DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150875

PRELIMINARY DESIGN PACKAGE FOR "SUNAIR" SEC-601 SOLAR COLLECTOR

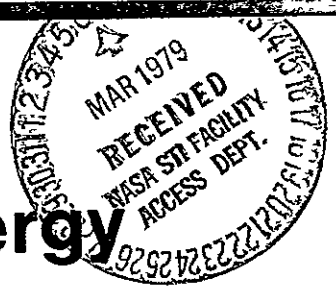
Prepared from documents furnished by

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, Ohio 43666

Under Contract NAS8-32259 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy

Solar Energy

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This work was done under the technical management of Mr. John Caudle, George C. Marshall Space Flight Center.

16. ABSTRACT

This report presents the preliminary design of the Owens-Illinois model "Sunair" SEC-601 tubular air solar collector. Information in this package includes the Subsystem Design and Development Approaches, hazard analysis, and detailed drawings available as the Preliminary Design Review.

Some reformatting has been done in the interest of clarity.

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Section 1

Preliminary Design Review Documentation

Contract No. NAS8-32259

4.1 Preliminary Design Review

4.1.1 a) Subsystem Design and Development Approaches

A two tube air collector subsystem has been under test since May 1976. The performance data derived is shown in Figure 1. The effective collector area used in the performance evaluation was the length of the exposed collector area times four (4) inches to reflect the spacing of tubes to be used in an actual array. The backing screen used was actually twelve (12) inches wide so more reflected light reached the experimental array than will be the case in actual practice. The upper line represents the average hourly efficiency of the collector based on daily operating data. The divider between the inlet and outlet ducts was insulated with two (2) one eighth (1/8) inch thick fiber board strips on each side of an aluminum divider element. The second from the top line represents the average hourly efficiency of the collector with the two insulating members removed and using only the aluminum divider element between the inlet and outlet ducts. The third from the top line represents a derating of the experimental data to account for a four (4) inch spacing between collector tube elements and using only the metal divider strip. The fourth or bottom line indicates the level of performance submitted as the baseline for an air collector array. The single point, denoted by a circle, represents the data from one day of testing using a black background and thus no light enhancement from background reflections.

The collector array fabricated for the ERDA demonstration contract has been fabricated in twelve (12) foot sections of manifolding with 72 collector tube elements per manifold. The manifold's inner and outer skins were fabricated using hand lay-up of fiber glass following small boat building techniques. It was anticipated that the process could be implimented for volume production using automotive practices to form the fiber glass skins. This procedure has been reduced to practice by Owens-Illinois in forming the shells for the stagnant air/liquid collector. These shells cannot be used for the air collector because of flow passage cross section limitations. The cost of tooling is very high to fabricate the shells and to contain the polyurethane foam during the foam-in-place process.

The prototype manifold system has been modified as the result of the experience gained during the fabrication of the manifolds for the ERDA demonstration project. The design objective, in addition to performance and cost considerations, is to provide a configuration of manifold that can be produced from commercially available components in a small, modestly tooled shop or small business concern. A review of the drawings will reflect this objective. The air interfaces utilize thin gage

aluminum sheeting. The insulation material consists of Babcock & Wilcox KAOWOOL ceramic blanket or equivalent between the inlet and outlet air ducting. The outlet air ducting is contained within the inlet air ducting to minimize the surface area exposed to ambient conditions. A degree of insulation (of the same magnitude as that used in the experimental system) is provided between the two ducts toward the attainment of the thermal performance level indicated by the top curve in Figure 1. The insulation of the outer duct will be Owens Corning glass fiber blanket or equivalent at 1.5 inches thickness at the bottom and sides, and 2.0 inches thickness at the top. It is anticipated that this arrangement will provide manifold insulation equal to or greater than that of the ERDA demonstration system.

The manifold ducting sizes were chosen to cause the pressure drop due to air flow in the manifold to be small compared to the air flow pressure drop in the tubes. Figure 2 indicates test points of pressure drop vs. air flow rate per tube pair in SCFM. In the ERDA demonstration unit, two tubes are operated in series flow with all tube pairs operated in parallel. The feeder tube diameter was a nominal 1 inch, with a 1/32 inch wall thickness aluminum tubing. In the prototype system for the subject contract, the feeder tube will be standard KG-33 glass tubing of a nominal diameter of 25 mm and wall thickness of 1.2 mm. The use of glass for the feeder tubing will reduce cost and increase thermal performance to a minor degree. Further, the prototype design has been modified to allow all tubes to operate in parallel. This will reduce the pressure drop due to air flow in the collector. The nominal air flow is of the order of 2 SCFM per tube resulting in a temperature rise of the order of 50°F in the heat transfer fluid under good sun conditions. The thermal performance data presented in Figure 1 is for such a typical temperature rise in the experimental collector.

The development approach includes a continuation of the two (2) tube experimental testing and the testing of the 144 tube collector array under a wide range of controlled inlet temperature and air flow conditions. Attached is the Task 1 report outlining the design criteria and the Test Matrix and Procedures planned to be performed under the ERDA contract. The prototype system of the subject contract uses a somewhat modified manifold design and the tubes are operated all in parallel. The basic performance of the air/liquid system will be demonstrated using the air collector installed under the ERDA demonstration contract and the addition of ancillary equipment under the subject contract. The prototype design will be built for first article review and the degree of performance testing needed to verify the system will be conducted. Verification that the prototype manifold design meets the requirements of the Interim Performance Criteria will be by analysis and similarity.

b) The schedule for the completion of the installation drawings will be established at the time of the Preliminary Design Review.

c) Detailed design and experimental test data will be available for the selection of internal engineering documentation desired for subsequent design review activity.

d) The schedule for the Prototype Design Review needed to support the delivery schedule will be confirmed during the Preliminary Design Review.

e) Approval of appropriate Type 1 documentation is anticipated during the Preliminary Design Review.

f) No Government Furnished Instrumentation is anticipated under the subject contract.

g) The basic drawings of the subsystem are attached hereto. Additional detailed drawings and material specifications will be available for the Preliminary Design Review. The updated System Performance Specification has been submitted to MSFC.

h) The Design Standards and Symbology to be used under the subject contract is available at contractor's site as Engineering Standards Manual dated December 1972 (Type 4 data).

4.1.2 Documentation to be available at the review

a) Drawings and Subsystem Performance Specification

1. Assembly control drawing SK-3550, two (2) sheets, dated 12/8/76 and appropriate subassembly and detailed drawings are attached as Appendix 1.

2. The Subsystem Performance Specification is attached as Appendix 2.

b) The design standards and symbology to be used for the subject contract are contained in the "Corporate New Product Development Engineering Standards Manual" December 1972.

c) The Type 1, 2 and 3 documentation status is as follows:

1. Development Plan. The development plan is as contained in Section I-2 of the subject contract. At the request of MSFC, the Preliminary Design Review has been scheduled for January 5, 1977 rather than eight (8) weeks after receipt of contract as called for by the Schedule.

2. Verification Plan. A draft of Sections 1 and 2 of the verification plan was submitted to the Technical Manager of MSFC on November 17, 1976. The complete plan is in preparation for review at the scheduled January 5, 1977 meeting. The plan has been delayed awaiting approval by MSFC of the proposed approach to the Independent Agency selection.

3. The Quality Assurance Plan is in preparation for submission by January 30, 1977.

4. The Subsystem Performance Specification was forwarded to MSFC on December 9, 1976 to the attention of C. P. McMurray.

5. The Source Control Drawings and Specifications will be provided with the acceptance data package.

6. No change proposals have been initiated.

7. The Preliminary Design Review Data are submitted herein.

8. The specific schedule for the Prototype Design Review has not been established.

9. The First Article Review is scheduled for 44 weeks after receipt of contract.

10. The Quarterly Report is not due.

11. The first Monthly Status Report was submitted on December 15, 1976.

12. The Acceptance Data Package is not due.

13. The Qualification and Acceptance test procedures are in draft as a part of the Verification Plan.

14. The Qualification Test and/or Analysis Report will be prepared in accordance with the Verification Plan.

15. It is anticipated that no Special Handling, Installation and Maintenance Tools will be required.

16. A Spare Parts List will be prepared following the Preliminary Design Review.

17. The Installation, Operation and Maintenance Manuals are behind schedule and will not be available for the Preliminary Design Review. Preliminary drafts will be prepared for discussion at that time.

18. A preliminary subsystem hazard analysis is attached.

19. The Design Data Brochure is not due.

20. No nonconformance items have been identified.

$$\eta = \frac{\bar{M}C_p(\bar{T}_o - \bar{T}_i)}{A_c\bar{I}}$$

$\bar{T}_o$ = collector transport media hourly average outlet temperature (°F)

$\bar{T}_i$ = collector transport media hourly average inlet temperature (°F)

$\bar{T}_a$ = average hourly ambient temperature (°F)

$\bar{M}$ = transport media hourly average flow rate (lb./hr.)

C_p = specific heat of transport media (Btu/lb.°F)

A_c = area of collector (sq. ft.)

$\bar{I}$ = hourly average total solar insolation in the collector plane (Btu/hr.-sq. ft.)

NOTE: The data utilized to obtain the hourly averages must be for at least one full day

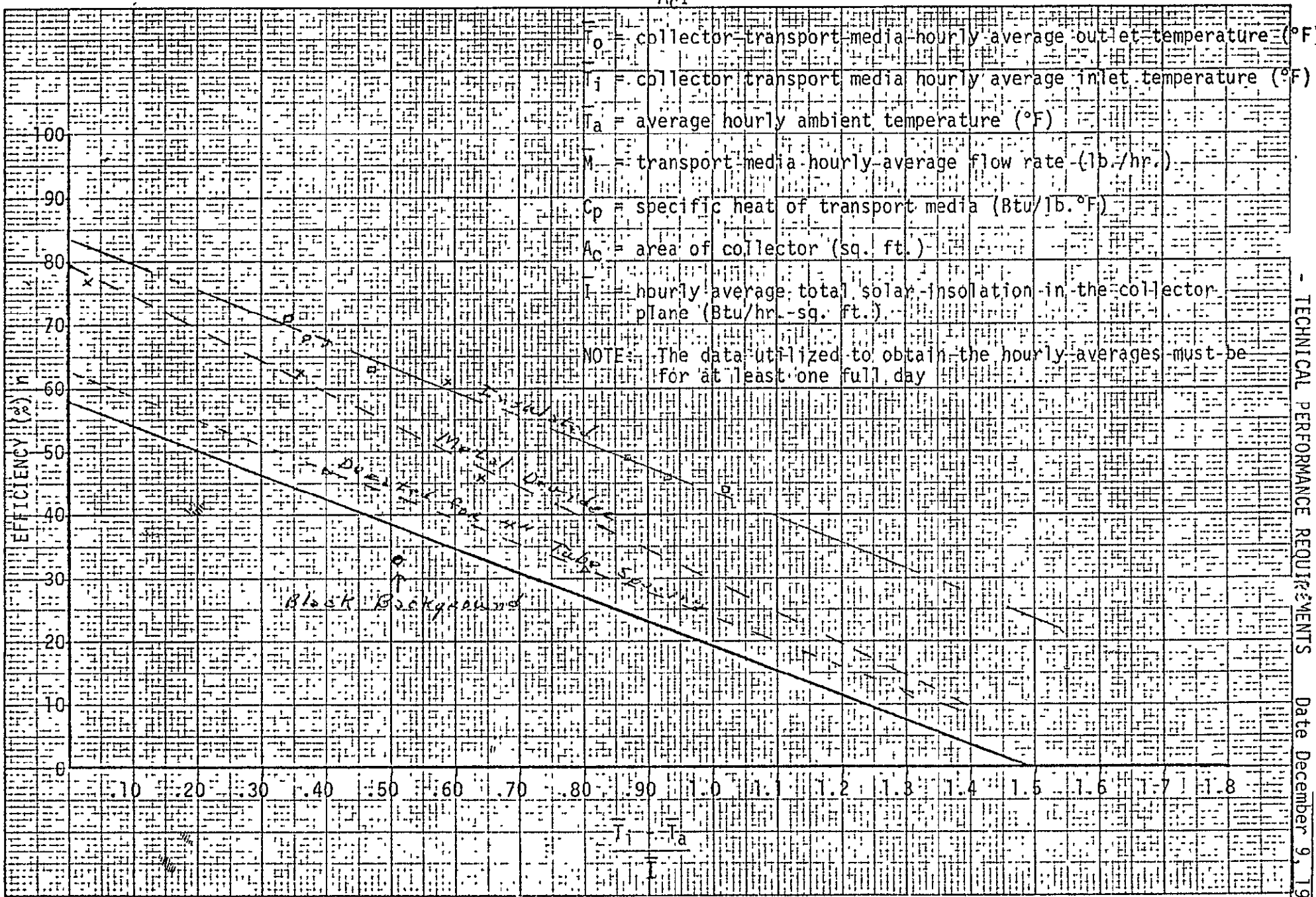

FIGURE 1 - EFFICIENCY AS A FUNCTION OF OPERATING CONDITIONS
PERFORMANCE MUST BE ABOVE LINE

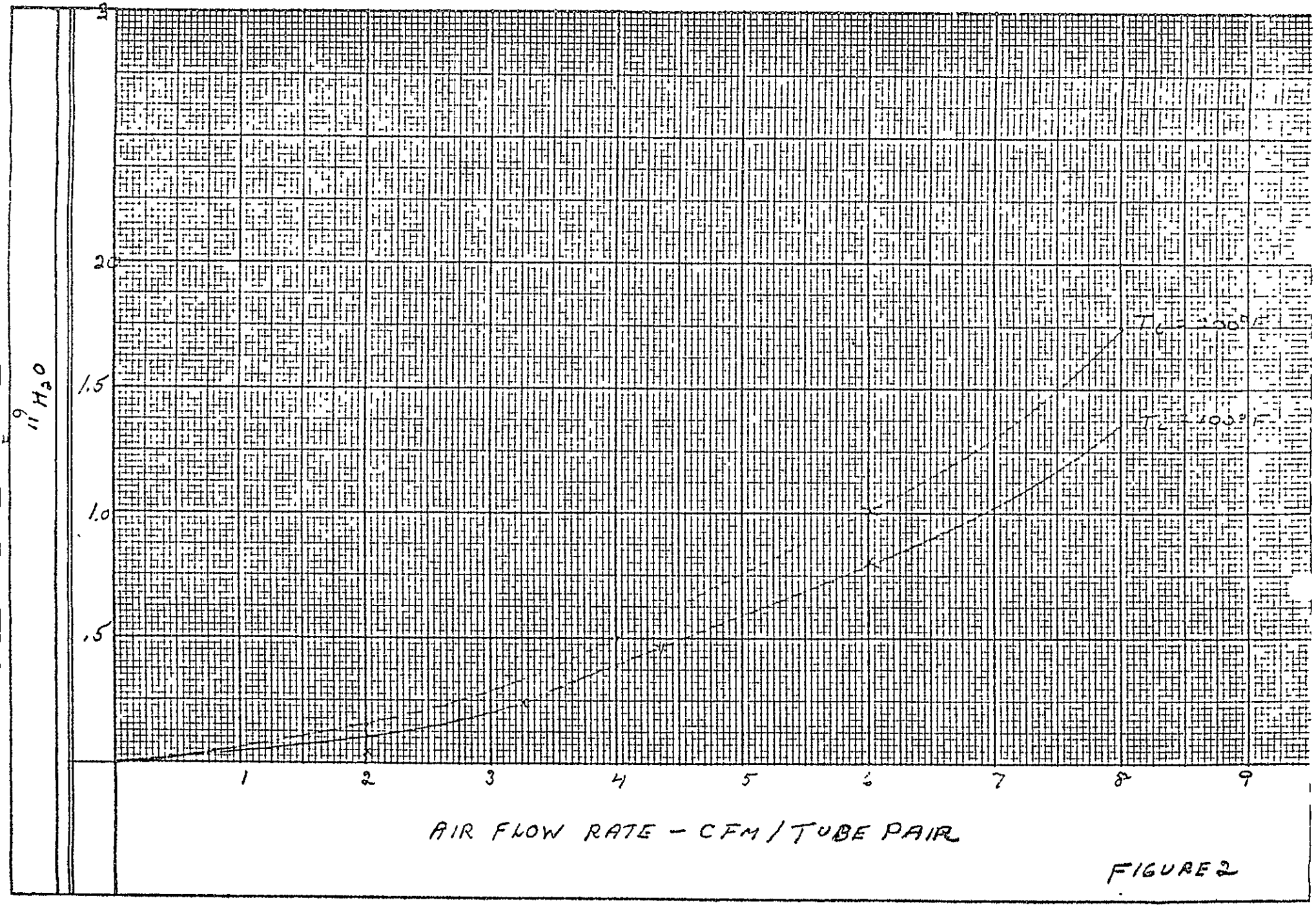

FIGURE 2

Subsystem Hazard Analysis

The air collector element presents no extreme condition or potential hazard sources. The operating air pressures are in the order of inches of water gage and under no foreseeable operating condition could explosive pressures be reached. The evacuated tubular glass components have been tested under liquid and gas pressures and withstand internal pressures of greater than 300 psig. The glass components have been tested by allowing the absorber surfaces to reach stagnation temperatures in excess of 600°F and then initiating flow. No evidence of thermal shock conditions exist. Under normal flow conditions, the heat transfer coefficient for the film is of the order of 2 to 3 BTU/hr. ft.^{2} °F, compared to the glass heat transfer coefficient of approximately 90 BTU/hr. ft.^{2} °F for the thickness of glass material used. With such factors, thermal shock of the absorber tube cannot be induced.

The glass components have been broken by rock and pellets. An implosion type failure is experienced and all the glass fragments remain contiguous to the array. No flying glass has been experienced.

During installation of the collector elements into the manifold, gross mishandling would be required to cause glass breakage. The force levels necessary to insert the glass components is low. A lubricant such as glycerin, oil, vaseline, etc., is recommended principally to inhibit any tendency of the seals to become unseated where the stack-up of tolerances could produce a somewhat tight fit.

The manifold materials are aluminum and KAOWOOL. The latter is rated at 1100°F and represents no fire hazard. Using air as the heat transfer fluid eliminates any hazard due to spillage, leakage, fire, etc. Negative pressures of any significance cannot be induced in the manifold, eliminating any such problem.

One residual hazard exists that can be identified. If the collector tube subassembly is removed under stagnation or hot operating conditions, the feeder tube will be hot to the touch. A warning will be contained in the operating, installation and maintenance manuals to be sure to allow time for the feeder tube to cool down after removal of the collector tube assembly or to wear protective gloves.

A tube failure at the point of insertion into the manifold could allow leakage of high temperature air. However, one would have to be in very close proximity to the point of leakage to be in danger from the high temperature air. The danger exists only during air flow conditions in the collector.

SHC-3060
Revision 1
December 9,1976

SUBSYSTEM PERFORMANCE SPECIFICATION

OWENS-ILLINOIS
AIR/LIQUID VACUUM
SOLAR COLLECTOR

SPECIFICATION NO. SHC-3060
BASIC ISSUE
DATE 10/1/76

Section 3

SUBSYSTEM PERFORMANCE SPECIFICATION
OWENS-ILLINOIS

1.0 This performance specification establishes the requirements for the design and performance of the air/liquid collector subsystem for use with solar combined heating and cooling systems. It designates the Interim Performance Criteria applicable to this collector subsystem. Appendix A contains preliminary performance and installation specifications for the air/liquid collector subsystem.

2.0 The document applicable to this performance specification is the Interim Performance Criteria for Commercial Solar Heating and Combined Heating/Cooling Systems and Facilities, Document No. 98M10001, Revision Basic, data February 28, 1975. George C. Marshall Space Flight Center, National Aeronautics and Space Administration.

3.0 All of the applicable Interim Performance Criteria for Commercial Subsystems as outlined in Table II so indicated are applicable after completion of the development and testing of the air/liquid collector subsystem as outlined in the Statement of Work.

4.0 No deviations from the Interim Performance Criteria are proposed.

5.0 No Government furnished property will be installed in the air/liquid collector subsystem.

6.0 No specific requirements have been directed by the Contracting Officer.

7.0 Preliminary performance and installation specifications for the air/liquid collector subsystem are attached as Appendix A.

SUBSYSTEM PERFORMANCE SPECIFICATION
OWENS-ILLINOIS

8.0 Warranty Contractor warrants for a period of five years that the solar collector material will be free of defects in quality and workmanship. Warranty is limited to shipping replacement parts prepaid which in the contractor's opinion are required to correct such defects. No field labor is included, and in no event shall Contractor be liable for special or consequential damages.

TABLE II

SPECIFICATION NO SHC-2060
REVISION
DATE 10/1/77

COMMERCIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER

COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
1.1 H and HC System Performance	NA	NA	NA	1.6 Energy Transport	NA	NA	NA
1.1.1 Heating Design Temperature	NA	NA	NA	1.6.1 Thermal Losses and Electrical Power	NA	NA	NA
1.1.2 Cooling Design Temperature	NA	NA	NA	1.7 Control	NA	NA	NA
1.1.3 Relative Humidity	NA	NA	NA	1.7.1 Installation and Maintenance	NA	NA	NA
1.1.4 Solar Contribution	NA	NA	NA	1.7.2 Manual Adjustment	NA	NA	NA
1.2 HW System/Subsystem Performance	NA	NA	NA	1.7.3 Inhabited Space Temperature Control	NA	NA	NA
1.2.1 Draw and Temperature Design Output	NA	NA	NA	1.7.4 Hot Water Temperature	NA	NA	NA
1.2.2 Non-Tap Temperature Design Output	NA	NA	NA	1.8 Auxiliary Energy	NA	NA	NA
1.2.3 Solar Contribution	NA	NA	NA	1.8.1 Design Heat Loads	NA	NA	NA
1.3 Collector Performance	A	A	A	1.8.2 Design Cooling Loads	NA	NA	NA
1.3.1 Collector Efficiency	A	A	A	1.8.3 Impairment of Operation	NA	NA	NA
1.4 Thermal Storage Performance	A	A	A	2.1 System Design Conditions	A	A	A
1.4.1 Storage Capacity and Rate	A	A	A	2.1.1 Equipment Capabilities	A	A	A
1.5 Habitability of Occupied Spaces	NA	NA	NA	2.1.2 Noise or Erosion-Corrosion	A	A	A
1.5.1 Heat or Humidity Transfer Effects	NA	NA	NA	2.1.3 Operating Conditions	A	A	A
				2.1.4 Fluid Flow in Collectors	A	A	A
				2.1.5 Entrapped Air	A	A	A
				2.1.6 Thermal Expansion of Fluids	A	A	A
				2.1.7 Pressure Drops	A	A	A

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COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
2.1.8 Condensate Removal	NA	A	NA	2.6.2 Air Quality	NA	NA	NA
2.2 Mechanical Stresses	A	A	A	2.6.3 Fluid Treatment	NA	NA	NA
2.2.1 Vibration Stress Levels	A	A	A	2.6.4 Freezing Protection	NA	NA	NA
2.2.2 Vibration from Moving Parts	A	A	A	2.7 Piping Supports	NA	NA	NA
2.2.3 Water Hammer	NA	NA	NA	2.7.1 Applicable Plumbing Standards	A	A	A
2.2.4 Vacuum Relief Protection	A	A	A	2.8 Excessive Pressure and Temperature Protection	A	A	A
2.2.5 Thermal Change	NA	NA	NA	2.8.1 Relief Valves and Vents	NA	NA	NA
2.2.6 Flexible Joints	A	A	A	3.1 Structural Design Basis	A	A	A
2.3 Leakage Prevention	A	A	A	3.1.1 Service Loads	A	A	A
2.3.1 Pressure Test: Non-Potable Fluids	A	A	A	3.2 Failure Loads and Load Capacity	A	A	A
2.3.2 Pressure Test: Potable Water	A	A	A	3.2.1 Ultimate Load Combinations	A	A	A
2.3.3 Air Transport System	A	A	A	3.2.2 Ice Loads	A	A	A
2.4 Collector Adjustments	A	A	A	3.2.3 Vehicular Loads	A	A	A
2.4.1 Orientation and Tilt	A	A	A	3.2.4 Load Capacity	A	A	A
2.4.2 Mutual Shadowing	A	A	A	3.3 Damage Control	A	A	A
2.5 Subsystem Isolation	NA	NA	NA	3.3.1 Resistance to Damage	A	A	A
2.5.1 Shutdown in Multi-unit Facilities	NA	NA	NA	3.4 Cyclic Loads	A	A	A
2.6 Heat Transfer Fluid Quality	NA	NA	NA	3.4.1 Deflection Limitations	A	A	A
				3.5 Cutting of Structural Elements	NA	NA	NA
				3.5.1 Design Provisions	NA	NA	NA

TABLE II

SPECIFICATION NO SHC-3060
REVISION
DATE 10/1/76

COMMERCIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

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COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
3.6 Creep and Residual Deflection	NA	NA	NA	4.3.2 Penetrations Through Fire-Rated Assemblies	NA	NA	NA
3.6.1 Deflection Limitations	NA	NA	NA	4.4 Toxic and Flammable Fluids	A	A	A
3.7 Hail Resistance	A	A	A	4.4.1 Provision of Catch Basins	A	A	A
3.7.1 Hail Size and Loading	A	A	A	4.4.2 Detection of Toxic and Flammable Fluids	NA	NA	NA
3.8 Constraint Loads	A	A	A	4.5 Safety Under Emergency Conditions	NA	NA	NA
3.8.1 Foundation Settlement	A	A	A	4.5.1 Emergency Egress and Access	NA	NA	NA
3.9 Ponding Conditions	A	A	A	4.5.2 Identification and Location of Controls	A	A	A
3.9.1 Design Provisions	A	A	A	4.6 Protection of Water and Circulated Air	A	A	A
4.1 Plumbing and Electrical Installation	A	A	A	4.6.1 Contamination by Materials	A	A	A
4.1.1 Plumbing Codes and Standards	A	A	A	4.6.2 Separation of Circulation Loops	A	A	A
4.1.2 Electrical Codes and Standards	A	A	A	4.6.3 Backflow Prevention	A	A	A
4.2 Fail-Safe Controls	A	A	A	4.6.4 Growth of Fungi	A	A	A
4.2.1 System Failure Prevention	A	A	A	4.7 Excessive Surface Temperature	A	A	A
4.2.2 Automatic Pressure Relief Valves	A	A	A	4.7.1 Protection from Heated Components	A	A	A
4.3 Fire Safety	A	A	A	5.1 Effects of External Environment	A	A	A
4.3.1 Applicable Fire Standards	A	A	A	5.1.1 Solar Degradation	A	A	A
				5.1.2 Soil Corrosion	A	A	A
				5.1.3 Airborne Pollutants	A	A	A

TABLE II

SPECIFICATION NO. SHC-3069
REVISION
DATE 10/1/76

COMMERCIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

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COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			COMMERCIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
5.1.4 Dirt Retention on Cover Plate Surfaces	A	A	A	5.4 Components Involving Moving Parts	A	A	A
5.1.5 Abrasive Wear	A	A	A	5.4.1 Wear and Fatigue	A	A	A
5.1.6 Fluttering by Wind	A	A	A	6.1 Accessibility for Maintenance and Servicing	A	A	A
5.2 Temperature and Pressure Resistance	A	A	A	6.1.1 Access for System Maintenance	A	A	A
5.2.1 Thermal Degradation	A	A	A	6.1.2 Access for System Monitoring	A	A	A
5.2.2 Deterioration of Heat Transfer Fluids	A	A	A	6.1.3 Draining and Filling of Liquids	A	A	A
5.2.3 Thermal Cycling Stresses	A	A	A	6.1.4 Flushing of Liquid Subsystems	A	A	A
5.2.4 Leakage	A	A	A	6.1.5 Filters	A	A	A
5.2.5 Deterioration of Gaskets and Sealants	A	A	A	6.1.6 Water Shutoff	NA	NA	NA
5.2.6 Transmission of Losses Due to Outglassing	A	A	A	6.2 Installation, Operation and Maintenance Manual	A	A	A
				6.2.1 Installation Instructions	A	A	A
5.3 Chemical Compatibility of Components	A	A	A	6.2.2 Maintenance and Operating Instructions	A	A	A
5.3.1 Materials/Transfer Fluid Compatibility	A	A	A	6.2.3 Maintenance Plan	A	A	A
5.3.2 Corrosion of Dissimilar Materials	A	A	A	6.2.4 Replacement Parts	A	A	A
				6.3 Repair and Service Personnel	A	A	A
5.3.3 Corrosion by Leachable Substances	A	A	A	6.3.1 Servicing of H and HC Systems	A	A	A
5.3.4 Effects of Decomposition Products	A	A	A	6.3.2 Servicing of HW Systems	A	A	A
				7.1 Design	NA	NA	NA

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REVISION
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	H	HC	HW		H	HC	HW
7.1.1 Design-Habitable Facilities	NA	NA	NA	8.1.3 Sensor Location	NA	NA	NA
7.1.2 Esthetics	NA	NA	NA	8.2 Mechanical and Electrical Functioning of Facility and Site	NA	NA	NA
7.1.3 Materials							
7.1.4 Passive Use of Solar Energy	NA	NA	NA	8.2.1 Exhaust and Venting	NA	NA	NA
				8.2.2 Utilities	NA	NA	NA
7.2 Adequate Space	NA	NA	NA	8.3 Mechanical and Electrical Functioning of Connections	NA	NA	NA
7.2.1 Solar Collector	NA	NA	NA				
7.2.2 Storage	NA	NA	NA				
7.2.3 Interface Between Facility and H and HC Systems				8.3.1 Plumbing Connections	NA	NA	NA
				8.3.2 Electrical Connections	NA	NA	NA
				8.3.3 Lightning Protection	NA	NA	NA
7.2.4 Portability	NA	NA	NA	9.1 Structural Integrity of H, HC and HW Systems	NA	NA	NA
7.3 Functioning of Facilities and Sites	NA	NA	NA				
7.3.1 Space Use	NA	NA	NA	9.1.1 Movement of Adjacent Structures	NA	NA	NA
7.3.2 Shading	NA	NA	NA				
7.3.3 Impact on Environment	NA	NA	NA	9.2 Structural Integrity of Facilities	NA	NA	NA
7.3.4 View	NA	NA	NA	9.2.1 Loads	NA	NA	NA
7.4 Compatibility with Conventional Systems	NA	NA	NA	9.2.2 Penetration of Structural Members	NA	NA	NA
				9.3 Structural Connections	NA	NA	NA
7.4.1 Utility Compatibility	NA	NA	NA	9.3.1 Structural Connections	NA	NA	NA
				9.3.2 Brittle Components	NA	NA	NA
8.1 Interference with Mechanical Operation	NA	NA	NA	9.3.3 Strength and Stiffness	NA	NA	NA
				10.1 Safety of Facility and Site	NA	NA	NA
8.1.1 Blockage of Solar Solar Components	NA	NA	NA	10.1.1 Fire	NA	NA	NA
8.1.2 Shading of Collec-	NA	NA	NA	10.1.2 Accidents	NA	NA	NA

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	H	HC	HW		H	HC	HW
11.1 Durability and Reliability of H, HC and HW Systems	NA	NA	NA	12.3.1 Accessibility	NA	NA	NA
11.1.1 Vegetation	NA	NA	NA	13.1 Visual Characteristics of Facility and Site	NA	NA	NA
11.2 Durability and Reliability of Facilities and Sites	NA	NA	NA	13.1.1 Facility	NA	NA	NA
11.2.1 Chemical Corrosion	A	A	A	13.1.2 Neighborhood	NA	NA	NA
11.2.2 Heat and Moisture	A	A	A				
11.2.3 Exterior Penetrations	NA	NA	NA				
11.3 Durability and Reliability of Connections	A	A	A				
11.3.1 Material Compatibility	A	A	A				
12.1 Maintainability of H, HC and HW Systems	NA	NA	NA				
12.1.1 Accessibility	NA	NA	NA				
12.1.2 Misuse	NA	NA	NA				
12.1.3 Permanent Maintenance Accessories	NA	NA	NA				
12.2 Maintainability of Facility and Site	NA	NA	NA				
12.2.1 Accessibility	NA	NA	NA				
12.2.2 Ice Dams	NA	NA	NA				
12.3 Connections	NA	NA	NA				

Air/Liquid Collector Performance

The Owens-Illinois Solar Collector Model No. (to be assigned) will collect a minimum of 900 Btu/ft.^{2} day of energy at an inlet fluid temperature equal to or less than 160°F and an air flow rate equal to or greater than 2 SCFM/ft.^{2} under the following conditions:

Tilt Angle: Equal to latitude; Azimuth Angle: 0°

Ambient Temperature: 30°F

Wind Velocity: 0-5000 ft./min.

Date: March 21, September 21

Noon Solar Flux Normal to Collector Surface: 305 Btu/ft.^{2} hr.

Longitude: Any; Latitude: Any

The Solar Collector will collect a minimum of 800 Btu/ft.^{2} day of energy at an inlet fluid temperature equal to or less than 220°F and an air flow rate equal to or greater than 2 SCFM/ft.^{2} under the following conditions:

Tilt Angle: Equal to latitude; Azimuth Angle: 0°

Ambient Temperature: 50°F

Wind Velocity: 0-5000 ft./min.

Date: March 21, September 21

Noon Solar Flux Normal to Collector Surface: 305 Btu/ft.^{2} hr.

Longitude: Any; Latitude: Any

$$n = \frac{\bar{M}C_p(\bar{T}_o - \bar{T}_i)}{A_c\bar{I}}$$

$\bar{T}_o$ = collector-transport media hourly average outlet temperature (°F)

$\bar{T}_i$ = collector transport media hourly average inlet temperature (°F)

$\bar{T}_a$ = average hourly ambient temperature (°F)

$\bar{M}$ = transport media hourly average flow rate (lb./hr.)

C_p = specific heat of transport media (Btu/lb.°F)

A_c = area of collector (sq. ft.)

$\bar{I}$ = hourly average total solar insolation in the collector plane (Btu/hr.-sq. ft.)

NOTE: The data utilized to obtain the hourly averages must be for at least one full day

EFFICIENCY (%) n

100
90
80
70
60
50
40
30
20
10
0

.10 .20 .30 .40 .50 .60 .70 .80 .90 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8

$\frac{\bar{T}_i - \bar{T}_a}{\bar{I}}$

FIGURE 1 - EFFICIENCY AS A FUNCTION OF OPERATING CONDITIONS
PERFORMANCE MUST BE ABOVE LINE

Section 4

Installation Drawing Sheets

Preliminary installation drawings for the air/liquid collector subsystem are contained in Owens-Illinois Drawing SK-3550 (2 sheets) dated December 8, 1976 and subassemblies drawings and references of issue date contained thereon.

"SUNAIR" MODEL SEC-601 SOLAR ENERGY COLLECTOR	Owens-Illinois Inc. 1700 N. Westwood Avenue Toledo, Ohio 607	Date: 12-13-76 Sheet 1 of 5 Sheets		File C-2370 Corporate Technology NTC

Required	Dwg No.	Size	Description		Material	
	SK-3550	D	Layout (2 sheets)			
1	SK-3551		Inlet-Outlet Tower Assembly	Refer Sheet 2		
2	SK-3552		*Collector Assembly*	*Refer Sheet 3 & 4*		
2	SK-3553		Termination Assembly	Refer Sheet 5		

ORIGINAL ... IS OF POOR QUALITY

"SUNAIR" MODEL SEC 601
SOLAR ENERGY COLLECTOR

Owens-Illinois Inc.
1700 N. Westwood Avenue
Toledo, Oh 43607

Date: 12-13-76
Sheet 2 of 5 Sheets

File C-2370
Corporate Technology NTC

Required			Dwg. No.	Size	Description	Material	
1			SK-3551		Inlet-Outlet Tower Assembly		
	1		SK-3575		Seal Ring - Mounting	3003 - H14 Alum .025 thick	
	1		SK-3576		Base Assembly-Tower	3003 - H14 Alum .025 thick	
		1	SK-3577	B	Sleeve - Inlet	3003 - H14 Alum .025 thick	
		1	SK-3578		Base - Tower	3003 - H14 Alum .025 thick	
		1	SK-3579	A	Insulation - Base	Glass Fiber Blanket 3#/cu. ft.	
		1	SK-3580		Liner - Base	3003 - H14 Alum .016 thick	
		6	SK-3581		8 x 1/4 lg. Pan Hd. Type "A"	Aluminum	
	1		SK-3582		Inlet Duct Assembly		
		1	SK-3583	E	Duct - Inlet	3003 - H14 Alum .016 thick	
		1	SK-3584	A	Insulation - Inlet	Ceramic Fiber Blanket 6#/cu. ft.	
	1		SK-3585		Duct Assembly - Hi Temperature		
		1	SK-3586		Cover - Hi Temperature Duct	3003 - H14 Alum .016 thick	
		1	SK-3587		Sleeve - Outlet	3003 - H14 Alum .016 thick	
		2	SK-3588	B	Baffle - Inlet	3003 - H14 Alum .032 thick	
		1	SK-3589		Insulation - Cylindrical	Ceramic Fiber Blanket 6#/cu. ft.	
		1	SK-3590		Insulation - Duct	Ceramic Fiber Blanket 6#/cu. ft.	
			SK-3591		Duct - Hi Temperature	3003 - H14 Alum .012 thick	
	2		SK-3632		Seal - Hi Temperature	Silicone Foam 25 Durometer Shore "A"	
	2		SK-3633		Seal - Liner	Silicone Foam 25 Durometer Shore "A"	
	2		SK-3594		Alignment Strip - Hi Temperature Seal	3003 - H14 Alum .012 thick	
	2		SK-3595		Liner - Tower	3003 - H14 Alum .016 thick	
	1		SK-3596	A	Insulation - Tower	Glass Fiber Blanket 3#/cu. ft.	
	1		SK-3597		Cover - Tower	3003 - H16 Alum .025 thick	
	2		SK-3592		Alignment Strip - Low Temperature	3003 - H14 Alum .012 thick	

"SUNAIR" MODEL SFC-601
SOLAR ENERGY COLLECTOR

Owens-Illinois Inc.
1700 N. Westw 1 Avenue
Toledo, Ohio 43607

Date: 12-13-76
Sheet 3 of 5 Sheets

File C-2370
Corporate Technology NTC

Required	Dwg. No	Size	Description	Material
2	SK-3552		Collector Assembly	
6	SK-2359	A	Bracket - Mounting	6063 - T52 Alum Extruded
6	SK-2360	A	Pin - Mounting Support	6262 - T9 Alum
12	SK-2361	A	Retainer	Rubber Neoprene 65 Durometer A
2	SK-3613	B	Rail - Outboard	6063-T52 Alum Extruded
4	SK-3614	B	Clip - Locator	6063-T52 Alum Extruded
1	SK-3615	C	Rail - Welded Center Assembly	
2	SK-3613	B	Rail - Outboard	6063-T52 Alum Extruded
2	SK-3614	B	Clip - Locator	6063-T52 Alum Extruded
3	SK-3616		Strap - Mounting	Type 304 Stainless Steel
6	SK-3617		10-24 x 1 lg Pan Hd. Screw	Stainless Steel
4	SK-2330	D	Support - Outboard Upper	Molded S.M.C.
4	SK-2329	D	Support - Outboard Lower	Molded S.M.C.
12	SK-3620		1/4 - 20 Hex Nut	Stainless Steel
16	SK-3621	A	Spacer	6262-T9 Alum
2	SK-3622	B	Deflector	6063-T52 Alum Extruded
16	SK-3623		1/4 - 20 x 3/4 lg. Hex Hd. Cap Screw	Stainless Steel
1	SK-3624		Base - Collector	3003 - H16 Alum .025 thick
1	SK-3625		Insulation - Bottom	Glass Fiber Blanket 3#/cu. ft.
2	SK-3626		Insulation - Side	Glass Fiber Blanket 3#/cu. ft.
1	SK-3627		Liner - Collector	3003 - H14 Alum .016 thick
1	SK-3628		Duct Assembly - Hi Temperature	
1	SK-3629		Liner - Hi Temperature	3003 - H14 .012 thick
1	SK-3630		Insulation - Hi Temperature	Ceramic Fiber Blanket 6#/cu. ft.
1	SK-3631		Duct - Hi Temperature	3003 - H14 .016 thick
2	SK-3632		End Seal - Hi Temperature	Silicone Foam Extruded
2	SK-3633		Seal - Liner	Rubber Neoprene to Durometer "A"
2	SK-3634		Insulation - Collector Side	Glass Fiber Blanket - 3#/cu. ft.
1	SK-3635		Insulation - Collector Top	Glass Fiber Blanket - 3#/cu. ft.
1	SK-3636		Cover - Collector	3003 - H16 Alum .025 thick
2	SK-3637		Seal - Outer Cover End	Rubber, Neoprene 70 Durometer "A"
1	SK-3638		Seal - Outer Cover Middle	Rubber, Neoprene 70 Durometer "A"
48	SK-3639	A	Feeder Tube Assembly	
48	SK-3640	A	Feeder Tube	KG-33 Glass Tubing
48	SK-3641	B	Mounting Ring - Feeder Tube	Silicone Rubber - Molded
48	SK-3642		Support - Feeder Tube	Type 302 Stainless Steel Spring Temper

- Continued on Sheet 4 -

"SUNAIR" MODEL SEC - 601
SOLAR ENERGY COLLECTOR

Owens - Illinois Inc.
1700 N. West Bd Avenue
Toledo, Ohio 43607

Date: 12-13-76
Sheet 4 of 5 Sheets

File C-2370
Corporate Technology NTC

Required				Dwg. No.	Size	Description	Material	
						- Continued from Sheet 3 -		
	48			SK-3643		Tube - Spacer	3003 - H14 Alum	
	48			SK-3644	C	Collector Tube Assembly		
		48		SK-2354	B	Cover Tube	KG-33 Glass	
		48		SK-2355	B	Absorber Tube - with Coating	KG-33 Glass	
		48		SK-2356	A	Vacuum Extension	KG-33 Glass	
		48		SK-2333	B	Tube Cap	"ABS" Plastic	
		48		SK-3645	B	Spring and Getter Assembly	Type 302 St. Steel Spring Temper	
		48		SK-3646	B	Mounting Ring - Collector Tube	Silicone Rubber - Molded	

"SUNAIR" MODEL SEC "01
SOLAR ENERGY COLLECTOR

Owens-Illinois Inc.
1700 N. Westwood Avenue
Toledo, Ohio 43607

Date: 12-13-76
Sheet 5 of 5

File C-2370
Corporate Technology NTC

Required	Dwg. No.	Size	Description	Material
2	SK-3553		Termination Assembly	
1	SK-3600	C	Air Stop - Hi Temperature	.012 Thick 3003-H14 Alum.
1	SK-3601	C	Insulation-End	Glass-[illegible] - 2" thick @ 3#/cu. ft.
7	SK-3602		Clip-End	.015 Thick Type 302 St. Steel
1	SK-3603	C	Cover-End	.025 Thick 3003 - H14 Alum.
11	SK-3604		10 x 1/4 lg Pan Hd., Type "A"	Alum
1	SK-3605	C	Air Stop - Low Temperature	.020 Thick 3003 - H14 Alum

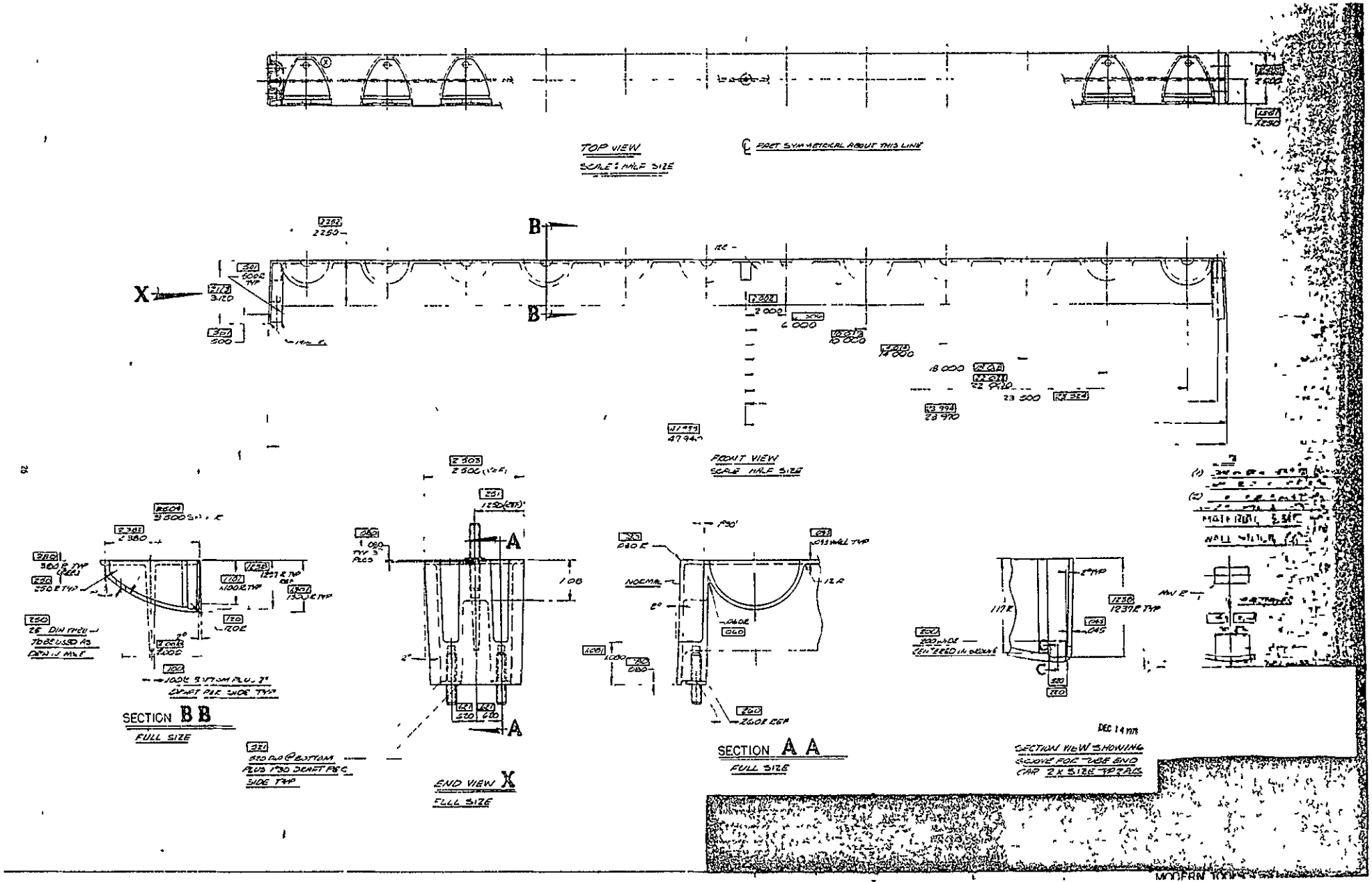
SECTION 5

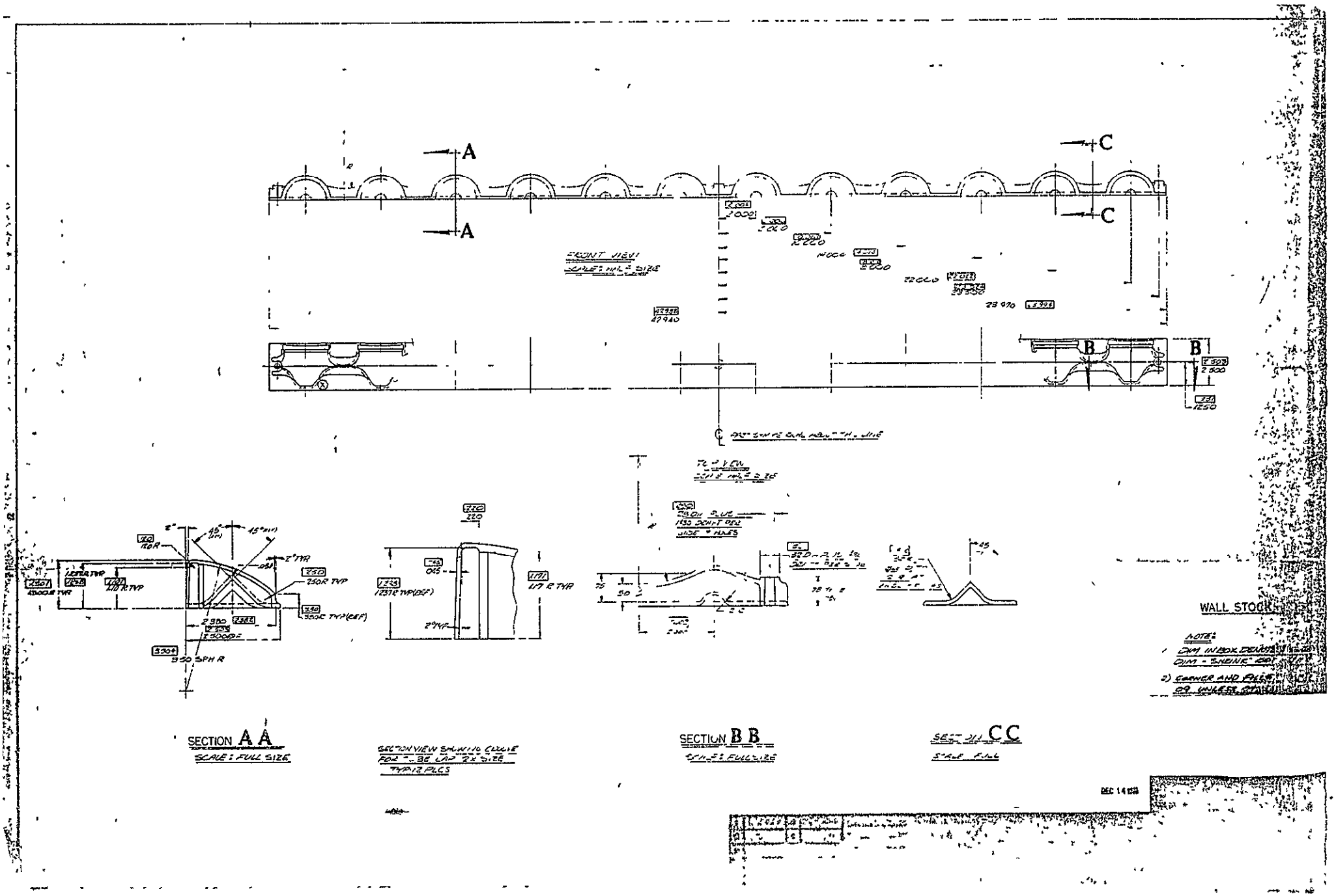
- PRELIMINARY DESIGN DRAWINGS

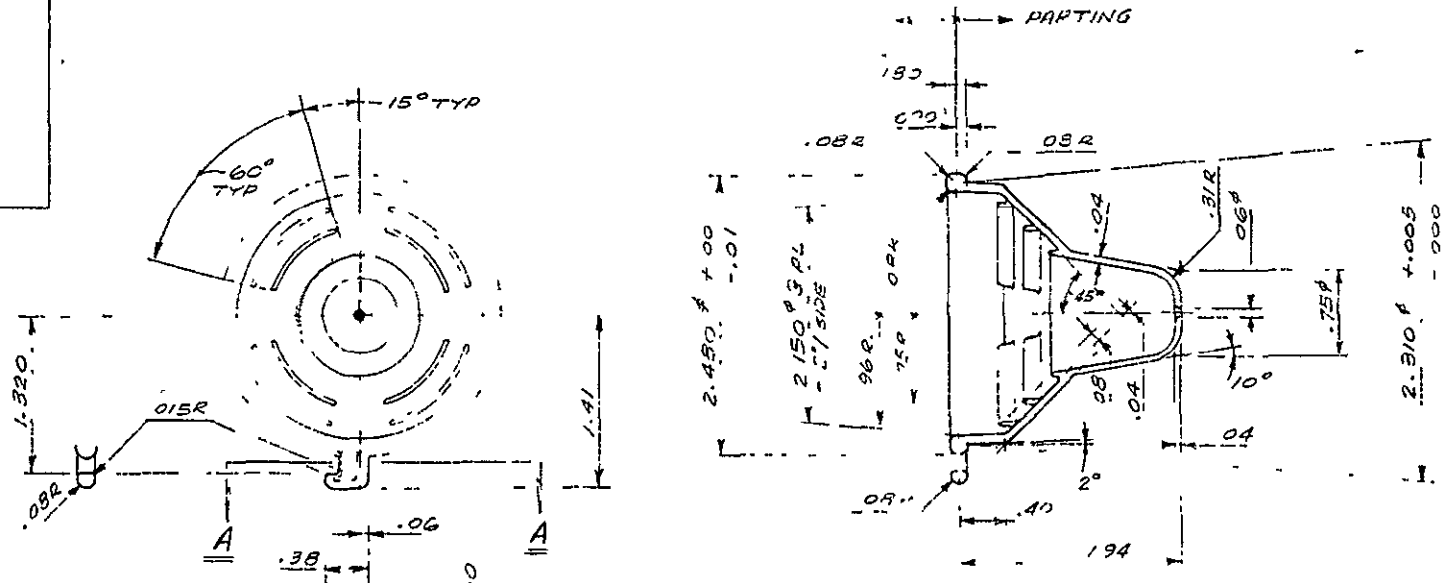
These drawings are released with the written permission of Owens-Illinois

Reference

O. I. Letter # 259-67
Dated March 29, 1978
Signed by T. W. Brock
Contract Administrator







SECTION A-A

TYP. RIB - 2X SIZE

MATERIAL -

COLOR- BLACK

DEC 14 1976

24 REQ'D ON ASSEMBLY NO SK-2326

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC ± .01	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE
	3 PLACE DEC. ± .005	CONCENTRICITY	MATERIAL —
	ANGLES ±	ROUNDNESS	HEAT TREAT
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.	FLATNESS	CASE DEPTH
	INSIDE RAD MAX	SYMMETRY	HARDNESS
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE NOTED	PARALLEL	SUR TREAT
		PERPENDICULAR	

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C-	DES'D	1 1	
	DR'N	7161	dw2
	CK'D	1 1	

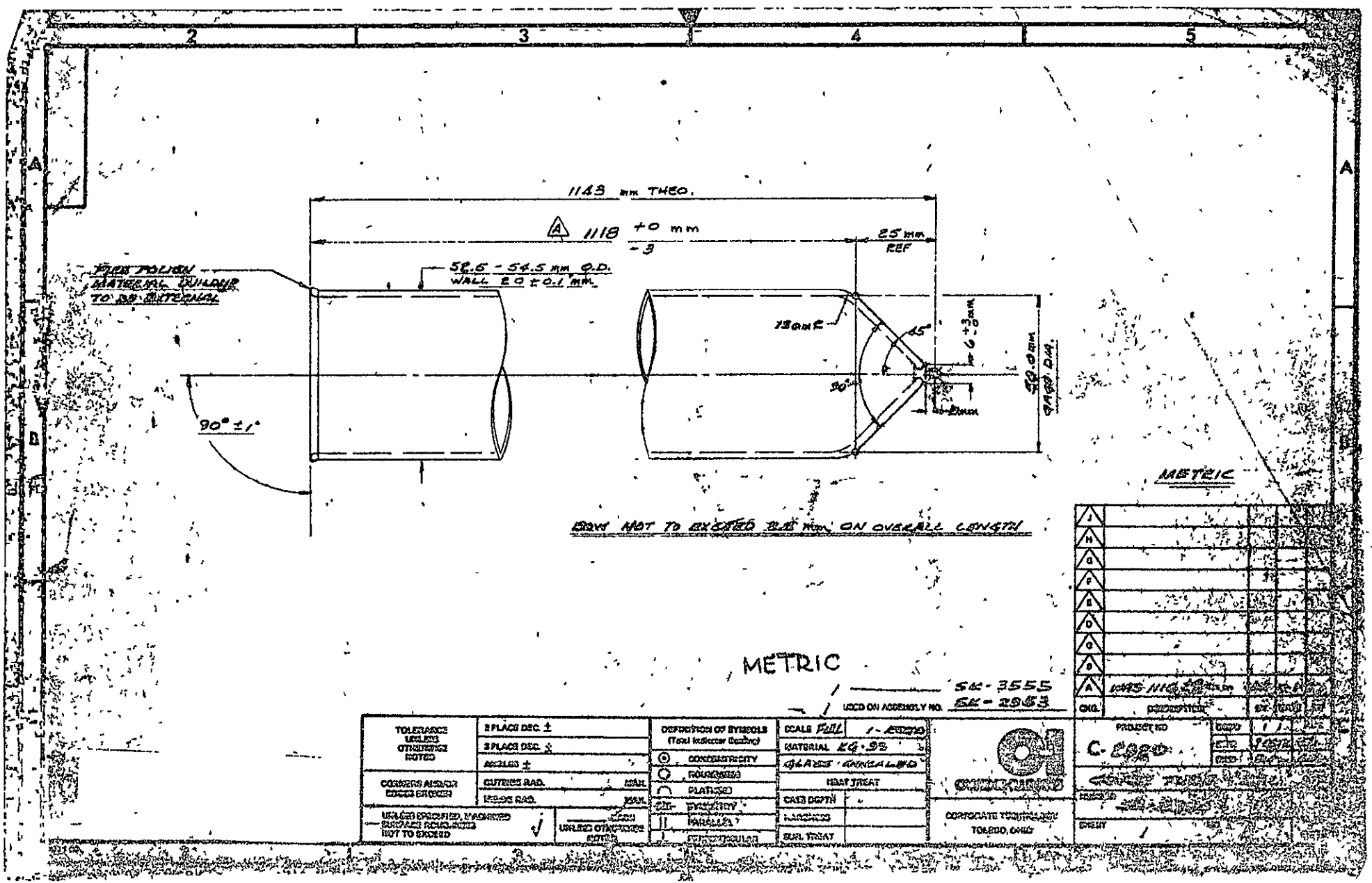
TUBE CAP "SAL"

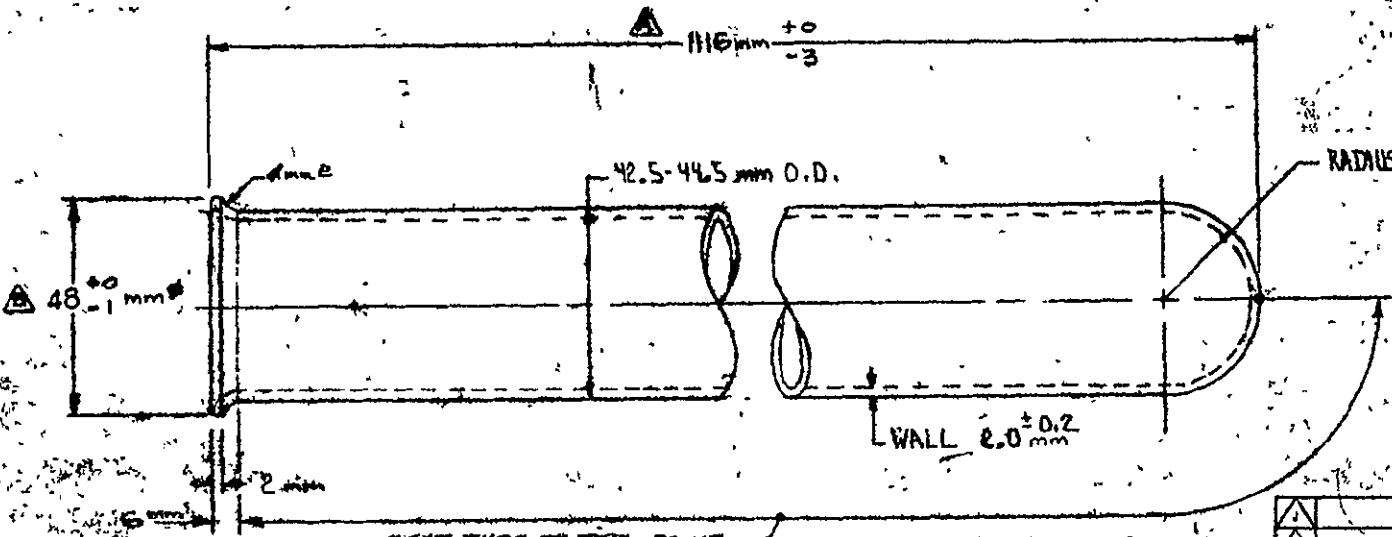
NUMBER SK- 2333

SHEET 1 OF 1

B SIZE

MEMFAX CO





BOW NOT TO EXCEED 2.0 mm ON OVERALL LENGTH

METRIC

USED ON ASSEMBLY NO. SK-3655 SK-2858

CHG	DESCRIPTION	BY	DATE	APP
J				
H				
G				
F				
E				
D				
C				
B	MAKE 52.8 +X mm			
A	MAKE 1116 +2 -3 mm			

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .100 3 PLACE DEC. ± .005 ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD. MAX. INSIDE RAD. MAX.
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED	√ RMS UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Type Indicates Reading)
- CONCENTRICITY
- ROUNDNESS
- FLATNESS
- SYMMETRY
- PARALLEL
- PERPENDICULAR

SCALE	FULL
MATERIAL	EG-33
	GLASS ANNEALED
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR. TREAT	

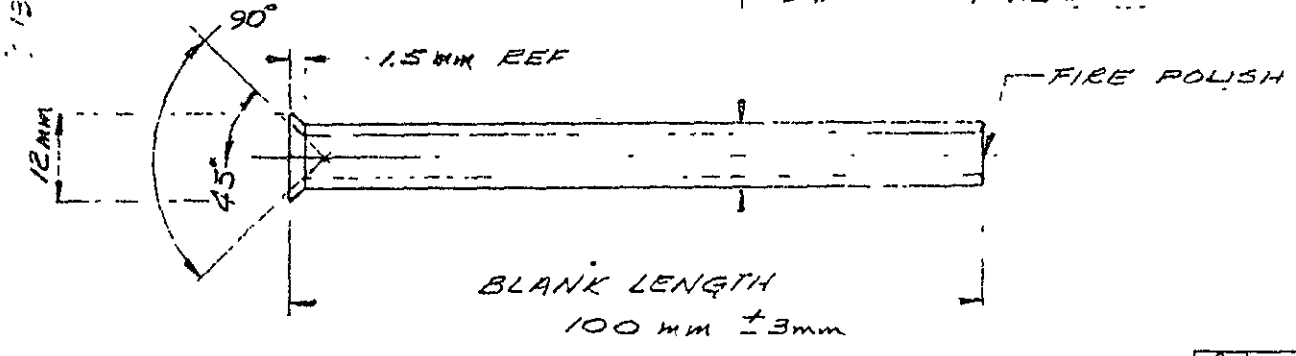
COMPUTER TECHNOLOGY TORRANCE, CALIF.

PROJECT NO.	C-2320
DRAWN	[illegible]
CHK'D	[illegible]
SHEET	1 OF 1

ABSORBER TUBE SAL

DRAWING NO. SK-3656

SIZE B



METRIC

DEC 14 1976

USED ON ASSEMBLY NO SK-2353

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ±
	3 PLACE DEC. ±
	ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.
	INSIDE RAD MAX.
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE STATED

DEFINITION OF SYMBOLS (Total Indicator Reading)
- ◎ CONCENTRICITY
- ○ ROUNDNESS
- ⌒ FLATNESS
- ⫽ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

SCALE	FULL 1-EQ-D
MATERIAL	EG-33
	GLASS ANNEALED
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR TREAT	

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO	C-2320
DES'D	
DR'N	
CK'D	

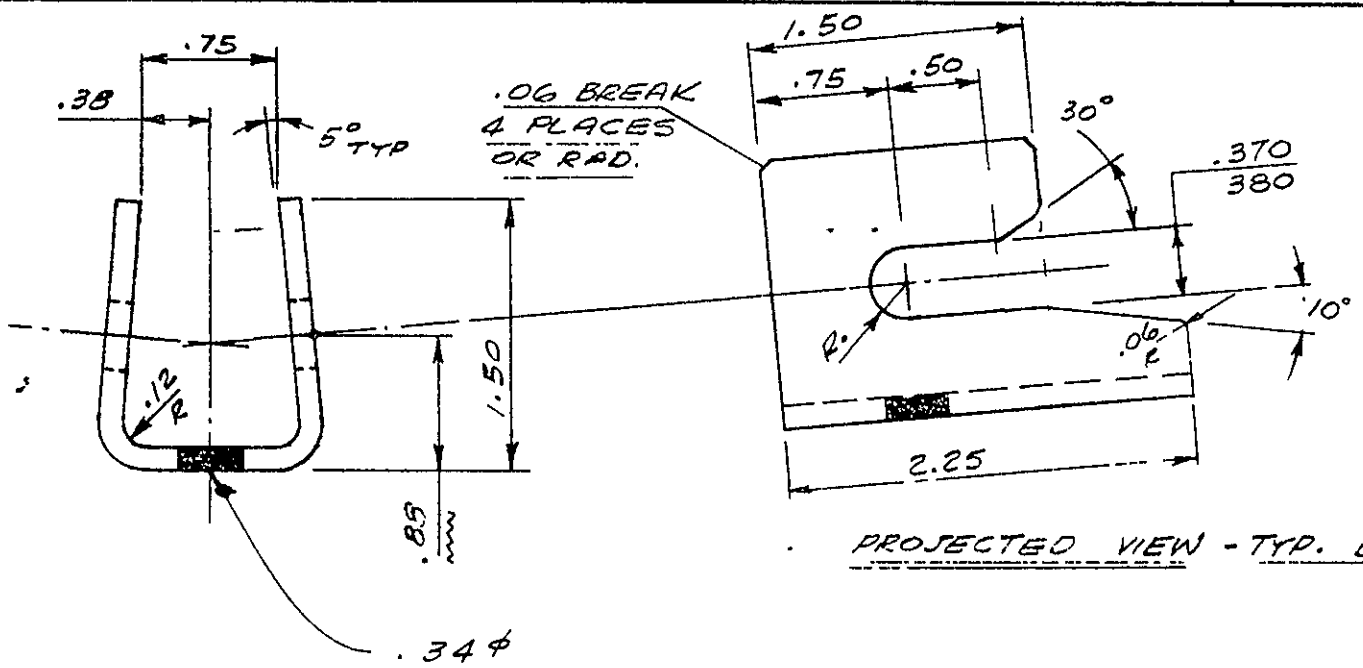
VACUUM EXTENSION - "SAL"

NUMBER SK-2356

SHEET

SIZE A

NEWFAB CO.



PROJECTED VIEW - TYP. BOTH SIDES

MATERIAL - 3003-0 ALUM. - $\frac{1}{8}$ THICK

5 ---------- K-3552

12 USED ON ASSEMBLY NO SK-2326

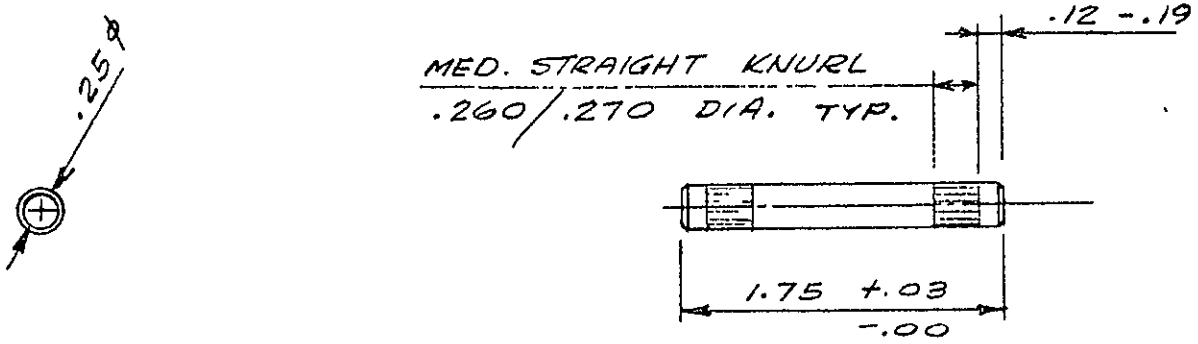
CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC ± .015	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE	FULL	OWENS-ILLINOIS
	3 PLACE DEC. ± —		MATERIAL	AS SHOWN	
	ANGLES ±	⊙ CONCENTRICITY	HEAT TREAT		
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX	○ ROUNDNESS	CASE DEPTH		CORPORATE TECHNOLOGY TOLEDO OHIO
	INSIDE RAD MAX	⌒ FLATNESS	HARDNESS		
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	____ RADII UNLESS OTHERWISE NOTED	⥱ SYMMETRY	SUR TREAT		
		∥ PARALLEL			
		⊥ PERPENDICULAR			

PROJECT NO	DES D	/ /	
C-2320	DR N	/	
	CK D	/ /	
ROOF BRACKET			
NUMBER SK-2359			A SIZE
SHEET 1 OF 1			

NEWFAX CO

SOLAR ENERGY 4 "SAL"



MATERIAL - 6262-T9 ALUM.

6 ——— SK. 3552
12 USED ON ASSEMBLY NO SK-2326

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ±
	3 PLACE DEC. ±
	ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.
	INSIDE RAD MAX
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	____ RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading)
- ⊙ CONCENTRICITY
- ○ ROUNDNESS
- ⌒ FLATNESS
- ⥤ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

SCALE	FULL
MATERIAL	AS SHOWN
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR TREAT	

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO	C-2320
DES'D	/ /
DR'N	9/27/
CK'D	/ /

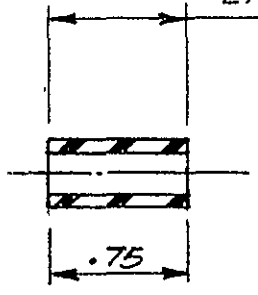
SUPPORT PIN

NUMBER	SK-2360
SHEET	1 OF 1
SIZE	A

NEWFAX CO

SK-E "SAL"

ENDS SQUARE WITHIN 5°



MATERIAL — .240 / .260 I.D. x .360 / .380 O.D

BLACK NEOPRENE TUBE

65-70 DUROMETER SHORE "A"

12 ——— SK-3552

24 USED ON ASSEMBLY NO SK-2326

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .015
	3 PLACE DEC. ±
	ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.
	INSIDE RAD MAX.
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	____ RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading)

- ⊙ CONCENTRICITY
- ○ ROUNDNESS
- ⌒ FLATNESS
- ⌯ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

SCALE	FULL
MATERIAL	AS SHOWN
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR TREAT	

OWENS-ILLINOIS

CORPORATE TECHNOLOGY

TOLEDO, OHIO

PROJECT NO	C-2320
DES'D	/ /
DR'N	[illegible]
CK'D	/ /

RETAINER

NUMBER SK-2361

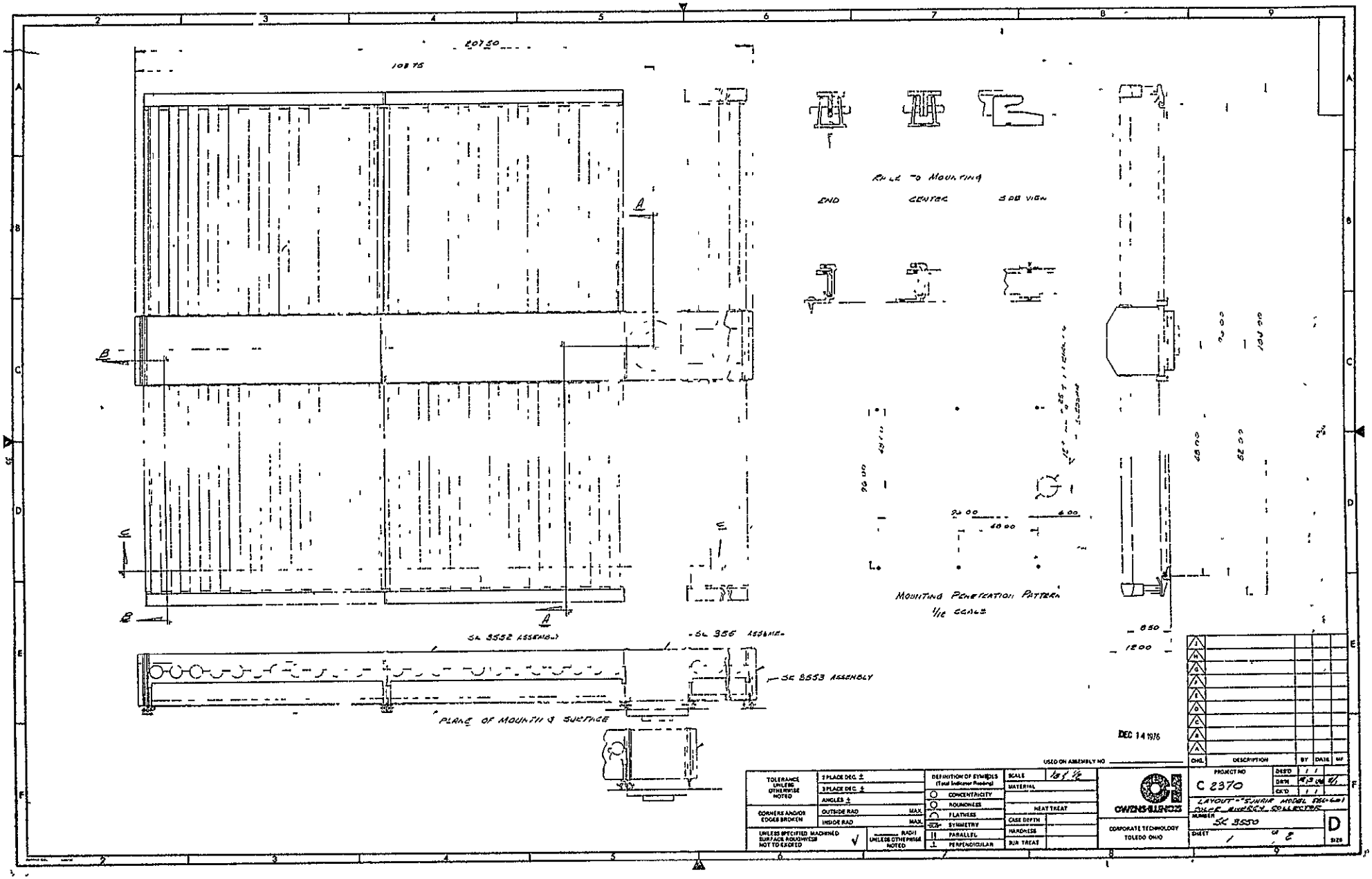
SHEET 1 OF 1

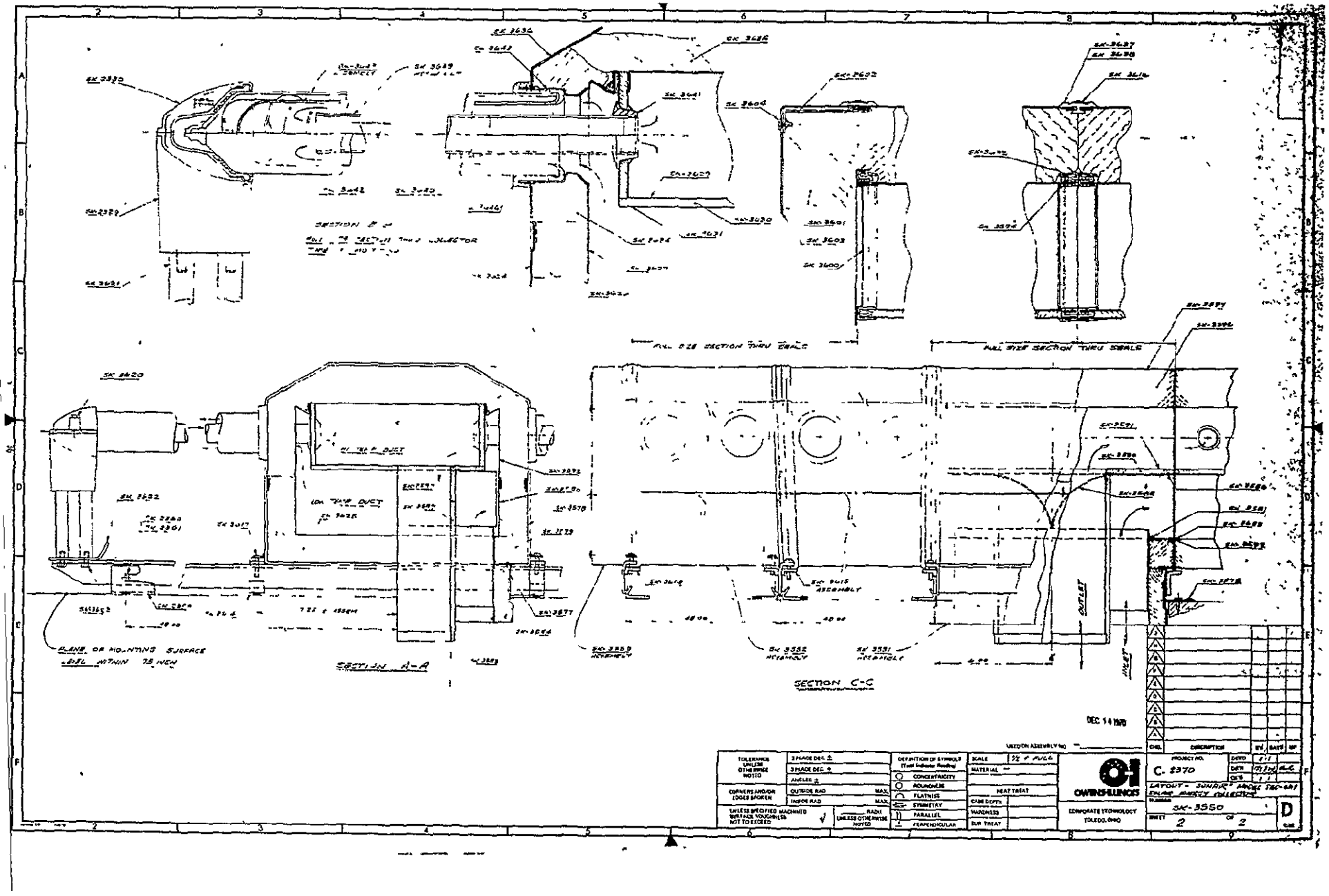
SIZE A

NEWFAX CO

SOLAR ENERGY & "STAL"

ORIGINAL PAGE IS
OF POOR QUALITY




SECTION B-B
FULL SIZE SECTION THRU GAGE
FULL SIZE SECTION THRU GAGE
SECTION A-A
SECTION C-C
PLANE OF MOUNTING SURFACE
OUTLET
INLET
DEC 14 1970
OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO, OHIO
C. 2370
LAYOUT - SONAIR ANGLE TRANSMITTER
SK-3550
SHEET 2 OF 2
SIZE D

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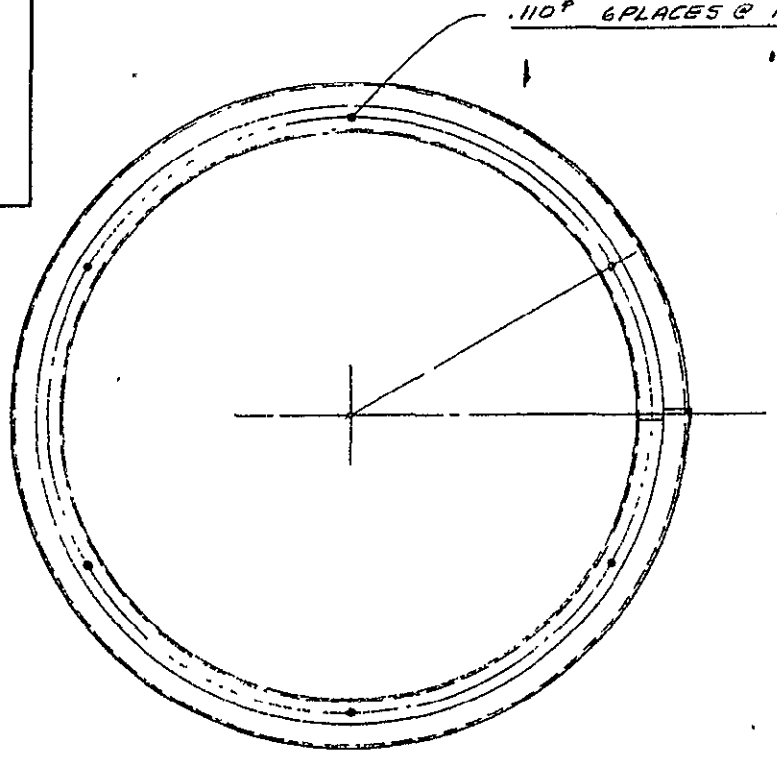
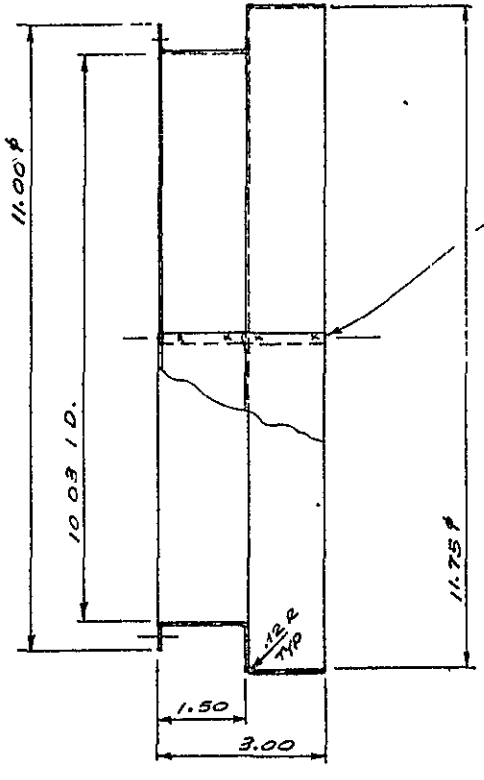
OF POOR QUALITY



.110" 6 PLACES @ 10.500 B C



.25 LAP SEAM - SPOTWELD

MATERIAL - 3003 H14 ALUM. - .012 THICK

DEC 1 / 19/6

/ USED ON ASSEMBLY NO. SK-3551

CHG.	DESCRIPTION	BY	DATE	INSP
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED: 3 PLACE DEC. ± .03; 2 PLACE DEC. ± .010; ANGLES ±

CORNERS AND/OR EDGES BROKEN: OUTSIDE RAD. MAX.; INSIDE RAD. MAX.

UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS TO BE ____ RMS

RMS UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading): CONCENTRICITY; ROUNDNESS; FLATNESS; SYMMETRY; PARALLEL; PERPENDICULAR

SCALE 1/2 SIZE

MATERIAL AS NOTED

HEAT TREAT: CASE DEPTH; HARDNESS; SUR TREAT

OWENS-ILLINOIS

CORPORATE TECHNOLOGY TOLEDO, OHIO

PROJECT NO. C-2870

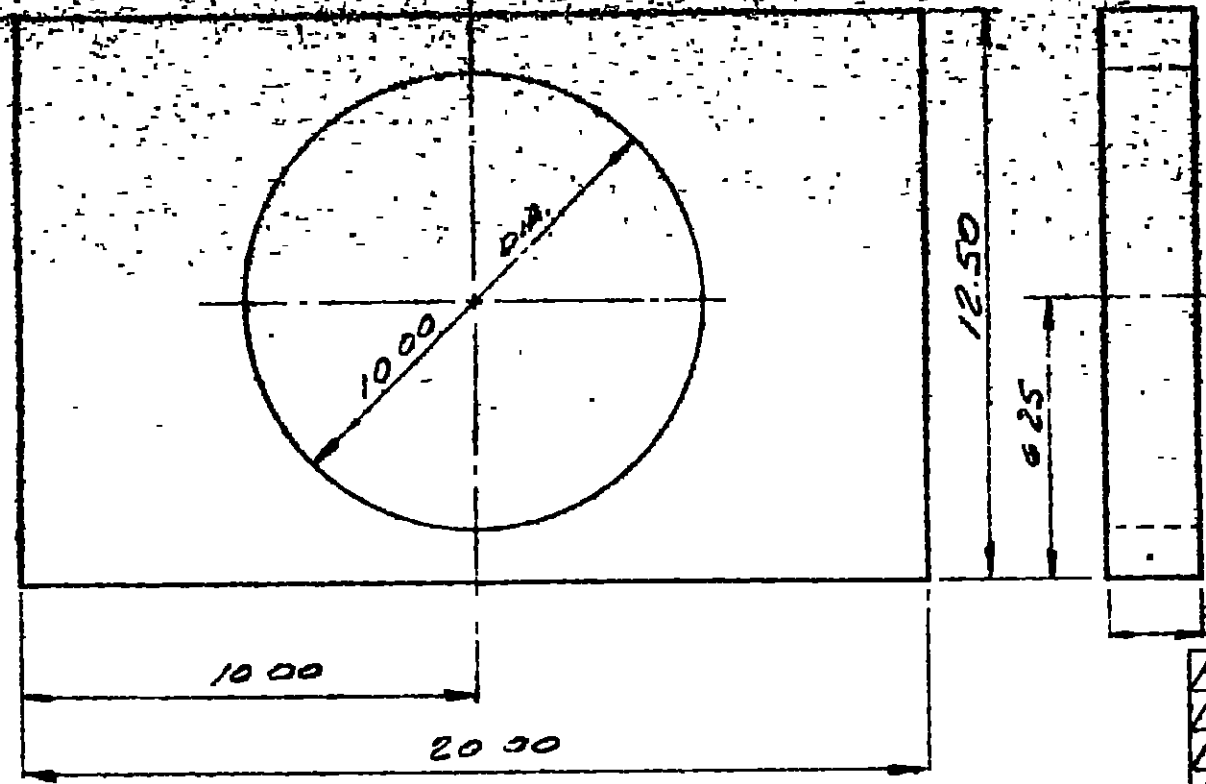
DESD | DRTN VINAL | CK'D

SLEEVE - INLET

NUMBER SK-3577

SHEET 1 OF 1

SUNAIRE MODEL SEC-601 5



MATERIAL - GLASS FIBER 1.50" THICK @ 3#/CU FT.

DEC 17 1976

USED ON ASSEMBLY NO. SK-3551

CHG.	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± 0.010
	3 PLACE DEC. ± 0.005
	ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD. MAX.
	INSIDE RAD. MAX.
UNLESS SPECIFIED, MACHINED SURFACES ROUGHNESS NOT TO EXCEED	√
	_____ RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading)
- ◎ CONCENTRICITY
- ○ ROUNDNESS
- ⌒ FLATNESS
- ⌯ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

SCALE	1/4
MATERIAL	AS NOTED
HEAT TREAT	
CASE DEPTH	
HARDNESS -	
SUR. TREAT	

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO, OHIO

PROJECT NO.	C-2370
DES'D	/ /
DRN.	12/16/76 E/I
CK'D	/ /

INSULATION - BASE

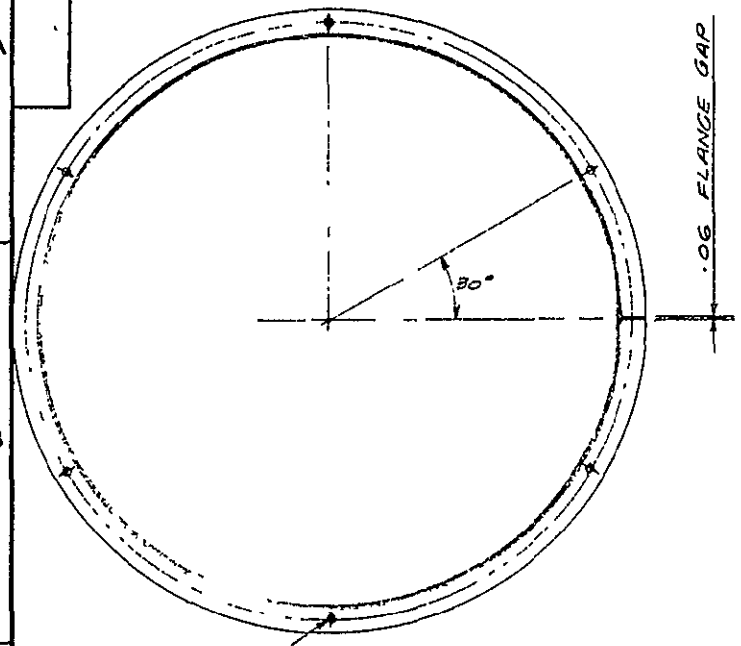
NUMBER SK-3579

SHEET 1 OF 1

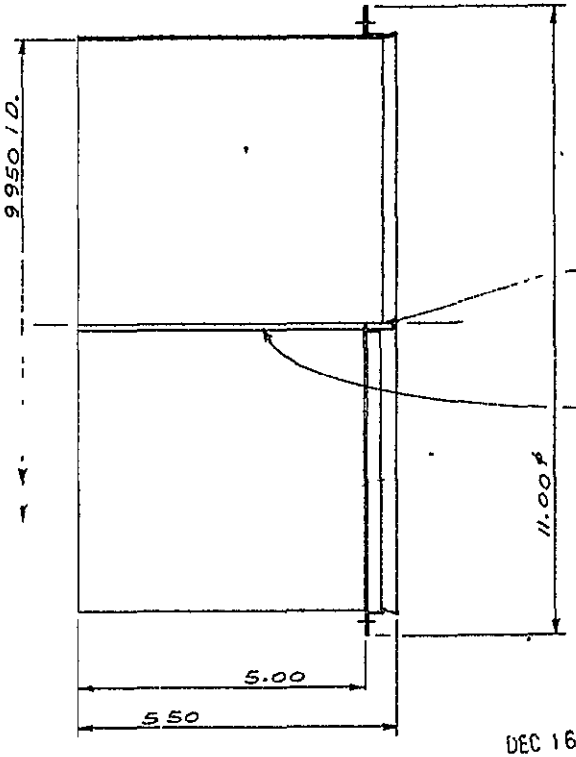
NEWFAX CO.

"SUNAIRE" INDUCTA SEC-601

MATERIAL - 3003 H14 ALUM - 016 THICK

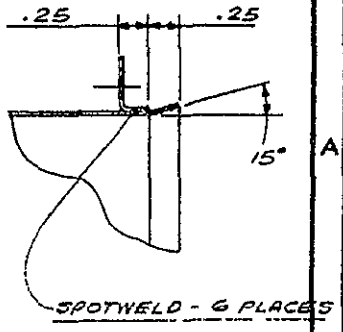


.190 ϕ 6 PLACES @ 60°
ON 10.500 B.C.



NOTCH RING FOR SEAM

AIR TIGHT - EXTERNAL LOCK SEAM



SPOTWELD - 6 PLACES

DEC 16 1970

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

/ USED ON ASSEMBLY NO SK-3551

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .03	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE FULL
	3 PLACE DEC. ± .01		MATERIAL AS NOTED
	ANGLES ±	CONCENTRICITY	
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.	ROUNDNESS	HEAT TREAT
	INSIDE RAD MAX.	FLATNESS	CASE DEPTH
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE NOTED	SYMMETRY	HARDNESS
		PARALLEL	SUR TREAT
		PERPENDICULAR	

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

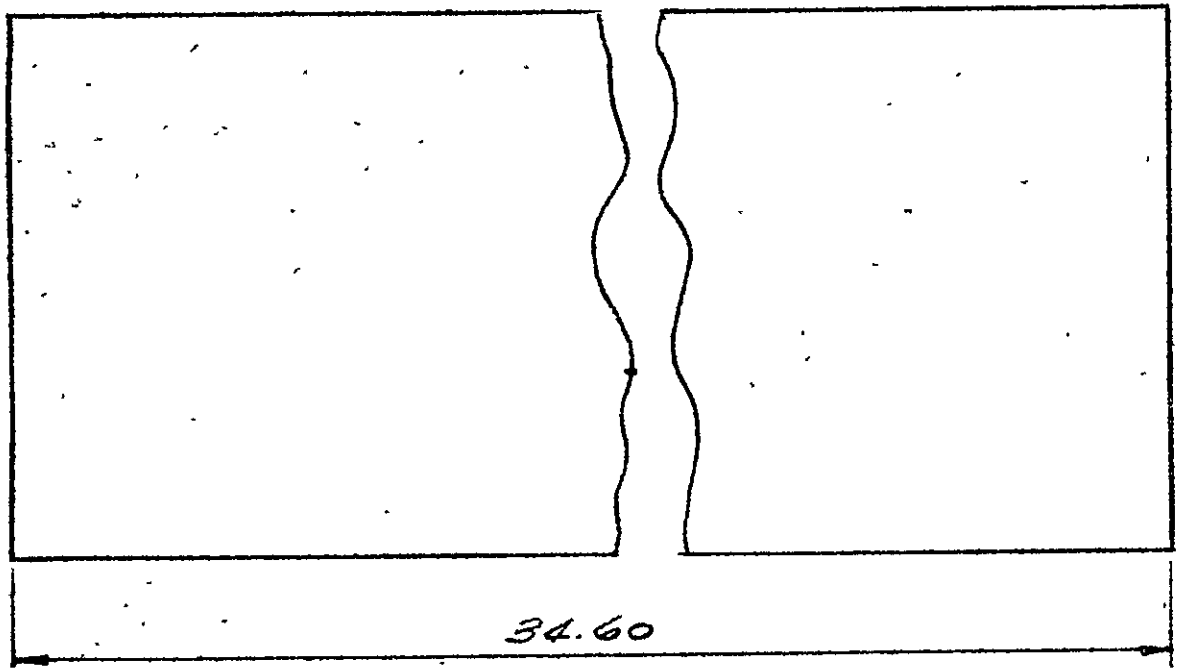
PROJECT NO C-2370 | DES'D | DR'N | CK'D | 12/16/70 AR

DUCT INLET

NUMBER SK-3583 | SHEET 1 OF 1 | B SIZE

"SUNAIR" MODEL SEC-601 5

NEWAX CO



MATERIAL - GLASS FIBER 1" THICK @ 3#/CU.FT.

DEC 17 1976

1 USED ON ASSEMBLY NO SK-3551

CHG.	DESCRIPTION	BY	DATE	BF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED: 2 PLACE DEC. ± 0.010; 3 PLACE DEC. ± 0.005; ANGLES ±; CHAMFERS AND/OR COUNTERBORES: OUTSIDE RAD. MAX, INSIDE RAD. MAX; UNLESS SPECIFIED, MACHINED SURFACE CONFORMS TO NOT TO EXCEED; FINISH UNLESS OTHERWISE NOTED

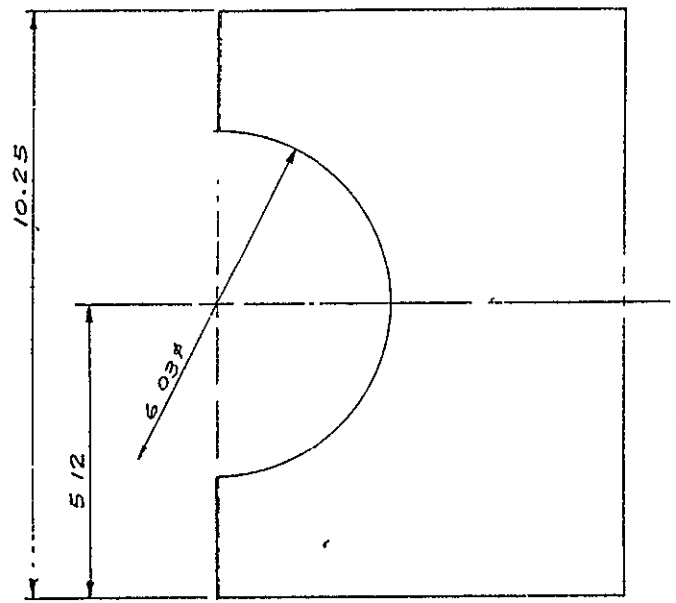
DEFINITION OF SYMBOLS (Tests Indicator Reading): CONCENTRICITY; ROUNDNESS; FLATNESS; SYMMETRY; PARALLEL; PERPENDICULAR

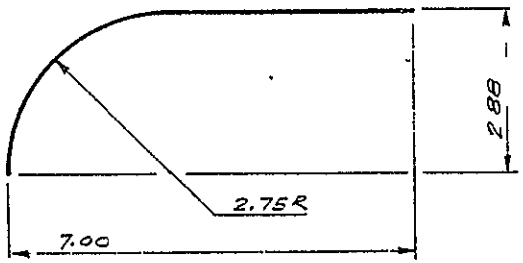
SCALE FULL; MATERIAL AS NOTED; HEAT TREAT; CASE DEPTH; HARDNESS; SURFACE TREAT

CORPORATE TECHNOLOGY, TULSA, OKLA.

PROJECT NO C-2370; DES'D; DRN'D 12/17/76 EJ; CK'D; INSULATION - PLATE; SOURCE SK-3551; SHEET 1 OF 1; SIZE A; DWG.

ORIGINAL PAGE IS
OF POOR QUALITY





MATERIAL - 3003 H14 ALUM. - .012 THICK

DEC 17 1976

2 USED ON ASSEMBLY NO SK-3551

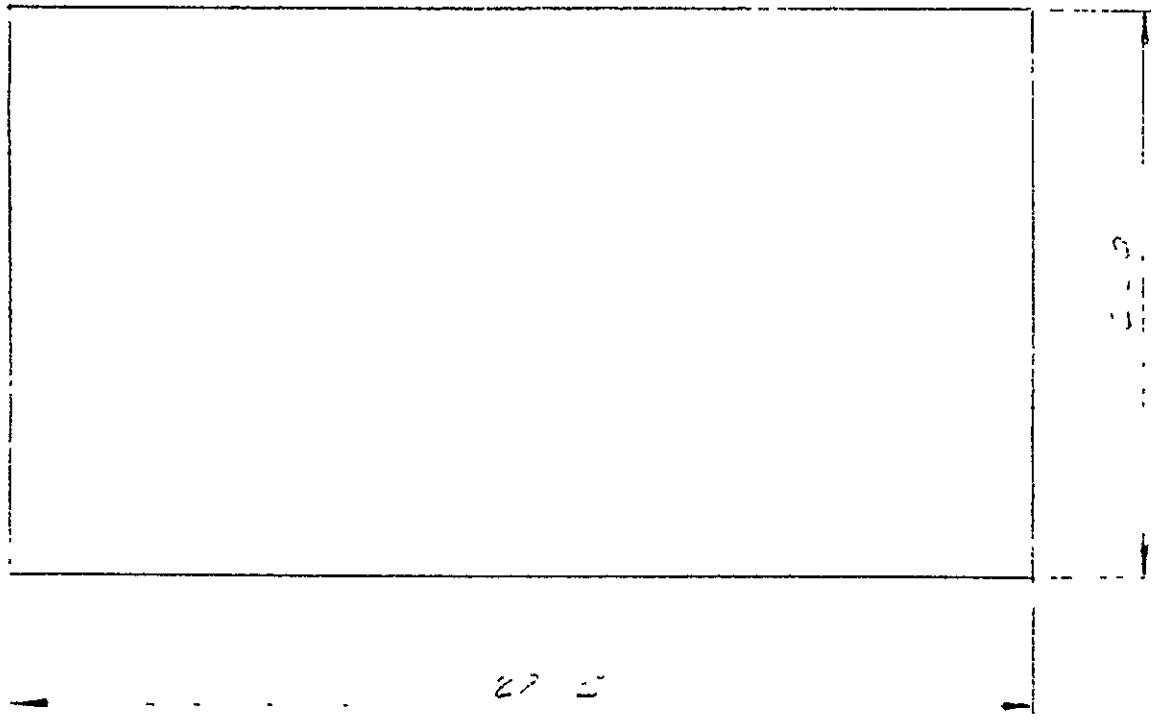
CHG.	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .03	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE 1/2 SIZE
	3 PLACE DEC. ±	⊙ CONCENTRICITY	MATERIAL AS NOTED
	ANGLES ±	○ ROUNDNESS	"
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.	⌒ FLATNESS	HEAT TREAT
	INSIDE RAD MAX.	⌯ SYMMETRY	CASE DEPTH
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	_____ RADII UNLESS OTHERWISE NOTED	∥ PARALLEL	HARDNESS
		⊥ PERPENDICULAR	SUR TREAT

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO, OHIO

PROJECT NO	C-2370
DRWN	BAFFLE - INLET
NUMBER	SK-3588
SHEET	1 OF 1
SIZE	B

"SUNAIR" MODEL SEC-601 5



DEC 17 1976

USED ON ASSEMBLY NO

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC ±	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE
	3 PLACE DEC ±		MATERIAL
	ANGLES ±	CONCENTRICITY	
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX	ROUNDNESS	HEAT TREAT
	INSIDE RAD MAX	FLATNESS	CASE DEPTH
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE NOTED	SYMMETRY	HARDNESS
		PARALLEL	SUR TREAT
		PERPENDICULAR	

OWENS-ILLINOIS

CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C- 2-70

DES D
DR N
CK D

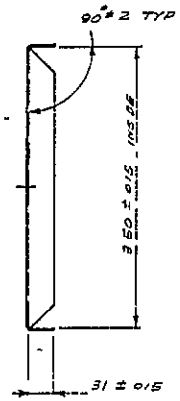
TOWER

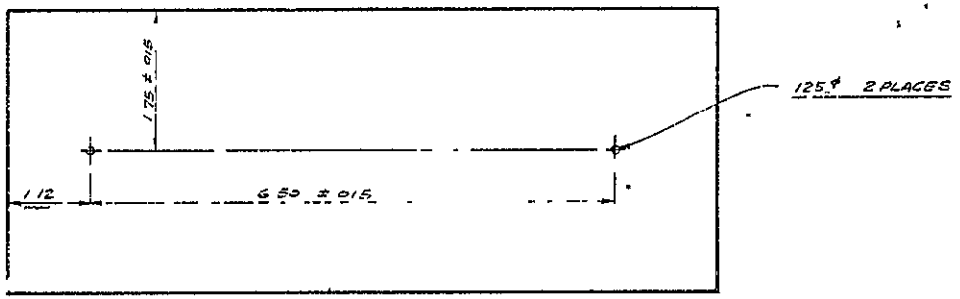
NUMBER SK 2-36

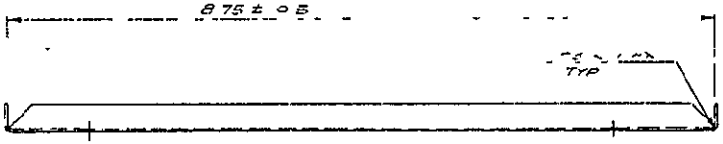
SHEET 1 OF 1

A SIZE

NEWMAX CO







MATERIAL - 3003 H14 ALUM - .012 THICK

J							
H							
G							
F							
E							
D							
C							
B							
A							
CHG	DESCRIPTION			BY	DATE	M#	

1 USED ON ASSEMBLY NO SK-8558

TOLERANCE UNLESS OTHERWISE NOTED: 3 PLACE DEC. ± —; 3 PLACE DEC. ± ——; ANGLES ±
CORNERS AND/OR EDGES BROKEN: OUTSIDE RAD MAX.; INSIDE RAD MAX.
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √; RADII UNLESS OTHERWISE NOTED

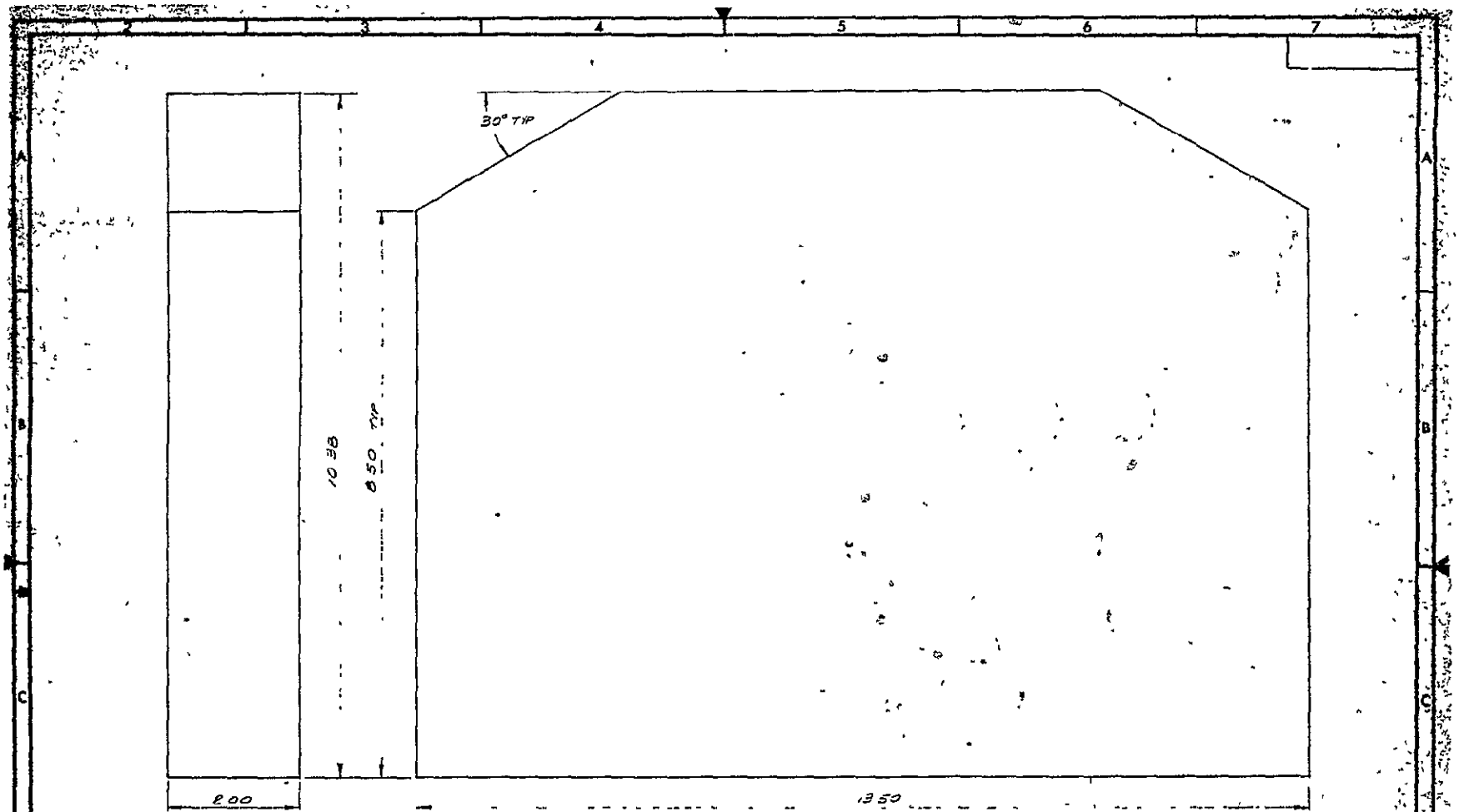
DEFINITION OF SYMBOLS (Total Indicator Reading)
○ CONCENTRICITY
○ ROUNDNESS
⌒ FLATNESS
⌯ SYMMETRY
// PARALLEL
⊥ PERPENDICULAR

SCALE FULL
MATERIAL AS NOTED
HEAT TREAT
CASE DEPTH
HARDNESS
SUR. TREAT

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C 2370
DES'D / /
DRN Willy, Jul
CK'D / /
AIR STOP HI-TEMP.
NUMBER SK-3600
SHEET 1 OF 1
SIZE C

6 "SUNAIR" MODEL SEC-6017



MATERIAL GLASS FIBER - 2" THICK @ 3#/CU FT

DEC 16 1975

1 USED ON ASSEMBLY NO SK 3553

NO.	DESCRIPTION	BY	DATE	AP
A				
B				
C				
D				
E				
F				
G				
H				
J				
K				

TOLERANCE UNLESS OTHERWISE NOTED: 2 PLACE DEC. ± .010; 3 PLACE DEC. ± .005; ANGLES ± 1° 0'

CORNERS AND/OR EDGES BROKEN: OUTSIDE RAD. MAX; INSIDE RAD. MAX

UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √; RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Read Indicator Reading): CONCENTRICITY; ROUNDNESS; FLATNESS; SYMMETRY; PARALLEL; PERPENDICULAR

SCALE FULL

MATERIAL AS NOTED

HEAT TREAT: CASE DEPTH; HARDNESS; SUB. TREAT

OWENS-ILLINOIS

CORPORATE TECHNOLOGY TOLEDO, OHIO

PROJECT NO C-2370

DES'D

DWN

CHK'D

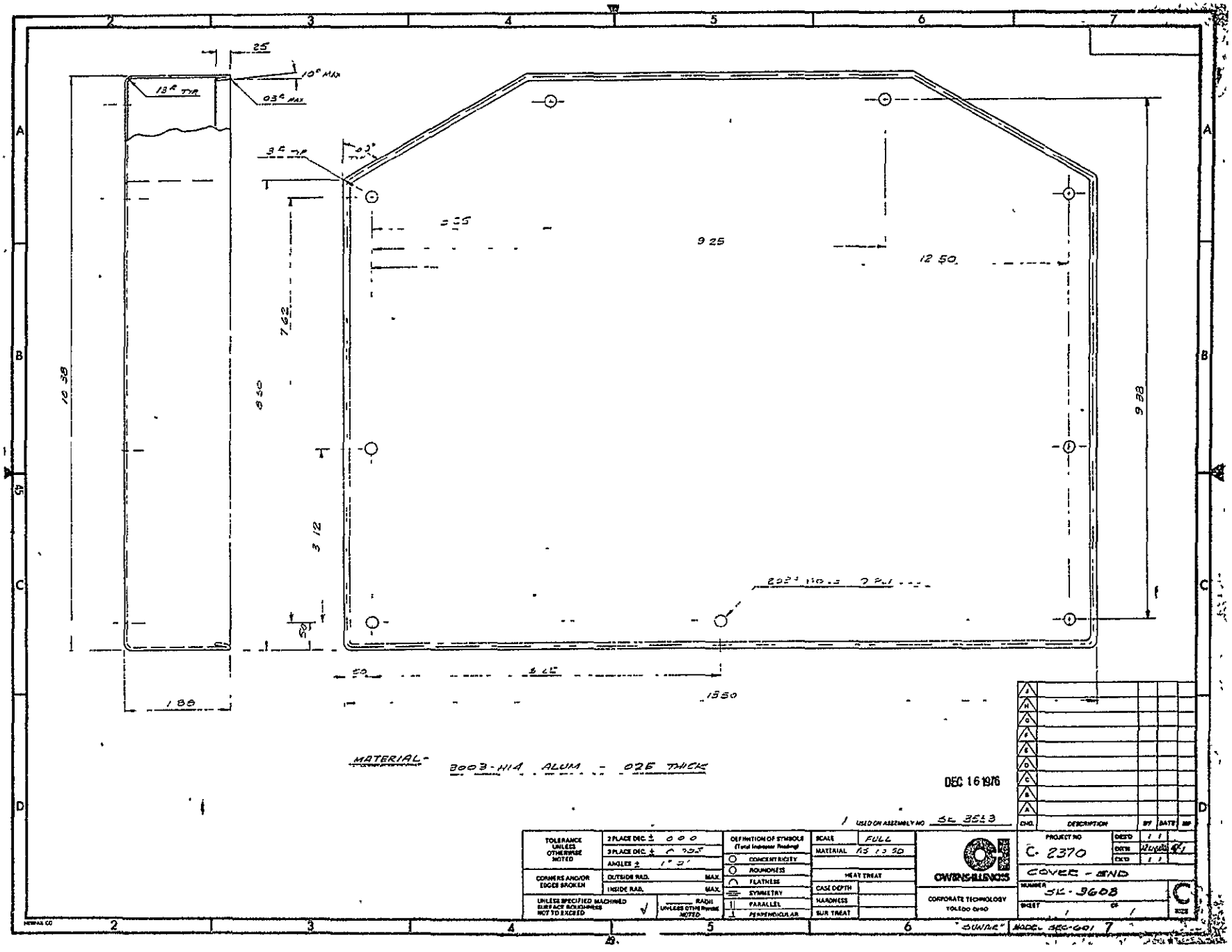
INSULATION - END

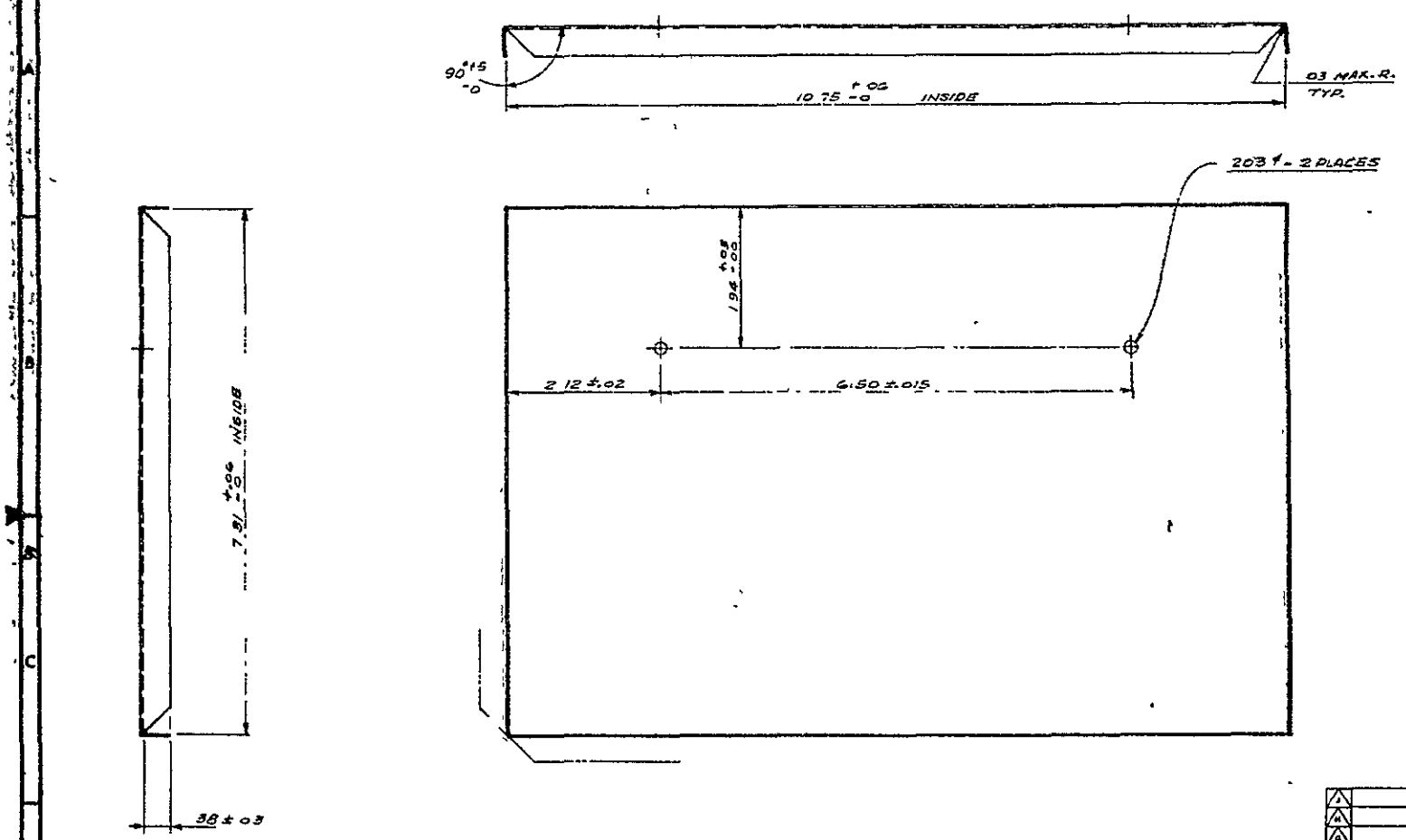
NUMBER SK-3601

SHEET 1 OF 1

SIZE C

6 "SUNAIR" MODEL SEC 5017





MATERIAL -

3003-H14 ALUM. - .020 THICK

NC 16370

∅ USED ON ASSEMBLY NO SK-3558

CHG	DESCRIPTION	BY	DATE	BY
A				
M				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED: 2 PLACE DEC. ± —; 3 PLACE DEC. ± —; ANGLES ±

CORNERS AND/OR EDGES BROKEN: OUTSIDE RAD MAX.; INSIDE RAD MAX.

UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √; RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading): CONCENTRICITY; ROUNDNESS; FLATNESS; SYMMETRY; PARALLEL; PERPENDICULAR

SCALE FULL

MATERIAL AS NOTED

HEAT TREAT

CASE DEPTH

HARDNESS

SUR. TREAT

OWENS-ILLINOIS

CORPORATE TECHNOLOGY TOLEDO OHIO

PROJECT NO C-2370

DRN'D

CK'D

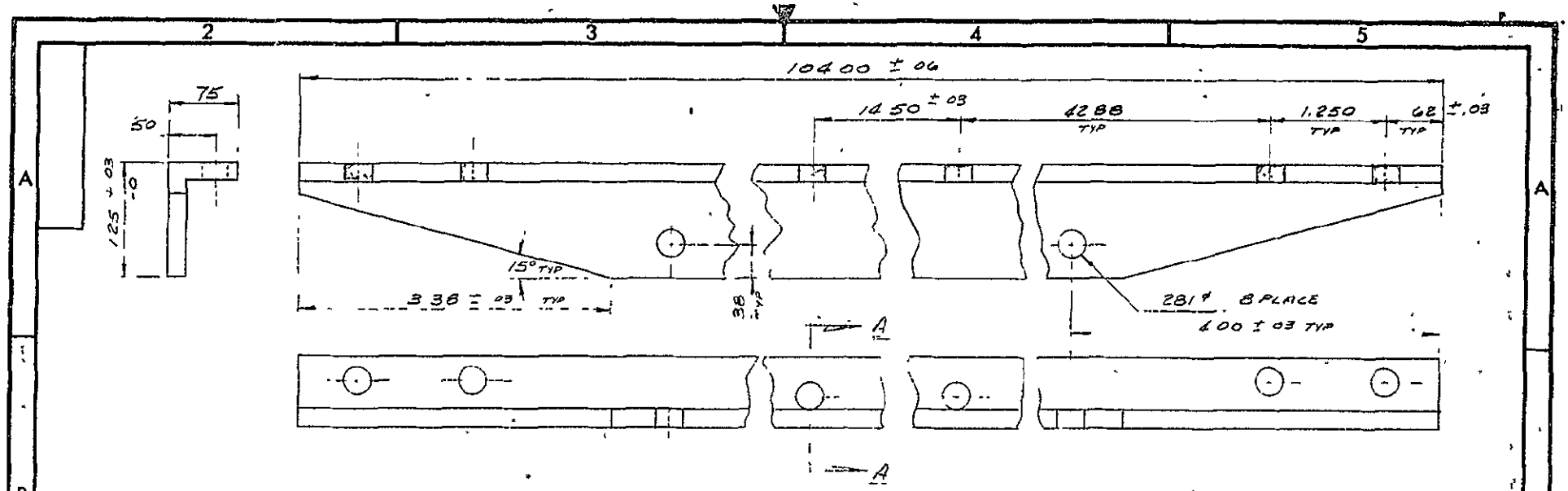
AIR STOP - LOW TEMP.

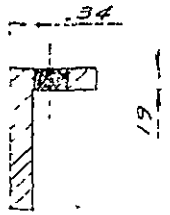
NUMBER SK-3605

SHEET 1 OF 1

"SUNRISE"

MODEL SEC-Lay 7





SECTION AA

MATERIAL -
6063-T52 ALUM EXTRUDED

DEC 17 1976

USED ON ASSEMBLY NO SC-3552 SK-3615

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .010	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE FULL
	3 PLACE DEC. ± .005	⌾ CONCENTRICITY	MATERIAL AS NOTED
	ANGLES ± 1° 0'	○ ROUNDNESS	
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.	⌒ FLATNESS	HEAT TREAT
	INSIDE RAD MAX.	≡ SYMMETRY	CASE DEPTH
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	___ RADII UNLESS OTHERWISE NOTED	∥ PARALLEL	HARDNESS
		⊥ PERPENDICULAR	SUR TREAT

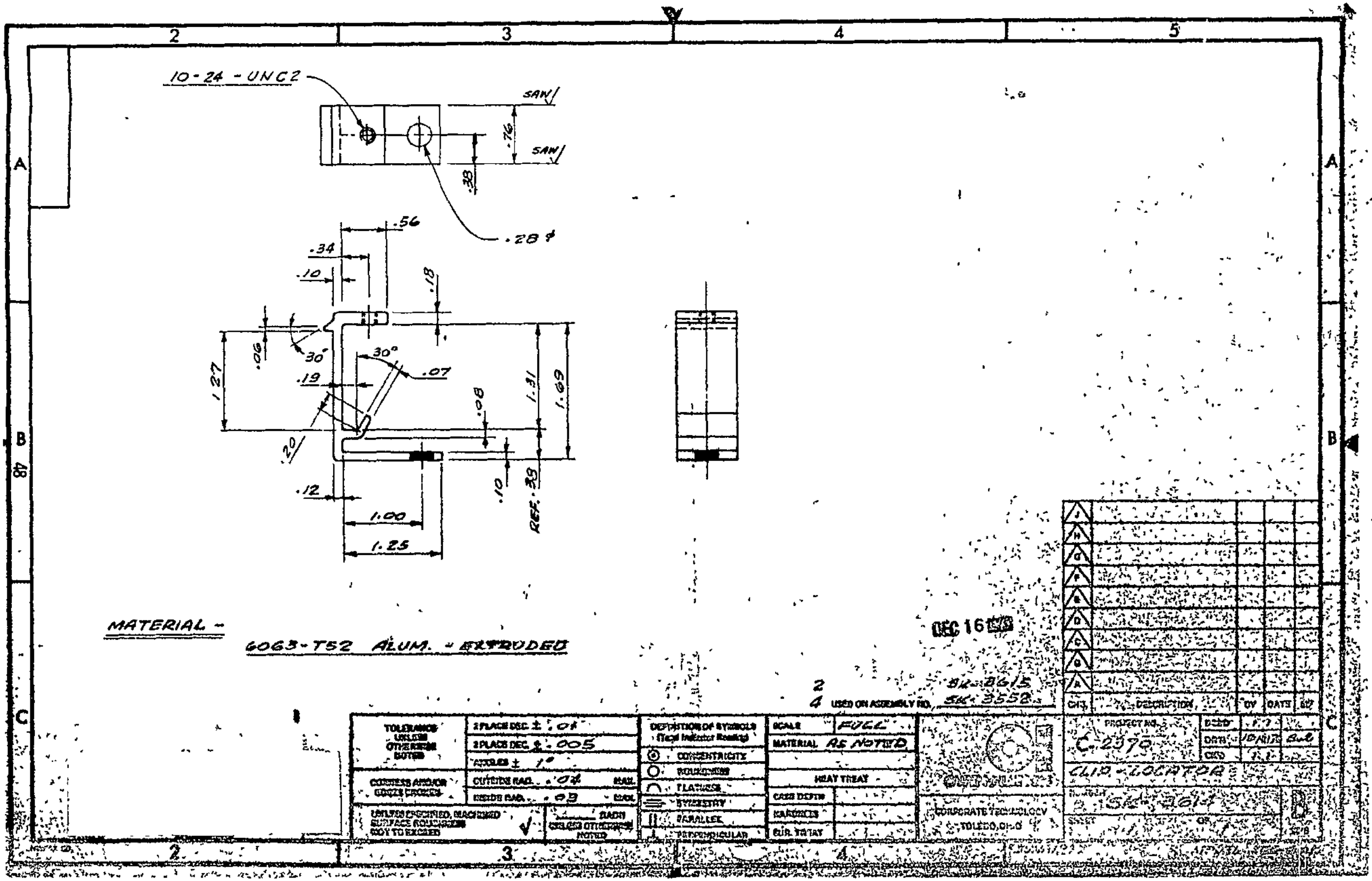
OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

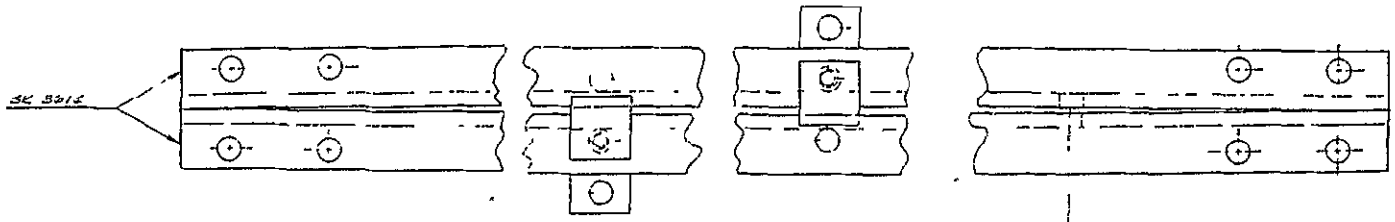
PROJECT NO C-2370
DES'D J J
DR'N 12/13/76 EJ
CK'D J J

RAIL - OUTBOARD
NUMBER SK-3613
SHEET 1 OF 1
B SIZE

'SUNAIR' MODEL SEC-6015

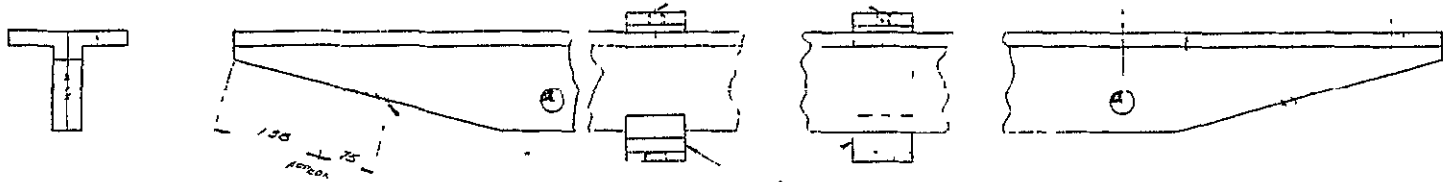
NEWFAX CO


10-24-UNC2
SAW
.76
.38
.28 ∅
.56
.34
.10
.18
.06
30°
30°
.07
.19
1.27
.08
1.31
1.69
.20
.12
.10
REF. .39
1.00
1.25
MATERIAL -
6063-T52 ALUM. - EXTRUDED
DEC 16
2 SK-3615
4 USED ON ASSEMBLY NO. SK-3552
TOLERANCE UNLESS OTHERWISE NOTED
2 PLACE DEC. ± .01
3 PLACE DEC. ± .005
ANGLES ± 1°
CORNERS AND/OR EDGES BROKEN
OUTSIDE RAD. .04 MAX.
INSIDE RAD. .03
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED
RADII UNLESS OTHERWISE NOTED
DEFINITION OF SYMBOLS (Total Indicator Reading)
CONCENTRICITY
ROUNDNESS
FLATNESS
SYMMETRY
PARALLEL
PERPENDICULAR
SCALE FULL
MATERIAL AS NOTED
HEAT TREAT
CASE DEPTH
HARDNESS
SUR. TREAT
CORPORATE TECHNOLOGY
TOLEDO, OHIO
CHG. DESCRIPTION BY DATE
PROJECT NO. C-2370
CLIP - LOCATOR
SHEET 1 OF 1
B



AFTER WELDING, HOLES MUST PASS
Ø80" GAGE SQUARE WITH CENTER AXIS WITHIN 3"

LOCATE CENTERLINE HOLES



DEC 16 1975

/ USED ON ASSEMBLY NO SK 3552

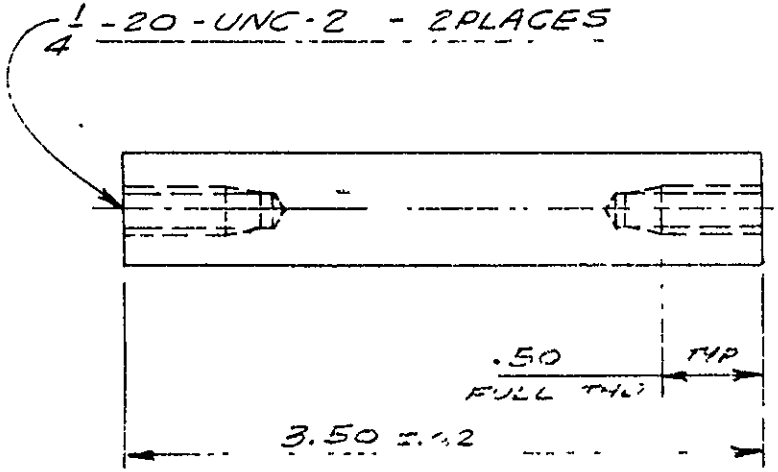
CHG	DESCRIPTION	BY	DATE	BY
A				
B				
C				
D				
E				
F				
G				
H				

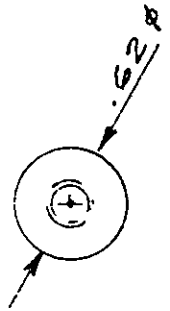
TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC ±	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE FULL
	3 PLACE DEC ±	○ CONCENTRICITY	MATERIAL AS NOTED
	ANGLES ±	○ ROUNDNESS	HEAT TREAT
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.	⌒ FLATNESS	CASE DEPTH
	INSIDE RAD MAX.	⫽ SYMMETRY	HARDNESS
UNLESS SPECIFIED MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE NOTED	∥ PARALLEL	SUB TREAT
		⊥ PERPENDICULAR	

OWENS-CORNING
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C-2370
DES'D | | |
DRN | RUCKER |
CK'D | | |
RAIL - WELDED CENTER ASSY
NUMBER SK 3615
SHEET 1 OF 1
SIZE C

"SUNAIR" MODEL SEC-6017





MATERIAL - 6061 - T9 ALUM.

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

16 USED ON ASSEMBLY NO SK-3552

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC ± .01	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE FULL
	3 PLACE DEC ±	CONCENTRICITY	MATERIAL AS NOTED
	ANGLES ±	ROUNDNESS	
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX	FLATNESS	HEAT TREAT
	INSIDE RAD MAX	SYMMETRY	CASE DEPTH
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	____ RADII UNLESS OTHERWISE NOTED	PARALLEL	HARDNESS
		PERPENDICULAR	SUR TREAT

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C-2370
DES D / /
DR'N 12/14/76 Anl
CK D / /

SPACER

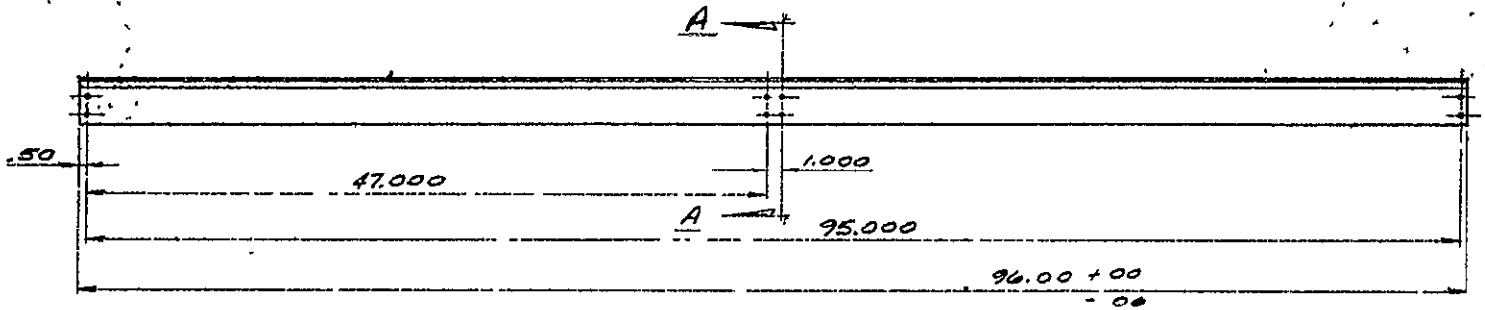
NUMBER SK-3621

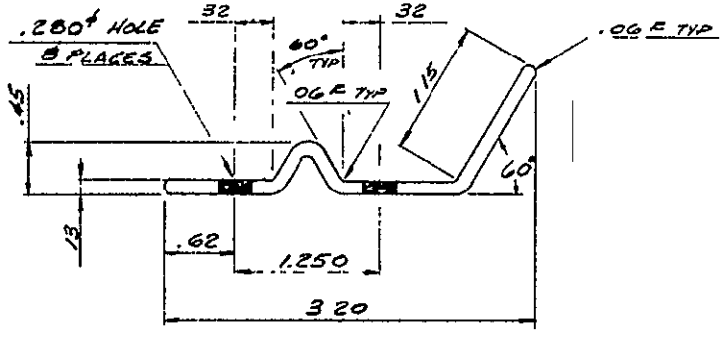
SHEET 1 OF 1

A SIZE

NEWFAX CO

"SUNAIR" MODEL SEC-601





SECTION AA

MATERIAL - 6063-T52 ALUM. EXTRUDED

DEC 16 1986

2 USED ON ASSEMBLY NO SK-3552

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ±	0.010
	3 PLACE DEC. ±	0.005
	ANGLES ±	1° 0'
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD	MAX.
	INSIDE RAD	MAX.
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED	√	RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading)
- ◎ CONCENTRICITY
- ○ ROUNDNESS
- ⏠ FLATNESS
- ⌯ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

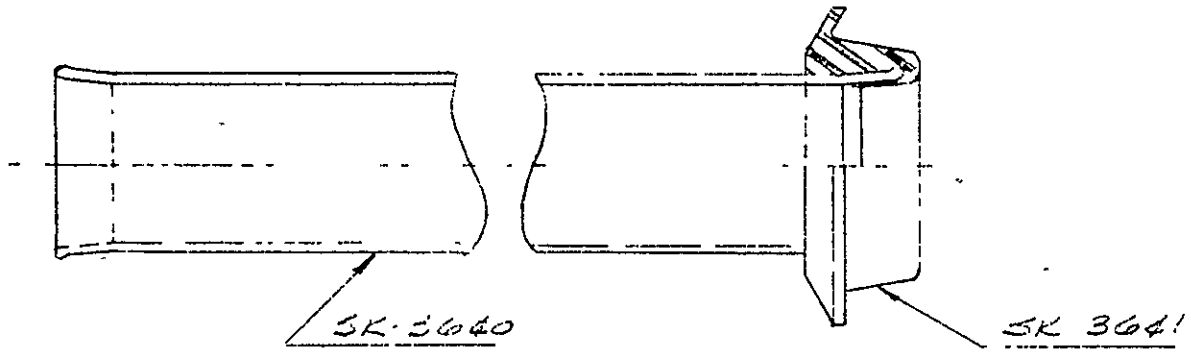
SCALE	1/8 F FULL
MATERIAL	AS NOTED
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR TREAT	

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO, OHIO

PROJECT NO C-2370
DES'D / /
DR'N 12/15/86 GA
CK'D / /

DEFLECTOR
NUMBER SK-3622
SHEET 1 OF ✓
B SIZE

"SUNAIR" MODEL SEC-6015



DEC 17 1976

-48 USED ON ASSEMBLY NO SK-3552

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC ±
	3 PLACE DEC. ±
	ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX.
	INSIDE RAD MAX
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED	√
_____ RADII UNLESS OTHERWISE NOTED	

DEFINITION OF SYMBOLS (Total Indicator Reading)

- ⊙ CONCENTRICITY
- ○ ROUNDNESS
- ⌒ FLATNESS
- ≡ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

SCALE	FULL
MATERIAL	----
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR TREAT	

OWENS-ILLINOIS

CORPORATE TECHNOLOGY
TOLEDO, OHIO

PROJECT NO	C-2370
DES D	/ /
DR'N	[illegible]
CK D	/ /

FEEDER TUBE ASSEMBLY

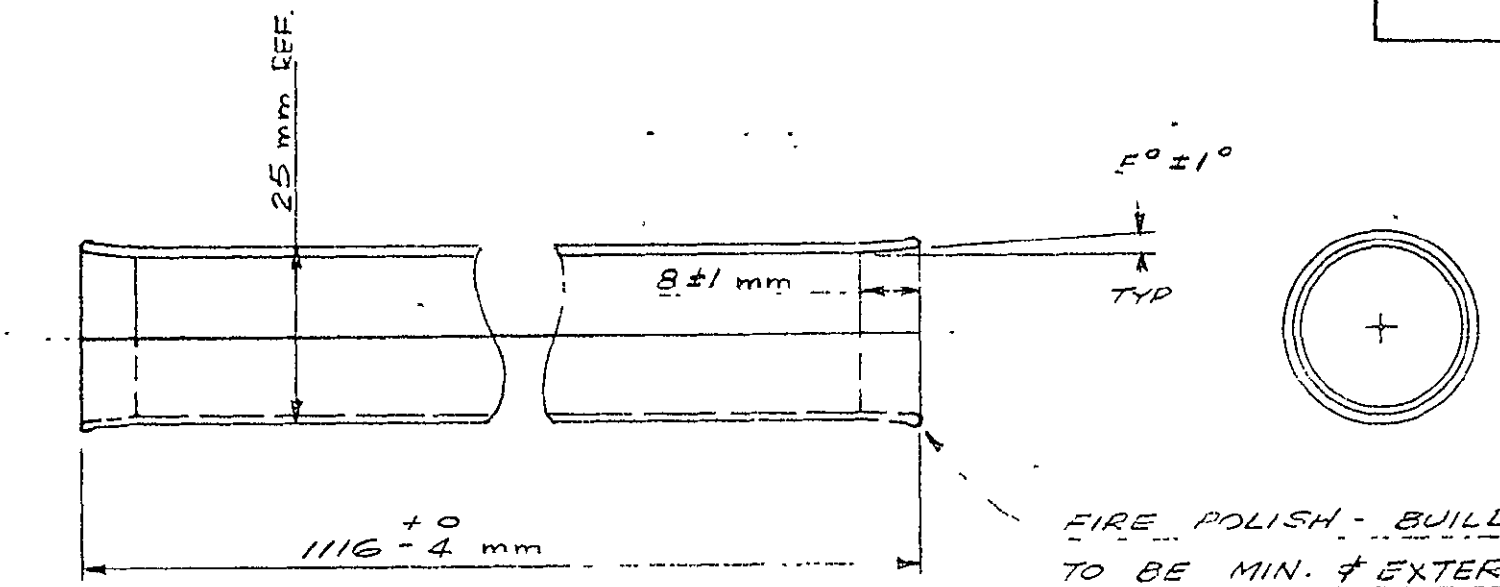
NUMBER SK-3639

SHEET 1 OF 1

A SIZE

NEWFAX CO.

"SUNAIR" MODEL SEC 601



FIRE POLISH - BUILDUP TO BE MIN. ¼ EXTERNAL BOTH ENDS

MATERIAL -

25mm O.D. x 1.2 mm WALL KG-33
GLASS — ANNEALED

METRIC
DEC 17 1976

1 USED ON ASSEMBLY NO SK-3633

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
G				
F				
E				
D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	~~2 PLACE DEC. ±~~ / ~~3 PLACE DEC ±~~ / ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD MAX / INSIDE RAD MAX
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	____ RADII UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading)
⊙ CONCENTRICITY
○ ROUNDNESS
⌒ FLATNESS
⥤ SYMMETRY
∥ PARALLEL
⊥ PERPENDICULAR

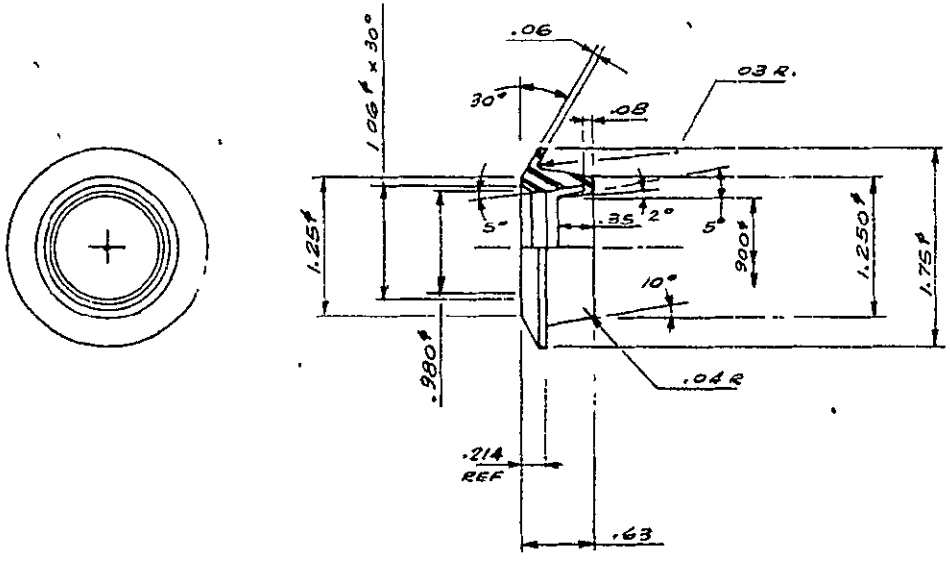
SCALE FULL
MATERIAL AS NOTED
HEAT TREAT
CASE DEPTH
HARDNESS
SUR TREAT

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C-2370
DES D
DR N
CK D
FEEDER TUBE
NUMBER SK-3640
SHEET 1 OF 1
A SIZE

NEWFAX CO

"JUMPER" MODEL SEC-601A



MATERIAL -

MOLDED SILICONE RUBBER 40±5 DUROMETER SHORE "A"

DEC 17 1976

1 USED ON ASSEMBLY NO. SK-3639

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .01
	3 PLACE DEC. ± .005
	ANGLES ±
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD. MAX.
	INSIDE RAD. MAX.
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	____ RMS UNLESS OTHERWISE NOTED

DEFINITION OF SYMBOLS (Total Indicator Reading)

- ⊙ CONCENTRICITY
- ○ ROUNDNESS
- ⌒ FLATNESS
- ⌯ SYMMETRY
- // PARALLEL
- ⊥ PERPENDICULAR

SCALE	FULL
MATERIAL	
HEAT TREAT	
CASE DEPTH	
HARDNESS	
SUR. TREAT	

CORPORATE TECHNOLOGY TOLEDO OHIO

CHG	DESCRIPTION	BY	DATE	BY
J				
H				
G				
F				
E				
D				
C				
B				
A				

PROJECT NO. C2874

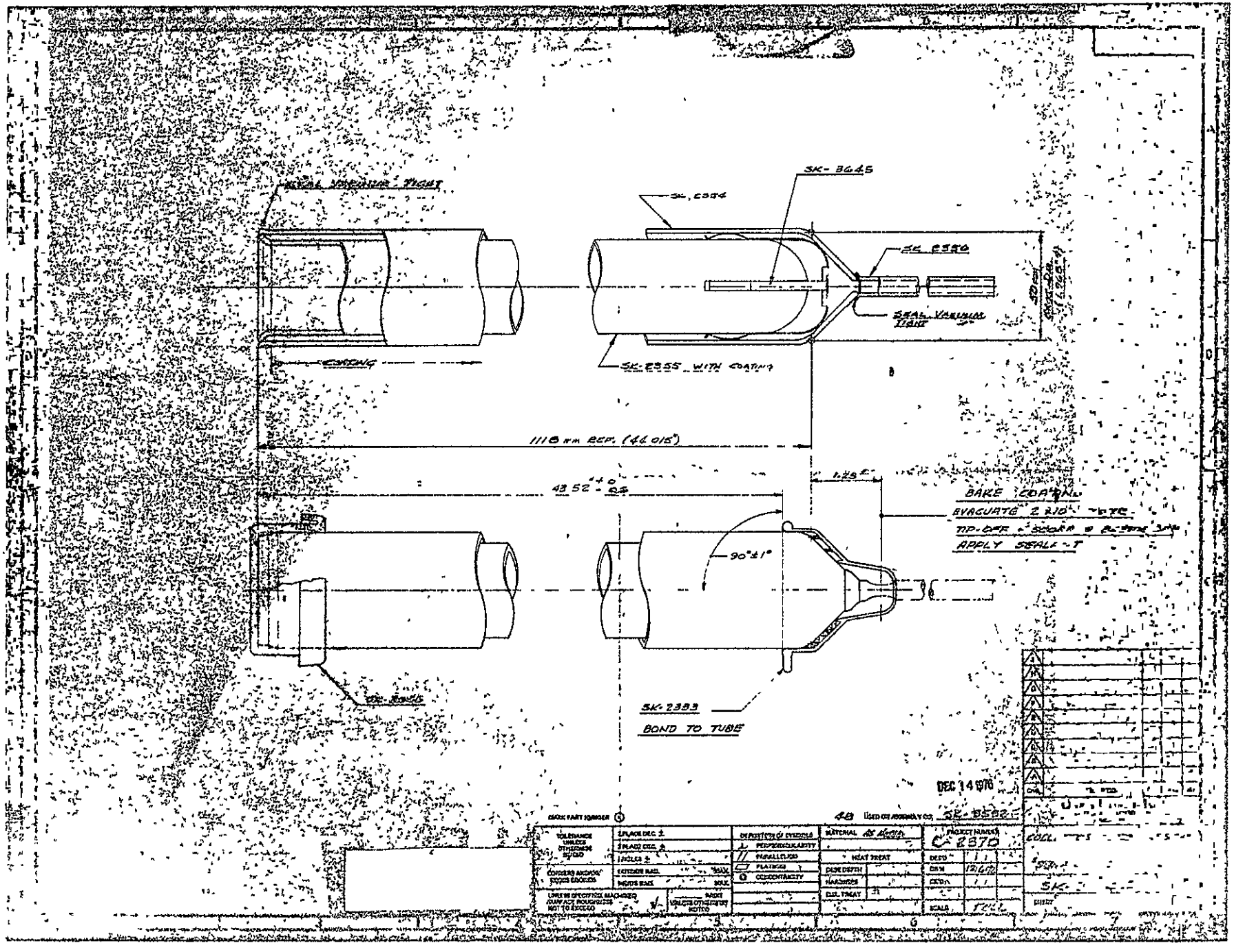
MOUNTING RING - SENSOR

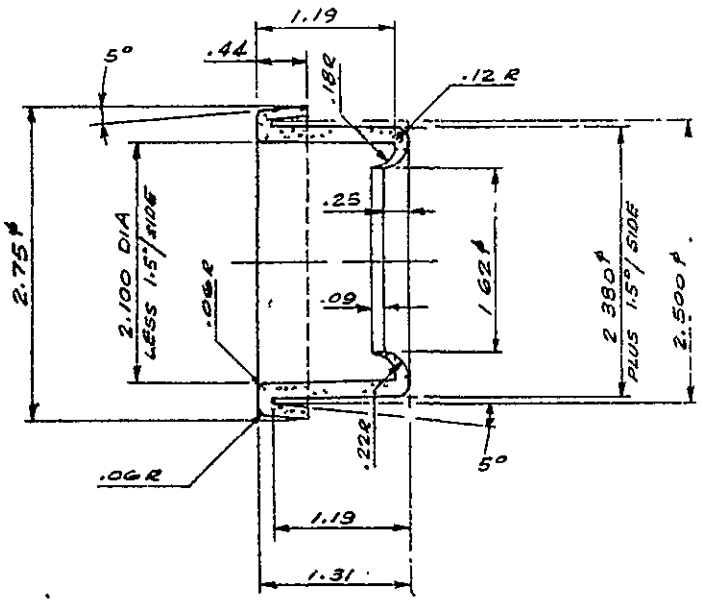
SURFACE FINISH

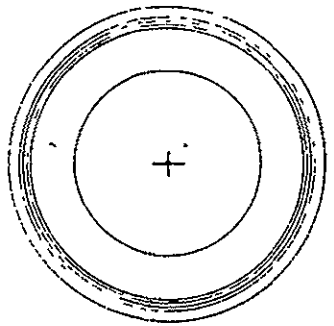
DRAWING NO. SK-3621

SHEET OF

SIZE B







MATERIAL — CLOSED CELL SILICONE FOAM 25 ±5 DUROMETER SHORE "A"

DEC 16 1976

48 USED ON ASSEMBLY NO SK-3552

CHG	DESCRIPTION	BY	DATE	MF
J				
H				
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D				
C				
B				
A				

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ± .01	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE FULL
	3 PLACE DEC. ± .005	◎ CONCENTRICITY	MATERIAL AS NOTED
	ANGLES ±	○ ROUNDNESS	
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD. MAX.	⌒ FLATNESS	HEAT TREAT
	INSIDE RAD. MAX.	= SYMMETRY	CASE DEPTH
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE NOTED	∥ PARALLEL	HARDNESS
		⊥ PERPENDICULAR	SUR TREAT

OWENS-ILLINOIS
CORPORATE TECHNOLOGY
TOLEDO OHIO

PROJECT NO C-2370	DES'D	1 1	
	DR'N	12/15/76	a-l
	CK'D	1 1	

MOUNTING RING - COLLECTOR

NUMBER SK-3646

SHEET 1 OF 1

B SIZE

"SUNAIR" MODEL SEC-601