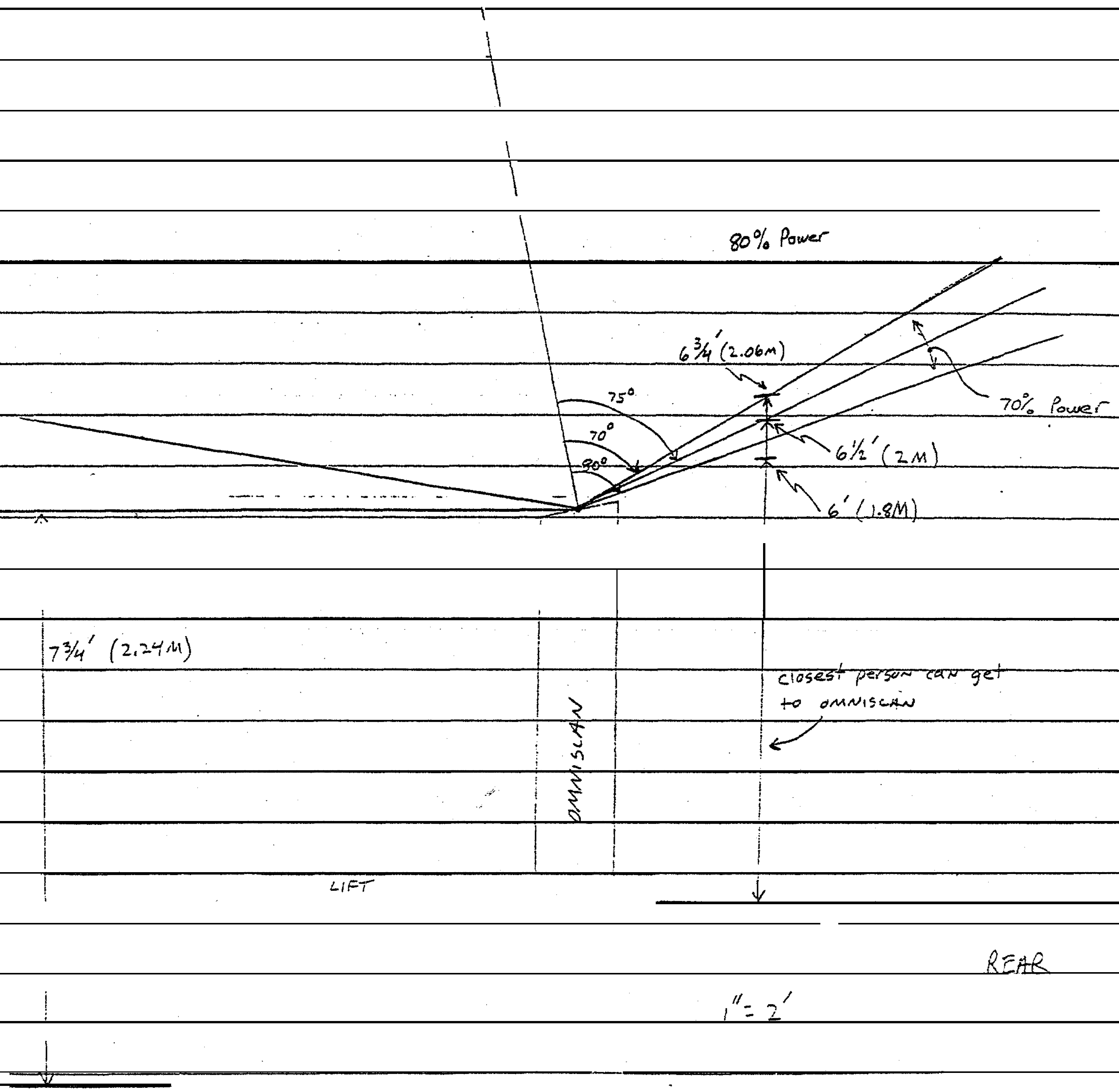
4) All operators will be knowledgeable about laser safety and will always be alert to the condition of the audience.

5) There will be no cameras or binoculars allowed in the planetarium.

6) It is highly unlikely that a scan failure would cause a scanner to stop scanning in "zero" time -- some inertia does exist. If a bearing were to freeze or if some other malfunction were to occur, it would be unlikely that the scanner would stop in less than the sampling period of 83uS. There is no data or tests to support this claim, but it should be considered. (The scanners used in the Omniscan™ have a small angle step response time of 300uS, which is considerably longer than the 83uS sampling period.)

* * *

As a review, only under extremely unusual circumstances (such as a person whose height is greater than two meters or a person standing on a chair or other raised platform, which is not allowed during a show) will a person ever have possible access to the scanned laser beam. Because the potential of possible exposure to the beam exists (however unlikely), a scanning safeguard system has been implemented in the Omniscan™. While this safeguard system cannot limit exposure to Class I limits, it is felt to be adequate to protect the public given the above statements. Another way of looking at this request is to consider that we are asking for a two-meter height compromise rather than the specified three-meter height requirement. We hope that the added safety precautions allow this compromise and the full use of the Omniscan™.



COLUMBUS, GEORGIA INSTALLATION

FRONT

Attachment J

proposed scan failure safeguard circuit.

A proposed circuit will measure the distance the beam travels in a given time increment. This distance along with the time increment will allow calculation of the beam velocity. Note the term velocity -- frequency is not calculated. (A beam scanning a square wave will have zero velocity except when a transition occurs.)

Since velocity is distance divided by time, the circuit will expect the beam to move a set distance in a given amount of time. If the beam does not move at least this distance in the alloted time, the velocity is too low and the beam will be shut off. Both the distance and the time increment will have to be chosen carefully in order for the circuit to respond fast **enough** to limit exposure. These values are calculated as follows:

Refer to figure 1. Since the Omniscan projector can scan a full 180 degrees by 360 degrees, the worst-case area of accessible exposure is a circle of 2.5' radius. This gives a total scan distance of 478.5 cm (the circumfrence of the circle). If this scan distance is divided up into 256 chunks, each chunk would be 1.87cm long. (This also is approx. equal to 1.4 degrees of scan angle). Now at this distance (1.87cm) how fast do we need to be scanning to be below the 1mW for 1/4 second maximum exposure? If we assume the worst case scan waveform (a square wave) or simply the absolute worst case (a stopped beam), how long will it take the beam to reach the 1mW for 1/4 second energy level? A beam power of 3W is chosen (the acutual output power of the Omniscan lens is less due to optical losses).

Solution: knowing that 3W X 1second = 3Joules and that 1mW for 1/4second = 0.000253 we can write: 3X =3

3xy=.00025

where x = 1 for 1 sec.

solving for y yields a time of 8.3X10^-5 or 83 microseconds. 1/8.3X10^-5 = 12048Hz which is the absolute minimum sample rate (time increment) necessary to shutter (via A.O. device) a 3W beam before it goes beyond the 1mW for 1/4 second energy level. The ultimate sample rate would be chosen to be 5% faster allowing for any circuit delays.

The distance of 1.87cm is about 10X the beam diameter which further increases the circuit threshold before the 1mW for 1/4 second level is reached.

Two proposed circuits can perform the necessary sampling and calculations/comparisons. In each circuit, the input signal is the actual mirror position taken from the position sensor in the scanner. It is extremely unlikely that a malfunction in the postion sensor would cause an oscillation thereby 'fooling' the safe guard circuit. The circuits are outlined as follows:

Refer to figure 2. In this circuit, the A/D converter will sample the input and will store its value in latch 'A'. Then at the specified time interval, the A/D will sample the input again and will store this value in latch 'B'. The comparator will be enabled and the two values will be compared. If the two values are equal, this means the beam did not move fast enough in a particular axis. Both x and y shutter outputs are anded together. 'Too slow will go high when ever the beam slows down below the threshold level. This signal is anded with 'safety zone' which goes high when ever the beam approaches the 3 meter height. Two such circuits will be in series to provide a back-up. In addition to driving an A.O., the circuit will also drive a mechanical shutter. While the mechanical shutter can not respond as quickly as an A.O., it can act as a back-up in the very unlikely event that the A.O. should fail in the 'on' state.

Figure 3 shows the second proposed circuit. This circuit basically performs the same task as the above circuit with the exception that microprocessors are used. Each microprocessor will act as a back-up for the other. A watch-dog time-out circuit connected to each microprocessor will shutter the beam in case the microprocessor should fail.

Power calculations including losses:

Laser output power: 3.5W

Efficiency before lens input: 80%

Efficiency of lens @ 0 - 140 deg. scan: 80%

Efficiency of lens @ 140 - 170 deg. scan: 70%

Efficiency of lens @ 170 - 180 deg. scan: 60%

(above efficiency amounts verified by direct measurements)

Total efficiency @ 150 deg. (2 meter height) scan: 56%

Total power out of lens @ 150 deg. scan: 1.96W

Total power out of lens @ 0 - 140 deg. scan: 2.24W

At 2 meter height (6 1/2 feet) with 1.96W output:

sample interval = 83uS

Scan-Fail condition output power: 1.96W X 83uS = 0.000165

Minimum scan frequeny: 47.1Hz (based on 83uS sample interval and 2 1/2 feet radius from Omniscan)

Integrated power at any given location while scanning: 7.5mW

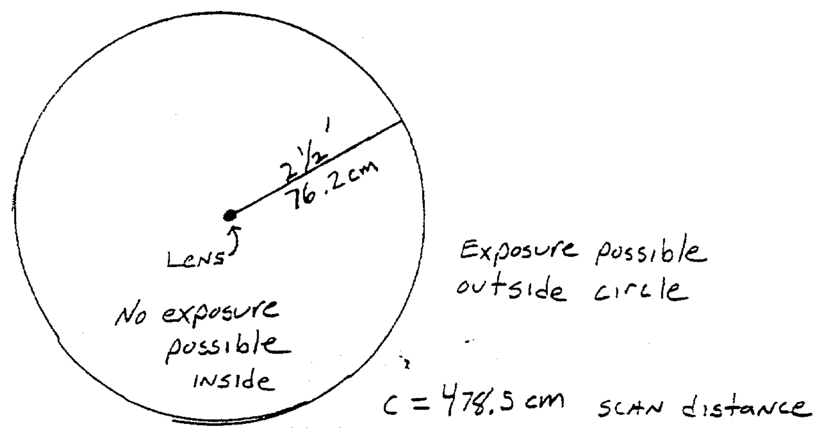
At 2.06 meter height (6 3/4 feet) with 2.24W output:

sample interval = 83uS

Scan-Fail condition output power: 2.24W X 83uS = 0.000195

Minimum scan frequency: 47.1Hz

Integrated power at any given location while scanning: 8.8mW



TOP VIEW

FIGURE 1.

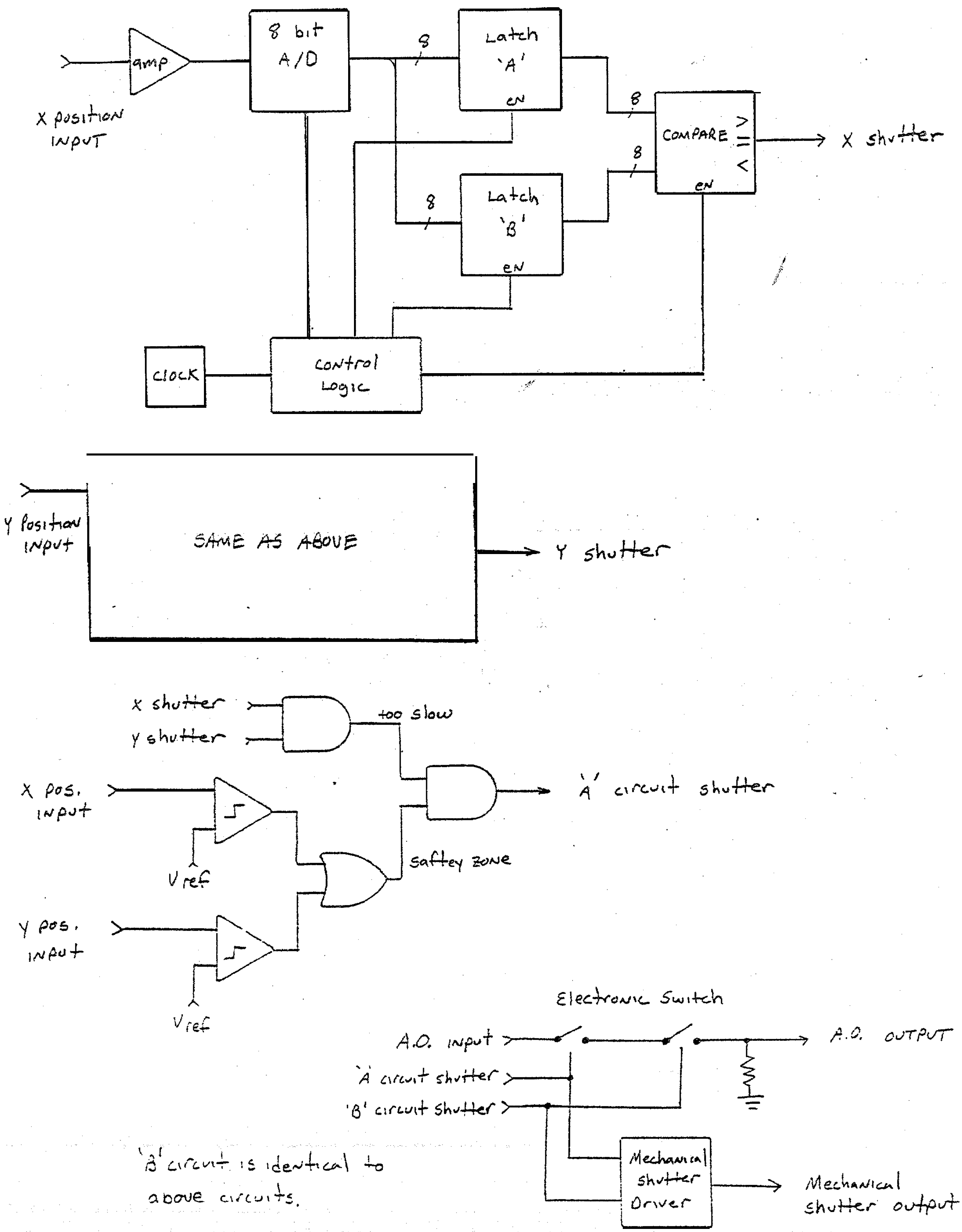
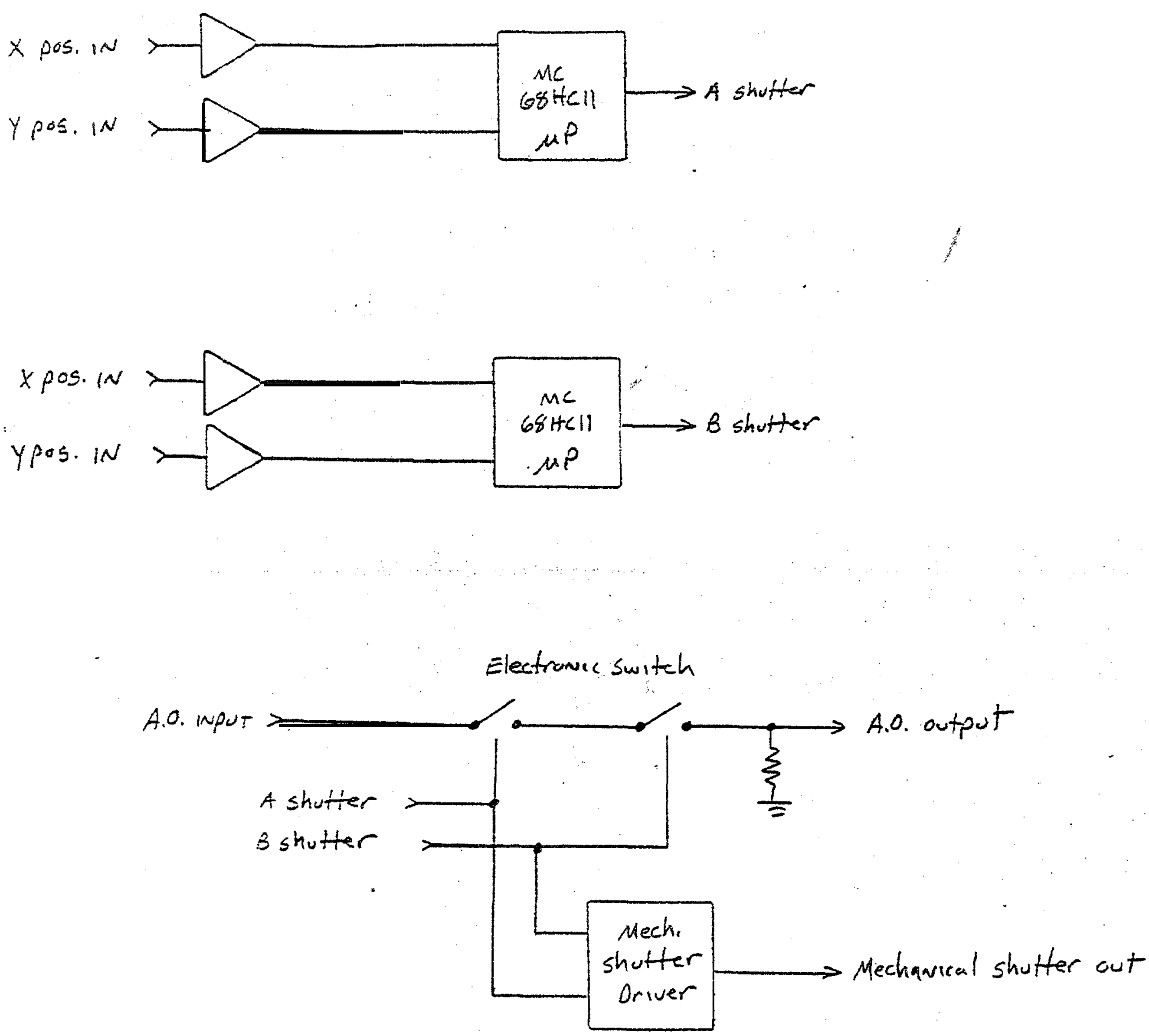

X position input
amp
8 bit A/D
8
Latch 'A'
EN
Latch 'B'
EN
COMPARE
>
=
<
EN
X shutter
clock
control logic
Y position input
SAME AS ABOVE
Y shutter
X shutter
Y shutter
too slow
X pos. input
Vref
Y pos. input
Vref
saftey zone
'A' circuit shutter
Electronic Switch
A.O. input
'A' circuit shutter
'B' circuit shutter
A.O. OUTPUT
Mechanical shutter Driver
Mechanical shutter output
'B' circuit is identical to above circuits.

FIG. 2



Each 68HC11 has built-IN A/D and watch-dog timers

FIG. 3

Attachment K

THEORY AND OPERATION OF SOFTWARE PROTECTION

The intensity of the laser beam exiting the Omniscan projector is determined by a computer program written in the Visual Basic programming language. This program is constantly looping in order to execute various events in time. During this loop comparisons are made between the position of an image, its scanning speed and its overall size. The information derived from these comparisons is then used to vary the intensity of the beam in order to maintain a measured power level of below Class I.

First, a comparison is done between the X axis and Y axis position values. This is done by finding the square root of the X vaiue squared plus the Y value squared (see Fig.1).

```
movXA2 = Abs(movXA)
movYA2 = Abs(movYA)
  mov = Sqr((movXA2 ^ 2) + (movYA ^ 2))
```

Fiaure 1

This value is then compared to a user set value which is derived from the position of a beam at the 3 meter height (see fig.2). Once the beam has passed this value a new value is determined which is passed on to a comparison with image size.

```
if mov > val10 Then
    vail = (mov - (val10))
    val2 = (100 * (val1 / (100 - val10)))
End If
```

Fiaure 2

The comparison between image size and the vaiue determined by position controls completely the overall intensity of the beam (see fig.3). This value (csizA) is passed to a library which directly controls the voltage output by the computer (see fig.4).

```
sclA2 = Abs(sclA)
vai6 = 1 - ((sclA2 / 100) * val5)
```

Fiaure 3

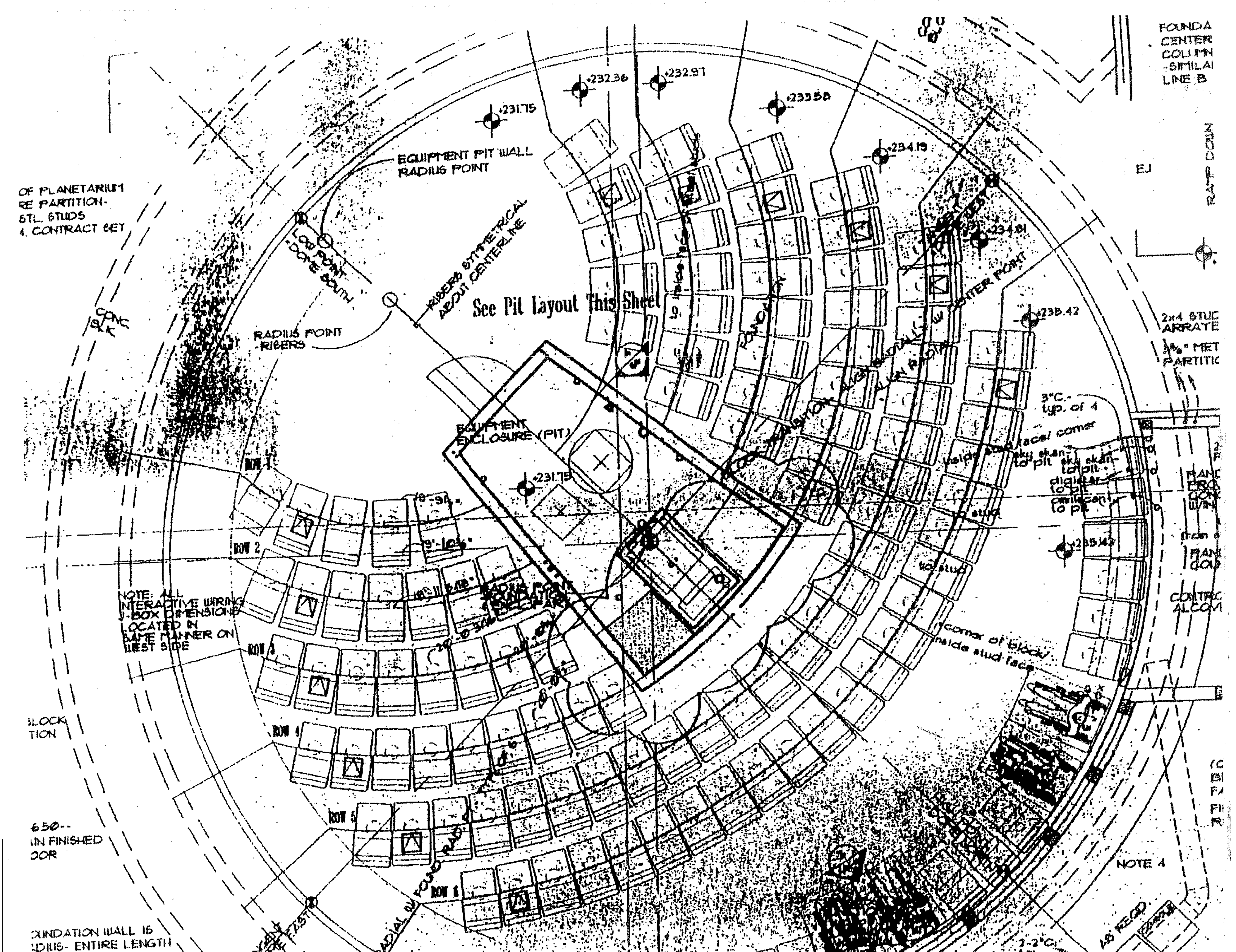
```
csizA = 100 - ((val2 * (val3 * val6)))
```

Figure 4

The complete oroarammina code is shown below:

```
'-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
val10 = 70      '—point on aome (percentage, where reduction begins. cannot he zero.
val3 = 1        '—amount cf intensity reduction. 1 is off totally. .5 is had.
val5 = 1        '—amount of scale factoring. i factors 1 CO percent of scale..5 is half.
'-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

```
While off = o                        '—Top of loop
'— Distance from center comparison to determine value for 'movX'
movXA2 = Abs(movXA)
movYA2 = Abs(movYA)
mov = Sqr((movXA2 ^ 2) + (movYA ^ 2))
   If mov > 100 Then mov = 100

'— Gets value for 'val1' once 'movX' is greater than 'val1 0', then
'—— gets 'val2'.
If mov > val10 Then
   val1 = (mov - (vail 0))
   val2 = (100 * (val1 / (100 - val10)))
End If

'— Factors in the overall size of the image (per track) and only reduces
'—— intensity when scanning (image scale) is reduced. 'Val5' is used
'-to modulate amount of scale factoring.
sclA2 = Abs(sclA)
val6 = 1 - ((sclA2 I 100) * val5)

'— Gets 'csizA' by allowing 'val3' to modulate 'val2' both of which are
'-then modulated by 'val6' and subtracted from full intensity of 100.
csizA = 100 - ((val2 * (val3 * val6)))


SetWorkingTracks TrackA
DisplayCsize csizA                   '-Final intensity value, controls beam directly
DisplayUpdate

Wend                                 '---Bottom of loop
```



FOUNDA
CENTER
COLUMN
-SIMILAI
LINE B
RAMP DOWN
EJ
+232.36
+232.97
+231.75
+233.58
+234.19
+234.81
+235.42
+235.42
+231.75
EQUIPMENT PIT WALL
RADIUS POINT
OF PLANETARIUM
RE PARTITION-
STL. STUDS
4. CONTRACT SET
LOW POINT
-DOME SOUTH
RISERS SYMMETRICAL
ABOUT CENTERLINE
See Pit Layout This Sheet
CONC
BLK
RADIUS POINT
-RISERS
2x4 STUD
ARRATE
METAL
PARTITIO
3"C.-
typ. of 4
EQUIPMENT
ENCLOSURE (PIT)
ROW 1
ROW 2
ROW 3
ROW 4
ROW 5
ROW 6
NOTE: ALL
INTERACTIVE WIRING
J-BOX DIMENSIONS
LOCATED IN
SAME MANNER ON
WEST SIDE
CONTRAC
ALCOM
corner of block/
inside stud face
to stud
BLOCK
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IN FINISHED
OOR
NOTE 4
OUNDATION WALL IS
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PLACE STICKER AT TOP OF ENVELOPE
TO THE RIGHT OF RETURN ADDRESS

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