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(NASA-CR-169206) AUTOMATED SOLAR PANEL N82-29723 ASSEMBLY LINE Final Report (ARCO Solar, Inc., Chatsworth, Calif.) 101 p HC A06/MF A01 CSCL 10A Unclas G3/44 28592

### AUTOMATED SOLAR PANEL ASSEMBLY LINE

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FINAL REPORT - MAY 1981



DOE/JPL-955278-81/5

9950-486

PREPARED UNDER CONTRACT NO. 955278

FOR

JET PROPULSION LABORATORY CALIFORNIA INSTITUTE OF TECHNOLOGY PASADENA, CALIFORNIA 91103

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The JPL Low-Cost Silicon Solar Array Project is sponsored by the U.S. Department of Energy and forms part of the Solar Photovoltaic Conversion Program to initiate a major effort toward the development of low-cost solar arrays. This work was performed for the Jet Propulsion Laboratory, California Institute of Technology by agreement between NASA and DOE, under NASA Contract NAS7-100.

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### ACKNOWLEDGEMENTS

This report is the result of a two-year effort to develop automated module assembly equipment. The author gratefully acknowledges the following ARCO Solar employees for their contribution to this program.

> PETER ASCHENBRENNER JOHL DOUGHERTY PAT GALLAGHER BILL HAWLEY GREG JONES DICK KEENAN DOMINIC SICOLI DON WILKES RAGNHIL WHITT

John W. Behm was the technical program monitor for JPL

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This report contains the results of a two-year effort to design, develop and operate automated equipment for the interconnection of solar cells and lamination of cell circuits into modules. The overall objective was to effect near-term reduction of silicon sclar cell array costs so as to achieve the 1986 goal of \$0.70/W\*.

The program consisted of four sections: 1) design of a module that lends itself to automated assembly, 2) design and development of prototype equipment for the interconnection and lamination of solar cells into a completed module, 3) the operation of a pilot production line using the equipment developed in this program, and 4) perform a cost analysis of the production run.

This program was originally proposed as a 12 month effort. However, because of the complexity of the soldering equipment task the program was extended to 27 months. In late 1979, a prototype element of the soldering machine was implemented into the module production operation. This section of the machine consisted of a roller transport mechanism integrated with an electromagnetic induction coil\*\* for soldering continuous ribbon interconnects to the front of solar cells. In a fashion, it was the first step in the mechanization of soldering or "tabbing" solar cells, and this simple mechanism has reliably tabbed about 1.8 million solar cells to date.

In mid-1980, the lamination system began operation in ARCO Solar's automated solar panel facility in Camarillo, California. This

\* All costs in this report are given in 1980 dollars.

\*\* The automated soldering machine was subssequently redesigned to use an infrared heat source. prototype system has produced PV modules representing in excess of one megawatt. The pilot production line operation integrating the completed soldering and lamination equipment was successfully conducted in April 1981.

The following achievements were made on this program:

- ° a lamination system capable of producing 20 modules/hour
- a soldering machine capable of interconnecting 900 cells/hour
- \*a cost reduction of approximately 40% in module materials and labor

\* Final SAMICS Format 'A's in this report have not been run. The

### II. INTRODUCTION

The objective of this program was to effect near-term cost reduction in the assembly of solar cell arrays through development of automated module assembly equipment. The specific tasks were to: 1) design a solar cell module that facilitates automated fabrication, 2) design and develop automated solar cell soldering and laminating equipment, and 3) operate a pilot production line with the developed equipment and achieve the following:

- solder interconnects 12 cells/minute
- laminate modules 12 modules/hour
- \* reduce module assembly and material costs to \$0.67/W based on the following assumptions: total estimated module cost - \$2.24/W (ref.) finished estimated solar cell cost - \$1.57/W (ref.) net module assembly/materials cost - \$0.67/W (goal)\*

The initial stage of the program was devoted to concept development and proof of approach through simple experimental verification. In this phase, laboratory bench models were built to demonstrate and verify concepts. Following this phase was machine design and integration of the various machine elements. The third phase was machine assembly and debugging. In this phase, the various elements were operated as a unit and modifications were made as required. The final stage of development was the demonstration of the equipment in a pilot production operation.

\* Assembly cost goal includes realized yields and is based on assumed annual production rate of 1.0 megawatts.

### III. MODULE DESIGN

### A. APPROACH TO AUTOMATED DESIGN

The origin of module size and configuration in the terrestrial photovoltaic market arose from battery charging requirements. In essence, charging 12 VDC batteries requires a PV module with 33-35 solar cells connected in series to produce 14-75 VDC. Modules typically used 75-100 mm (3-4 inch) diamezer cells producing 1-2 ADC so that most modules had a single series string, or 3-4 strings side-by-side for purposes of providing a module of a manageable length and width.

Early ARCO Solar designs used a rectangular shaped circuit of 3 strings (75 mm cells nested side-by-side for space efficiency) of series-connected solar cells as shown in Figure 1. This module was used in the LSA Block III procurement.

In early 1979, the LSA Block IV module design contracts were awarded and it was this design that was developed with automated assembly as its theme. Photovoltaic (PV) applications were still tied to battery charging at this time so ARCO Solar elected to develop automated interconnection of simple series strings. The two distinct advantages to this approach are: 1) the form of simple reels of ribbon interconnects available, and 2) the opportunity to provide redundancy and enhance reliability of the circuit. These features are illustrated in Figures 2 and 3. It was determined at this early stage that future circuit configurations requiring parallel and series combinations could be simply handled by taking multiple series strings

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ARCO Solar BLOCK III MODULE CONFIGURATION



USING REELS OF CONVENTIONAL COPPER RIBBON (SOLDER PLATED) TO FORM SERIES STRING OF SOLAR CELLS --- FUTURE VARIATION IN CIRCUIT (MODULE) LENGTH IS SIMPLY HANDLED BY CUTTING BETWEEN INTERCONNECTED CELLS AS NEEDED. ORICEVAL PAGE 13 OF POOR QUALITY

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### OLD APPROACH



IMPROVED INTERCONNECT RELIABILITY

of any desired length and end-connecting the correct polarities. This is depicted in Figure 4.

In designing the 16-2000 module the approach to cell interconnection and the use of 100 mm (4 inch) diameter solar cells represent the greatest departures from the Block III design. The basic superstrate design was retained and the module size was increased to accommodate the 100 mm solar cell. Figures 5 and 6 are drawings of the circuit and module respectively. Other changes included an extruded frame for sealing, mounting and providing structural rigidity for housing module terminations and a Korad/metal foil back cover for improved protection for the circuit and encapsulant.

### B. MATERIALS OF CONSTRUCTION

The rationale in material selection for the 16-2000 module was to approach a 20 year life and implement cost reductions established by the Low-Cost Solar Array Project (LSA) goals.

Tempered glass\* was retained as the module superstrate material because of its demonstrated long-life and its excellent optical, thermal and mechanical properties. Polyvinyl butyral\*\* (PVB-SR11) was also retained from the former module design because of its proven performance and approach to automating the encapsulation (lamination) of cell circuits. The number of layers of PVB utilized is four.

An important design improvement in this new module was the

replacement of the metal pan with an extruded aluminum molding. The advantages of this change were improved structural rigidity, better access to the module terminations, ease of array assembly and lower operating temperatures. The framing approach also facilitated mechanized assembly and the introduction of a lowcost sealant suitable for high volume applications. The aluminum was applied with an architectural finish that improves corrosion resistance in a terrestrial environment.

The edge sealant was changed from a Julcanized rubber sealant\* to a butyl hot melt\*\*. The reasons for this change were twofold: 1) it was discovered in temperature/humidity testing that the catalyst (typically an inorganic oxide) was causing the PVB to crosslink and discolor at the perimeter of the module, and 2) this sealant was not suitable for the high volume assembly of modules.

The final change to the module was the replacement of the Tedlar\*\*\* back cover material with a Korad-coated mild steel to improve its hermeticity to water vapor and other gaseous pollutants. The addition of this barrier virtually eliminated the passage of oxygen which, in the presence of ultraviolet light (UV), can cause degradation of the PVB.

### C. ELECTRICAL AND THERMAL CHARACTERISTICS

The I-V characteristic of the 16-2000 module is shown in

\* MIL-S-8802D (9 Dec. 1974) sealing compound \*\* H.B. Fuller Co., Minneapolis, Minnesota \*\*\* Borg-Warner Co. \*\*\*\* Dupont Co., Wilmington, Delaware

# CIRCUIT DESIGN SUITABILITY FOR PARALLEL/SERIES CONFIGURATION



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1P X 33S

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3P X 6S

CELLS WOULD BE MACHINE SOLDERED IN SERIES AND CUT AT 6 CELLS INSTEAD OF 11 ---STRINGS WOULD BE ARRANGED INTO CIRCUIT AND END CONNECTED AS SHOWN.

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# 16-2000 CIRCUIT FIGURE 5

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16-2000 MODULE FIGURE 6 Figure 7 and reflects the power increase resulting from the larger 100 mm diameter solar cell and higher efficiency due to lower operating temperature.

An important change in operating characteristics is the lower Nominal Operating Cell Temperature (NOCT) of the ASI 16-2000 module. It has been determined to be 47°C as compared with 58°C of the Block III module. This is a direct result of changing the pan-type frame which was producing a "greenhouse" effect at the rear of the module.

### D. PROOF OF DESIGN TESTING

In the development of the 16-2000 design, two types of rigorous tests were applied to module components (during in-house testing by ARCO Solar): thermal cycling to reveal undesirable material combinations in which thermal strains might be induced, and humidity cycling to expose areas of permeation to moisture and its consequences.

Thermal Cycling:

<u>Conditions</u>	No. Cycles	<u>No. Modules</u>
-40°C to +90°C	750	6

The temperature ramp was 100°C/hour maximum in accordance with JPL environmental test procedures. Electrical tests and visual examinations were conducted following each 100 cycles. No significant physical changes were observed after 750 cycles and all I-V measurements were within 1% of initial values.

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Humidity Cycling:

Conditions	No. Cyclas	No. Modules
23-75°C 95% RH	60 (one/day for 60 days)	12

The temperature ramp was done in accordance with MIL-STD-810C, Method 507.1 (2 hours from low to high, 16 hours dwell at high temperature). The one departure from this method was that the upper temperature was increased from 40.5°C to 75°C. Six of the twelve modules had a Tedlar\* backing while the balance had a Korad-steel-Korad\*\* backing. Within three days there was evidence of moisture penetration of the Tedlar and debonding in isolated areas of the PVB from the glass. The foil-backed modules exhibited no change in the laminate or evidence of moisture ingress.

### IV. AUTOMATED EQUIPMENT DESIGN

A. SOLAR CELL ASSEMBLY PROTOTYPE (SCAP)

The purpose of the Solar Cell Assembly Prototype (SCAP) is to interconnect solar cells into a continuous single series string. Figure 8 is a schematic of the first machine concept. This first machine consisted of five elements:

1. wafer unloading (not shown)

- 2. ribbon feed and deployment
- 3. soldering mechanism
- 4. solder flux removal
- 5. handling strip attachment station

Wafer handling or unloading is the process of removing completed solar cells from a plastic cassette into the machine, one at a time. The ribbon feed is two storage reels of solder plated copper ribbon, a roller feed mechanism and a shear for dispensing controlled lengths of dual interconnects to the solar cell.

The soldering mechanism is simply a transport/clamping/heating device that produces solder connections between the solar cell metallization and copper ribbon. Solder paste (a thick film product of solder particles, vehicle and flux) is pre-applied to the finished solar cells prior to entering the SCAP. Solder flux removal is the process of cleaning the residual flux in a fluorinated hydrocarbon/alcohol mixture in an ultrasonic tank. The handling strip attachment station is the application of a perforated plastic strip to the bottom of the completed solar cell string for purposes of handling.



FIGURE 8

ORIGINAL PAGE IS OF POOR QUALITY In this first machine concept, wafer transport and alignment from the cassette to the soldering head was to be achieved by using a gravity feed. This is evident in Figure 8 from the slope of this section of the machine.

The first soldering approach was a conductive method. This is depicted in Figure 9. In this design, two opposed, resistively heated copper heads were moved to the cell by a cam operation; soldering was achieved with attendant cooling; the heads were then moved away from the cell and it was advanced to the next position via gravity feed. A working model of the soldering mechanism was fabricated and bench tests of this approach were conducted. The following problems were encountered with this approach:

- 1. Lubrication of hot moving parts without contamination of the solar cells with lubricant.
- 2. Temperature control of heads and cooling of cells prior to transport.
- 3. Obtaining a non-stick heating surface.
- 4. Complexity of heating mechanism.

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5. Cell breakage and alignment problems associated with gravity feed.

The most significant problem was the difficulty in obtaining a non-stick surface on the heating mechanism. A hard, chrome plate finish was first attempted with some success. However, after some use, the remaining rosin from the flux did not permit separation. A second approach was to use TFE Teflon\* impregnated



into the surface of the soldering head. This, too, presented problems with separation of the interconnects from the head after some use. Finally, an electroless nickel plating that was furnace-oxidized was used with greater success, however, it also had similar problems. Early in the program this approach to soldering was abandoned in favor of such non-contact approaches as electromagnetic induction and infrared heating.

A second element of the original machine that was designed, tested and abandoned was the handling strip attachment station. It was originally thought that the solar cell series string would require stiffening before it could be taken from the machine and handled. The addition of this feature would also allow a more precise spacing control between cells. This machine element was similar in operation to the ribbon feed and soldering mechanism; a roll of perforated, adhesive-backed Mylar\* is fed beneath the emerging solar cell string, the cell and Mylar tape are heated, pressed together via transport rollers and the finished string proceeds to a cutoff area where strings are cut to appropriate length. The perforated Mylar is shown in Figure 10.

This machine element was similarly abandoned early in the program for two reasons: first, it was learned that a series of interconnected solar cell strings with dual redundant ribbons could be readily handled on large diameter (20-25 cm/8-10 inches) reels as it emerged from the soldering-defluxing operation; second, the cost of a module - compatible plastic film



NOTE: THESE DIMENSIONSIONS APPLY THROUGHOUT REPETITIVE PATTERN,

# PERFORATED MYLAR HANDLING STRIP

for handling was about \$0.003/cm (\$0.10/foot). This amounted to \$0.90/module.

The concepts for wafer unloading, ribbon feed and solder flux removal remained essentially unchanged and will be discussed in succeeding sections.

1. SOLAR CELL HANDLING AND TRANSPORT

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Preparation of solar cells for use in the SCAP required the application of a solder paste. The paste is applied by screen printing and handling of cells is done through the use of polypropylene cassettes familiar to the semiconductor industry\*. Each cassette accommodates 25-100 mm cells and is compatible with automated loading equipment\*\*.

Initial work centered around the use of this handling equipment, however, no equipment was available for handling multiple cassettes. The goal in soldering for this program was 12 cells/minute, and in order to best utilize the machine operator a cassette handler/unloader was built\*\*\* with expansion capability to accommodate 4-5 cassettes.

This equipment is shown in Figure 11. It consists of a vertical magazine of cassettes that are driven downward by sychronous motors, one wafer at a time. When the cassettes are loaded with cells, the pusher bar displaces a wafer out of the cassette into a wafer alignment/transport conveyor.

The pusher bar then retracts to its rest position and the \*Fluoroware, Co., Chaska Minnesota \*\*Silec, Sunnyvale, California \*\*\*Kinematics, Princeton, New Jersey



cassette stack moves down one wafer position. When a cassette is emptied, it drops out of the magazine into a chute and finally out of the machine into a basket of cassettes. The machine rate was designed for a range of 1-20 cells/minute so that the program goal of 12 cells/minute could be easily accommodated. The one important requirement of the loaded cassettes was the orientation angle of the flats of the solar cells relative to the pusher bar.

This is illustrated in Figure 12. In order to insure proper orientation all cassettes were placed on a flat-finder prior to loading of the magazine.

From the cassette unloader cells are moved onto a set of rails where the alignment and transport occur. As the cell moves onto the rails, a second pusher bar transports the cell into the alignment grips of the conveyor. This is shown in Figure 13, Using the principal of a flat and two points (the flat being the second pusher bar while the points are the forward grips of a station on the conveyor), alignment is effected simultaneously with forward motion of the cell into the ribbon application area. The conveyor is shown in Figure 14.

The conveyor consists of two gear-synchronized tracks with 13 alignment/transport stations. Like the cassette unloader the rate is variable between 1-20 cells/minute.

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# CRITICAL ANGLE OF CELL FLAT

FIGURE 12



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### 2. RIBBON FEED AND DEPLOYMENT

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The first concept for ribbon feed and deployment was to push the ribbon from reels into guide tubes and onto or below the cell. This idea is shown in Figure 15. Typically the ribbon materials are "pulled" from one end for deployment since their stiffness precludes "pushing" due to buckling. Preliminary tests on .05 mm (.002 inch) thick copper ribbon by 2.6 mm (.1 inch) wide indicated that it could, in fact, be "pushed" through properly designed guides onto or beneath the cell with horizontal alignment of  $\frac{1}{2}$  .38 mm (.015 inch) over a length of 10.2 cm (4 inches), the length of a 100 mm solar cell. A bench model of this concept was fabricated and tested successfully to demonstrate proof of approach.

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A search was then made of industries using and/or manufacturing ribbon or rod feeding equipment. A company\* that builds equipment for feeding welding rod was found and contracted to build a modified rod feeder to handle ribbon. A shear was designed in-house and integrated with the ribbon/feeder.

### 3. SOLDERING METHOD

As mentioned in Section IV A., the first approach to soldering interconnect was conduction and this was abandoned in favor of non-contact approaches such as electromagnetic induction and infrared heating, the former being the primary choice with infrared as a backup. Historically, solar cells



RIBBON FEED AND DEPLOYMENT

FIGURE 15
have been applied with short wibbon tabs while the cell is in a fixed position and soldered while being clamped together. The application of dual full-length ribbons to the cell while it was in motion appeared feasible, particularly if rollers could clamp the ribbon and cell together long enough for solder joint formation to occur. It was experimentally determined, in the prior section, that long ribbons could be reliably fed above or below the solar cell. The next step was to examine the use of RF induction as a heat source to complement this approach to soldering solar cells.

Following some preliminary screening of RF power supplies and successful attempts to solder full length ribbons to solar cells in a fixed position, a 3 kW RF induction power supply was purchased\*. A bench top roller mechanism was designed and integrated with the RF power supply and work coil. This is shown in Figure 16. In early tests two reels of solderplated copper ribbon (not shown) were fed through two sets of rollers and cells were located beneath the ribbons and similarly sent through the rollers as the RF power was activated. The cells were pre-applied with Sn62 solder paste (Sn62/Pb36/Ag2) having a moderately active rosin flux (RMA).

The RF work coil, located between the two sets of rollers and below the cell, was a double hairpin designed to induce



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Using optical methods, measurements of temperature uniformity were made as the solar cell tranversed the RF coil. In these tests it was found that the side of the cell closest to the power supply operated at slightly higher temperatures than the side farther from the power supply. Also, the temperature of the leading edge of the cell was found to be lower than the trailing edge. This probably results from wafer heating at the leading edge with subsequent conduction to the trailing edge in addition to the effects of normal induction heating. Figure 18 is the outline of a cell with the observed temperature gradients.

Further refinements of the work coil, roller clamping and drive mechanism gave rise to a useful mechanism that could be used for applying dual ribbon interconnects to the front of individual solar cells (in a so-called "tubbing" operation) and resulted in lower labor content. In August 1979, this simple SCAP machine element was integrated into ARCO Solar's regular module production facility and has reliably soldered about 2,000,000 - 100 mm solar cells.

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#### TABLE 1

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#### INDUCTION SOLDERING OF SOLAR CELLS

TRANSPORT	RF POWER	CONTACT*	NO.
FEED (CM/SEC)	SETTING (%)	PULL TEST (GMS)	SAMPLE
2.5	60	350 - 600	50

\* 90° PULL TEST OF COPPER RIBBONS FROM SOLAR CELL USING UNITEK MICROPULL #6-092





EFFECTS OF INDUCTION HEATING ON SOLAR CELL TEMPERATURE

FIGURE 18

#### 4. SOLDER FLUX REMOVAL

The first attempts at solder flux removal was to develop an in-line solvent spray system. This approach is depicted in Figure 19. Based on rates of 2.5 cm/sec. travel through the SCAP, it was not possible to remove flux residue with a spray system using chlorinated solvents such as 1-1-1 trichloroethane, methylene chloride as well as solvent blends using Freon\*-alcohol azetropic mixtures. Evidence of rosin presence was determined both visually and colorimetrically\*\*.

Insufficient removal of flux residue is believed to be a direct result of the interconnect/cell metallization configuration. This is shown in Figure 20. The second approach was to use a warm ultrasonic solution of the aforementioned solutions, determine the dwell time required for residual flux removal, and design a tank that renders sufficient residence time for flux removal. It was determined that 40 seconds dwell in Freon TMS Plus\* (90% Freon, 5% ethanol and 5% methanol with a stabilizer) was effective in removal. Figure 21 is the resulting tank designed to provide this required residence time and be integrated as an in-line component\*\*\*. The tank was equipped with refrigeration coils to minimize solvent loss as well as a solvent recirculating system with a remote still, so that used solvent could be recycled as required.

\* Dupont Trademark \*\* Appendix A



SOLVENT SPRAY FLUX REMOVAL

FIGURE 19



CELL INTERCONNECT / MATALLIZATION PATTERN

FIGURE 20



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#### B. SOLAR PANEL LAMINATION PROTOTYPE (SPLP)

The purpose of the Solar Panel Lamination Prototype (SPLP) is to encapsulate or laminate the solar cell circuit using polyvinyl butyral (PVB-SR-11)\* or similar hot-melt encapsulant to a glass superstrate. In early studies two lamination approaches applicable to photovoltaic modules were examined; both use evacuation followed by pressure application. In the first, atmospheric pressure levels are used while in the second pressures up to about 13 atmospheres are present. Sample laminations produced by both processes resulted in comparable adhesion of the PVB to glass (1.1-1.4 Kg/cm and .9-1.6 Kg/cm respective 90° peel adhesion strengths).

In a low pressure process PVB tends to block or adhere to itself even though the film is ribbed to aid in the evacuation of air. One approach that can be used to minimize blocking and accelerate the evacuation process is a double vacuum. This is illustrated in Figure 22. In this arrangement the module is evacuated while a second vacuum is applied to the rear of the module. The vacuum level is typically 1-5 TORR in both chambers. The prototype chamber used to develop the lamination process is shown in Figure 23. The design of this chamber is such that different sealing approaches can be examined, additional heat sources can be added, if required, and cooling can be implemented if necessary.

#### 1. LAMINATION VESSEL DESIGN

In work with the prototype chamber, two approaches to

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DOUBLE VACUUM LAMINATION

FIGURE 22



PROTOTYPE LAMINATION CHAMBER BLACK AND WHITE PHOTOGRAPH

chamber sealing were examined. In the first, a gasket was placed in the chamber flange and the Tedlar rear module cover was cut oversize so that it could be used as a diaphragm between the two chambers as well as the back cover for the module. The problems with this approach were poor chamber sealing and wrinkling of the Tedlar. The second approach was to use a large sheet of silicone rubber 3.2 mm (.125 inch) thick as both a chamber seal and bladder between the two chambers. This approach worked well and eliminated the 0-ring requirement in the flange. The problem of the bladder sticking to the Tedlar was resolved by the addition of a Teflon-coated glass fabric beneath the bladder. This was later changed to a perforated cloth fabric for cost reasons.

In related experiments, it was determined that forced cooling was unnecessary and that heat-up could be accomplished from the lower chamber using a 2.5-3 kW infrared heating unit. These results led to simpler chamber design. Figure 24 llustrates the production chamber design.

#### 2. PROCESS OPTIMIZATION

Figure 25 shows the evolution of the lamination process from work in the prototype chamber to the first production unit. Due to non-uniform lamp temperatures in the prototype unit, the 4 lamp configuration was changed to a 2 lamp arrangement in the bottom of the semi-cylindrical chamber. Polished aluminum lighting sheet (83% reflective) was cut

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PRODUCTION LAMINATION CHAMBER

#### LAMINATION PROCESS OPTIMIZATION

PROTOTYPE OPERATION (50 MINUTES) PRODUCTION OPERATION (32 MINUTES)

- 1. EVACUATE LOWER CHAMBER
- 2. EVACUATE UPPER CHAMBER
- 3. MAINTAIN UPPER AND LOWER VACUUM FOR 15 MINUTES
- 4. BACKFILL TOP CHAMBER TO ATMOSPHERIC PRESSURE
- 5. HEAT TO 150°C (302°F) AND HOLD FOR 15 MINUTES
- 6. COOL TO 65°C (150°F)
- 7. BACKFILL LOWER CHAMBER TO ATMOSPHERIC PRESSURE
- 8. REMOVE FINISHED LAMINATE

- 1. EVACUATE LOWER CHAMBER
- 2. EVACUATE UPPER CHAMBER
- 3. START HEATUP

\*1

- 4. BACKFILL TOP CHAMBER TO ATMOSPHERE WHEN TEMPERATURE IS 100°C (212°F)
- 5. HOLD AT 150°C FOR 8 MINUTES
  - 6. BACKFILL LOWER CHAMBER TO ATMOSPHERE
- 7. REMOVE FINISHED LAMINATE

to fit the curvature of the chamber. The lamps (quartz-halogen), which were each rated at 5 kW @ 960 V, were operated at 480 VDC in an on/off mode as dictated by the need for here from the controller. At this voltage the lamps were each rated at about 1.6 kW, and both lamp life and uniformity were good. High temperature areas in the center of the lamps were moderated by the addition of pieces of aluminum lighting strips over the lamps. In this way it was possible to maintain a temperature of  $\frac{+}{2}$  10°C over the .37 m<sup>2</sup> (4 ft<sup>2</sup>) area of the glass superstrate.

Early laminations were allowed to cool under vacuum to 65°C (150°F) since it was thought that edge blow-in of air would occur while the PVB was soft. Investigation of this aspect revealed that removal of the laminate at 150°C did not result in edge blow-in and this step was subsequently eliminated.

#### 3. PRODUCTION OPERATION

In August 1979, two prototype production units were integrated into ARCO Solar's module production facility and were operated at yields of 97-98%. These units were operated on a 35-40 minute cycle such that 3 modules/hour could be fabricated. Later in 1979, two additional units were added to double this capacity.

All units had manual valving and temperature control was maintained by the thermocouple feedback to a temperature controller. The controller operated a high voltage on/off



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## LAMINATION CAROLISEL

FIGURE 26

#### V. PILOT OPERATION AND SAMIS ANALYSIS

#### A. PILOT PRODUCTION VERIFICATION

The purpose of this pilot operation was to demonstrate equipment operation by producing 288 module assemblies and prepare a manufacturing cost analysis. This cost information was then used as a data base for SAMIS\* preparation and determination of program cost achievements. The production line verification run was conducted April 8 and 9, 1981. Table 2 10 the production run history of the auto-soldering equipment indicating downtime and reasons. The lamination equipment was operated continuously during each day shift and a total of 350 modules were manufactured. No downtime was experienced with the lamination equipment.

In Table 3 are the resulting yields from the pilot operation. Below a comparison is made between program goals and achievements from the pilot verification run.

PROGRAM GOALS	PILOT PRODUCTION
12 cells/minute	16 cells/minute**
12 modules/hour	20 modules/hour***

- \* SAMIS-Standard Assembly-line Manufacturing Industry Simulation. A computer program developed by JPL for DOE to project photovoltaic module fabrication costs.
- \*\* Single automated soldering machine.

SOLDERING RATE

LAMINATION RATE

TABLE 2AUTO-SOLDERING PRODUCTION RUN HISTORY

	CLOCK	RUN TIME	DOWN TIME	MAINTENANCE	NOTES
START	9:32:00	12.00			
STOP	9:44	12:00	2.00		Broken Cell
START	9:46	6.00	2:00		BLOKEN CELL
STOP	9:52	0:00			
START	9:58	5.00		6:00	Change Ribbon
STOP	10:03	5:00	20:00		Ribbon Jam(stop
START	10:23				for break)
STOP	10:46	23:00			
START	11:00		14:00		Ribbon Jam
STOP	11:42	42:00			
START	11:55			13:00	Clean Equipment
STOP	12:52	57:00			
START	12:57		30:00		Lunch Break
STOP	1:05	8:00			
START	1:10		5:00		Ribbon Jam
STOP	1:18	8:00	]		
			82:00		Clean Equipment and make adjust.
START	2:40	12:00			
STOP	2:52				
START	3:04	83:00		12:00	Change Ribbon
STOP	4:27	). 	3:00		Ribbon Jam
START	4:30	22:00			
STOP	4:52		2:00		Ribbon Jam

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#### TABLE 2 (continued) AUTO-SOLDERING PRODUCTION RUN HISTORY

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	CLOCK	RUN TIME	DOWN TIME	MAINTENANCE	NOTES
START	4:54	14.00			
STOP	5:08	14:00			
START	5:10	1 * 20	2:00		Ribbon Jam
STOP	5:26	16:00			
START	5:29	15 00	3:00		Ribbon Stopped
END OF RUN	5:44	15:00			
TOTAL		338:00	<u>†</u> 38:00	31:00	
START	8:53	47.00			
STOP	9:40	47:00		7.00	Ohanaa Dibbaa
START	9:47	27.00		7:00	change kibbon
STOP	10:24	37:00	4 00		
START	10:28	07.00	4:00		boat Jam
STOP	12:05	97:00			
START	2:05	70.00			Out of Cells
STOP	3:17	/2:00		7 00	
START	3:22			5:00	Change Ribbon
END OF RUN	5:45	143:00			
TOTAL		396:00	4:00	12:00	
GRAND TOTAL		719:00	,	43:00	
	ł				1 1

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SOLDERING	TOTAL	NOT REWORKED	REWORKED
CRACKED CELLS	53	53	
MISALIGNED CELLS	361		361
NO RIBBON	55	. •	55
CRACKED CELLS	56	56	
USE CLEANER	17	17	
CELL SPACING	39		39
CASSETTE JAM	11	11	
OTHER	<b>an a</b>	tion, such	·
TOTAL	592	137	455

#### TABLE 3 PILOT PRODUCTION YIELD

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FOTAL NUMBE	R OF CELLS	SOLDERED:	11,504
INITIAL SOL	DERING YIE	LD:	94.85%
YIELD AFTER	<b>REWORK</b> :		98.81%

#### LAMINATION

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NUMBER	OF	MODULES	LAMINATED:	350
YIELD:				99.8%*

\* This percentage based upon limited runs. The yield value is not conclusive.

#### B. COST ANALYSIS

Appendix A contains the Format A forms for the module assembly manufacturing process, including the two automated equipment/ process sequences developed under this program. SAMIS analysis reveals that the module assembly cost is approximately \$1.61/pW\*\* based on an assumed yearly production rate of 2 MW/yr. Table 4 summarizes the program cost goals and actual projected costs. As can be seen, the cost goals were not totally met; however, the use of the automated equipment has resulted in a significant cost reduction in actual fact.

At the time this program was proposed as part of the Near Term Cost Reduction Program\* to the LSA Project, production modules were primarily fabricated and assembled using hand labor. In-house analysis by ARCO Solar at that time indicated that module assembly costs (labor, materials and all other applicable costs excluding cells) were typically \$2.43/pW (1978 dollars). If this same mode of fabrication were performed during the time of the automated equipment demonstration (April 1981) the assembly cost would have increased to approximately \$3.15/pW based on an assumed SAMIS average inflation rate of 9% per year. Therefore, the development and use of this equipment has reduced the module assembly cost from \$3.15/pW to \$1.61/pW. This represents a very significate cost reduction of approximately \$1.54/pW (a 49% cost reduction.

 \* The Near Term Cost Reduction Program was funded as part of a special funding amendment sponsored by Congressman Tsongas.
\*\* Based on preliminary data.

#### VI. CONCLUSIONS

The conclusions of importance to JPL and LSA program are that a significant reduction in solar cell module manufacturing lost was achieved, and the state-of-the-art of module assembly manufacuring equipment was sufficiently automated to permit large scale low-cost module assembly.

#### APPENDIX A

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#### COLORIMETRIC DETECTION OF ROSIN

TYPE OF TEST: Rosin insolation and qualitative identification using sucrose/sulfuric acid test.

DESCRIPTION OF TEST: Extract rosin from assembly using methylene chloride (dichloromethane) or toluene. Concentrate extract by forced evaporation. Shake extract with small amount of concentrated sucrose solution. After addition of 2-3 drops of concentrated sulfuric acid, a scarlet red color will develop if rosin is present.

INTERPRETATION: Detection limit of using this test.

Detection limit of rosin is 1.0mg/liter

SAMICS

FORMAT "A," "B," and "C" FORMS

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_][	SOLAR ARRAY M FORMA	ANUFACTURING INDU: T C — INDUSTRY DESCF Y 91103	STRY COSTIN	G STANDAI	RDS Page <u>1 of 1</u> C-1 Industry Referent ARCOMOD
C·2	Descriptive Name of Industry	ARCO MODULE	COMPANY		
C-3 C-4	INDUSTRY OBJECTIVE	Produce_peak Peak-watts/y	-watt_po vear	wer	
DESC	CRIPTION OF THE FINAL P	COLLCT OF THE INDUSTR	v		
C-5	Reference PAKMOD		ked modu	les in	carton
C-6	Production is Measured in	Carton			
C-7	Hardware Performance 132	Peak-watts/ca	rton		(Units are C=4 per C=6)
C∙8	Product Design Description	Four 16-2000	Modules	in one	carton
•	•	********			
MAK	ERS OF THE FINAL PRODU	CT OF THE INDUSTRY			annan an ann an Stain ann an Anna ann an Anna a
C•9	Company Reference	MODULECO		. Market	Share
	Company Reference			Market	Share
	Company Reference			Market	Share
PREPA	HED BY				DATE

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비	JET PROPULAION LABORATOF California Initiate al Yechaology Adimi Och Grose Dr. / Paiadena, Cali	4 91103	Company Ref MODULE
DESCRI	SOLAR MODUL	LAR ASSEMBLY	
0, <sup>(b)</sup> (a)	(Final) Product(s) Produced (Final) Process(es)	PAKMOD PACKG	
(c) 1. (b) (a)	Ideal Ratio(s) with units Intermediate Product(s) Process(es)	.25 Carto MODTEST FINTEST	ns/Module
(c) 2, (b) (s)	Ideal Ratio(s) with units Intermediate Product(s)	1 Module/ CLNMOD	Module
(c) 3. (b)	[deal Ratio(s) with units Intermediate Product(s)	FRAMMOD	Module
(a) (c)	Process(es) Ideal Ratio(s) with units	FRAME 1 Module/	Module
4, (b) (a)	Intermediate Product(s) Process(es)	DSPBUTYL AFIXBTYL	
(c) 5. (b)	Ideal Ratio(s) with units Intermediate Product(s)	1 Module/ HIPOTTEST	Module
(a) (c)	Ideal Ratio(s) with units	HIPOT 1 Module/	Module
(0) 8. (b) (a)	Intermediate Product(s) Process(es)	SODTRLUG	
(c) 7, (b) (a)	Ideal Ratio(s) with units Intermediate Product(s) Process(es)	1 Module/ TRMLAM EDGTRM	Module
(c) 8, (b)	Ideal Ratio(s) with units Intermediate Product(s)	POSLAMCT 1 Module/ POSLMCKT	Module
(a) (c) 9. (b)	Process(es) Ideal Ratio(s) with units Intermediate Product(s)	LAMCKT	Module
(a) (c)	Process(es) Ideal Ratio(s) with units	LAMMOD	· · · · · · · · · · · · · · · · · · ·
	Purchased Product(s) Supplier and Percentage	•••••••••••••••••••••••••••••••••••••••	
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Format B: Company Description (Continued) - Financial Parameters

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Note: In the LSA SAMICS context, leave this page blank; use default values of all company financial parameters.

Company Referent (From Front Side)

LSA SAMICS defaults and appropriate un	its are shown preprinted.
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8-1 Percent of Capacity	8-20 Startup Production Fraction
100%	0,635 units/unit
B-2 (Financial) Leverage	B-21 Cash Balance Operation Time
1.2 S/S	0.06 yrs.
8-3 Debt Interest Rate	B-22 Setween Process Inventory Time
9.25%/yr.	0 yrs.
B-4 Other Tax Rate	B-23 Fiscal Hours Per Shift
2%/yr.	8 hrs./shift
B-5 Insurance Rate	8-24 Fiscal Minutes Per Fiscal Hour
4%/yr.	60 min./hr.
B-6 Facility Life	B-25 Fiscal Days Per Fiscal Week
40 yrs.	7 days/wk.
B-7 Rate Of Return On Equity	B-26 Fiscal Weeks Per Fiscal Year
20%/yr.	52,1429 wks./yr.
B-8 Misc. Expense (as) Percentage Of Revenue	8-27 Closed Weekdays Per Fiscal Year
3%	20 days/yr.
B-9 Misc. Expense (as) Percentage Of Operating Expense	8-28 Working Hours Per Person Per Shift
4%	8 hrs./person/shift
B-10 Misc. Expense (as) Percentage Of Book Value	පිං29 Working Days Per Working Week
0%/yr.	5 days/wk.
B-11 Facilities Tax Depreciation Method	B-30 Paid Holidays Per Fiscal Year
DDB	8 days/yr.
B-12 Facilities Book Depreciation Method	B-31 Paid Vacation Days Per Fiscal Year
SL	13.5 days/yr.
B-13 Facilities Inflation Rate Table	B-32 Working Weeks Per Fiscal Year
1975 8.0 • (yr. %/yr.)	52.1429 wks./yr.
	B-33 Average Paid Absenteeism Days Per Fiscal Year 17.5 days/yr.
B-14 Raw Materials Inventory Time	B-34 Second Shift Wage Factor
0.04 yrs	1.15 (S/hr.)/(S/hr.)
B-15 Processing Time Multiplier	B-35 Third Shift Wage Factor
1,0 min./min.	1.20 (\$/hr.)/(\$/hr.)
B-16 Finished Goods Inventory Time	B-35 Fourth Shift Wage Factor
0.04 yrs.	1.20 (\$/hr.)/(\$/hr.)
B-17 Accounts Receivable Turnover Time	B-37 Number Of Shifts Per Day
0.10 yrs.	3 shifts/day
B-18 Accounts Payable Turnover Time	B-38 Facilities (Construction) Contingency Percentage
0.09 yrs.	15%
8-19 Startup Direct Commodity Usage Fraction	B-39 Eouipment Contingency Percentage
1.25 units/unit	15%

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UESC	AND CALLER CONTRACT CALL 9103 AND CALLER OF PRIMA CALL 9103 RIPTIVE NAME	
		nand all market and the second se
<b></b>	(Gunal) Product(a) Produced	
0, (a	(Final) Process(es)	
(c	) Ideal Ratio(s) with units 1	Module/Module
1. (5	Intermadiate Product(s) ASMMOD	) <b> </b>
()	Processies) ASLMMOD	
(c	deal Ratio(s) with units	Module/Module
2. (5	) Intermediate Product(s)	, ,***********************************
()	Process(es) GLWASH	
10	Ideal Ratio(s) with units	Module/Module
3. 15	Intermediate Product(r)	WOARFBY WOARFGT
	Ideal Detrofe) with inste	No 501 - /No 301 -
10		Module/Module
4. (0	) Intermediate Productis) SODMODCK	
[9	) Process(es) TASOD	
(c	ldeal Ratio(s) with units	Module/Module.
5, (o	Intermediate Product(s) CKTSUBTA	
()	Process(es) TACKTSUB	
lc	) Ideal Ratio(s) with units	030303CELLCK/CF
ð. (b	Intermediate Product(s) SCIS	
(a	Process(es) CELSTSOD	
lc	Ideal Ratio(s) with units	Cell/Cell
7. (b	Intermediate Product(s) SODPACELL	· · · · · · · · · · · · · · · · · · ·
(3	) Process(es) SPSP	
(c	Ideal Ratio(s) with units	۵٬۰۰۰ ۵٬۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۱ ۲۰۰۰ ۲۰۰۰
8. (0	Intermediate Product(s)	
6	Process(es)	,
10	Ideal Ratio(s) with units	
9.16	1 Intermediate Product(s)	
1.	Promosciael	
	i i fotosi (si)	
<sup>10</sup>	i - 1968) 774(19) With Units 	
	Purchased Product(s)	
ļ	Supplier and Percentage	

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#### Format B: Company Description (Continued) - Financial Parameters

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Note: In the LSA SAMICS context, leave this page blank; use default values of all company financial parameters.

Company Referent (From Front Side)

LSA SAMICS defaults and appropriate units are shown preprinted.

B-1 Percent of Capacity	8-20 Startup Production Fraction
100%	0.635 units/unit
B:2 (Financial) Leverage	8-21 Cash Balance Operation Time
1,2 \$/\$	0.05 yrs.
B-3 Debt Interest Rate	B-22 Between Process Inventory Time
9.25%/yr.	0 yrs.
5-4 Other Tax Rate	8·23 Fiscal Hours Per Shift
2%/yr.	8 hrs./shift
C-5 Imurance Rate	8-24 Fiscal Minutes Per Fiscal Hour
4%/yr.	60 min./hr.
B-6 Facility Life	8-25 Fiscal Days Per Fiscal Week
40 yrs,	7 days/wk.
8-7 Rate Of Return On Equity	B-28 Fiscal Weeks Per Fiscal Year
20%/yr.	52,1429 wks./yr.
B-8 Misc. Expense (as) Percentage Of Revenue	B-27 Closed Weekdays Per Fisual Year
3%	20 days/yr.
B-9 Misc. Expense (ad) Percentage Of Operating Expense	8-28 Working Hours Per Person Per Shift
4%	8 hrs./person/shift
B-10 Misc. Expense (as) Percentage Of Book Value	B-29 Working Days Per Working Week
0%/yr.	5 days/wk.
8-11 Facilities Tax Depreciation Method	B-20 Paid Holidays Per Fiscal Year
DDB	8 days/yr.
B-12 Facilities Book Depreciation Method	B-31 Paid Vacation Days Per Fiscal Year
SL	13.5 days/yr.
B-13 Facilities Inflation Rate Table	B-32 Working Wecks Per Fiscal Year
1975 6.0 + (yr. %/yr.)	52,1429 wks./yr.
	B-33 Average Paid Absenteeism Days Per Fiscal Year 17.5 days/yr.
8-14 Raw Materials Inventory Time	B-34 Second Shift Wage Factor
0.04 yrs	1.15 (S/hr.)/(S/hr.)
8-15 Processing Time Multiplier	B-35 Third Shift Wage Factor
1.0 min./min.	1.20 (\$/hr.)/(\$/hr.)
B-16 Finished Goods Inventory Time	B-36 Fourth Shift Wage Factor
0.04 yrs.	1.20 (S/hr.)/(S/hr.)
B-17 Accounts Receivable Turnover Time	B-37 Number Of Shifts Per Day
0,10 yrs.	3 shifts/day
B-18 Accounts Payable Turnover Time	B-38 Facilities (Construction) Contingency Percentage
0.09 yrs.	15%
8-19 Startup Direct Commodity Usage Fraction	8-39 Equipment Contingency Percentage
1.25 units/unit	15%

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SOLAR ARRAY MANUFACTURING INDUSTRY COSTING STANDA FORMAT A — PROCESS DESCRIPTION				D8 A-1 Prees S1	Page <u>1 of 2</u> s (Referent) PSP
		Note: Names gi requested by the	ven in brackets ( ) a s SAMIS computer pro	ire the nan ogram.	nes of process attribute
A-2 [Descriptive, Name] of Process .	Screen	print sol	der paste		
PART 1 - PRODUCT DESCRIPTION A-3 (Product, Referent) SODP, A-4 Descriptive Name (Product, Nam A-6 Unit Of Measure (Product, Units	ACELL .; <u>Solder</u> Cell	paste pri	nted cell		
PART 2 PROCESS CHARACTERIS A-6 [Output, Rate] (Not Thruput) A-7 [Ingrocess, Inventory, Time] A-8 [Outy, Cycle] A-8a [Number, Of, confts, Per, Day] A-8b [Personne], Integerization, Overr	TICS 22,7904 6.0549 .85238 3 Ide. Switch]	25 548 095 Off	. 5% Units (given on line Calendar Minutes (f F Operating Minutes I Shifts (Off or On)	A·6) Per ( Used only i Per Minute	Operating Minute to compute nventory)
PART 3 — EQUIPMENT COST FACTO A:9 Component [Referent] A:9a Component [Descriptive, Name]	DRS (Machine De E	PAPRINTER	CSTACKEI Stackei	R CF	URNACE Furnace
A-10 Base Year For Equipment Prices A-11 [Purchase, Cost, Vs. Quantity, Bi (Number Of and \$ Per Compone)	(Price, Year) ought, Table) ht)	1979 125000	1979 20000		1979 31000
A-12 Anticipated (Useful, Life) (Year A-13 (Salvage, Value) (\$ Per Compon	s) rnt)	7 Ø	7 Ø		7 Ø
A-14 [Removal, And, Installation, Co:	t] (\$/Component)		200	-	2500

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation. Rate, Table], the [Equipment, Tax. Depreciation, Method], and the [Equipment, Book. Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.) ۰.

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Format A: Process Description (Continued)

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A-15 Process Referent (Frem Front Side Line A-1) \_\_\_\_\_\_\_

PART 4 - DIRECT RE (Facility, Or, A-15 Catalog Number (Expense Item Referent) A2096D B3752D	QUIREMENTS FER MA Persennel Requirement A-18 Amount Required Per Machine (Per Shift (Amount, Per, Machine 350	CHINE (Feelilities) OR P A-19 Units <u>SQFt</u> Person/Shi	Requirements Manufactu	T (Persennel) A-17 Int Description or Name It ing Space Prod-Maching
PART 5 - DIRECT RE (Byproduct) A-20 Catalog Number (Expense Item Referent) C1032B C2032D E1065D E1141D	QUIREMENTS PER M/ and (Utility, Or, Comm A-22 Amount Required Per Machine Per Minut (Amount Per, Cycle) 1.11111 10 3.571428 21.873298	ACHINE PER MINUTE hodity Requirement) A-23 B Units KWin/min CFM 5 GR/min	(SAMIS will ask first for Provident for Provident for Cell Voltal: Cell	Byproducts) A-21 Ent Description or Name Hity Red air (aste <u>Cream</u> Immy) Photos
PART 6 INTRA-IND A-24 [Required, Product] (Reference)	USTRY PRODUCT(S) ( A-28 [Yiekd] * [( (%) L	REQUIRED A-26 Ideal, Ratio) ** Of Inits Out/Units in	A-27 Units Of A-28***	A-25 Product Name SODPACELL

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*\*Examples: Modules/Cell or Cells/Wafer,

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<b>M</b>		JRING INDUSTRY CO	STING STANDA	RDS Page 1 of 2
−J∦	FORMATA -	PROCESS DESCRIPTI	ON [	A-1 Process [Referent]
9	JFT FROPULSION LABORATORY California lautines at Tathabasy ANIM Och Grees Dr / Paisdena, Calif 91103			CELSTSOD
		Note: Names g requested by th	iven in brackets [ _ ] e SAMIS computer p	are the names of process attrib rogram.
A∙2	(Descriptive, Name) of Process	String Solde	ering	
PART	1 - PRODUCT DESCRIPTION			
A-3	(Product, Referent)SCIS	and the second state of th		
A-4	Descriptive Name (Product, Name) Sold	der Cell Into	o String	
A•5	Unit Of Measure (Product, Units)	1 CK		
PAR1	T 2 - PROCESS CHARACTERISTICS [Output, Rate] (Not Thruput)	6324 ·	L.5. Units (given on lin	LOSS e A·5) Per Operating Minute
A.7	[Inprocess. Inventory, Time] 6.5	986108	Calendar Minutes	(Used only to compute
A-8	(Duty, Cycle)	75	Operating Minutes	n-process (nventory) s Per Minute
A-8a	[Number, Of, Shifts, Per, Day]	3	Shifts	
A-8b	(Personnel, Integerization, Override, Switch)	Off	(Off or On)	
PAR				
, , , , , ,	T 3 - EQUIPMENT COST FACTORS (Mac	nine Description)		
A-9	T 3 - EQUIPMENT COST FACTORS {Mac Component [Referent]	nine Description)		
A-9 A-9a	T 3 — EQUIPMENT COST FACTORS {Mac Component [Referent] Component {Descriptive, Name}	nine Description) STRGSOD String So	lder	
A-9 A-9a A-10	T 3 - EQUIPMENT COST FACTORS (Mac Component (Referent) Component (Descriptive, Name) Base Year For Equipment Prices (Price, Year	hine Description) STRGSOD String So 1980	lder	
A-9 A-9a A-10 A-11	T 3 - EQUIPMENT COST FACTORS (Mac Component [Referent] Component [Descriptive, Name] Base Year For Equipment Prices [Price, Year [Purchase, Cost, Vs, Quantity, Bought, Table [Number Of and S Per Component]	hine Description) STRGSOD String So 1 1980 250,000 7	lder	
A.9 A.9a A.10 A.11 A.12	T 3 - EQUIPMENT COST FACTORS (Mac Component (Referent) Component (Descriptive, Name) Base Year For Equipment Prices (Price, Year (Purchase, Cost, Vs, Quantity, Bought, Table (Number Of and S Per Component) Anticipated (Useful, Life) (Years)	hine Description) STRGSOD String So 1980 250,000 7	lder	
A-9 A-9a A-10 A-11 A-12 A-13	T 3 - EQUIPMENT COST FACTORS (Mac Component (Referent) Component (Descriptive, Name) Base Year For Equipment Prices (Price, Year (Purchase, Cost, Vs, Quantity, Bought, Table (Number Of and S Per Component) Anticipated (Useful, Life) (Years) (Salvage, Value) (S Per Component)	hine Description) STRGSOD String So 1 1980 e) 250,000 7 Ø	lder	

Note: The SAMIS computer program also prompts for the (Payment, Float, Interval), the (Inflation, Rate, Table), the (Equipment, Tax, Depreciation, Method), and the (Equipment, Book, Depreciation, Method). In the LSA SAMICS context, use 0.0, (1975 6.0 \*), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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PART 4 — DIRECT RE [Facility, Or	QUIREMENTS PER , Personnel Regulrer	t MACHINE (Facilities) ( ment]	DR PER MACHINE PER SHIF	T (Parsonnel)
A-16	A-18	A-19		A-17
Gatalog Number (Expense Item Referent)	Amount Hequir Per Machine (Per S (Amount, Per, Mac	ed Shift) Units shine)	; Requireme	nt Description or Name
A2096D B3752D	<u>168.333</u> 2.5	33P <u>ersons</u>	Shift Operato	turing Space r Prod-Machine
PART 5 - DIRECT RE	QUIREMENTS PER	MACHINE PER MINUT	TE (SAMIS will ask first for	Byproducts)
(Byproduct) A-20	A-22			A-21
Catalog Number (Expense Item Referent)	Amount Requir Per Bashine Per M [Amount, Per, Cy	red linute Units /cle]	į Requireme	Int Description or Name
C1032B	.1242833	kWh/min	n Electric	ity
2032D	5	CFM	Compress	ed Air
ART 6 - INTRA-IND A-24 (Required, Product) (Reference) SODPACELL	A-28 [Yield] * (%)	(S) REQUIRED A-26 (Ideal, Ratio) ** Of Units Out/Units In 1/33	A-27 Units Of A-26*** CELLCK/CELL	A-25 Product Name SCIS
الدوم الدوم الدوم الدوم				DATE

\*100% minus percentage of required product lost in this process, \*\*Assume 100% yield here. \*\*\*Examples: Modules/Gell or Cells/Wafer.



SOLAR ARRAY MANUFACTURING INDUSTRY COSTING STANDARDS

Page 1 of 2

FORMAT A - PROCESS DESCRIPTION

U JET PROPULSION LABORATORY Culturing Institute of Technology WHO Oak Green Dr. / Polodena Colil. 91103

#### A-1 Process [Referent] TACKTSUB

Note: Names given in brackets [ ] are the names of process attributes requested by the SAMIS computer program.

A•2	[Descriptive, Name] of Process Turn Arou	ind CKT	Sub-Assembly			
PAR	PART 1 PRODUCT DESCRIPTION					
A•3	A-3 (Product, Referent) CKTSUBTA					
A-4	Descriptive Name (Product, Name)CKT_SU	ib turn	around			
A-5	Unit Of Measure (Product, Units)SUBCK1	1				
PAR	T 2 - PROCESS CHARACTERISTICS					
A·ð	[Output, Rate] (Not Thruput)		Units (given on line A-6) Per Operating Minute			
A•7	{Inprocess. Inventory, Time}		Calendar Minutes (Used only to compute			
A-8	(Duty, Cycle)	)	Operating Minutes Per Minute			
A-8a	[Number, Of, Shifts, Per, Day]3		Shifts			
A-8b	A-Bb (Personnel, Integerization, Override, Switch)Off (Off or On)					
PAR	T 3 - EQUIPMENT COST FACTORS (Machine Des	cription)				
A-9	Component (Referent)	TAMACH				
A.9.	Component [Descriptive, Name]	CKT TA	<u>Ma</u> ch <u>ine</u>			
A-10	Base Year For Equipment Prices (Price, Year)	1980				
A-11	(Purchase, Cost, Vs, Quantity, Bought, Table) (Number Of and \$ Per Component)	20000				
A-12	Anticipated (Useful, Life) (Years)	7				
A-13	[Salvage, Value] (\$ Per Component)	Ø				
A-14	(Removal, And, Installation, Cost) (\$/Component)	500				

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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A-15 Process Referent	(From Front Side Line	A-1) TACKTSU	IB	
PART 4 - DIRECT RE	QUIREMENTS PER I	MACHINE (Facilities) OR	PER MACHINE PER SHIF	T (Personnel)
(Facility, Or. A-16 Catalog Number	Personnel Requirem A-18 Amount Required	int) A-10 1		A-17
(Expense Item Referent)	Per Machine (Per Sh (Amount, Per, Mach	ift) Units ine]	Requireme	nt Description or Name
A2096D	27.5	SqFt	Manufactu	ring Space
<u>B3752D</u>		Persons/Sh	ift Operator	Prod-Machine
PART 5 - DIRECT RE (By/roduct)	QUIREMENTS PER I and (Utility, Or. Cor	MACHINE PER MINUTE nmodity Requirement)	(SAMIS will ask first for I	Byproduces)
A-20 Catslog Number (Expense item Referent)	A-22 Amount Required Per Machine Per Min [Amount, Per, Cyc	A-23 d nute Units (s)	į Requireme	nt Description or Name
<u>C1032B</u>	.1	kWh/min_	_ Electrici	ty
$\left  \frac{E1835D}{EP15D} \right $	007142857	$\frac{1}{1-\frac{PR}{min}}$	$-\frac{Gloves co}{200 v 005}$	tton
	enter provident Cold Cold		مەمەرلىلى «ئېمچېكىكىكى» مەمە	
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				ani ar fallad manafah yang dalam kana na manana si sa ana si sa ana si sa
and the second se		nantasianya mantanya mananya jalamputén ja		
(paratelistic francessis)				
		and the second		
		en januaraan en janginaa amanana amana ama	angelinen anjunen, forsterrigisernen einen einen sonsterrigisernen einen sonsterrigisernen einen sonsterrigisernen sons	an a
PART 6 - INTRA-IND	USTRY PRODUCTIS	) REQUIRED	ning and a substantial from the state of the substantial from	na (na mana na kao na kao na ka
A-24 (Required, Product) (Reference)	A-28 (Yield) * (%)	A-28 (Ideal, Rotio) ** Of Units Out/Units In	A-27 Unit: 01 A-26***	A-25 Product Name
	0.0 5			
	<u> </u>	L	SUBCKT	CKTSUBTA
alan manana kanan manana manana manana manana kaona ang ka		******		
interfelietungis andere and and and and and and	na se	in faithin beyond as the providence of the last of The Victory called Microsoft and an alternative last of the faith of the last of the faith of the last of the last of the last of the faith of the last of the		
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\*100% minus promitage of required product loss in this process. \*\*Assume 100% yield here. \*\*\*Examples: Modules/Gell or C - Water.

Format A: Process Description (Continued)

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Page 2 of 2

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- <b>]</b> [	SOLAR ARRAY MAR FORMA	UFACTURING T A PROC 10)	INDUSTRY C ESS DESCRIPT	OSTING STAND, TION	ARDS Pr A-1 Process (Re TASOD	ferent]
Δ.2	[Descriptive, Name] of Process	Turn	Note: Names requested by t around so	given in brackets ( the SAMIS computer Oldering	) are the names of program.	process attributes
PART	1 - PRODUCT DESCRIPTION					
A-3	[Product, Referent] SODMO	DCK	Marting 1 100			
A4	Descriptive Name [Product, Name	Solde:	r severa	l strings	together	
A•5	Unit Of Measure [Product, Units]	Modul	3			
PART	1 2 – PROCESS CHARACTERIST	ICS				1) <del></del>
A-6	(Output, Rate) (Not Thruput)	1.155		Units (given on I	ine A·5) Per Opera	ting Minute
A•7	(Inprocess, Inventory, Time)	103.5		Calendar Minute	s (Used only to co	mpute
8-A	(Duty, Cycle)	.937	5	Operating Minut	in·process inventi tes Per Minute	ory)
A-8a	[Number, Of, Shifts, Per, Day]		3	Shifts		
А•8Ъ	(Personnel, Integerization, Overrid	e, Switch)	Off	(Off or On)		
PAR	T 3 – EQUIPMENT COST FACTO	RS (Machine Des	cription)	and a substant of the substant of t		
A-9	Component [Referent]		TABECH			
A•9a	Component (Descriptive, Name)		Bench	•		
A•10	Base Year For Equipment Prices (	Price, Year)	1980	narryska (†254 oktober 2005) skolenný (†264 oktober 2005) skolenný (†264 oktober 2005) skolenný (†264 oktober 2005) skolenný (†264 oktober 2005)	, , , , , , , , , , , , , , , , , , ,	
A-11	(Purchase, Cost, Vs, Quantity, Bod (Number Of and \$ Per Component	ught, Table} )	3000	anan a an		
A•12	Anticipated (Useful, Life) (Years)		7			
A-13	(Salvage, Value) (\$ Per Componet	nt}	ø			
A-14	(Removal, And, Installation, Cost	(\$/Component)	500	4/////////////////////////////////////		

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0,0, (1975 6.0 •), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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#### Format A: Process Description (Continued)

Page 2 of 2

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TASOD A-15 Process Referent (From Front Side Line A-1)

PART 4 - DIRECT RE	QUIREMENTS PER I	ACHINE (Facilities) O	R PER MACHINE PER SHIFT	(Personnel)
(Facility, Or	Personnel Requireme	int)		
A-16	A-18	A-19		A-17
Catalog Number	Amount Required	1	•	
(Expense item Referent)	Per Machine (Per Sh [Amount, Per, Mach	ift) Units ine]	Requirement	Description or Name
A2096D	35.5	SqFt	Manufacty	ring space
B3032D	1.0	Person/S	<u>hift Assembler</u>	Electronics
			······································	
PART 5 - DIRECT RE (Byproduct)	and (Utility, Or, Cor	MACHINE PER MINUT nmodity Requirement]	E (SAMIS WIII MAK TINT TOP BY	(products)
A-20	A-22	A-23		A-21
(Expense Item Referent)	Per Machine Per Min [Amount, Per, Cyc	ute Units Iel	e Requirement	Description or Name
C1032B	.002	kWh/mi	n Electrici	Lty
ET922D.	.0077777	Glove	GLoves co	otton
	,		alexander and a second and the second second and the second second second second second second second second se	
		والمتناز والمتحمد فيستمر والمتحد والمتحد والمتحد والمتحد والمتحد والمتحد والمتحد والمتحد والمتحد والم		A REAL PROPERTY AND A REAL PROPERTY A REAL PROPERTY AND A REAL PROPERTY AND A REAL PRO
«»				anan ing kang ang ang ang ang ang ang ang ang ang
				naman da yana danan kana kana kana kana kana kana
			APERiotecte Application and a second s	
	45 <sup>1</sup> 8 <sup>19</sup> 1766		anninga maan dip participana amangang tangga tang	
4	477-1962) ; mission and a low provide the second state of the			an series and a second s
	Constant and a second se			ana la cana ang ang ang ang ang ang ang ang ang
				eya nyana mananya kapanya kapanya a ina da ana kapanya ana ana kapanya ana kapanya kana kapanya kapanya kapany
PART 6 - INTRA-IND	USTRY PRODUCT(S	) REQUIRED		
A-24	A-28	A-26	A-27	A-25
(Reference)	(%)	Units (Jut/Units In	Units Of A-26***	Product Name
SCIS	100	1/1	MODULE/CELLCK	SODMODCK
CKTSUBTA	100	1	MOD/SUBCKT	Contraction of the second s
		in a second s	· · · · · · · · · · · · · · · · · · ·	
PREPARED BY			an a	DATE

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*Examples: Modules/Cell or Cells/Wafey.

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SOLAR ARRAY MANUFACTURING INDUSTRY COSTING STANDARDS

Page 1 of 2

FORMAT A - PROCESS DESCRIPTION

A-1 Process (Referent) PRLAMCT

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Note: Names given in brackets [ ] are the names of process attributes requested by the SAMIS computer program.

A-2 [Descriptive, Name] of Process Prelamination CKT test							
PAR	T I - PRODUCT DESCRIPTION						
A-3	(Product, Referent)PREI	MCKT					
A-4	Descriptive Name (Product, Nam	el Test ckt	for bein	a ful	lly operal	ble	
A•5	A-5 Unit Of Measure (Product, Units) Module						
PAR	T 2 - PROCESS CHARACTERIS	TICS					
A-6	(Output, Rate) (Not Thruput)	1.33333		Units (giv	ven on line A·5) Per	Operating Minute	
A•7	(Inprocess, Inventory, Time)	17.25		Calendar	Minutes (Used only	to compute	
8-A	(Duty. Cycle)	.875		Operatin	In-process In Minutes Per Minu	inventory) te	
A-8a	[Number, Of, Shifts, Per, Day]	3		Shifts			
∧·8b	m-8b (Personnel, Integerization, Override, Switch)Off			. (Off or On)			
PAR	T 3 – EQUIPMENT COST FACT	ORS (Machine Des	cription)			201. 20 14 7 <del>16 2 10 2 10 1 10 10 10 10 10 10 10 10 10 10 10 1</del>	
A-9	Component (Referent)		XENON	G	auge		
A-91	Component (Descriptive, Name	1	Generator	, 		8 mil 1999-1990 anterna en	
A-10	) Base Year For Equipment Prices	[Price, Year]	1979	<u></u>	1979		
A-11	(Purchase, Cost, Vs. Quantity, E Number Of and S Per Composi	Bought, Table]	4500	<b></b>	29061		
A.1	Anticipated [[]teful_life] [Ves	re)	7		7		
	t Calvana Valual /C Par Cumoo	nent)	1000	3 <b>6</b>	500		
A-14	Removal, And, Installation, Go	st) (\$/Component)	500		250		

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method], in the LSA SAMICS context, use 0.0, (1975.6.0.\*), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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mat A: Process Desc	ription (Continued)			PageOf	2
15 Process Referent	(From Front Side Li	PRLA	MCT		
AT 4 - DIRECT RE	QUIREMENTS PER	MACHINE (Fedilities) C	R PER MACHINE PER SHIF	T (Personnel)	
(Facility, Or A-15 Catalog Number (Expense item	, Personnel Requiren A-18 Amount Requir Per Machine (Per S	nent) A-19 ed hift) Units	Banaireme	A-17	
Referent)	(Amount, Per, Mac	hine)			
A2096D	38	SqFt	Manufact	uring Space	
B3732D	L			Prod-Mach	
RT 5 - DIRECT RE	QUIREMENTS PER	MACHINE PER MINUT	E (SAMIS will ask first for t	Byproduces)	
(Byproduct) A•20	and [Utility, Or, Co A-22	mmodity Requirement) A-23		A-21	
Catalog Number (Expense Item Referent)	Amount Requir Per Machine Per M [Amount, Per, Cy	rd Inute Units clip]	, Requireme	nt Description or Name	•
C1032B	.166666	kWh/mir	<u> </u>	icity	·
		and the first of the second			
DT & MITDA INO	USTRY PRODUCT(	S) REQUIRED			
NI 0 - INTRA-IND			A-27	A-25	
A-24 (Required, Product) (Reference)	A-28 [Yield] * (%)	A-25 [Ideal, Ratio] ** Of Units Out/Units In	Units Of A-26***	Product Name	
A-24 Required, Product) (Reference) SODMODCK	A-28 [Yield] * (%) 	A-25 (Ideai, Ratio) ** Of Units Out/Units In 1/1	Units Of A-26*** MODULE/MODULE	Product Name PRELMCKT	

\*100% minus percentage of required product lost in this process, \*\*Assume 100% yield here, \*\*\*Examples: Modules/Cell or Cells/Wafer.

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SOLAR ARRAY MANUFACTURIN FORMAT A - PRO	IG INDUSTRY COS CESS DESCRIPTIC	STING STANDARDS Page ]. DN A.1 Process (Referent GLSWASH	of
Class w	Note: Names giv requested by the	en in brackets [ ] are the names of proce SAMIS computer program.	14 Attribu
PART 1 - PRODUCT DESCRIPTION A-3 (Product, Referent) <u>CLIGLASS</u> A-4 Descriptive Name (Product, Name) <u>Wash</u> A-5 Unit Of Measure (Product, Units) <u>Glass</u> PART 2 - PROCESS CHARACTERISTICS . 1% 0.5	l'X4' Pane Loss no	of glass t considered in out	put
A-8 [Output, Hate] (Not Thruput) A-7 [Inprocess, Inventory, Time] A-8 [Outy, Cycle] 0.83174	603	Units (given on line A-5) Per Operating M Calendar Minutes (Used only to compute in-process Inventory) Operating Minutes Per Minute	inute
A-8a (Number, Of, Shifts, Per, Day)	ff	Shifts	
PART 3 - EQUIPMENT COST FACTORS (Machine D	attriptical		
A-9 Component [Referent] A-9a Component [Descriptive, Name] G	<u>GLASWASH</u> lass washi	ng	0 <del>7</del>
A-10 Base Year For Equipment Prices (Price, Year)	1980		
A-11 [Purchase. Cost. Vs. Quantity. Bought. Table] (Number Of and \$ Per Component)	17000		
A-12 Anticipated (Useful, Lile) (Years)	7	. Saida da ana amin'ny sorana amin'ny sorana amin'ny sorana amin'ny sorana amin'ny sorana amin'ny sorana amin'n	
A-13 [Salvage, Value] (\$ Per Component)	Ø	and a second	
A-14 [Removal, And, Installation, Cost] (\$/Component)	500		

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A: Process Descr	iption (Continued)			Page _2_of_2
A-15 Process Referent (	From Front Side Line A-1)	GLSWASE	<u> </u>	-
PART 4 DIRECT RE (Facility, Or A-16 Catalog Number (Expense Item Referent) A2096D B3752D	QUIREMENTS PER MACH , Personnel Requirement) A-18 Amount Required Per Machine (Per Shift) (Amount, Per, Machine) 336 2.0	INE (Feellities) OR PI A-19 Units SqFt P <u>ersons/Sh</u>	Requirement Manufacti	Personnel) A-17 Description or Name aring Space , Prod-Machine
PART 5 - DIRECT RE [Byproduct] A-20 Catalog Number (Expense item Referent) C1032B C1016B E1815D ECD11D	QUIREMENTS PER MACh and [Utility, Or. Commod A-22 Amount Required Per Machine Per Minute [Amount, Per, Cycle] . 10564055 . 016729589 2.0 . 0006998683	HINE PER MINUTE Ity Requirement) A-23 Units KWh/min CUFT 2pcs/min 8 LB	(SAMIS will ask first for By Electric Water do Glass, Detrex #531700869	products) A-21 Description or Name city 8.5 HP omestic Sunadex Soap -00 \$740/550#
PART 6 INTRA-IND A-24 (Required, Product) (Reference)	A-28 [Yield] * [ide (%) Unit	A-26 A-26 al. Ratio] ** Of ts Out/Units In	A-27 Units Of A-26***	A-25 Product Name
FREFARED BY				DATE

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*Examples: Modules/Cell or Cells/Wafer.

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FORMAT A - PRO	G INDUSTRY CO	STING STANDARDS Page -	<u> </u>
	Note: Names giver requested by the	ven in brackets [ ] are the names of proc e SAMIS computer program.	414 ALC
A-2 (Descriptive, Name) of Process ABBEmblo	laminatio	on module	
PART 1 PRODUCT DESCRIPTION			
A-3 [Product, Referent] ASMMOD			
A4 Descriptive Name [Product, Name] ASSC	mbled modu	le	
A-5 Unit Of Measure (Product, Units) Modu	le		
PART 2 - PROCESS CHARACTERISTICS			La
A-6 (Output, Rate) (Not Thruput)	3333		Minute
A-7 [Inprocess, Inventory, Time]		Calendar Minutes (Used only to comput	e
A-8 (Duty. Cycle) .8	75	_ Operating Minutes Per Minute	
A-8a (Number, Of, Shifts, Per, Day)	3	_ Shifts	
A-8b (Personnel, Integerization, Override, Switch) Of	f	(Off or On)	
PART 3 EQUIPMENT COST FACTORS (Machine D	escription)	en de general de la contra de la contra de la contra de la contra de la del de la contra de la contra de la con	
A-9 Component (Referent)	ATOMCHAM		
A-9a Component (Descriptive, Name)	Ball Cham	nber	وبالبالين ويبد
	Destroyant and the second s	nen, gelandistyningen ander an de gelander (er en	
A-10 Base Year For Equipment Prices (Price, Year)	1980	anna an	
A-10 Base Year For Equipment Prices (Price, Year) A-11 (Purchase, Cost, Vs. Quantity, Bought, Table) (Number Of and S Per Component)	1980 150000	ang 29799 Terrangan dari kanangan dari kanangan S. Bakar dari Kanangan dari kanangan dari kanangan dari kananga	
A-10 Base Year For Equipment Prices (Price, Year) A-11 [Purchase, Cost. Vs. Quantity, Bought, Table] (Number Of and S Per Component) A-12 Anticipated (Useful, Life) (Years)	<u>1980</u> 150000 7	na forder Sameran and a second s	
<ul> <li>A-10 Base Year For Equipment Prices [Price, Year]</li> <li>A-11 [Purchase, Cost. Vs. Quantity, Bought, Table] (Number Of and S Per Component)</li> <li>A-12 Anticipated [Useful, Life] (Years)</li> <li>A-13 [Salvage, Value] (S Per Component)</li> </ul>	1980 150000 7 Ø		

The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method], in the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.) Note:

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Format A: Process Description (Continued)

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A-15 Process Referent (	From Front Side Line	A-1) <u>AS</u>	ILMMOD	
PART 4 - DIRECT RE	QUIREMENTS PER M	ACHINE (Papilities) OI	A PER MACHINE PER SHIP	(Personnol)
(Facility, Or. A-16	Personnel Requiremen A-18	t] A-19		A-17
Catalog Number (Expense Item Referent)	Per Machine (Per Shif (Amount, Per, Machin	t) Units •]	Reguireme	nt Description or Name
A2096D	851.35937	SqFt	Manufact	uring Space
B3080D	2.0	persons/S	hift Assemble	r Module
(Byproduct)	and (Utility, Dr. Comr	nodity Requirement)	E (aAMIa WII alk TINK IOF :	sybiooneal
A-20 Catalog Number	A-22 Amount Required	A-23		A-21
(Expense item Referent)	Per Machine Per Minu (Amount, Per, Cycle)	te Units	Requirement	nt Description or Name
C1032B	18331742	kwh/	<u>min Elec</u>	tricity
EG22D	1.3333333	<u>Saft</u> Saft	CORA	D
E1815D	1.333333	Saft	)	
••••••••••••••••••••••••••••••••••••••				
				· · · · · · · · · · · · · · · · · · ·
	<b>.</b>			
PART 6 - INTRA-IND	USTRY PRODUCT(S)	REQUIRED		
A-24	A-28	A-26	A-27	A-25
(Reference)	(%) (	Ideal, Ratio) ** Or Jnits Out/Units In	Units Of A-26***	Product Name
CLGLASS	1.0	1/1	MODULE/GLASS	ASMMOD
PRELMCKT	1.0	1/1	MODULE/MODUL	E
<b></b>	-			
PREPARED BY				DATE

\*100% minus percentage of required product lost in this process, \*\*Assume 100% yield here, \*\*\*Examples: Modules/Cell or Cells/Wafer,

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-ĴĮ	SOLAR ARRAY MAN FORMA'	UFACTURING F A PROC	3 INDUSTRY CO IESS JESCRIPTI	isting Standa On	ARDS Page 1 of 1 A 1 Process [Referent] IJAMMOD
			Note: Names gi requested by th	iven in brackets [ # SAMIS computer	) are the names of process attribution of the second stribution of the
<b>∧</b> ·2	(Descriptive, Name) of Process ones	Glass &	circuit	laminatio	on
PAR1 A-3 A-4	T 1 PRODUCT DESCRIPTION [Product, Referent]IAMCK Descriptive Name [Product, Name]	T Laminat strate	ion of ce	ell circui	it to glass sup
A:9	Unit Of Measure (Product, Units) ,				
A-6	(Output. Rate) (Net Thruput)	.288	36813188	.5% LO Units (given on li	88 ne A-6) Per Operating Minute
<b>▲</b> •7	(Inprocess, Inventory, Time)	T93.207		Calendar Minuter	I (Used only to compute In-process inventory)
8-A	(Duty. Cycle)	.875	) 	Operating Minuti	es Per Minute
A-8a	[Number, Of, Shifts, Per, Day]			Shifts	
A-8b	(Personnel, Integerization, Overrid	. Switch]	/ da da	(Off or On)	
PART	T 3 - EQUIPMENT COST FACTOR	18 (Machine De	scription)		
A:9	Component (Referent)		LACHAMB	her	ingy 19/000000000000000000000000000000000000
A-9#	Component [Descriptive, Name]			الله تب الله الله الله الله الله الله الله الل	
					Construction Construction Construction
A-10	Base Year For Equipment Prices (P	rice. Year]	1980		
A-11	(Purchase, Cost, Vs, Quantity, Bou (Number Of and \$ Per Component	ght. Table) )	200000		
A-12	Anticipated [Useful, Life] (Years)		7		
A-13	(Salvage, Value) (\$ Per Componen	t)	ø	a nana ponantika na anana	
A-14	[Removal. And, Installation, Cost]	(\$/Component)	2500		

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Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the {Equipment, Tax. Depreciation, Method], and the (Equipment, Book, Depreciation, Method). In the LSA SAMICS context, use 0.0, (1975 6.0.+), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A: Process Description (Continued)

Page 2 of 2

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LAMMOD A-15 Process Referent (From Front Side Line A-1)

PARTA - DIRECT RE	QUIREMENTS PER M	ACHINE (Fedilities) C	R PER MACHINE PER SHIFT (	Personnei)
A-15	A-18	A-19		A-17
(Expense Item Referent)	Per Machine (Per Shi (Amount, Per, Machir	t) Units w)	Requirement	Description or Name
A2096D	647.2222	2 SqFt	Manufactu	iring Space
<u>B3048D</u>	2.0	Persons/	Shift Assemble	<u>encapsulator</u>
			anna (* anna San Bananya an Adam Mana	and a second
		The second s		
		nyennet dayanan internetienen		
PART 5 - DIRECT RE [Byproduct]	QUIREMENTS PER M	ACHINE PER MINUT modity Requirement	E (SAMIS will ask first for By	products)
A-20	A-22	A-23		A-21
Catalog Number (Expense item Referent)	Amount Required Per Machine Per Minu [Amount, Per, Cycle	ite Units ]	: Requirement	Description or Name
C1032B		<u>kWh/min</u>	Electricit	:y
C2032D	1.0	CFM	Compressed	air
E1569D	.002197802	1 Sheet	Rubber she	ets
	,			
······				
PART 6 - INTRAIND	USTRY PRODUCT(S)	REQUIRED		
A-24	A-28	A-26	A-27	A-25
(Reference)	(%)	Units Out/Units In	Units Of A-26***	a guidt Name
ASMMOD	1.0	1/1	MODULE/MODULE	LAMCKT
	ning straticities, particular, party			
	****	,		
PREPARED BY				DATE

\*100% minus percentage of required product lost in this process, \*\* Assume 100% yield here, \*\*\* Examples: Modules/Cell or Cells/Wafer.

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	SOLAR ARRAY MANUFACTURING INDUSTRY COSTING STANDA	ARDS Page of
コ胍一	FORMATA — PROCESS DESCRIPTION	A-1 Process [Referent]
Culuto ANIM	ROPULBION LANORATORY ma failuite al Taidnalagy Dak Graig Dr. / Paindand, Calil. 91103	POSLAMCT

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Note: Names given in brackets [ ] are the names of process attributes requested by the SAMIS computer program.

A-2	(Descriptive, Name) of Process Post 1	amination ci	rcuit test			
	,					
PAR	T 1 - PRODUCT DESCRIPTION					
A-3	A-3 [Product, Referent]					
A-4	Descriptive Name (Product, Name) Tes	t circuit fo	or being fully operable			
A•5	Unit Of Measure (Product, Units) Mod	ule				
PAR	T 2 - PROCESS CHARACTERISTICS					
A-6	[Output, Rate] (Not Thruput)	33333	Units (given on line A-5) Per Operating Minute			
A-7	(Inprocess, Inventory, Time)17	.25	_ Calendar Minutes (Used only to compute			
A-8	[Duty, Cycle]	75	in-process inventory) Operating Minutes Per Minute			
A-84	[Nuniber, Of, Shifts, Per, Day]	3	_ Shifts			
A-85	Personnel, Integerization, Overvide, Switch]	Off	_ (Off or On)			
PAR	T 3 - EQUIPMENT COST FACTORS (Machir	e Description)				
A-9	Component (Referent)	XENON	•• •••••••••••••••••••••••••••••••••••			
A-94	Component [Descriptive, Name]	Generator				
A-10	Base Year For Equipment Prices (Price, Year)	1979	ni			
A-11	{Purchase, Cost, Vs, Quantity, Bought, Table} {Number Of and \$ Per Component}	4500				
A-12	? Anticipated (Useful, Life) (Years)	7	-			
A-13	[Salvage, Value] (\$ Per Component)	1000				
A-14	[Removal, And, Installation, Cost] (\$/Compor	ent) 500				

Note: The SAMIS computer program also prompts for the (Payment, Float, Intervel), the (Inflation, Rate, Table), the {Equipment, Tax, Depreciation, Method], and the [Lquipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 •), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A:	Process Desk	ription ((	Continued)
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Page 2 of 2

A-15 Process Referent (From Aront Side Line A-1) \_\_\_\_\_ POSLMCT

PART 4 DIRECT RE	QUIREMENTS PER	MACHINE (Facilities) O	R PER MACHINE PER SHIFT (	Personnel)
(Facility, Or	Personnel Requireme	int]		
A-16	A-18	A-19		A-17
Catalog Number (Expense Item Referent)	Per Machine (Per Sh [Amount, Per, Mach	a lft) Units ine)	: Requirement	Description or Name
A2096D	38	SqFt	: Manufact	turing space
B3752D	J.	Persons/S	hift Operator I	Prod-Mach
ومراحلين فتعتد بأجية فاعتلجه فليدريها المتعاد المربي	Ne gages de sont francés de la facture ganne de sont de sont			
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	an a		and provide the second s	
PART 5 - DIRECT RE	QUIREMENTS PER	MACHINE PER MINUT	E (SAMIS will ask first for By	producta)
A-20	A-22	A-23		A-21
Catalog Number	Amount Require	d		
(Expense Item	Per Machine Per Mi	nute Units	Requirement	Description or Name
	(Amount, Per, Gyg	12) . Terr 71. (		
CTO35B	• 70000	KWn/n	<u>iin Electri</u>	laity
-		and the case of the second		
10130	****			
etti ingenoral entilgen anderen an enter heren	ىىلىدىن بەلىرىمىيى <u>بىرىمىيە ئىلىنى بىرىم بىر 19</u> 14-يىلى بىرىمىيەر <del>بىر 1</del> 924-يىلى بىرىمىيەر يەتتەر			
-		3 fellingen		
and the second	-	مىسىيە <u>مەممىرى ئ</u> ەرچىنىغ <del>مىسىيەمىر</del>		
	An	analyzeran y and Stall Summarian and		
		المتحدية (الألبية الكالي المتهامات		
PART 6 INTRA-IND	USTRY PRODUCT(S	) REQUIRED		
A-24	A-28	A-26	A-27	A-25
[Required, Product]	(Yield) *	[Ideal, Ratio] ** Of		
(Reference)	(%)	Units Out/Units In	Units Of A-26***	Product Name
LAMCKT	. 995	1/1	MODULE/MODULE	POSLMCKT
PREPARED BY				DATE
			<u> </u>	

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*Examples: Modules/Cell or Cells/Wafer.

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Page 1 of 2

FORMAT A - PROCESS DESCRIPTION

A-1 Process (Referent)

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Note: Names given in brackets [ ] are the names of process attributes requested by the SAMIS computer program.

A-2	(Descriptive, Name) of Process	Lamir	nation	edq	e trim	
						· · · · · · · · · · · · · · · · · · ·
PAR	T 1 - PRODUCT DESCRIPTION					
A-3	(Product, Referent) TRMLAM	1				
A-4	Descriptive Name (Product, Name)	Trim es	xcess	lam	from edge o	f module
A-5	Unit Of Measure (Product, Units)	Module				
PAR	T 2 - PROCESS CHARACTERISTIC	S			10.	
A-6	[Output, Rate] (Not Thruput)	.833	33		e ,⊥:∙6 Units (given on line A•5	) Per Operating Minute
A.7	(Inprocess, Inventory, Time)	2.25			Calendar Minutes (Used	i only to compute
A-8	(Duty, Cycle)	.87	75		in-pro Operating Minutes Per I	ocess inventory) Minute
A-84	[Number, Of, Shifts, Per, Day]	3			Shifts	
А•8ь	[Personnel, Integerization, Override,	Switch]			(Off or On)	7
PAR	T 3 – EQUIPMENT COST FACTORS	Machine De	scription)	1.11,12,219,12,219,19,19		an an Bù a she ann a she ann an
A-9	Component (Referent)		ETRI	M		
A-9a	Component (Descriptive, Name)		Edge	trim		inna (alimin katikati inni dayaman katikata damatan mang yana tatikati
A•10	Base Year For Equipment Prices (Pri	ce. Year)	198	0		
A-11	<sup>(Purchase, Cost, Vs, Guantity, Bough (Number Of and \$ Per Component)</sup>	nt, Table]	≈100	0		
A-12	Anticipated (Useful, Life) (Years)		7		••••••••••••••••••••••••••••••••••••••	
A-13	[Salvage, Value] (\$ Per Component)		50	) 		
A-14	[Removal, And, Installation, Cost] (	\$/Component)				

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax. Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 •), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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A-15 Process Referent (From Front Side Line A-1) \_\_\_\_\_EDGTRM

PART 4 - DIRECT RE	OUREMENTS PER M	ACHINE (Pagilities)	OR PER MACHINE PER SHIF	T (Personnal)
(Facility, Or	, Personnel Requiremen	tj.		
A-16	A-18	A-19		A-17
Catalog Rumber (Expense Item Referent)	Per Machine (Per Shift (Amount, Per, Machin	l) Units	Requireme	nt Description or Name
A2096D	27.5	SaFt	Manufact	uring Space
B3080D		Persons	Shift Assemble	module
V. When in such that the second division in the second second second second second second second second second				
	·	They are a second and the second s	and a second	and a second design of the second
and a statement of the second s	<b>Constant Constant Constant Constant</b>	nandera film die staat verster vers		
	Constanting and a second s			
PART 5 - DIRECT RE	OUIREMENTS PER M	ACHINE PER MINU nodity Requirement	TE (SAMIS will ask first for I	Byproducts)
A-20	A-22	A-23		A-21
Catalog Number	Amount Required	** *		
(Expense Item Referent)	Per Machine Per Minu (Amount, Per, Cycle)	te Units	i Requirame	nt Description or Name
EG1036D	.47619047	Blades/m	in Razor b	lades
EI835D	.007142857	l Pair	Gloves	cotton
E1370D	<u>-33333</u>	<u> </u>	Label_S	V.
$-\frac{21}{21}\frac{37}{7}\frac{7}{10}$		- <u>Fach</u>	<u> </u>	rounding
	<u></u>		man and the DE tyme W	aroing
alan an a	(Augusta Sand Anny an IA 2019) and an		unandaranteette Wythistion, and the mail calles and the second states of	nan ana tanàna minandra amin'ny fanina manana mandrany fanina mandrana mandra amin'ny fanina amin'ny fanina ami
		analisiinin analisiinin		
		and a second		<u>ar a gen ville, an en ville de ser en </u>
	Constant and the second se			an a
Pr 3T 6 - INTRA-IND	USTRY PRODUCT(S)	REQUIRED		
A·24	A-28	A-26	A-27	A-25
[Required, Product]	[Yield] * [	Ideal, Ratio) ** Of		<b>-</b>
(Ruference)	(%) (	Jnits Out/Units in	Units Of A-26***	Product Name
POSLMCKT	1.0	1/1	MODULE/MODULE	TRMT.AM
annen an				
TREFARED BT				DOTE

\*100% minus percentage of required product lost in this process, \*\*Assume 100% yield here, \*\*\*Examples: Modules/Cell or Cells/Wafer,

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SOLAR ARRAY MANUFACTURING INDUSTRY COSTING STANDARDS

Page 1 of 2

FORMAT A - PROCESS DESCRIPTION

U JFT PROPULSION LABORATORY Culturens Instructs of Technology UNIX) Ook Green Dr. / Poledexu, Colil. 91103 A-1 Process [Referent]

TERMSOD

Note: Names given in brackets [ ] are the names of process attributes requested by the SAMIS computer program.

A-2	(Descriptive, Name) of Process <u>Termi</u>	nal solde	ring
PAR	T 1 - PRODUCT DESCRIPTION	alla a su	
A-3	[Product. Referent] SODTRLUG		
A-4	Descriptive Name (Product, Name) Solder	terminal	lug to module
A•5	Unit Of Measure (Product, Units) Module		
PAR	T 2 - PROCESS CHARACTERISTICS	Mandraman in Charlen an	Ø Loss
A-8	[Output, Rate] (Not Thruput)	5	ل Units (given on line A-6) Per Operating Minute
A•7	[Inprocess. Inventory. Time]1.3	3333	Calendar Minutes (Used only to compute
8-A	(Duty, Cycle) .8	75	Operating Minutes Per Minute
A-8a	[Number. Of. Shifts. Per. Day]3		Shifts
A∙85	(Personnel, Integerszation, Override, Switch)	££	(Off or On)
PAR	T 3 - EQUIPMENT COST FACTORS (Machine De	scription)	
A-9	Component (Referent)	INDHTR	
A-9a	Component (Descriptive, Name) Induc	tion Heat	er
٩.10	Base Year For Equipment Prices (Price, Year)	1979	
A-11	(Purchase, Cost, Vs, Quantity, Bought, Table) (Number Of and S Per Component)	10000	
A-12	Anticipated (Useful, Life) (Years)	7	
A-13	[Salvage, Value] (\$ Per Component)	1000	
A•14	[Removal, And, Installation, Cost] (\$/Component)	1000	

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A: Process Description (Continued)

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TERMSOD A-15 Process Referent (From Front Side Line A-1) \_

PART 4 - DIRECT RE	QUIREMENTS PER MA	CHINE (Fecilities)	OR PER MACHI	NE PER SHIFT	(Personnel)
A-16	A-18	A-19			A-17
Catalog Number (Expense Item Referent)	Amount Required Per Machine (Per Shift) (Amount, Per, Machine)	Units		: Requirement	Description or Name
A2096D	104	Sq	Ft M	lanufact	uring Space
<u>B3032D</u>	1.0	Persons/	Shirt A	Assemble	r, Electronics
			······		
		·····•			
*		ande and a second s			
BARTS - DIRECT RE	OURFMENTS PER MA		TE (SAMIS w)	Il ask first for Bu	un modulate l
(Byproduct)	and (Utility, Cr. Comm	odity Requirement]	i is (Samis Wi	n aak not ivr by	hinadaal
A-20 Catalog Number	A-22 Amount Required	A-23			A-21
(Expense Item Referent)	Per Machine Per Minut (Amount, Per, Cycle)	Units	!	Requirement	Description or Name
<u>C1032B</u>	.3125	kWh/m	<u>in El</u>	<u>ectrici</u>	ty
E1065D	.39682538	GR.		ompresse	d Alr
<u>E1900D</u>		Each	underse see all and a see all and a see all a see a	Termina	1 Lugs
E1910D	<u></u>			Screw 1 Flat Wa	0-32 sher
E1905D	1.5	N	2	Lock Wa	sher
		())) ())))))))))))))))))))))))))))))))		and the second s	
PART 8 - INTRA INC	ISTRY PRODUCTICS	FOURDED	., <b>, , , , , , , , , , , , , , , , , , </b>		
ALL ALL AND	Contra Phobolic (S) H	FROIVER			
A-24 [Required, Product]	A-28 [Yiald] * fle	A-26 Isal, Ratio) ** Of	A۰	27	A-25
(Reference)	(%) Ui	nits Out/Units In	Units Of	A-26***	Product Name
TRMLAM	1.0	1/1	MODULE	MODULE	SOLTRLUG
FREFARED BY					DATE

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*Examples: Modules/Cell or Cells/Wafer,

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Note: Names given in brackets [] are the names of process attributes requested by the SAMIS computer program.         A2       [Descriptive, Name] of Process       H1 VOLtage pot test         A3       [Product, Referent]       HIPOTTEST         A4       Descriptive Name (Product, Name)       H1 Voltage pot test         A5       Unit of Measure (Product, Units)       Module         PART 2 - PROCESS CHARACTERISTICS       A6       Output, Ratel (Not Thruput)       1.3333;         A6       [Output, Rate] (Not Thruput)       1.7.25       Calendar Minutes (Used only to compute in process inventory)         A8       [Duty, Cycle]       .875       Operating Minutes Per Minute         A3       [Personnel, Integerization, Override, Switch]       Off       (Off or On)         PART 3 - EQUIPMENT COST FACTORS       (Machine Description)       A9       Component (Referent)         A9       Component (Referent)       H1 pot test	SOLAR ARRAY MANUFACTURING FORMAT A - PROC JFT PROPILISION LABORATORY California Interfactory California Del Grete Dr. / Paradires Calif. 91103	3 INDUSTRY COS ESS DESCRIPTIC	TING STANDAF	NDS Page <u>1</u> of <u>2</u> A-1 Process (Referent) HIPOT
A-2       (Descriptive, Name) of Process       Hi voltage pot test         PART 1 - PRODUCT DESCRIPTION         A-3       (Product, Referent)       HIPOTTEST         A-4       Descriptive Name (Product, Name)       Hi voltage pot test         A-5       Unit Of Measure (Product, Units)       Module         PART 2 - PHOCESS CHARACTERISTICS       A-6       (Output, Rate) (Not Thruput)       1.3333         A-7       (Inprocess, Inventory, Time)       17.25       Calendar Minutes (Used only to compute Improcess Inventory)         A-8       [Output, Rate] (Not Thruput)       1.3333       Operating Minutes (Used only to compute Improcess Inventory)         A-8       [Duty, Cycle]       .875       Operating Minutes Per Minute         A-8       [Duty, Cycle]       .875       Operating Minutes Per Minute         A-8       [Number, Of, Shifts, Per, Day]       3       Shifts         A-8       [Number, Of, Shifts, Per, Day]		Note: Names giv requested by the	en in brackets [ ] ; SAMIS computer pr	are the names of process attributes ogram.
PART 1 - PRODUCT DESCRIPTION         A-3 (Product, Referent)       HIPOTTEST         A4 Descriptive Name (Product, Name)       Hi voltage pot test         A-5 Unit Of Measure (Product, Units)       Module         PART 2 - PROCESS CHARACTERISTICS         A-6 (Output, Rate) (Not Thruput)       1.3333.         Units (given on line A-5) Per Operating Minute         A-7 (Inprocess, Inventory, Time)       17.25         Calendar Minutes (Used only to compute lin-process inventory)         A-8 (Duty, Cycle)       .875         A-9 Component, Integerization, Override, Switch)       Off         A-9 Component (Referent)       (Mathine Description)         A-9 Component (Descriptive, Name)       HI pot test         A-10 Base Year For Equipment Prices (Price, Year)       1200         A-11 (Purchase, Cost, Vs. Quantity, Bought, Table)       1200         A-13 (Salvage, Value) (\$ Per Component)       7         A-13 (Salvage, Value) (\$ Per Component)       500	A-2 (Descriptive, Name) of Process Hi vol	Ltage pot	test	
A-3       (Product, Referent)       HIPOTTEST         A-4       Descriptive Name (Product, Name)       Hi voltage pot test         A-5       Unit Of Measure (Product, Units)       Module         PART 2 - PROCESS CHARACTERISTICS       A-6       (Output, Bate) (Not Thruput)       1.3333         A-7       (Inprocess, Inventory, Time)       17.25       Calendar Minutes (Used only to compute inprocess inventory)         A-3       (Duty, Cycle)       .875       Operating Minutes Per Minute         A-8       (Number, OI, Shifts, Per, Day)       3       Shifts         A-8       (Number, OI, Shifts, Per, Day)       3       Shifts         A-9       Component (Referent)       (Off or On)       OPART 3 - EQUIPMENT COST FACTORS (Machine Description)         A-9       Component (Descriptive, Name)       Hi pot test	PART 1 - PRODUCT DESCRIPTION			
A4 Descriptive Name (Product, Name)       H1 VOLtage pot test         A-5 Unit Of Measure (Product, Units)       Module         PART 2 - PROCESS CHARACTERISTICS         A-6 (Output, Rate) (Not Thruput)       1.3333;         A-7 (Inprocess, Inventory, Time)       17.25         Calendar Minutes (Used only to compute in-process inventory)         A-8 (Duty, Cycle)       .875         A-8 (Number, Of, Shifts, Per, Day)       3         Shifts       Shifts         A 8b (Personnel, Integerization, Override, Switch)       Off.         (Off or On)       OPART 3 - EQUIPMENT COST FACTORS (Machine Description)         A-9 Component (Referent)       H1 pot test         A-10 Base Year For Equipment Prices (Price, Year)       1200         A-11 (Purchase, Cost, Vs, Quantity, Bought, Table)       1200         A-13 (Salvage, Value) (S Per Component)       500         A-13 (Salvage, Value) (S Per Component)       300	A-3 (Product, Referent) HIPOTTEST		<b>t</b>	
A-5       Unit Of Measure [Product, Units]       MOdule         PART 2 - PROCESS CHARACTERISTICS         A-6       [Output, Rate] (Not Thruput)       1.3333;       Units (given on line A-5) Per Operating Minute         A-7       [Inprocess, Inventory, Time]       17.25       Calendar Minutes (Used only to compute in-process inventory)         A-8       [Duty, Cycle]       .875       Operating Minutes Per Minute         A-8a       [Number, OI, Shifts, Per, Day]       3       Shifts         A-8b       [Personnel, Integerization, Override, Switch]       Off       (Off or On)         PART 3 - EQUIPMENT COST FACTORS       (Machine Description)       A-9       Component (Referent)         A-9a       Component (Referent)       HIPOTTES	A-4 Descriptive Name (Product, Name) H1 VOLt	age por t	est	
PART 2 - PROCESS CHARACTERISTICS         A-6 [Output, Rate] (Not Thruput)       1.3333;         A-7 [Inprocess, Inventory, Time]       17.25         Calendar Minutes (Used only to compute in-process Inventory)         A-8 [Duty, Cycle]       .875         A-8 [Duty, Cycle]       .875         A-8 [Number, OI, Shifts, Per, Day]       3         Shifts       A8b (Personnel, Integerization, Override, Switch)         Off       (Off or On)         PART 3 - EQUIPMENT COST FACTORS (Machine Description)         A-9 Component (Referent)       HIPOTTES         A-9a Component (Descriptive, Name)       Hi pot test         A-10 Base Year For Equipment Prices (Price, Year]       1200         A-11 (Purchase, Cost, Vs, Quantity, Bought, Table)       1200         A-12 Anticipated [Useful, Life] (Years)       7         A-13 (Salvage, Value) (S Per Component)       500         A-14 (Removel And Installation, Cost) (S/Component)       3000	A-5 Unit Of Measure (Product, Units) <u>Module</u>			
A-6       [Output, Rate] (Not Thruput)       1.3333;       Units (given on line A-6) Per Operating Minute         A-7       [Inprocess, Inventory, Time]       17.25       Calendar Minutes (Used only to compute in-process inventory)         A-8       [Duty, Cycle]       .875       Operating Minute         A-8       [Duty, Cycle]       .875       Operating Minutes Per Minute         A-8       [Number, Of, Shifts, Per, Day]       3       Shifts         A-8a       [Number, Of, Shifts, Per, Day]       3       Shifts         A 8b       [Personnel, Integerization, Override, Switch]       Off f       (Off or On)         PART 3 - EQUIPMENT COST FACTORS       (Machine Description)       A       A         A-9       Component (Referent)       HIPOTTES	PART 2 - PROCESS CHARACTERISTICS			
A-7 [Inprocess, Inventory, Time]       17.25       Calendar Minutes (Used only to compute in-process Inventory)         A-8 [Duty, Cycle]       .875       Operating Minutes Per Minute         A-8a [Number, Of, Shifts, Per, Day]       3       Shifts         A-8a [Number, Of, Shifts, Per, Day]       3       Shifts         A-8b [Fersonnel, Integerization, Override, Switch]       Off f       (Off or On)         PART 3 - EQUIPMENT COST FACTORS (Machine Description)       A         A-9 Component (Referent)       HIPOTTES	A-6 (Output, Rate) (Not Thruput)1.3333)	• •	Units (given on line	A-5) Per Operating Minute
A.8 [Duty, Cycle]       .875       Operating Minutes Per Minute         A-8a [Number, OI, Shifts, Per, Day]       3       Shifts         A-8a [Number, OI, Shifts, Per, Day]       3       Shifts         A-8b [Personnel, Integerization, Override, Switch]       Off       (Off or On)         PART 3 - EQUIPMENT COST FACTORS       (Machine Description)       Operating Minutes Per Minute         A-9 Component (Referent)       HIPOTTES	A-7 [Inprocess. Inventory, Time] _17.25		Calendar Minutes (	Used only to compute
A-Ba [Number, OI, Shifts, Per, Day]       3       Shifts         A-Ba [Number, OI, Shifts, Per, Day]       Off       (Off or On)         PART 3 - EQUIPMENT COST FACTORS (Machine Description)       (Off or On)         A-9 Component [Referent]	A-8 [Duty, Cycle] .875		i Operating Minutes	n-process inventory) Per Minute
A 8b (Personniel, Integerization, Override, Switch)       Off       (Off or On)         PART 3 - EQUIPMENT COST FACTORS (Machine Description)	A-8a [Number, Of, Shifts, Per, Day]3		Shifts	
PART 3 - EQUIPMENT COST FACTORS (Machine Description)         A-9 Component (Referent)       HIPOTTES         A-9a Component [Descriptive, Name]       Hi pot test         A-9a Component [Descriptive, Name]       Hi pot test         A-10 Base Year For Equipment Prices [Price, Year]       1980         A-11 [Purchase, Cost, Vs. Quantity, Bought, Table]       1200         A-12 Anticipated [Useful, Life] (Years)       7         A-13 [Salvage, Value] (S Per Component)       300	A 8b (Personnel, Integerization, Override, Switch) Of 1	a Ma Manguna ang ang ang ang ang ang ang ang ang a	(Off or On)	
A-9       Component (Referent)       HIPOTTES         A-9a       Component (Descriptive, Name)       Hi pot test	PART 3 - EQUIPMENT COST FACTORS (Machine De	scription)	nadel mana China an ann an Anna Ban a' Dhanna a' Anna an Anna An An	, and a second time of the soft frequency second
A-9a Component [Descriptive, Name]       Hi pot test         Hi pot test	A-9 Component (Referent)	HIPOTTES	•	
A-10 Base Year For Equipment Prices [Price, Year]       1980         A-10 Base Year For Equipment Prices [Price, Year]       1200         A-11 [Purchase, Cost, Vs. Quantity, Bought, Table]       1200         A-11 (Number Of and S Per Component)       7         A-12 Anticipated [Useful, Life] (Years)       7         A-13 (Salvage, Value) (S Per Component)       500         A-14 (Bampuel, And Jestallation, Cost) /S/Component)       300	A-9a Component [Descriptive, Name]	Hi pot te	st	
A-10 Base Year For Equipment Prices (Price, Year)       1980         A-11 [Purchase, Cost, Vs. Quantity, Bought, Table] (Number Of and S Per Component)       1200         A-12 Anticipated [Useful, Life] (Years)       7         A-13 [Salvage, Value] (S Per Component)       500         A-14 [Removal And Installation Cost] (S/Component)       300			• • • • • • • • • • • • • • • • • • •	
A-11 [Purchase, Cost, Vs. Quantity, Bought, Table]       1200         A-11 [Number Of and S Per Component]	A-10 Base Year For Equipment Prices (Price, Year)	<u>1980</u>	•	
A-12 Anticipated [Useful, Life] (Years)     7       A-13 [Salvage, Value] (\$ Per Component)     500	A-11 [Purchase, Cost, Vs, Quantity, Bought, Table] (Number Of and S Per Component)	1200		
A-13 (Salvage, Value) (\$ Per Component) 500 A-14 (Removal And Jostallation Cost) (\$/Component) 300	A-12 Anticipated [Useful, Life] (Years)	7	- <u></u>	
A.14 (Removal And Installation Cost) (\$(Component) 300	A-13 (Salvage, Value) (\$ Per Component)	500	-	
A-14 (nemotal And, installation, cost) (arounponent)	A-14 [Removal, And, Installation, Cost] (\$/Gomponent)	300	- <u></u>	

Note: The SAMIS computer program also prompts for the (Payment, Float, Interval), the (Inflation, Rate, Table), the {Equipment, Tax, Depreciation, Method], and the (Equipment, Book, Depreciation, Method). In the LSA SAMICS context, use 0.0, (1975 6.0 •), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A: Process Description (Continued)

### Page 2 of 2

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HIPOT A-15 Process Referent (From Front Side Line A-1)

PARTA - DIRECT RE	QUIREMENTS PER M	ACHINE (Facilities)	OR PER MACHINE PER SHIFT	(Personnel)		
(Facility, Or	, Personnel Requiremen	nti		•		
A-16	A-18	A-19		A-17		
Catalog Number	Amount Required					
(Expense item	Per Machine (Per Shil	it) Units	Requiremen	t Description or Name		
Referenti	(Amount, Per, Machin	14)	_			
A2096D	27.5	SqFt	Manufactu	ring Space		
B3704D	1	Persons/S	Shift Electroni	<u>cs technician</u>		
		, Innen di di data di successione de la companya de				
PART 5 - DIRECT RE	QUIREMENTS PER M	ACHINE PER MINU	TE (SAMIS will ask first for B	yproducts)		
(Byproduct)	and (Utility, Or, Com	modity Requirement				
A-20	A-22	A-23		A-21		
Catalog Number	Amount Required			-		
(Expense Item	Per Machine Per Mini	ute Units	i Requiremen	t Description or Name		
	Amount Per, Gycia	1) 		TTTT as an all so all donted		
<u>C1032B</u>		<u>KWN/I</u>	<u>nin</u> Electi	Electricity		
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		and a second				
		anang tertining termentation				
angenerating of property of Calum Andrews Statements of the	in the second	ning 27 million & Chanadigunga, and paramitan part for the	eranan dalaman yang berken ang be			
	In the second	antina antina panyanya katalahan ina dalah	Marand and a state of the state	وجميعات فحماط المحمد <del>إ</del> حديث بالتحدية منصف المحمد والمحمد والمحمد والمحمد والمحمد والمحمد والمحمد والمحمد والم		
	Martin	and a state of the				
······	the second s			۵٫۰٫٫٫٫٫٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬٬		
	**************************************	«,				
			ويالكا الشاريب بغميي مراقيته وخطعها ببتنا			
I FAKI§≃INIKA-IND	USINT PHODUCT(S)	REGUIRED				
A-74	4.00	A 00	A 07	A.75		
Required Produce1	Middi *	A-20 [Ideal Ratio] ** Of	<b>D</b> *47	A-20		
(Reference)	(%)	Units Out/Units In	Units Of A-26***	Product Name		
	(11)		0	1100000110110		
SODTRLUG	.995	1/1	MODULE/MODULE	HIPOTTEST		
PREPARED BY				DATE		

\*100% minus percentage of required product lost in this process, \*\*Assume 100% yield here, \*\*\*Examples: Modules/Cell or Cells/Wafer,

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SOLAR ARRAY MAN FORMA	UFACTURING II T A PROCES	NDUSTRY COS 38 DESCRIPTIO	ring stan N	DARDS	Page <u>1</u> of s (Referent) FRAME
		Note: Names give requested by the S	n in brackets SAMIS compu	( ) are the nan ter program.	nes of process attrib
A-2 [Descriptive, Name] of Process	Framing	the modul	<u>e</u>		
PART 1 - PRODUCT DESCRIPTION					
A-3 (Product, Referent) FRA	MMOD				
A-4 Descriptive Name [Product, Name	I_Framing_	the modul	<u>.e</u>		
A-5 Unit Of Measure (Product, Units)	-Module-		den en e		
PART 2 - PROCESS CHARACTERIST	ICS		d +		
A-6 [Output, Rate] (Not Thruput)	.33333		سل کر Units (given d	OBB on line A-5) Per	Operating Minute
A-7 (Inprocess, Inventory, Time)	69.0		Calendar Min	utes (Used only	to compute
A-8 (Duty. Cycle)	.875		Operating *4	in-process i nutes Per Minut	nventory) C
A-Ba (Number, Of, Shifts, Per, Day)	3		Shifts		
A-8b [Personnel, Integerization, Overrig	le. Switch)C	)ff	(Off or On)		
PART 3 - EQUIPMENT COST FACTO	R5 (Machine Descr	iption)		d haf het an Main sonn die 5 su fingele und 3 son	n gang manga gina jagang and gin di pangang ma
A-9 Component (Referent)	F	TXTURE	HE7	ATER	
A-9a Component (Descriptive, Name)	Wood 	l Fixture	F <u>lat</u>	leater	
A-10 Base Year For Equipment Prices (	Price, Year]	1980	<u>1</u>	980	
A-11 (Purchase, Cost, Vs. Quantity, Bo (Number Of and \$ Per Componen	ught. Table) t) —	2000	3	00	
A-12 Anticipated (Useful, Life) (Years	)	7		7	
A-13 [Salvage, Value] (S Per Compone	nt)	100	1	0.0	
A-14 [Removal, And, Installation, Cost	(\$/Component)	100	1	00	

Note: The SAMIS computer program also prompts for the (Payment, Float, Interval), the (Inflation, Rate, Table), the [Equipment, Tax, Depreciation, Method], and the (Equipment, Book, Depreciation, Method). In the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A: Process Description (Continued)

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FRAME A-15 Process Referent (From Front Side Line A-1) \_

A.16		A.10		<b>4.17</b>
Latalog Number	Amount Required	0.14		<b>M</b> 11
(Expense Item Referent)	Per Machine (Per Shif (Arnount, Per, Machin	t) Units •)	Requirement	Description or Name
A2096D	94.66666	SaFt	Manufact	uring Space
B3080D		Persons/S	hift_Assembly	Module
			and a second	
ART 5 - DIRECT RE		ACHINE PER MINUTE	(SAMIS will ask first for By	(products)
(Byproduct)	and (Utility, Or, Com	modity Requirement)		A.91
Catalog Number	A·22 Amount Required	A-23		M141
(Expense Item Referent)	Per Machine Per Minu (Amount, Per, Cycle	ite Units }	Requirement	Description or Name
C1032B	.2892	kWin./mi	n <u>Electrici</u>	tv
E1920D	2.2857142	<u>Screw/m</u>	in Screw #32	0700416-01
	Anno and a state of a			
				والمرابعة المحاوية ومربي موان ألافته المربوع والمراجع والمراجع والمحاولة الموجوع والمحاص والم
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و المراجع المر المراجع المراجع المراجع المراجع المراجع المراجع المراجع المراجع				
ART 6 - INTRA-IND	USTRY PRODUCT(S)	REQUIRED		
ART 6 INTRA-IND A-24	USTRY PRODUCT(S)	REQUIRED	A-27	A-25
ART 6 INTRA-IND A-24 [Required, Product] (Reference)	A-28 [Yield] * ( (%)	REQUIRED A-26 Ideal, Ratio] ** Of Units Out/Units in	A-27 Units Of A-26***	A-25 Product Name
ART 6 INTRA-IND A-24 (Required, Product) (Reference) DSPBUTYT.	A-28 [Yield] * ( (%) ] _ 0	REQUIRED A-26 Ideal, Ratio] ** Of Units Out/Units In	A-27 Units Of A-28*** MODULLE /MODRA TT	A-25 Product Name FTR 3 MMOD
ART 6 - INTRA-IND A-24 (Required, Product) (Reference) DSFBUTYL HTPOTTEST	A-28 [Yield] * ( (%) 1.0	REQUIRED A-26 Ideal, Ratio] ** Of Units Out/Units In 1/1	A-27 Units Of A-28*** MODULE/MODRAIL	A-25 Product Name F'RAMMOD
ART 6 - INTRA-IND A-24 (Required, Product) (Reference) DSPBUTYL HTPOTTEST	A-28 [Yield] * ( (%) 	REQUIRED A-26 Ideal, Ratio] ** Of Units Out/Units In 1/1	A-27 Units Of A-26*** MODULE/MODRAIL	A-25 Product Name FRAMMOD

\*100% minus percentage of required product lost in this process, \*\*Assume 100% yield here. \*\*\*Examplest Modules/Cell or Cells/Wafer.

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-][	SOLAR ARRAY MANUFAC FORMAT A -	RDS Page <u>1</u> of <u>2</u> A-1 Process (Referent) AFIXBTYL			
powersteam			Apte: Names give requested by the t	en in brackets [ ] SAMIS computer p	are the names of process attributes program.
A-2	(Descriptive, Name) of Process Aff	ix bi	ityl to moo	lule fran	nes
PART	1 - PRODUCT DESCRIPTION				
A-3	(Product, Referent) DSPBUTYL				
A4	Descriptive Name (Product, Name)	spen	se butyl or	nto modul	le frames
A-5	Unit Of Measure (Product, Units)	DRAT	Ľ	a, nó wita na ita wakaza ga 400-1-ir -	₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩
PART	2 - PROCESS CHARACTERISTICS				
A-6	(Output, Rate) (Not Thruput)	1.25		Units (given on lin	ne A-6) Per Operating Minute
A-7	(Inprocess, Inventory, Time)	.30		Calendar Minutes	Used only to compute
A-8	(Duty. Cycle)	175		Operating Minute	In-process inventory) s Per Minute
A-84	(Number, Of, Shifts, Per, Day)	3		Shiits	
A 8b	(Personnel, Integerization, Override, Swit	ch](	Off	(Off or On)	
PART	13 - EQUIPMENT COST FACTORS (N	lachine De	scription)	ia in 7,74 in 1977, 1978, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1979, 1	
A-9	Component (Referent)	i	APPLICATOR	DISPENSE	ER DISPENSER
A-Sa	Component (Descriptive, Name)		tinnamenteen jaar aan dit tit tit teen andersakkanse	<b>Collected and a second of the second of the</b>	Dispenser
				a the first of the second s	۵۱۱ <u>۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰</u>
A-10	Bate Year For Equipment Prices (Price, Y	'eur]		and in price of a long state of the long	1979
A-11	(Purchase, Cost, Vs, Quantity, Bought, Ta (Number Of and \$ Per Component)	able)	ganadriningen genaansentiite : Aleksiningen anteres		35000
A-12	Anticipated (Useful, Life) (Years)			A	/
A-13	(Salvage, Value) (\$ Per Component)		•		Ø
A-14	(Removal, And, Instaliation, Cost) (\$/Co	mponent)			800

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the (Equipment, Book, Depreciation, Method], in the LSA SAMICS context, use 0.0, (1975 6.0 +), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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#### Format A: Process Description (Continued)

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AFIXBTYL A-15 Process Referent (From Front Side Line A-1)

PART 4 - DIREST RE	OUREMENTS PER MACH	INE (Facilities) OR J	ER MACHINE PER SHIFT	(Personnel)
(Facility, Or	, Personnel Requirement)			
A-16	A-18	A-19		A-17
Catalog Number	Amount Required			
(Expense item	Per Machine (Per Shift)	Units	Requiremen	t Description of Name
Referent)	(Amount, Per, Machine)	•••••	110 qui i i i i	
320060	252	Contract	No an an Albert	
A2090D		Sqrt	Manurad	sturing space
B3752D	2 P	arsons/Sh	ift	
		<u></u>		
the second s		, <u>1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997</u>		
		<b>1)                                     </b>		
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PART 5 - DIRECT RE	QUIREMENTS PER MACH	NE PER MINUTE	(SAMIS will ask first for B	(vproducts)
[Syproduct]	and (Utility, Or, Commodit	v Requirement}	•••••	
A.20	A.73	A.77		A.91
Catalon Number	Amount Required	0.72		0.41
(Excense Item	Per Machine Per Moute	Hoite	Bernitemer	A Description of Name
Referent)	[Amount, Per, Cycle]	9:01 <b>9</b>	i staržatna (1961	LE DABRID DOIL OF HAILIA
01 02 0D	0.001 41 5	1		
CIU32B	.0621415	<u>kwn/min</u>	Electricit	:y
C2032D	• 1	CFM	Compressed	Air
E1232D	.02028566	GR	Edge Seal	
E1835D	0071428571	Dair	Gloves	
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	The second se			
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كالواسا المراكب ومعالية بالمتحدية والمراجعين				
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-		••••••••••••••••••••••••••••••••••••••		
		Wasa		
FARL O HININAIND	DELET PHODUGI (5) REQ	UINED		
A-24	A-28	∿-26	· A-27	A-25
[Bequired, Product]	[Yield] * [Ideat	Jatio] ** Of		
(Reference)	(%) Units	Out/Units In	Units Of A-28***	Product Name
	······································		• .	<i>i</i> 1
				<u></u>
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and the second provide the second				و و مساول المراجب ، و من من من من من المراجب ، و من
PREPARED BY				IDATE

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here, \*\*\*Examples: Modules/Cell or Cells/Wafer.

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FORMAT A — PROCESS DESCRIPTION						A-1 Proces	(Referent)
A-2	(Descriptive, Name) of Process	Clean e	Note: I requests ntire	Names give Id by the S MODU	n in brackets ( AMIS computer 1.C	) are the nam program.	nes of process attribute
PARI A-3	(Product, Referent)	D				-,	
A-1 A:5	Descriptive Name (Product, Name) , Unit Of Measure (Product, Units)	Clean Module	modul	8			
PART A:6 A:7 A-8 A-8a A-8a	T 2 PROCESS CHARACTERISTIC [Output, Rate] (Not Titruput) [Inprocess, Inventory, Time] [Duty, Cycle] [Number, Of, Shifts, Per, Day] [Personnel, Integerszation, Override,	s .119047 193.2 .875 3 Switch)	61 )ff		) Units (given on I Calendar Minute Operating Minut Shifts (Off or On)	J LOSS ine A-5) Per s (Used only in-process i les Per Minut	Operating Minute to compute nventory) e
PAR' A-9 A-9a	T'3 → EQUIPMENT COST FACTOR: Component (Referent) Component (Descriptive, Name)	i (Machine Dei	CLEA	NMOD modul	e	tere and the second	
A-10	Base Year For Equipment Prices (Pr	ice. Year]	19	80	filling and an and a state of the state of t		
A-11	(Purchase: Cost, Vs. Quantity, Boug (Number Of and \$ Per Component)	ht. Table]	20	0	<b>Side The group and the s</b>		Processing and the second s
A-12	Anticipated (Useful, Life) (Years)			7			
A-13	[Salvage, Value] (\$ Per Component) [Removal, And, Installation, Cost] (	\$/Component)	5	0 0			<b>Valence</b>

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method], In the LSA SAMICS context, use 0.0, (1975 6.0 \*), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

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Format A: Process Description (Continued)

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5 Process Referent	(From Front Side Li	ne A-1)CLIE/ALVI		
AT 4 - DIRECT RE	QUIREMENTS PER	MACHINE (Fedilities) OR	PER MACHINE PER SHIFT	(Personnei)
(Faoility, Or A-16	, Personnel Requirer A-18	nent) A-19		A-17
Catalog Number (Expense Item	Amount Requir Per Machine (Per 2 (Amount Par Man	ed Shift) Unita	Requiremen	nt Description or Name
A2096D	44	Saft	Manufactu	iring Space
B3080D		Persons/Sh	lift Assemble	module
ART 5 - DIRECT RE (Byproduct)	OUIREMENTS PER	MACHINE PER MINUTE	(SAMIS will ask first for E	Syproducts)
Catalog Number (Expense Item Referent)	A-22 Amount Requir Per Machine Per M (Amount, Per, Cy	A-23 ed Inute Units cle]	: Requiremen	A-21 ht Description or Name
EG1036D	.11904761	Blades/n	in Razor bla	ldes
EL353D	.00952380	195 Gal/min 195 Gal/min	Solvant	
E1836D	.00238099	23 Pair	Gloves Pl	letex
E1837D EG60D	23809523	<u>)9 Each</u> B Each	<u> </u>	<u>support</u>
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angener versen die seinen anderen				
ART 6 - INTRA-IND	USTRY PRODUCT	S) REQUIRED		
A-24	A-28	A-26	A-27	A-25
(Reference)	(%)	Units Out/Units In	Units Of A-26***	Product Name
FRAMMOD		1/1	MOD/MOD	CLNMOD

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*Examplest Modules/Cell or Cells/Wafer.

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MICROCOPY RESOLUTION TEST CHART NATIONAL BUREAU OF STANDARDS STANDARD REFERENCE MATERIAL 1010a (ANSI and ISO TEST CHART No. 2)



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SOLAR ARRAY MA	NUFACTURIN AT A PROG 91103	G INDUSTRY COS CESS DESCRIPTIC	STING STANDA DN	RDS Page <u>1</u> of <u>2</u> A-1 Process (Referent) FINTEST
		Note: Names giv requested by the	ven in brackets [ ] SAMIS computer p	are the names of process attributes program.
A-2 [Descriptive, Name] of Process	Final mo	dule elect	rical tes	;t
PART 1 - PRODUCT DESCRIPTION				
A-3 (Product, Referent) MODTE	ST			
A4 Descriptive Name (Product, Nam	ne) Test m	odule for	rating	
A-5 Unit Of Measure (Product, Units	Module			
PART 2 - PROCESS CHARACTERIS	TICS			
A-6 (Output, Rate) (Not Thruput)	.8571428	5	• 4 1 4 9 3 7 Units (given on lin	75 LOSS .5/120.5 he A-5) Per Operating Minute
A-7 [inprocess, inventory, Time]	26.8333	35	Calendar Minutes	(Used only to compute
A-8 (Duty. Cycle)	.875		Operating Minute	In-process Inventory) s Per Minute
A-8a [Number, Of, Shifts, Per, Day]	3		. Shifts	
A-8b (Personnel, Integerization, Overr	ide. Switch] O	ff	_ (Off or On)	
PART 3 - EQUIPMENT COST FACT	ORS (Machine De	scription)		
A-9 Component (Referent)		FINTESTER	2	
A-9a Component (Descriptive, Name)				
A-10 Base Year For Equipment Prices	[Price, Year]	1980		
A-11 [Purchase, Cost, Vs, Quantity, B (Number Of and S Per Compone	ought. Table} nt/	150000		

The SAMIS computer program also prompts for the (Payment, Float, Interval), the (Inflation, Rate, Table), the [Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, Note: use 0.0, (1975 6.0 •), DDB, and SL. (The asterisk is a signal to the computer, not a reference to a footnote.)

150000 7

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A-12 Anticipated (Useful, Life) (Years)

A-13 [Salvage, Value] (\$ Per Component)

A-14 {Removal, And, Installation, Cost] (\$/Component)

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#### Format A: Process Description (Continued)

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FINTEST A-15 Process Referent (From Front Side Line A-1)

PART 4 - DIRECT RE	QUIREMENTS PER M	ACHINE (Facilities)	DR PER MACHINE PER SHIFT	(Personnel)
[Fac lity, Or.	Personnel Requirement	nt]		
A-16	A-18	A-19		A-17
Catalog Number	Par Machine (Par Shi	ft) I laiter	1 Domilooment	Description or Name
Referent)	(Amount, Per, Machi	ne) Units	Reduitament	Description of Name
A2096D	204	SaFt	Manufact	uring Space
-B20801		Persons	Shift Digital	Comp Operator
DACCOL				00110 00010024
A				
PART 5 - DIRECT RE	OUIREMENT'S PER N	ACHINE PER MINU	TE (SAMIS will ask first for B	ypro(lucts)
(Byproduct)	and (Utility, Or, Com	modity Requirement)		
A-20	A-22	A-23		A-21
(Expense I tem	Per Machine Per Min	uta Unite	Requiremen	t Description or Name
Referent)	(Amount, Per, Cycl	•]	,	
C1032B	- 048	KWh/m	in Electric	itv
E1835D	.00714285	71 Pair/	Min Gloves	otton
E1375D	.23809523	Label	/Min Label. c	color
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			······	
	••••••••••••••••••••••••••••••••••••••	وميسيده		
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	······································			
PART 6 - INTRA-IND	USTRY PRODUCT(S	REQUIRED		
A-24	A-28	A-26	A-27	A-25
[Required, Product]	[Yield]	[Ideal, Ratio] ** Of		Product Name
(Heterance)	(76)		Units Of A-26	Product Name
CLNMOD	.995	1/1	MODULE/MODULE	MODTEST

PREPARED BY

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here. \*\*\*Examples: Modules/Cell or Cells/Wafer.

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FORMAT A - PROCESS DESCRIPTION

U JET FROPILSION LARORATORY Culturnia Initiate al Technology UNIM Oak Groco De / Paiadana, Calil 91103 A-1 Process (Referent)

PACKG

Note: Names given in brackets [ ] are the names of process attributes requested by the SAMIS computer program.

A·2	(Descriptive, Name) of Process Par	Process Packaging modules in carton							
					1974 - The space of the state o				
PAR	PART 1 - PRODUCT DESCRIPTION								
A-3	[Product, Referent]PAKMOD	••••••••							
A-4	Descriptive Name (Product, Name)	ck mo	dules in	cai	ton				
A•5	Unit Of Measure (Product, Units)	rton							
PAR	T 2 – PROCESS CHARACTERISTICS			0	677429 T	266			
A•6	[Output, Rate] (Not Thruput) • 2	.5		z Unli	ts (given on line A-5)	Per Operating Minute			
A•7	[Inprocess, Inventory, Time]90	.7857	14	Cale	indar Minutes (Used o	only to compute			
A-8	[Duty, Cycle]	.875		in-process inventory) Operating Minutes Per Minute					
A-8a	(Numoer, Of, Shifts, Per, Day)	3		_ Shifts					
A-85	[Personnel, Integerization, Override, Swite	ch]O	ff	_ (01	f or On)				
PAR	T 3 - EQUIPMENT COST FACTORS (M	lachine Des	cription)						
A•9	Component (Referent)		STAPLER	<b></b> ·	Bander				
A-94	Component (Descriptive, Name)		STAPLER	<b>_</b> .	Bander	9-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1			
A-10	Base Year For Equipment Prices (Price, Y	'ear] .	1980	_	1980				
A-11	(Purchase, Cost, Vs. Quantity, Bought, Ta	atile)	500		180				
A.17	Anticipated [Useful: 1 ife] (Years)	· · · · · · · · · · · · · · · · · · ·	7		7				
A.13	(Salvage, Value) (\$ Per Component)		400	-	20				
Δ.14	[Removal, And, Installation, Cost] (\$/Co	mponent)	ø		0	<b></b>			
						·····			

Note: The SAMIS computer program also prompts for the [Payment, Float, Interval], the [Inflation, Rate, Table], the {Equipment, Tax, Depreciation, Method], and the [Equipment, Book, Depreciation, Method]. In the LSA SAMICS context, use 0.0, (1975 6.0 •), DDB, and SL. /The asterisk is a signal to the computer, not a reference to a footnote.}

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Format At Process Descr	ription (Sontinued)			PageOf
A-15 Process Referent	(From Frant Side Line	A-1) PACKO		-
PART 4 - DIRECT RE	QUIREMENTS PER M	ACHINE (Familities) O	R PER MACHINE PER SHIFT	(Personnel)
(Facility, Or	, Personnel Requireme	nt]		
A-16	A-18	A-19		A-17
Catalog Number	Amount Required	fe)	<b>•</b> • • • •	
Referent)	(Amount, Per, Machi	ne]	Hednisment	Description or Neme
A2096D	594	SqEt	Manufac	turing Space
<u>B3720D</u>		Persons/S	hiftInspect	or_system
		and and a second s	۲۰۰۵۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰	والمحافظة المراجعة المراجع والمحافظة والمحافظ والمحافظ والمحاور والمحاد ويس
			و و المحمد بين المحمد المحمد و المحمد ا	
	······		an a'n yna ffwr fan ffwr yn	
PART 5 - DIRECT RE	QUIREMENTS PER M	ACHINE PER MINUTI	SAMIS will ask first for By	products)
(Eyproduct)	and [Utility, Or. Com	modity Requirement)		
A-20 Catalon Number	Amount Regulard	A-23		A-21
(Expense Item	Per Machine Per Min	ute Units	Requirement Description or Name	
Referent)	Amount. Per. Cycl	•]		
C1032B	.004142760	56 kWh/mi	Electricity	
C2032D	3	CFM	Compressed_air	
<u>E1930D</u>	10.0	<u>    Staple</u>	<u>Staple</u>	S
	-22300045	<u> </u>	Box sets	
				وجويدة كالمتعاد المتعاد المتعاد المتعاد المتعاد ومعيدة المتعاد المتعاد المتعاد المتعاد المتعاد المتعاد المتعاد
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			and the second second state and the second secon	n anna agus an an Francis, 'Saint agus ann an Alas anna Múir Saint A' Sainteacra
PART 5 - INTRA-IND	USTRY PRODUCT(S)	REQUIRED		
A-24	A-28	A-26	A-27	A-25
[Required, Product]	[Yield] *	(Ideal, Ratio) ** Of		
(Heference)	(%)	Units Out/Units In	Units Of A-26***	Product Nemo
MODTEST	1.0	1/4	CARTON/MODULE	PAKMOD
		ananimi kala si gunam amini astada, ar quan unvatada, ana	بالمناسبين المناسبين والمكافرة والمناسبين بالمالين المناسبين بالمالين والمناسبين والمحاسبين والمناسبين والمحاسب	
PREPANED Y				DATE

\*100% minus percentage of required product lost in this process. \*\*Assume 100% yield here, \*\*\*Exemples: Modules/Cell of Cells/Wafer,