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ATARI®
Atari, Inc.
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A Warner Communications Company

TITLE
7800 RELIABILITY GUIDELINES

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ATARI PRODUCTS DEVELOPMENT

ENVIRONMENTAL/RELIABILITY ENGINEERING

PRODUCT 7800

SUBJECT RELIABILITY GUIDELINES

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DATA TAKEN BY N/A DATE

REVIEWED BY *E.R. [illegible]* DATE *October 5, 1983*
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DIRECTOR, DESIGN ASSURANCE

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RELIABILITY GUIDELINES

INTRODUCTION

Optimum reliability and product value; a) originates with design decisions, b) is maintained through application of controlled processes, c) is critically dependent on reliability of components, and d) must be monitored constantly to assure continuing success.

Reliability-oriented design practices are critical factors in maximizing reliability within the functional and cost objectives required to provide a commercial product with maximum value to our customers.

The intrinsic reliability of a good design can be seriously compromised through failure to follow design documentation and/or to maintain controlled production processes.

Continuing success for both design and production reliability contribution depends on recognizing that many factors are involved, with each subject to potential change at any time. These changes may not be corrected in a timely manner unless there is a feedback system capable of providing information to promote prompt definition of abnormal conditions. Feedback must cover all factors involved, including vendor reliability, production processes, and most importantly, field performance in our customers' applications.

COMPONENTS: Product reliability is ultimately determined by the reliability of the components used. Every effort must be made to encourage the use of components with a history of reliable performance.

A. New Devices. Due to device complexity and vendor production learning factors of fabrication and process, the new unproven MARIA LSI chip, must have 100% device testing and burn-in for the first six (6) months of production. (Reference Table I.)

B. Preferred Parts (existing). Use established quality sampling plans for active, passive and mechanical parts.

C. Reliability Testing at the component level is to establish the failure rates and failure modes of the electronic components. Further life testing of mechanical parts will establish the wearout characteristics. (Note: Principal 3600 high failure rate components by % contribution - Table I.)

D. Vendor Selection and Surveillance

- o Selection and control
- o Qualification of a specific vendor part
- o Vendor survey teams include members capable of evaluating the following areas:

  - Financial responsibilities
  - Production capability
  - Technology utilized and degree of expertise demonstrated
  - Production process control methods
  - Quality and reliability program implementation

- o Vendor surveillance (follow up):

  - Receiving inspection results
  - Monitoring of reliability performance in production and field environments
  - Random auditing of vendor's facility
  - Audit testing results in-house

E. Failure analysis program for components has the objective of identifying potential fabrication and process failures prior to preferred parts usage and actual fabrication and process failure identification during usage.

- o Data analysis
- o Problem identification
- o Corrective action

F. Receiving inspection testing and data may be best indicated by the following checklist:

- o Determine the level of testing required, i.e., 100% testing or <100% testing.
- o Provide resources and identify the expectations.
- o Provide inspection test procedures that ensure all necessary tests and inspections have been performed.
- o The test and visual inspection record shall contain the following information:

  (1) Lot number
  (2) Date
  (3) Inspection
  (4) Quantities involved
  (5) Disposition of the material
  (6) Reasons for rejection if the material is rejected

- o All defect information is to be entered into a failure information system and corrective action provided by the responsible function following analysis of the data and problem identification.

PRIME ASSEMBLIES: Continued effort must be made to provide product assembly reliability through the application of controlled processes.

A. Console

1. The return rate goal for the console is <1.75% over an operating time of 180 hours.

2. PCB (Printed Circuit Board) testing to include the following:

   - o In-circuit test capability or equivalent.
   - o PCB burn-in @ 55 degrees C for two hours minimum.
   - o Power on/off cycling, one minute on, twelve seconds off, for the first hour of PCB burn-in.

3. Environment and qualification testing done at the product level.

B. All System Components less console (controllers, power adaptor, switch box and cartridge)

The return rate goal for the system components less console is <0.5% over an operating time of 180 hours.

C. Workmanship standards are to be such that defects are identifiable as follows:

- o Specific workmanship problems within each assembly.
- o Most significant general type of workmanship problem.
- o Where, in the production process, the defect was found.

D. Process control of assemblies are controlled by several methods. Every assembly will be covered by a complete material list showing every component or part used and information showing the location of the item in the assembly. When more complex assemblies are involved, an assembly drawing may be added, and may include process control sheets covering any critical steps in the assembly.

E. In-process inspection involves a mixture of 100% and sample inspection. All inspection operations, production and quality assurance, are to enter defect information into a production failure information system.

F. Production testing is one of the normal operations for all major assemblies. Controlled test procedures are to be used, and all failures reported within the production failure information system.

G. Production failure and inspection data will provide the following information for each assembly:

- o How many produced during the report period.
- o How many failues during assembly level tests.
- o Specific components that failed in this assembly during the period.
- o Quantity of each component used for total assemblies produced.
- o Failure rate for each component.

NOTE: Follow-up to include data analysis, problem definition and corrective action.

PRODUCT: The product value will be based on performance, appearance, cost, reliability, time and serviceability.

A. Performance requirements. Establish field measurable goals for how well the new product will perform its intended functions in response to the reliability and serviceability requirements of the market place.

1. The product return rate goal for the entire system is ≤2.25% over an operating time of 180 hours.
2. MTTR goal for the system product following six months of production shipments is <20 minutes/unit. MTTR is based on how rapidly a problem can be diagnosed and a defective item replaced, and the following conditions.
   - o Competitive maintenance contract available.
   - o Availablity of service personnel and spare parts.
   - o Personnel training complete.
3. Warranty period will be three months.
4. Power on/off cycles are approximately five (5) per day. Over the warranty period approximately 450 power on/off cycles will occur during the 180 hours of unit operation.
5. Design validation testing identified in Figure II.
6. Component screen requirements are identified in Attachment II.

7. Field qualification period will be a total of six (6) months.

   (a) The 3600 console has a predicted return rate of 1.1% for 180 hours of game play, under the conditions of 100% test and burn-in of the MARIA chip for the first six months of production shipments. If no MARIA chip burn-in occurs, the predicted return rate will increase to 2.2% for 180 hours of game play.

   (b) The predicted system return rate, shown in Figure 1, shows a decreasing number of returns over the initial six months of production. Note at the end of six months, with the MARIA chip burn-in, the predicted system return rate can be 1.6%. Following the completion of all qualification testing, a hazard rate cure, (failures as a function of time) can be generated and compared to the initial prediction.

8. Level of support for product in the field will be to the component level.

B. Environmental and electromagnetic compatibility are to follow the function specification requirements.

C. System Prediction

The 3600 system return rate, at the end of six months production shipments, will be 1.6% over an operating time of 180 hours. (Three months warranty period.)

1. All system components less console (controllers, power adaptor, switchbox and cartridge) must be < 0.5% return rate over 180 hours of game play.

2. The MARIA chip, for the first six months of production, or four different production build lots of 50K each, must have 100% test and dynamic burn-in per attachment II. Following the new device learning curve period of six months, a re-evaluation of test and burn-in cost/benefit is in order.

3. This initial prediction is based on a constant failure rate condition, after six months production and similar product history to weight design escapes and infant mortalities. (Reference Figure I - System return rate, Assumption - Listed on Attachment I.) Utilizing the data from reliability and qualification testing, an approximation on early failures, infant mortalities and design escapes, can be determined and compared to initial prediction.

D. Performance qualification testing will be conducted to confirm functional specs, performance requirements and production acceptance test procedures for all new products. This can be accomplished with the production proto and pilot built units.

E. Reliability qualification testing will be conducted to confirm the return rate goal for the product and provide early product failure rate data. The testing will consider test planning, failure definitions and test requirements.

1. Test plan to include:

   (a) Purpose of test
   (b) Environmental conditions
   (c) Operating mode to be used.

2. Reliability failure classifications:

   (a) Design failures
   (b) Pattern failures
   (c) Infant mortality failures
   (d) Random reliability failures
   (e) Production quality failures
   (f) Detection of pattern failures, and design stress failures.

3. Conducting reliability tests requires the following:

   (a) Test plans in advance of the test. Plans to include number of units, type of test, hardware and software approach, purpose, environmental conditions, operating mode, performance test routing, and definition of failures to be included. (Ref: To Fig. 1, Design Validation testing.)
   (b) Logging forms
   (c) Documentation for recording and analyzing
   (d) Provisions for repairing failures
   (e) Provisions for analysis of the failed part

F. Production acceptance testing is to be done in accordance with test procedures developed concurrently with the product. The design team provides the basic procedure covering the product. Product and test engineering adapts it to the production test. The adapted procedure is verified, and approved by the design function and the reliability engineer assigned to the product.

G. In-process inspection involves a mixture of 100% and sample inspection. The 100% routine inspection operations are conducted by Production personnel, whereas the sample inspection operations are covered by the Quality Assurance personnel.

H. QA audit test and inspection. In order to maintain production process reliability, the following major elements of the production operation will have auditing control and inspection programs.

Buyers purchase parts and components only in accordance with the controlled list of approved vendors.

Receiving inspection is accomplished using inspection plans, defect classifications, and specific procedures as supplied by Components Engineering, Product and Test Engineering, and Quality/Reliability Engineering.

Materials Handling

Stockroom Acceptance.

General Process Control. Activities include definition and documentation of the process, recognition of the points in the process where auditing will provide a maximum sensitivity to changes in the process, also development and implementation of continuing process auditing to assure maintenance of process control.

Product/part sensitive processes are to be controlled by the operation process sheets incorporated in the production plan for the item involved. Auditing and control over these becomes part of the inspection program included in the plan.

Production Assembly Processes.

Assembly Testing

Assembly and Product Inspection.

Product Level Assembly and Testing Processes.

I. Production inspection and failure data can be derived from many sources within the production operation. Data is to be processed and analyzed as required to identify problem areas. Primary emphasis is on identification of component problems which may be due to infant mortality, a specific pattern problem with a vendor, design application problems, and problems introduced by the test used.

Product level failures to provide the following failure information:

(1) How many produced during report period.
(2) How many assemblies failed and overall failure rate.
(3) Point in product test cycle where failure occurred.

Assembly level failures are identified by ranking the critical few major contributors in order of production failure repair costs.

Component level failures are identified by costing the production failure repair charges for each type, and ranking in terms of diminishing failure costs.

J. Field warranty failure data is derived from our independent service centers and regional service centers. The data acquired will permit the following information to be developed for each product.

Product level failure rate under warranty conditions.

Number of assemblies, of each type, that have failed during period.

Within each assembly type, the specific parts failing, and quantity associated with each circuit position.

K. Information reliability feedback is provided by Production Test personnel as they observe abnormal conditions, and by customers, or Atari Customer Service personnel as they observe abnormal conditions or pattern problem areas. These inputs will serve to identify any major problem area that develops suddenly; however, they do not identify the more subtle, and often costly, failure patterns detected by the methodical processing of production and field warranty failure data.

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UNIVERSAL PLANNING FORM

3600 CONSOLE - TABLE I

		MARIA CHIP		(3) LSI'S		(2) RAM		ROM, MSI SSI (6)		POT (2)		SWITCHES (7)	
		Limit B/I	No B/I	Limit B/I	No B/I	Limit B/I	No B/I	Limit B/I	No B/I	Limit B/I	No B/I	Limit B/I	No B/I
New Device in Initial Production. (MARIA Chip)													
o MARIA Dynamic Burn-In @ 125°C For 48 Hrs. @ Approx. 6.5 Volts.													
Principal (3600) High Failure Rate Components By % Contribution.													
o 1st (6) months of production	LIM.B/I	9.9%		49.6%		11.7%		11.8%		6.6%		1.8%	
	NO B/I		52.3%		26.3%		6.2%		6.3%		3.5%		1.0%
o After (6) months of production	LIM B/I	3.5%		53.1%		12.6%		12.6%		7.1%		2.0%	
	NO B/I		26.8%		40.3%		9.5%		9.6%		5.4%		1.5%

NOTES:

1. Limited burn-in; Only the MARIA Chip is burn-in.

Operating Unit: ENVIRONMENTAL RELIABILITY ENGINEERING

Prepared By: GIL SEYMOUR

Date: 9/27/83

6A315 (1/81)

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SIZE: A

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REV: 1

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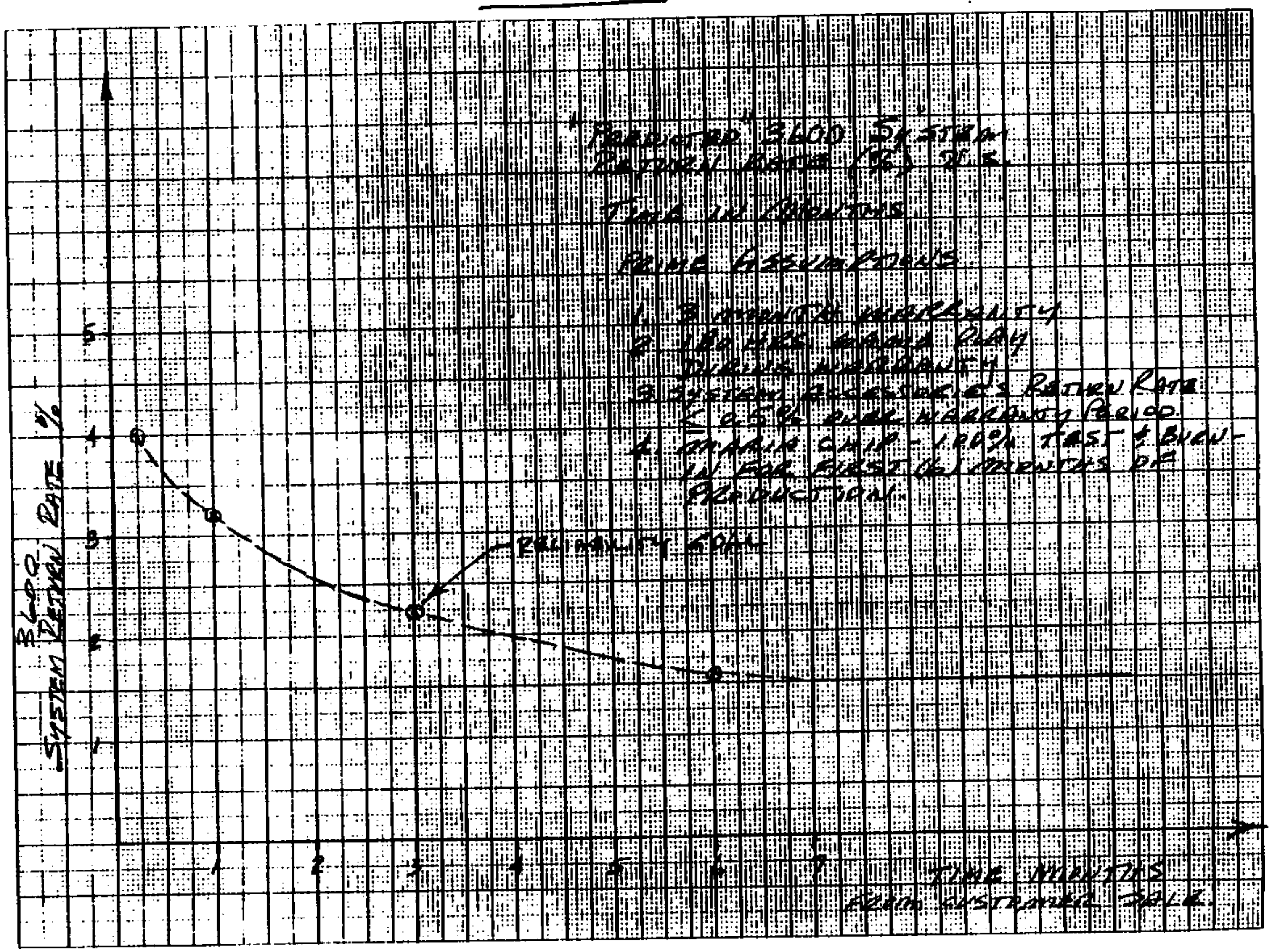
9-28-83

FIGURE I



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DESIGN VALIDATION TESTING

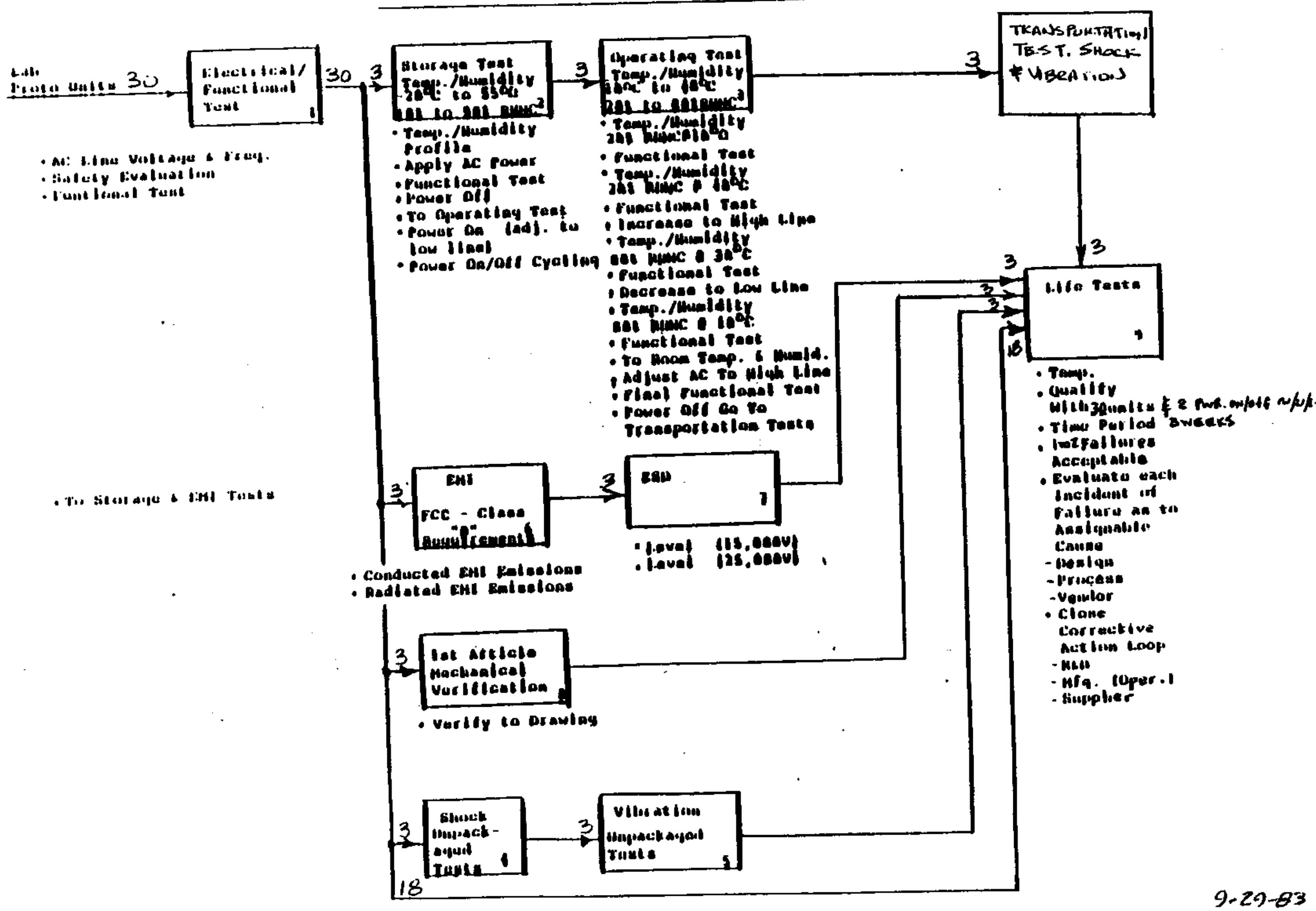

FIGURE II

9-29-83
GIL SEYMOUR

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3600 SYSTEM

ATTACHMENT I

RELIABILITY PREDICTION ASSUMPTIONS

1. Failure rates are due to chance only, and the failure rate is constant.
2. Preliminary production testing and/or burn-in has removed the early failures, and wearout has not begun to occur.
3. Normal average operating temperature of 40 degrees C inside of console.
4. Reliability figures are taken from MIL-217D Handbook.
5. Connections computed by taking all component solder connections x 1.5 allow for soldered through holes, etc.
6. Any component failures will cause sub-system malfunction since there are no redundant components.
7. Since all reliability figures are based on MIL Spec. parts, and we are using commercial grade parts, the parts failure per million hours is multiplied by a quality factor.
8. Independence among all system elements is assumed unless otherwise stated.
9. Game play is an average of approximately two (2) hours per day. The total operating time is 180 hours over a warranty period of three (3) months.
10. Cartridge changes per day are a maximum of approximately six (6) cartridges per day.
11. Power on/off cycling is a maximum of five (5) times per day.
12. No design escapes exist.
13. System components less console has a return rate $\leq 0.5\%$ over an operating time of 180 hours.

3600 SCREENING REQUIREMENTS

ATTACHMENT II

COMPONENT REQUIREMENTS (ELECTRICAL)

Predetermined sampling plans for components may be used when the cost of not 100% testing is justified (one will always receive faulty components, and sampling plans do not reduce failures on the circuit board or in the field).

A. New MARIA Chip:

1. First six months of production shipments, MARIA will receive a 100% dynamic burn-in at 125 degrees C, with an applied voltage of 6.5 volts, for 48 hours prior to test. Devices to be processed through a 100% screen for all functional electrical parameters.

2. After six months of production shipments: Unless exempted by a predetermined sampling plan, the MARIA chip will receive a dynamic burn-in at 125 degrees C for 48 hours prior to test. Further, devices will be processed through a 100% screen for prime functional electrical parameters.

B. LSI AND RAM

Devices to be processed through a 100% screen for all functional electrical parameters unless exempted by a predetermined sampling plan.

C. IC (Various MSI and SSI devices)

ICs to be processed through a 100% screen for all functional electrical parameters unless exempted by a predetermined sampling plan.

D. MODULATOR, OPERATIONAL AMPLIFIERW, VOLTAGE REGULATORS AND LINEAR DEVICES

Components to be processed through a predetermined sampling plan for all critical electrical parameters.

E. POWER ADAPTOR AND SWITCHBOX ASSEMBLIES

Assemblies to be processed through a 100% screen for all functional electrical parameters unless exempted by a predetermined sampling plan.

F. TRANSISTORS AND DIODES

Simple active devices to be parametrically tested on a 100% basis, unless exempted by a predetermined sampling plan.

G. PASSIVE PARTS (RESISTORS, CAPACITORS, INDUCTORS AND OTHER ELECTRICAL COMPONENTS)

Components shall be sampled for acceptability to predetermined sampling plans.