First Draft

7/23/75

7/25/75

25 METER - MILLIMETER WAVE TELESCOPE

MEMO # 30

I. Scope of Work:

Furnish design services, materials, equipment, labor, supervision, testing services and testing equipment to manufacture and test one prototype surface panel, with a detail report of the complete procedure, for a proposed mm wave receiving antenna.

II. Object of Project:

The object of this project is to confirm the availability of panels which will meet the requirements of a radio telescope for maximum efficiency in receiving radio signals at a frequency of 250 GHz or 1.2 mm wave length. The manufacturing accuracies and ~~tuberances~~ toler required for these panels will utilize the state of the art to its maximum or better.

The proposed telescope will use a 25 meter diameter paraboloid "dish" which will consist of 528 panels, similar to the prototype developed by this contract, in 8 concentric rings. The "dish" will be supported by a special "homology" back up structure which will adjust and retain a parabolic shape in all attitudes of the dish. The dish will be maneuverable for pointing toward any point in the sky above the horizon with a pointing accuracy of 2 arc seconds.

III. Panel Parameters:

The prototype panel shall be a typical row 5 panel shown in the attached schedule having the dimension shown and meeting the following specifications when delivered.

1. Will properly fit into the contour of the equation- $X^2 = 10500\ y$ mm (f/D = 0.42) when mounted at the four corners.
2. Have a machined reflector surface error of .035 mm (1.5×10^{-3} in) RMS or less with a max. allowable error of .070 mm (3.0×10^{-3} in.), from the above calculated curve.
3. Have a maximum gravitational deflection of .020 mm ($.8 \times 10^{-3}$ in.) from the above calculated curve.
4. Have a maximum deformation due to 29 km/hr. (18 mph) wind of .02 mm ($.8 \times 10^{-3}$ in.), from the above calculated curve.

5. Have a maximum thermal deformation of .025 mm (1 x 10^{-3} in.), with a ΔT of 1.5°F between front and rear surface of panel.
6. Have machined edges with maximum dimensional error at any point of $\pm$ .1 mm (4 x 10^{3} in.).
7. Survive a wind load of 161 km/hr. (100 mph) without permanent deformation.
8. Survive a distributed load of 97 kg/m^2 (20 lb/ft^2) or 550 kg over a 15 cm square area (250 lb - 6 in. square) without permanent deformation.
9. Shall not have machining cusps of heights exceeding .015 mm (.6 x 10^{-3} in.).
10. Have a maximum weight of 20 kg/m^2 (4 lbs/ft^2).
11. Be equipped with a mounting pad in each corner machined to within .025 mm (1 x 10^{-3} in.) of the mounting plane and equipped with required inserts or receptacles to receive an adjustable mounting brackets.
12. The panel shall have a nominal thickness of 3.2 mm (.125 in.) in areas between reinforcing ribs (thinnest areas of the panel).

IV. Manufacturing:

The panels shall be cast-machined aluminum using A 356 aluminum or better, stress relieved and aged to T51 conditions. Reflective surfaces shall be machined to grade C or better, while other machined surfaces on the panel shall be machined to grade D or better.

Casting shall generally follow the requirements of MIL-C-6021G specifications using wood patterns. Finished casting shall be carefully inspected for defects and dimensional errors before heat treating and aging. Heat treating shall continue for a minimum of 7 to 9 hours. Radio-graph the finished casting before machining.

The panel shall be machined with a numerically controlled machine equipped with separate read out instrumentation for checking the input instructions and machine operation. A special designed mounting fixture shall be used to support the panel, from the mounting pads on the panel, while machining. The cutting tool shall have a spherical cutting edge which has the capability of generating a curved surface in two directions. Extreme care shall be taken to control temp-

erature and pressure while machining so as not to introduce distortion. The panel shall be allowed to stand in a normal relaxed position for sufficient time between each machining to allow stabilization. Sanding of surface may be required to reduce heights of ridges developed in machining. The panel shall be stabilized and/or stress relieved by heat treatment after final machining and before testing.

The above specifications for manufacturing are to be considered as a general guide. The manufacturer shall develope detail procudures and submit them for review. The intent in to introduce areas where concern exists that (with out) special attention the final product, the prototype panel, will not meet the accuracy and durability specified is section III above. Other approaches to the construction will be considered if proposed by the manufacturer.

V. Testing:

A detail testing procedure shall be developed and carried out to prove the prototype panel meets the specifications set forth in section III and it has the durability to withstand expected environmental conditions. The tests shall include but not be limited to the following:

1. After the finished panel is stabilized or stress relieved tests 2 thru 7 shall be made in a controlled environment.
2. Make detail accurate measurements to prove the exact shape and size of the panel and tabulate them along side the specified or theoretical dimensions. This shall include weight.
3. Place panel in a properly designed fixture and measure the curvature and calculate the rms error from the theoretical. The panel shall be supported from the corner support points and shall be inclined to the horizontal in the approximate position the panel would take if the antenna were pointing to zenith. Error measurements and error calculations shall reference from a plane through the four points on the reflecting surface just above the support points. Measurements shall be made on 25 mm centers,

each way, over the entire surface with electric transducers with an accuracy, linearity and repeatability required to prove the accuracy of the surface. First and last reading in all rows shall be at the edge of the panel.

4. Rotate the panel in its fixture 90^{o} around its long axis and repeat step 3.
5. Rotate the panel in its fixture another 90^{o} around its long axis and repeat step 3. In both step 4 and 5 the measuring equipment shall be instrumented so as to correct for any movement or deflection of the measurement system.
6. Support the panel from its four support points, in a position approximating the position the panel would take if the telescope were in the zenith position, and load with a distributed load of 97 kg/m^{2} and allow to remain in a normal outside environment for a period of 48 to 72 hours minimum. After removing the distributed weight apply a load of 550 kg on a 15 cm square for a period of 30 minutes and remove. Repeat step 3 after the temperature of the panel has stabilized to the controlled temperature in the measuring area.
7. Repeat step 3 with an equally distributed load suspended under the panel. The load shall be the equivalent to the force on the surface of the panel with the wind blowing 29 km/hr. directly toward and perpendicular to the surface. From these figures calculate the stress and deflection of the panel if it were to experience a similar wind at 161 km/hr.
8. Develope a heat differential, by using heat lamps or the sun on top on the top surface and cooled air on the bottom, and repeat step 3. This should be done for a minimum of three stabilized temperature differences. Calculate the thermal deformation.
9. Place the panel alternately in an environment of 120^{o}F and -20^{o} F for a period of not less than 6 hours in each environment and repeat through a minimum of six complete cycles. Repeat step 3.

10. Repeat step 3 for at least three different ambient temperatures approximating the normal temperature range expected during operation 80°F to -10°F.

11. Make such other tests as might be necessary to verify the data and resulting calculations in each of the above steps or to clarify questions raised by the tests above. If any of the above test indicate the panel does not meet specifications testing shall be stopped and corrective steps taken before proceeding.

VI. Report:

A detail report shall be prepared to provide a complete history of the design, manufacturing and testing of the panel including a summary and conclusions. The report shall include, but not be limited to the following.

1. Complete design calculations and stress analysis.
2. All engineering drawings, sketches and specifications including pattern and shop drawings used in manufacturing and testing.
3. Detail description of manufacturing procedure and instructions including a description of machines used, radiographs and instructions and drawings including subcontractors.
4. Complete description of testing procedures including copy of all test data, calculations and conclusions including a description of test equipment.
5. A breif summary and conclusions.
6. A copy of all computer programs, data and results used in the design manufacturing and testing.
7. A cost estimate for manufacturing, testing and delivering 528 similar panels, in 1976 dollars, including an estimate of the time required (delivery time). The test procedure would be a modified version of the procedure called for above to establish quality control.

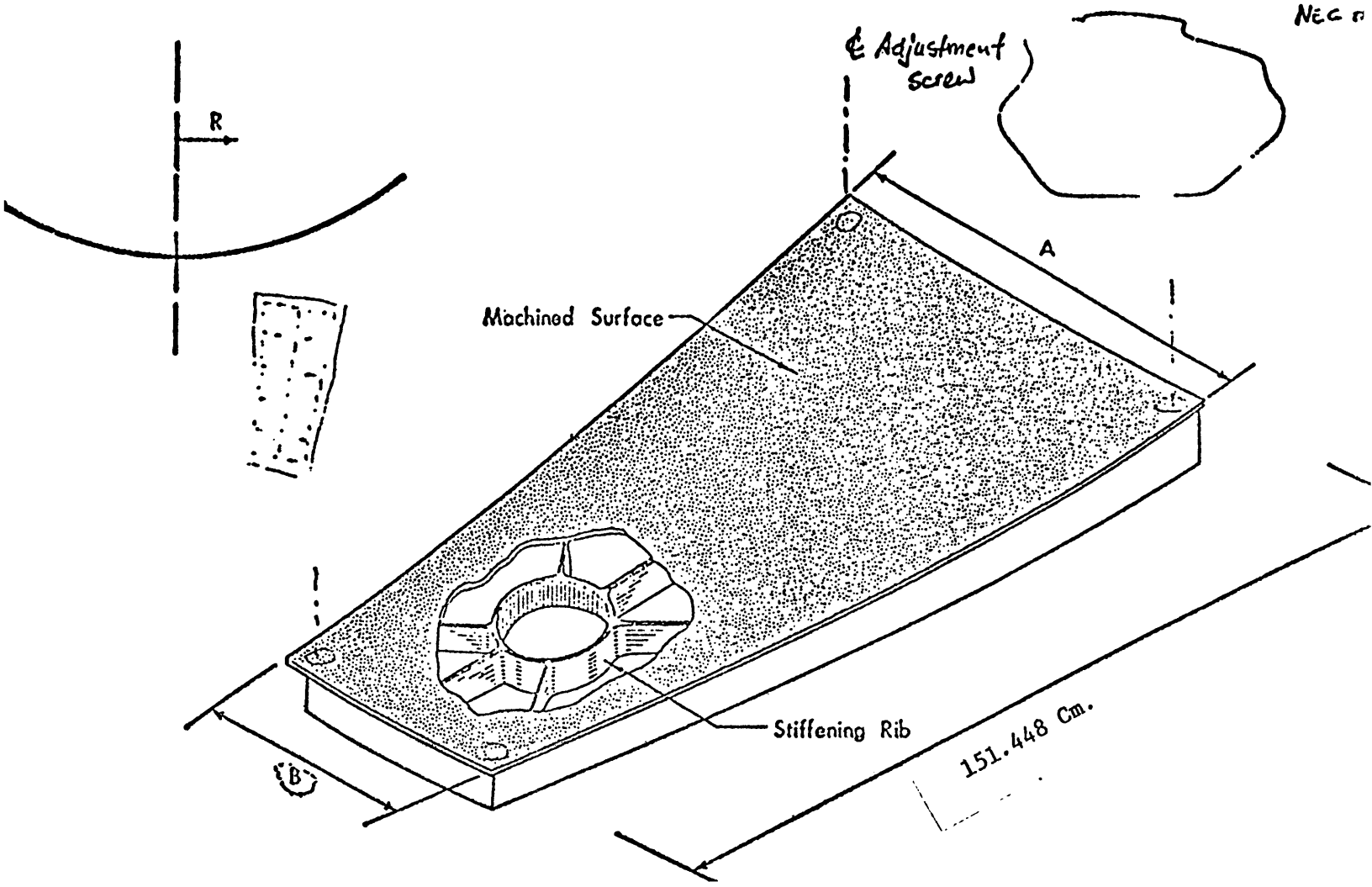
VII. Available Study:

Associated Universities, Inc. has in hand a design, test and manufacturing

study and report of a similar panel, of a larger size, for a larger telescope. The panel approaches but does not reach the specifications outlined for the panel called for under this RFP. The report and a typical panel described by the report will be made available to the successful manufacturer for reference and possibly as a point of departure in their design ~~if requested.~~ if they so desire.

VIII. Progress Reports

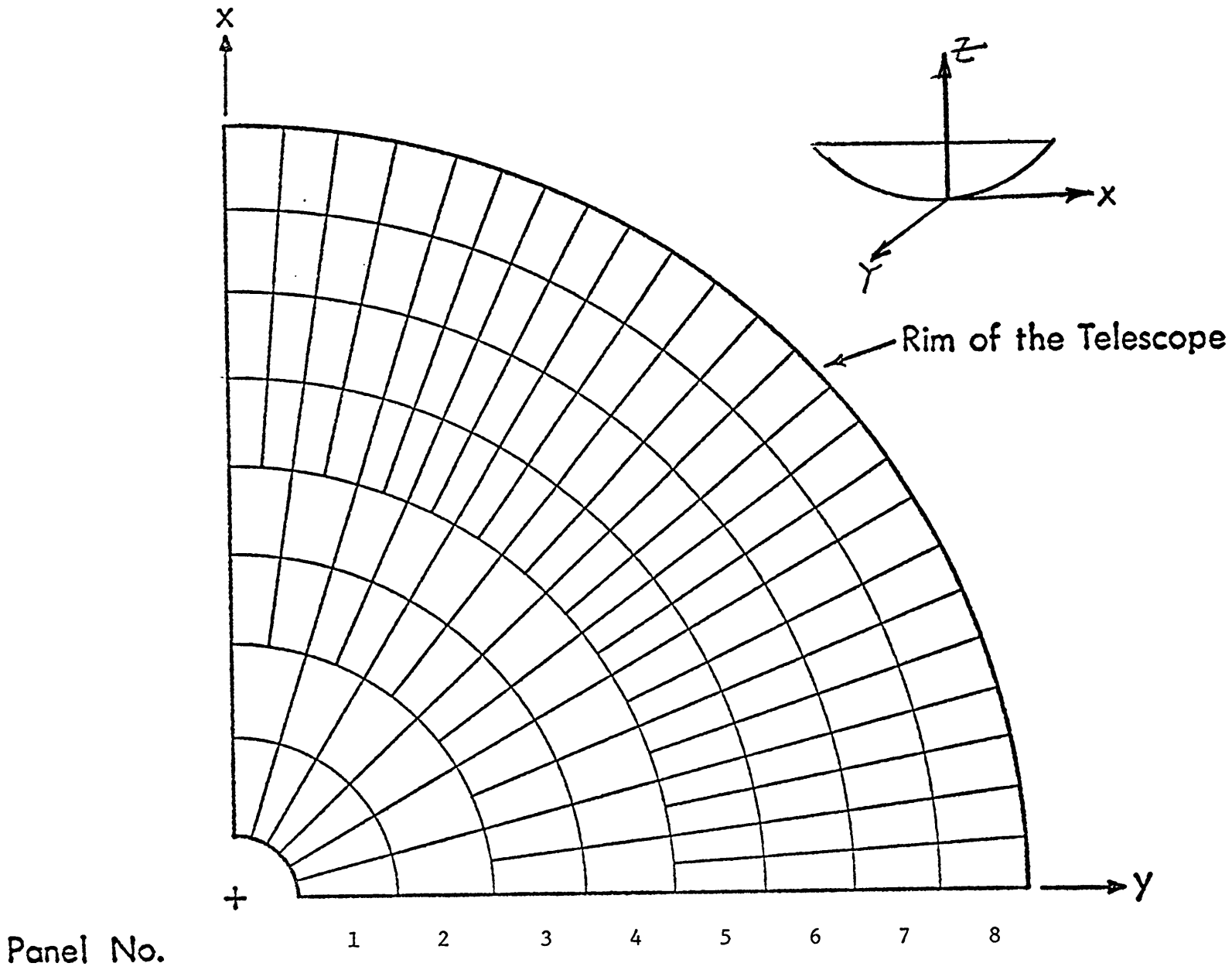
During design, manufacturing, and testing regular letter progress reports shall be issued. Representative of Associated Universities, Inc., will make frequent visits to the manufacturer's facilities for verbal reports and discussion, to observe tests, manufacturing procedures and results and to generally provide input as to what is required.



Sizes and Configurations of Surface Plates

Ring No.	R	A	B	No. Plates
1	107.429	67.605	29.472	24
2	258.227	106.771	67.605	24
3	555.513	72.718	53.386	48
4	700.712	91.722	72.718	48
5	843.008	55.174	45.862	96
6	982.099	64.277	55.174	96
7	1117.793	73.160	64.277	96
8	1249.995	81.811	73.160	96
				528

R, A, and B are dimensions in centimeters.



III.11 Surface plates arrangement on one quarter of the aperture.