Introduction
This document describes the specification for the communications tower to be constructed on gently rising ground to the North of national route 40 on the road between San Rafael and El Sosneado in Mendoza province, Argentina. The site is located approximately 60km north-north-east (NNE) of the town of Malargue and the tower forms part of the infrastructure of the Southern Observatory site of the Pierre Auger Project. The tower will be placed adjacent to the Loma Amarillo Fluorescence Detector facility.
Access to the site is excellent – the tower will be located 5km to the north of national route 40 (due north from the position marked as ‘km264’ on route 40). A good road passes from route 40 directly to the site.

1 Tower Specification and Location
Height: 40 meters  
Type: Self supporting (TAS)  
Approximate position: UTM 0480747 6134066  
Actual position is fixed relative to Fluorescence Detector facility  
Altitude: 1455 meters (WSG-84 datum)  
Orientation: One face of the tower should face due South (ie. parallel to due East-West).

2 Ground Plan
Please refer to figures 1 and 2 for details of the orientation and location of the tower with respect to the FD building reference point - which for this purpose is defined as the centre of the rear outer wall of the FD building.

![Diagram of tower and FD building layout]

_Figure 1: Loma Amarillo Tower ground plan within FD building compound_
3 Shelter Building and Internal Equipment

The tower must be provided with a single-storey, 3m x 3m communications shelter building as detailed in figure 2. Plans for this building may follow the general design of the shelter provided at the Pierre Auger project central observatory tower in Malargue. A photograph of this existing shelter building is shown in figure 3 for reference purposes only and should not be used as a literal design. A commercially available ready-made shelter, such as those offered by the EASTEL company, are also acceptable for this application.

Figure 2: Loma Amarillo Tower detailed ground plan

Note the following requirements for the shelter building:

1. The shelter building must have a 1-meter wide door in the centre of the north-eastern wall.

2. An aperture for a cable entry panel in the centre of the south-western wall is required. This aperture should be adjacent to the cable bridge and its centre should be at a height of 2.6 meters above ground level. The entry port that will be used is Andrew Corp part number 204673-12. Details of the dimensions are given in the figure 4. The wall aperture for the entry panel should be 25 x 25 inches and the aperture should be lined with a 2-inch wide wooden frame that is level with the outer edge of the wall. This will permit the entry panel to be screwed to the wood.

3. The shelter must be equipped with lighting, power outlets and an automatic heating and cooling system that is capable of keeping the internal temperature of the shelter between +5 deg C and +30 deg C. The power dissipation of the equipment within the shelter is not expected to exceed 1kWatt.
4. The shelter must be equipped with an internal grounding cage using 50mm sq. copper.

5. The shelter must be equipped with a wall-mounted fire extinguisher suitable for electrical fires.

6. Facilities must be provided for a buried cable tunnel to pass between the shelter and the main FD building. This cable tunnel must have 2 bores of at least 4inches diameter.

Figure 3: Example of Shelter Building
4 Antenna Mounts

The tower must be able to support a total of 8 ‘cellular-style’ panel antennas. These antennas are 3 metres in height by 0.3 meters in width. In addition, the tower must accommodate up to 2 parabolic antennas of 1.5 meters diameter. The required pipe-mount structure is shown in figures 5(a) and (b) with a detailed drawing of each section shown in figures 6(a) and (b). The orientation of the antenna mounts with respect to the tower is shown in figure 5(b) and figure 7. Note that 2 sets of antenna mounts (each of 4 pipes) are required on the Southern face of the tower, and 1 set of mounts (with 3 pipes) is required on the North-Western face (Set ‘3’). The North-Western-facing pipe mounts must be positioned at the same height as the upper set on the Southern face (38.5 metres). Note that an increased pipe spacing of 1.2m and a pipe diameter of 110mm is specified for Set 3.

The tower and antenna mounts should have a minimum survival wind-speed of 200 km/h when carrying the antennas listed above.

Important Note: In order to ensure the long-term safety of the antenna mounts, all brackets associated with the antenna mounts must be fitted with double nuts and the vertical pipes must be fitted with welded anti-torpedo safety rings or clamps.
Figure 5(a): Antenna Pipe Mounts : Sets 1 and 2 (Southern Face)
Figure 5(b) : Antenna Pipe Mounts : Set 3 (North-Western Face)
Figure 6(a): Antenna Pipe Mounts Detail : Sets 1 and 2 (90mm Tubes)

Figure 6(b): Antenna Pipe Mounts Detail : Set 3  NOTE 110mm Tube Diameter
The tower must be equipped with a vertical cable ladder, (also known as a ‘feeder ladder’), to support the cables to the antennas. This cable ladder must be provided with specially drilled horizontal members in order to receive the cable clips that will be used. Figure 8 shows the spacing between the horizontal supports of the ladder and figure 9 shows the detailed drilling pattern for one of the horizontal supports. Figure 10 shows the vertical support detail and figure 11 shows the required depth of concrete foundation for the ladder to rest on. The ladder must be securely attached to the centre of the north-eastern face of the tower as shown in figure 7.

Particular attention is drawn to the thickness of the horizontal supports of the cable ladder (figure 9). Please note that the maximum permissible thickness of material for the horizontal members is 3.2mm (1/8th inch) as any increase above this thickness causes problems with the installation of the cable clips that pass through the 19mm holes.
**Figure 8: Cable Ladder Horizontal Support Spacing**

12 holes Ø19.0mm spaced 80.0mm

Material: 3mm Hot-Dip Galvanised Tower Steel

**Figure 9: Cable Ladder Horizontal Support Detail**
Figure 10: Cable Ladder Vertical Support Detail

Figure 11: Cable Ladder Foundations
6 Cable Bridge / Ice Shield

A horizontal covered Cable Bridge/Ice Shield is required to run between the vertical Cable Ladder on the tower and the Cable Entry Panel of the Shelter building. This bridge serves to support the weight of the cables and to protect them from damage from falling ice. The orientation of the cable bridge with respect to the tower is shown in figure 7. Figure 12 shows the required specification for a suitable design. Note that the Cable Bridge is an important part of the tower cabling system and must have the following specification:-

1. An overall height of 3 meters minimum.

2. An overall width of 1.5 meters minimum.

3. A length, suitable to pass between the tower and shelter with no large gaps in the overhead coverage. It is permissible for the Ice Shield to overhang the roof of the shelter. The gap between the ice shield and the cable ladder on the tower must be adjustable to permit the passage of the cables from vertical to horizontal past the ice shield. A typical spacing of 10 cm is suitable.

4. The Cable Bridge must have 3 cable support sections at horizontal distances as per figure 12. Refer to figure 9 for an example.

5. Each cable support section must have 3 horizontal supports, each support must have adjustable height and must be at least 0.8 meters long and punched with a series of 19mm diameter holes at a spacing of 80mm between holes. These holes are intended to take cable clips in an identical manner to the cable ladder, please refer to figures 8 and 9 for further information.

6. The roof of the Ice Shield may be angled to allow snow to slide off. However, this is not essential and a flat roof is preferable.

7. The objective of the cable supports is that they should align the cables horizontally with the cable entry panel in the centre of the south-western wall of the shelter. The aperture for this panel should be adjacent to the cable bridge and its centre should be at a height of 2.6 meters above the level of the top of the concrete base of the shelter building.
Figure 12: A suitable Ice-Shield design
7 Tower and Shelter Grounding System

The tower and shelter require a buried double-ring grounding system as shown in figure 14. The grounding loops must remain at least 1 meter away from the concrete of the tower foundations wherever possible. Several grounding spikes (Javelins) must be provided as shown in figure 13 with detail in figure 14. At each position where cables and/or ground spikes are joined, an inspection hatch must be provided. All inspection hatches must be provided with iron covers.

![Figure 13: Tower Grounding Scheme](image)

The ground conductivity at Loma Amarillo has been found to be of poor quality. Consequently it is necessary to use high conductivity ‘Bentonite’ soil surrounding all of the underground copper cables and grounding spikes. Figure 14 illustrates the method that must be used.
Grounding Spike Detail

Figure 14: Grounding Spike, Inspection Hatch and Bentonite Detail
8 Lightning Rod and Lightning Conductor

The tower must be provided with a lightning rod at the top of the tower as per figure 5. The lightning rod should be connected to a 50mm sq. cross-section vertical lightning conductor. The lightning conductor must be connected to a grounding stake that is bonded to the tower grounding ring system as shown in figure 13.

9 Tower Working and Rest Platforms

Three working platforms must be provided at the heights given below. The working platforms must consist of a steel mesh floor extending to the inside edges of the tower on all three sides, as shown in figure 7. A single small rest platform must also be provided at a height of 15 meters and should have a minimum size of 1.2 meters by 0.5 meters. The platforms should be located at the following heights:

1. one full working platform at 39 meters height.
2. one full working platform at 37 meters height.
3. one full working platform at 32.5 meters height.
4. one small rest platform at 15 meters height.

10 Tower Safety ladder

An enclosed safety ladder must be provided extending to 40 meters height. This ladder must be located inside the tower.

11 Tower Exterior painting

The tower must be painted with regulated exterior red-white tower colour scheme.

12 Tower Nocturnal Lighting

The tower must be provided with automatic night lighting in accordance with local statutes and regulations.

13 Fence

The tower and shelter are located inside the FD building compound which is protected by a 2 meter high security fence. However, a 1 meter high safety fence must also be provided around the tower and shelter to prevent unauthorised personnel approaching the tower. This is required to protect people from the danger of ice falling from the tower. Details of the dimensions of the fence may be obtained from Figure 2. The fence must be earth bonded to the main tower grounding ring at any 2 opposite corners.

14 Inspections during Construction

The following inspections must be carried out by representatives of the Pierre Auger Collaboration during construction, to ensure that the relevant specifications are being met.
1. Inspection of the tower foundation reinforcing steel-work before the concrete is poured.

2. Inspection of the grounding system trenches, grounding stakes and cables before the trenches are filled with Bentonite.

3. Inspection of the grounding system trenches after the trenches are filled with Bentonite, but before they are covered with normal top-soil.

4. Final acceptance inspection of the tower and shelter structures including antenna mounts, cable ladder, cable bridge and entry panel aperture.

15 Other Items
Any quotation offered must also include the following items:

1. Soil quality survey
2. Delivery of the tower and antenna mounts to the site
3. Erection of the tower and fitting of the antenna mounts
4. Foundations for the tower, including grounding loops and stakes
5. Foundations and platform for the shelter building

16 Important Note on Variations
Please note that this document describes in detail the specification for the Loma Amarillo communications tower and shelter. No variations or deviations from this specification will be acceptable to the Pierre Auger observatory without the prior written consent of an authorised member of the Auger project team.