

Solar Module Logistics

Current Packaging Methodologies & Considerations



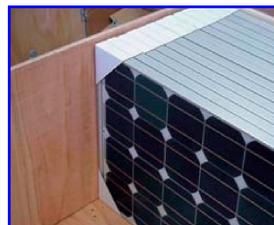
MATERIALS

- Solar modules are likely produced in an area geographically distant from their destination.
- Packaging materials known to produce good results in one part of the world may be unavailable or overly expensive in another part of the world.
- Ability to use multiple or different materials that both result in acceptable package performance characteristics is critical to a globally integrated supplier of solar modules.



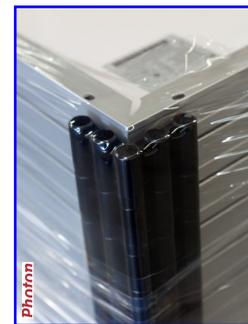
MODULE ORIENTATION

- Because of their large and flat structure, solar modules have very different response characteristics to mechanical vibration depending on the orientation of the module during excitation, that is, transportation.
- Example, module natural frequency in the z-axis is normally in the 15 Hz range which is precisely where input from truck vehicles is most severe.
- Changing the orientation for shipment to the X or Y axes may be justifiable based on product protection.



PRODUCT PROTECTION

- This is a **primary function** of the package system.
- A distribution environment is the most mechanically severe environment the product will experience during its entire lifecycle.
- The purpose of the package is to efficiently protect the product and prevent damage during this time.



INSTALLATION CONSIDERATIONS

- Without careful considerations of the requirements of the installation sites, a properly manufactured and delivered solar module may suffer damage during installation that can easily be avoided.
- Considerations include:
 - Ability to remove modules easily from a package system.
 - Ability to deliver modules to a job site in a pallet load configuration.
 - Removing waste materials easily from the job site.
 - Possibility of reverse logistics with reusable packaging.



COST EFFICIENCY

- Because of the size of typical solar modules relative to the size of distribution vehicles, the actual dimensions of the module has a great deal to do with the overall distribution costs and therefore of logistics.
- Products that are sized to be efficient in the distribution environment are far less costly to deliver than the same products that have lower efficiency in distribution.



RELIABILITY AND LONGEVITY

- The distribution environment is the most **mechanically active** environment that the product will likely experience during its entire lifecycle.
- Product ruggedness and the associated longevity of the product is highly dependent on isolating it from forces that are above its design.
- The packaging system must be designed to increase module reliability and longevity.



LOGISTICS

- The single largest identifiable cost of a delivered solar module anywhere in the world is the logistics necessary to get it from the point of its production to its ultimate destination.
- Without control of logistics, a module manufacturer does not have control of major product costs.
- Packaging is one of the single largest components of logistic costs.

