



**Brian Thompson and Aaron Clarke, Matrix Applied Technologies, USA,** explain why it is important to eliminate surprises when selecting a geodesic aluminium dome roof.

# COMPARING APPLES TO APPLES

**G**eodesic domes have been perfected by architects since the turn of the 20<sup>th</sup> Century, now standing as some of the most inspiring structures in the world. In the past 40 years, this iconic form has given rise to the geodesic aluminium dome roof (ADR), which is fast becoming the norm in the energy industry for use on new-build petroleum tanks and retrofits to meet changes in environmental standards and other regulations.

Every ADR manufacturer has its own design preferences. As such, buyers should take a structured approach to bid evaluation to help ensure that they select the ADR that provides the best value for a particular project.

It all comes down to asking the right questions and knowing what to look for to ensure an 'apples to apples' comparison or, if the bids do not allow such comparison, factoring in the differences.

## **Breaking down the bid**

When evaluating competing bids for ADRs, buyers naturally look for the best value possible. That said, a multitude of elements need to be



**Figure 1.** Pre-engineered modules decrease installation time, reduce leak potential, minimise ongoing maintenance costs, and maximise asset longevity.

considered. To ensure that the ADR meets expectations while avoiding project impacts, such as unforeseen delays or high cost surprises, each bid should be thoroughly evaluated point by point.

### Vendor validation

When validating a vendor, be sure to look beyond its years in business to those who have drawn on engineering and innovation to provide a product solution that starts with ease of installation and provides engineered solutions to historically challenging issues, such as water and vapour leakage, custom requests, or structure stability under extreme conditions. Buyers should also ensure vendor-specific parts and assemblies that may be needed will be available.

### Structure and design

A vendor's ADR structure specifications can have a large impact on project cost. For example, if an integral tension ring has not been included, a fixed type of support with a steel tension ring will need to be installed on the tank shell. The ADR proposal will be less costly without an integral tension ring. However, the buyer is still exposed to additional costs, either after the fact through a change order or by reinforcing the tank shell.

Roof attachment points may incorporate a slide bearing with low-friction pads to minimise the horizontal radial forces transferred to the tank. As an alternative, the roof may be attached directly to the tank if the top of the tank is designed to sustain the horizontal thrust transferred from the roof. In general, there is no defined advantage between one or the other. Furthermore, it is easier to retrofit an existing tank with an ADR that includes an integral tension ring, which in turn can save on installation costs.

For new tank builds, this is simply a preference. However, for gas tight or vapour tight domes, a fixed type dome with tension ring installed on the tank shell will provide an improved gas tight design. This eliminates the need for fabric due to thermal expansion and contraction differences between a steel tank and aluminium dome.

Other structure and design questions to be considered include the following:

#### *Has consideration been made for the addition of a suspended internal floating roof (IFR)?*

Suspending an aluminium IFR from a dome is a great way to increase tank capacity and reduce the need for workers to enter the tank. This can, in turn, improve safety by minimising confined space risks. If adding a suspended IFR is a possibility at a later date, one should consider purchasing a dome that includes suspension assembly points. The dome gussets and hub connection points will have a relatively small cost impact and will be outweighed by ease of switching to suspended IFR and increased tank capacity.

#### *What type of struts are being used, and what is the impact to cost?*

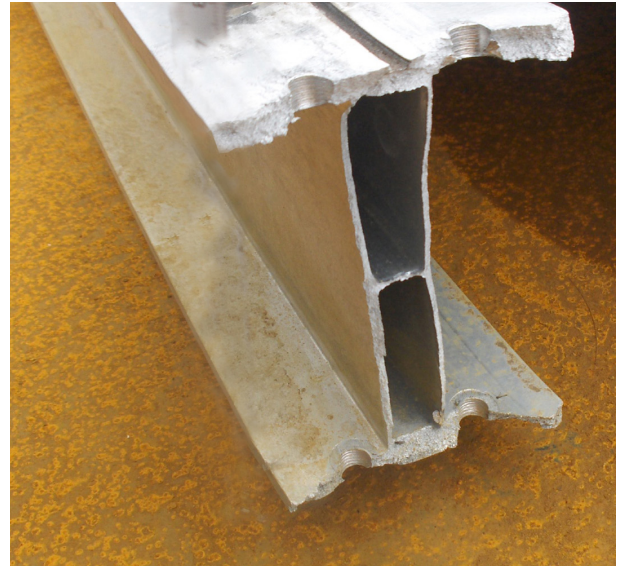
There are multiple configuration of struts currently on the market. These are typically custom extrusions similar to an I-Beam and will include single- or double-webbed sections with top and bottom flanges. When designed, engineers take into account both the required strength to carry the design loads and weight-to-strength ratio. That being said, different levels of material efficiencies exist, which will impact cost.

#### *From a design perspective, is the ADR considered low profile or standard?*

Typically, the height of a dome is around 16% of the tank diameter. This is the most popular design offered in the market. Another option, when required, is a low profile dome. This dome is usually requested when there is a total height restriction in the area, and is typically more expensive, such as near an airport or community worried about optics or appearances.

#### *Is the ADR free vented or gas tight?*

Gas tight domes are more expensive due to the larger load requirements, which increase material use. For gas tight or vapour tight domes, a fixed type dome with tension ring installed on the tank shell will provide an improved gas tight design.



**Figure 2.** Full consideration of local regulations with the dome's custom configuration regarding the geographic location can ensure the aluminium dome roof will withstand environmental conditions; not doing so can be catastrophic.

*Consider dome lifting options based on available laydown area at the project site.*

Preliminary discussions with a vendor about lifting options can reduce overall project time by addressing design and installation conflicts upfront. The dome lifting style can affect installation time and equipment cost (e.g. crane vs grip hoist). A vendor should be able to provide guidance in choosing a method that best suits a buyer's needs.

*Ask for specific information about water or vapour leak resistance.*

Look for innovative design features that eliminate or reduce this potential. Ensure the dome is not dependent upon heavy application of silicone sealant. When large amounts of silicone are applied in an effort to seal the ends of the battens and the hub covers, long-term exposure to light, temperature and humidity can cause the sealant to fail. Conversely, if well-designed, the top of the panels and battens are flush, which fixes the main dome leak point: the hubs. Any applied silicone should then be tucked primarily beneath the hub cover, protecting the sealant from damaging elements. Additionally, designs that do not have grooves and lips limit the number of areas for water to pool.

*Does the estimate include pre-engineered modules, such as the bird screen, skylight, and inspection hatches, or is it dependent upon on-site/field assembly?*

If the panel is precision engineered and pre-cut at the factory with welded/sealed curbs, these modules can be attached to the pre-cut panels to ensure no leak points are created during installation. This method also decreases the required installation time. Alternatively, on-site panels cut to suit accessories are field assembled, however, extra field time will be required and, if not properly executed, the dome is at greater risk for leaking and continued maintenance.



**Figure 3.** Aluminium dome roofs could provide additional safety features compared to other alternatives including fire protection, protection from unauthorised access, and improved emission controls.

### Design loads

The design loads supplied on a quote should be compared with local regulations, as well as other competing bids. Some companies may only choose to meet the regulations and not give full consideration to the dome's custom configuration for the geographic location. When properly designed, these configurations ensure the dome can withstand environmental conditions at the build location. Critical design loads to consider when comparing bids include: live, wind, snow, seismicity, and internal and environmental pressures. The results of not doing so can be catastrophic.

Based on applicable regulations and vendor preferences, different factors of safety can be applied, which can affect the overall price and life span of the ADR. A good indicator is the dome weight, which correlates with the dome strut sizing or beam height, width and thickness.

## Material specifications

Has the vendor provided specific data on the panel sheeting, material finish, struts and gussets, gaskets, sealants, and hardware. Additionally, have they supplied supporting documentation?

It is important to ensure that these elements meet applicable industry standards. By not following industry standard material choices, owner/operators or engineering, procurement and construction (EPC) companies risk dome longevity due to failing gaskets, sealants, chemical compatibility issues and even structure under extreme conditions. For example, if an ADR is not designed for heavy uneven snow loads in a geographic area that experiences such events, the result could be a total loss of the dome.

## Accessories

Dome suppliers offer a number of accessories, including inspection hatches, skylights, gauging platforms, radial walkways, rolling ladder connections, roof nozzles, IFR suspension systems, entry manholes, and sprinkler support systems, to name a few.

When comparing bids, it is essential to ask whether these accessories are included and which are pre-engineered for a more custom fit. Consider pre-engineered walkways and platforms designed to meet the operation's needs; doing so can reduce installation time and the need for skilled labour on-site. A buyer should also ask about potential future tank enhancements and the ability to retrofit accessories to meet changing needs.

## Indirect costs

Other indirect costs can have a significant impact on the bottom line, so it is important to determine whether

these items are included in the package price. Among them are installation, vendor supervision, shipping, lead time, equipment, design revisions and warranty.

It is also important to learn about the requirements for lay down area and whether the dome will be built inside or outside of the tank, which, as mentioned earlier, can impact the equipment needed to lift the dome. In some instances where the dome will be assembled on an existing external floating roof, the assembly location makes installation more complex. Additional structural supports and calculations may need to be considered.


Finally, ask about required lead time. The further ahead of schedule these client decisions are made, the more opportunity there is to reduce overall project cost. For example, maximising lead time can reduce shipping costs and ensure labour resources are not wasted due to delays or complications in receipt of materials.

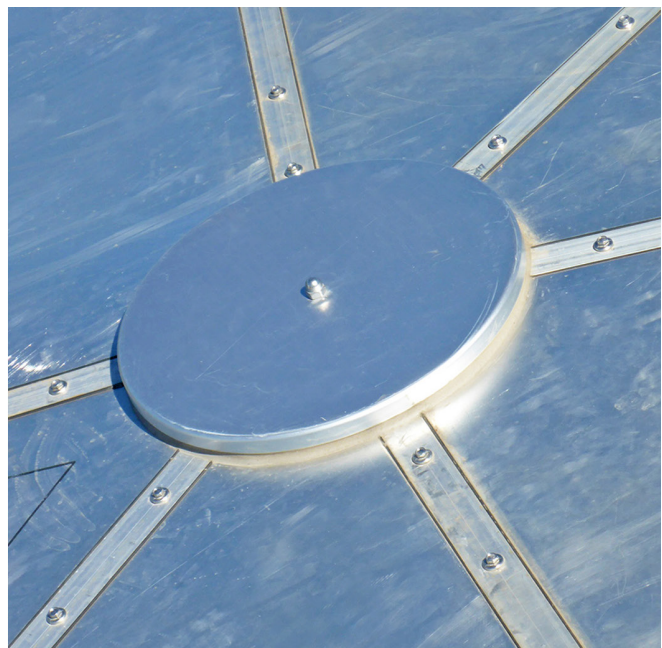
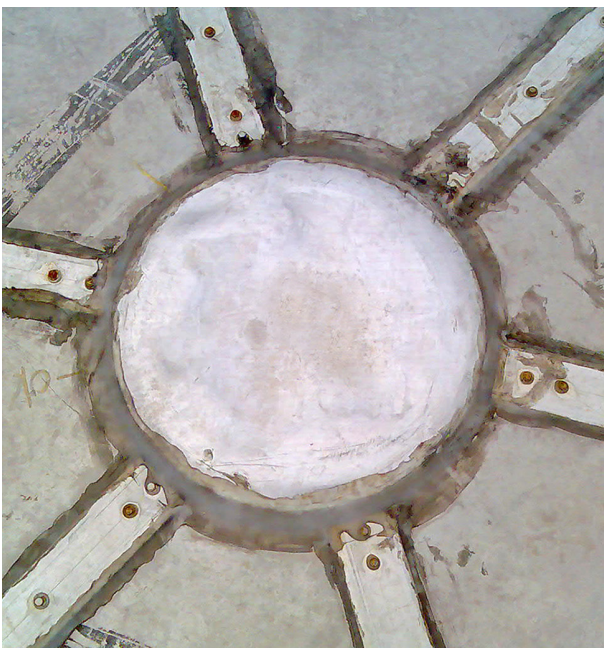
## Codes and regulations

Compliance with governing codes and regulations is an area that, when overlooked, could be costly. The bid request should identify all codes and regulations applicable to a project. Proposing vendors should also validate compliance during evaluation.

Even in the instances where API compliance may not be required, given the years of expertise that have led to the standard's development, it is prudent to follow their lead.

## Conclusion

Buyers should take the time to evaluate each of these areas. It is this kind of 'apples to apples' comparison that will not only help eliminate surprises and hidden costs, but ensure a clear understanding of the short- and long-term value each vendor has to offer. 



**Figure 4.** Designs that require heavy application of sealants may require ongoing maintenance, where innovative design features can eliminate or minimise leaks and reduce lifecycle maintenance.