



**INAF**

**ISTITUTO DI RADIOASTRONOMIA**

*Via Gobetti 101 - 40129 Bologna*

**Object: “supply of the panels for the primary reflector mirror surface, as part of the Active Surface System, for the parabolic dish 32 meter antenna sited at radio astronomical station in Medicina (BO)”**

**Statement of work + Technical Specification**

**C.I.G. - 84659101F1 # C.U.P. - C56C18000840005**

**Open procedure pursuant to art. 60 of Legislative Decree April 18, 2016, n. 50, and s.m.i.**

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### ACRONIMUS LIST

**QA:** Quality Assurance  
**FAT:** Factory Acceptance Test

### 1. SCOPE

This section of the document defines the scope of work related to the manufacturing and testing of one set of primary reflector panels for the 32-m Medicina Radio Telescope. All work shall be in accordance with the applicable documents specified in Paragraph 2.0 and the requirements of the Statement of Work.

The contractor is to supply all management, design, labor, tooling, materials, drawings, quality control, overseas packaging, and facilities to fulfill this Statement of Work, with the exception of the items shown in Paragraph 4.0 that are supplied by the customer.

The contractor is responsible for all fabrication and shop drawings necessary to transform the provided design drawings. Design tolerances must not be altered.

The manufacturer shall perform the following tasks:

1. Manufacture all panel assembly fixtures and tooling as required to meet all panel specifications.

2. Manufacture all panels.
3. Fabricate or utilize an already available inspection fixture in order to check RMS surface accuracy.
4. Measure RMS surface accuracy of each panel using the above inspection fixture and a system based on digital photogrammetry, having a measure accuracy better than 20  $\mu\text{m}$ .
5. Measure panel dimension and connection locations of each panel.
6. Painting all panels.
7. Package panels for shipment to telescope site (Medicina, (Bologna, Italy)).
8. Shipping, delivery and unload from the trucks of panels to the telescope site (Medicina, (Bologna, Italy)).

## 2. DOCUMENTATION

The following drawings and documents, prepared by the customer INAF-IRA are an integral part of the Statement of Work. :

Dwg - Documents No.	Sheet	Title
SAM-015-001_(G.V.)	1	Primary Reflector Panels General View
SAM-015-002_(A.P.)	1	Primary Reflector Panels Assembly Plant
SAM-015-003_(Zee)	1	Primary Reflector Panels Z-Profiles + Plates
SAM-015-004_(Row1)	1	Primary Reflector Panels Row 1
SAM-015-005_(Row1Sp)	1	Primary Reflector Panels Row 1 Special Type B
SAM-015-006_(Row2)	1	Primary Reflector Panels Row 2
SAM-015-007_(Row3)	1	Primary Reflector Panels Row 3
SAM-015-008_(Row4)	1	Primary Reflector Panels Row 4
SAM-015-009_(Row5)	1	Primary Reflector Panels Row 5
SAM-015-010_(Row5Sp)	1	Primary Reflector Panels Row 5 Special Type B&C
SAM-015-011_(Row5Sp)	1	Primary Reflector Panels Row 5 Special Type D&E
SAM-015-012_(Row6)	1	Primary Reflector Panels Row 6
SAM-015-013_(Row6Sp)	1	Primary Reflector Panels Row 6 Special Type B&C
SAM-015-014_(S.D.)	1	Primary Reflector Panels System Dimension
SAM-015-015_(R.D.)	1	Primary Reflector Panels Real Dimension Inspection
SAM-015-016_(R.D.C)	1	Primary Reflector Panels Attacks Dim. Inspection
SAM-015-017_(P.S.)	1	Panel Support Studs (Reference Only)
p2847_rep1_v2 (FEA Report)		“PARABOLOIDE Ø32m MEDICINA ANALISI NUOVI PANNELLI DEL PRIMARIO VI ANELLO” (In italian language Reference Only)

The drawings listed above have been prepared, by the customer INAF-IRA, taking into account all the structural indications derived from the Finite Element Model of the panel type in row N° 6 (FEA report is attached only for information). Therefore the structural configuration of the panels shown in the drawings cannot be changed, except for the non-structural aspects.

All drawings, prepared by the contractor, related to panels, panel fabrication, manufacturing tooling and installation drawings shall be prepared to good commercial standards. All drawings shall bear the approval signature of the cognizant Customer Representative. No manufacturing shall proceed until contractor's drawings have been approved or revised where applicable.

### **3. DELIVERABLE ITEMS**

The following items (hardware and documents) are to be delivered as part of this scope of work:

1. One complete set of primary reflector panels.
2. One spare panel of each type on the rows
3. Fabrication drawings for each type of panels.
4. Installation drawing showing mark number.
5. Surface Accuracy and Dimensional Inspection report of each panels
6. Quality control record of the panel fabrication.
7. Progress Reports at least every months
8. Packaging and Delivery plan.
9. Materials and Packing lists.
10. One complete set of the panel fabrication fixtures must be keep at manufacturer's facility for a minimum period similar to that offered for "maintenance under warranty" in the technical tender offer.

### **4. CUSTOMER FURNISHED ITEMS**

**NONE**

### **5. QUALITY CONTROL**

All hardware shall be fabricated and inspected according to supplied documentation.

Surface Accuracy, Dimensions and Connection Locations of each panel shall be measured. The surface accuracy of each panel shall be measured as required to achieve at least one reading per 25 square centimeters of surface area. The surface accuracy of each panel shall be as reported on the document at Technical Specifications sections point 2.

QA inspection is required for all phases of the panel fabrication. All QA inspection certificates are to be assembled in one document. A copies of this document shall be presented to the customer at the completion of the contract.

The QA inspection must include at least:

- Materials Certificates, glue included
- Materials surface preparation for bonding
- Bonding process
- Painting process

All panels to have a permanent tag showing part and serial numbers and measured RMS.

## 6. PACKAGING AND SHIPPING

All hardware shall be packaged for shipment to telescope site at Medicina (Bologna, Italy) in non-refundable 40-foot shipping sea containers. The panels shall be packed on edge, secured inside the containers by proper wood blocking material and protected with foam and rubber material to insure safe shipment. Packaging method must be detailed in the technical section of the tender offer and will be presented at design review.

All hardware shall be delivered INCOTERMS© 2020 DDP Medicina (Bologna, Italy) at the contractor's facility\*. **Take into account that also the containers unload from the trucks at telescope site\*, with a proper crane is completely in charge at the contractors.**

### **\* Contractor's facility – Telescope site**

INAF-IRA Radiotelescopio VLBI

Via Fiorentina 3513 – 40059 – Medicina, Bologna – Italy

**PLEASE NOTE:** Take into account that the packaging method must be described in detail in the technical section of the tender offer, because this is one of the "discretionary evaluation criteria" available to the tender commission for a technical evaluation. For further information and details see document "AS\_PannelliPrimario\_DisciplinareGara" chapters 15.3, 16.2 and 17.3. (in Italian only).

## 7. OWNERSHIP

Unless if otherwise noted on the contract, the ownership of all panels hardware shall become the property of the customer (INAF-IRA) at time of the emission of the document "Certificato di Regolare Esecuzione". Panels hardware could be shipped in partial shipments as individual shipping containers are packaged, or as instructed by the customer.

## 8. SCHEDULE

A preliminary concise schedule, where only the fundamental steps of panels manufacturing and delivery are reported, must be detailed in the technical section of the tender offer. The contractor preliminary schedule must take into account and absolutely try to reduce, or to fit at the best, the concise preliminary schedule of the customer here below reported, without any further delay of the schedule end.

**PLEASE NOTE:** Since a reduction of the delivery time with respect to the schedule below reported is one of the "evaluation criteria" available to the tender commission for the technical evaluation, the contractors are strongly suggested, to try to reduce the delivery time. For further information and details see document “AS\_PannelliPrimario\_DisciplinareGara” chapters 15.3, 16.2 and 17.3. (in Italian only).

Milestone	Activity	Start	Finish
M1	Contract execution	T0	
M2	Detailed implementation plan	T0	T0+1
M3	Assembly fixtures and tooling drawings	T0	T0+3
M4	Panels fabrication drawings delivery	T0	T0+4
M5	Fabrication of the fixtures and tooling	T0+3	T0+8
M6	Preparation of prototype panels	T0+5	T0+9
M7	Acquisition and preparation of materials	T0+8	T0+10
M8	Serial production of panels	T0+10	T0+17
M9	Panels painting and packaging	T0+12	T0+18
M10	Transport and delivery to Telescope Site		T0+18

The contractor shall supply the customer, within 4 weeks after awarding of the contract, a complete detailed schedule covering all phases of the panels manufacturing and delivery.

## 9. PAYMENT

The customer will make progress payments, as will be clearly defined on the purchase contract signed by the parts.

As a preliminary information only, not binding, the progress payments could follow this scheme:

- 25% at the completion of the panels fabrication fixture and tooling;
- 25% at the end of prototype panels and acquisition of all the materials for panels serial fabrication;
- 40% at the completion of the FAT;
- 10% after panels delivery at site and emission of the document “Verbale di Verifica di Conformità” from the customer (INAF-IRA).

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## 1. INTRODUCTION

This section of the document describes the requirements for the primary reflector panels including the required engineering tasks and in-plant acceptance test.

## 2. PRIMARY REFLECTOR

Diameter	32080.2 mm
Surface contour	parabolic
Focal length	10210.0 mm
f/D	approx. 0,318
Centre hole dia.	3352.8 mm
Number of panel rings	6
Panel dimensions	refer to drawings from SAM-015-001 to SAM-015-016
Number of panels	240
Gaps between panels	$2.5 \pm 0.5$ mm

The average panel weight of the complete primary reflector shall not exceed **15 Kg/m<sup>2</sup>**.

Each panel will be supported by means of 4 threaded bolts (studs) at the corners.

### 2.1 Panel Surface Fabrication Accuracy

1) Mean Value – Single Panel <sup>(1)</sup>	$\mu \leq \pm 45 \mu\text{m}$
2) Fabrication Accuracy – Single Panel <sup>(2)</sup>	rms ( $\sigma$ ): $\leq 65 \mu\text{m}$
3) Fabrication Accuracy - Total Surface <sup>(3)</sup>	rss ( $\epsilon$ ): $\leq 65 \mu\text{m}$
4) Workshop measurement accuracy	rms: $\leq 20 \mu\text{m}$

<sup>(1)</sup> As computed in section 2.2 expression **(1)**

<sup>(2)</sup> As computed in section 2.2 expression **(2)**

<sup>(3)</sup> As computed in section 2.2 expression **(3)**

Notes:

- 1) The single panel fabrication accuracy mean value ( $\mu$ ) must not exceed  $\pm 45 \mu\text{m}$ . In case of a panel with a greater value, this panel will be accepted only if it fulfil the following requirement: The surface fabrication accuracy ( $\sigma_1$ ), as computed in section 2.2 expression **(4)**, will be  $\leq 79 \mu\text{m}$ .
- 2) The single panel fabrication accuracy rms ( $\sigma$ ) must not exceed  $65 \mu\text{m}$ . For calculation of the single panel rms, some random anomalies can be deleted.
- 3) **PLEASE NOTE:** Take into account that the rss sum of the panels of the complete primary reflector ( $\epsilon$ ), is one of the "evaluation criteria" available to the tender commission for a technical evaluation. For further information and details see document "AS\_PannelliPrimario\_DisciplinareGara" chapters 15.3, 16.2 and 17.3. (in Italian only). The Contractor, in base at your own evaluation, will decide how many microns you can reduce this value in your own offer for the tender.

## 2.2 Surface Accuracy and Panel Dimensions Inspection

The surface accuracy of the panels is to be measured by a digital photogrammetry system. The measurement system is to be accurate to within **20µm RMS**. The surface accuracy of each panel shall be measured achieve at least **one reading per 25 square centimetres of surface area**. The results have to be printed out for each panel and kept as a record.

Each panel has to be tagged with the resulting panel accuracy.

The reflector panels must be verified for surface accuracy (RMS) at the same position they will be on the parabola when mounted at zenith position. **All measurements have to be made relative to the four (4) corner grid points which have to be adjusted so that the measuring system readings for these four (4) points are zero (0).**

The data has to be reduced to **mean  $\mu$**  and **root mean square value (RMS)  $\sigma$** :

$$\text{Where } \mu = \frac{\sum \delta}{N} \quad (1)$$

$$\sigma = \sqrt{\frac{(\sum \delta^2 - N\mu^2)}{(N-1)}} \quad (2)$$

Where N= number of readings

Finally, when all manufactured panels will be measured and the **(RMS) value  $\sigma$**  of each one will be available, the Fabrication Accuracy - Total Surface ( **$\epsilon$** ) shall be computed as reported:

$$\epsilon = \sqrt{\frac{\sum \sigma^2}{Np}} \quad (3)$$

Where Np= number of manufactured and measured panels

For each panel, the **mean value ( $\mu$ )** computed as above at expression (1) must be  $\leq \pm 45\mu\text{m}$ , if some panel anomalies occur, the panel with a mean greater value can be accepted only if it fulfil the following requirement: The surface fabrication accuracy ( **$\sigma_1$** ), as computed below at expression (4), will be  $\leq 79\mu\text{m}$ .

$$\sigma_1 = \sqrt{\frac{\sum \delta^2}{N}} \quad (4)$$

Where N= number of readings

The overall dimensions for all panels have to be inspected and measured as shown on the drawing SAM-015-015\_(RD). All measurements have to be recorded on data sheets.

The panel connection (support mounting hole) locations for all panels have to be verified as shown on the drawing SAM-015-016\_(AD). All measurements have to be recorded on data sheets.

**PLEASE NOTE:** Take into account that the entire surface accuracy measurement process method must be described in detail in the technical section of the tender offer, because this is one of the "discretionary evaluation criteria" available to the tender commission for a technical evaluation. For further information and details see document "AS\_PannelliPrimario\_DisciplinareGara" chapters 15.3, 16.2 and 17.3. (in Italian only).

### 3. PANEL MARKING

The contractor has to supply an erection drawing of the panels with a clear identification marking for each panel. This mark along with the measured surface accuracy ( $\mu$  and  $\sigma$ ) has to be placed on a tag that is permanently attached to each panel.

### 4. LIFETIME

The manufacturing process of the primary reflector panels shall be designed for an operational life of at least 25 years. Refurbishing within this period should be limited to painting or other activities that do not require major disassembly. Such refurbishment shall not be required in intervals shorter than 5 years. Minor paint repair, inspection work, etc. shall be foreseen and performed as part of the normal maintenance.

The contractual warranty of all structural items incl. painting etc. of the primary reflector panels, is 2 years. The mechanical stability and surface accuracy, derived from the manufacturing process, must be designed and guaranteed for an operational life of at least 25 years.

**PLEASE NOTE:** Take into account that the capability of the panels to maintain structural stability and surface performance over the years is one of the "discretionary evaluation criteria" available to the tender commission for a technical evaluation. So a detailed list of previous production orders of panels, with similar manufacturing process method and surface accuracy, must be detailed and described in the technical section of the tender offer. For further information and details see document "AS\_PannelliPrimario\_DisciplinareGara" chapters 15.3, 16.2 and 17.3. (in Italian only).

### 5. MATERIAL

Material certificates must be presented.

#### ZEE AND PLATE PROFILES

Aluminum 6061 - T6 Tensile Yield strength:  $\geq 240$  N/mm<sup>2</sup>  
Ultimate tensile strength:  $\geq 260$  N/mm<sup>2</sup>  
Ultimate shear strength:  $\geq 180$  N/mm<sup>2</sup>

## PANEL SKIN

Aluminum 6061 – T6 Tensile Yield strength:  $\geq 240 \text{ N/mm}^2$   
Ultimate tensile strength:  $\geq 290 \text{ N/mm}^2$   
Ultimate shear strength:  $\geq 180 \text{ N/mm}^2$

Aluminum 6082 - T6 Tensile Yield strength:  $\geq 250 \text{ N/mm}^2$   
Ultimate tensile strength:  $\geq 300 \text{ N/mm}^2$   
Ultimate shear strength:  $\geq 190 \text{ N/mm}^2$

## ADHESIVE

A thixotropic epoxy adhesive must be used for structural bonding of the panels. The Henkel Loctite Structural Adhesives HYSOL EA 9330.5 is strongly recommended.

## 6. PANEL MANUFACTURING

The primary reflector panels manufacturing process must follow the recommendations reported below:

- The panels must be realized in aluminium alloy, only bonded with structural glue. Any roughness on the top surface due to bolts or countersunk rivets is forbidden, with the exception of the 4 attach holes design at panel corners.
- As a surface preparation treatment for structural adhesive bonding, all profiles and sheets in aluminium alloy must be treated by means of phosphoric acid anodizing, as per BAC 5555 specifications, and oven dry. In order to guarantee a good result and avoid that contamination occur on the bonding surface after surface preparations, an automated chemical treatment line must be on the manufacturer's factory facility.
- After chemical treatment, all aluminium alloy profiles and sheets must be stored, for a period no longer than a few days, in a low humidity room until the bonding assembly work will start.
- The panels must be fabricated inside an environmentally controlled room for temperature and humidity.
- The panel under construction must be held for the bonding curing on the assembly fixtures for at least 24 hours at temperature between  $22 \div 25 \text{ }^\circ\text{C}$  and humidity  $\leq 50\%$
- After constructions the panels must be stored inside an environmentally controlled room at temperature between  $22 \div 25 \text{ }^\circ\text{C}$  and humidity  $\leq 50\%$  for a time period no shorter than a week.

**PLEASE NOTE:** Take into account that the entire manufacturing process method, including the surface preparations and gluing, must be described in detail in the technical section of the tender offer, because this is one of the "discretionary evaluation criteria" available to the tender commission for a technical evaluation. For further information and details see document "AS\_PannelliPrimario\_DisciplinareGara" chapters 15.3, 16.2 and 17.3. (in Italian only).

## 7. PAINTING

After the panels have been manufactured and cured and both surface and dimensional accuracy have been checked the panels must be painted.

- The painting specification cycle could be different between the front side (reflector surface) and the back side of the panel
- Before the application of paint the panels must be adequately degreased.

### FRONT SIDE (reflector Surface)

1. Primer coat of "Aquapoxi Green Aluminium Primer" I.N. 283PAJ60, TRIANGLE COATING, INC. – Livermore CA - Dry film thickness of 25÷30 microns
2. Top coat of "GOLDSTONE 7 Series" Low Gloss White, TRIANGLE COATING, INC. – Livermore CA - Dry film thickness of 40÷50 microns

The reported above coating system, foreseen for the front side of the panels, is the only one that it is approved and must be used without any modifications.

### BACK SIDE

1. Primer coat of 2-comp. Epoxy Primer, Colour light grey - Dry film thickness of 50÷60 microns
2. Top coat of 2-comp. aliphatic polyurethane with excellent gloss and colour retention. Colour White RAL 9010 - Dry film thickness of 60÷70 microns  
A paint with the most high percentage of both "Solar Reflectance index" and "Emissivity (Infrared Emittance)" must be preferred and chose.

The full paint process procedures, that will apply on the back side of the panels, must be handed over to the customer with the design report / design review.

**PLEASE NOTE:** Take into account that the painting process method and inspections must be described in detail in the technical section of the tender offer, because this is one of the "discretionary evaluation criteria" available to the tender commission for a technical evaluation. For further information and details see document "AS\_PannelliPrimario\_DisciplinareGara" chapters 15.3, 16.2 and 17.3. (in Italian only).

## 8. ENGINEERING

The scope of delivery includes the following engineering work:

- Detail time schedule for all activities of the job.
- Design and manufacturing drawings, including:
  - Female Templates drawings
  - Manufacturing drawings of each type of panel, including special type
  - Overall layout of complete primary reflector
- FAT (Factory acceptance test) procedure and test records.
- Execution of the FAT, including provision of the measurement equipment, as foreseen at the chapter 9 in the follow.
- Complete Design Documentation, FAT Report, and QA Inspection in electronic format and 1 sets of hard copies.
- At least a Monthly work progress report, in electronic format

## 9. FACTORY ACCEPTANCE TEST (FAT)

- Internal workshop measurements including measurement records of each panel (unpainted) of the primary reflector:
  - Panel Surface Accuracy (RMS)
  - Panel Dimensions as per DWG SAM-015-015\_(R.D.)
  - Panel Attack Locations as per SAM-015-016\_(AH.D.)
- Repeated the measurements above, in attendance of the customer of:
  - 2 panels of rows 1 and 2
  - 4 panels of rows 3, 4, 5 and 6
- Calculation of the RSS value for the complete primary reflector (sum of all panels).

## 10. ATTACHMENT (SEPARATE DELIVERIES)

- Primary Reflector Panels design and panel dimensions inspection; refer to drawing reported at the SOW section of this document, see chapter 2 page 4.
- Primary Reflector Panel ROW 6, FEA Analysis, (document p2847\_rep1\_v2); ; refer to document reported at the SOW section of this document, see chapter 2 page 4.