

Remote Infrared Heating of the External Tank



ET Ice
Mitigation

One of the Space Shuttle Program return-to-flight objectives was to develop ice mitigation techniques that could be performed on launch day to reduce or eliminate ice on the Space External Tank (ET). In response, ASRC Aerospace was asked to design a system employing an array of infrared projection assemblies (IPAs), consisting of halogen light bulbs, parabolas, and bulb reflectors, to heat the surface of the ET. The intent was to raise the surface temperature of a local specific area of the tank as closely as possible to the ambient air temperature to prevent condensation, which may result in frost or ice.

Figure 1 shows a potential location of the skid containing the 12 IPAs. The skid is designed to withstand the launch environment and to minimize potential foreign-object debris (FOD) projectiles that could damage surrounding facilities and ground support equipment.

The IPA (Figure 2) was designed to allow 20 degrees of adjustment in the vertical direction and 360 degrees of adjustment about the horizontal. It was intended to provide the adjustability to point the IPAs at their final target in the field manually. There are self-containment features in the design to minimize the chance of creating FOD. The bulb, parabola, and reflector work together to direct the infrared (IR) radiation onto the designated ET target. The bulb adjustment mechanism controls the focus to achieve uniform light intensity over a specific diameter. The respective alignment of the bulb, reflector, and parabola is critical to determining the amount of IR radiation that can be projected.

The IR projection system can deliver heat by means of light and/or IR radiation to mitigate the formation of condensation on the ET foam at the ET liquid-oxygen feed

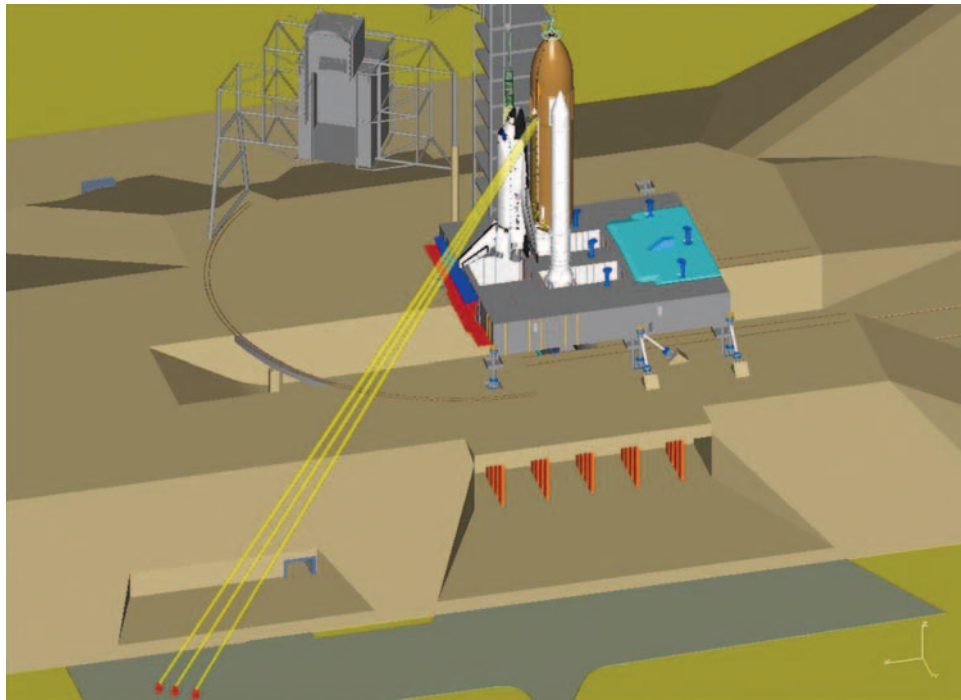


Figure 1. Proposed installation of infrared projector system at Space Shuttle launch pad.

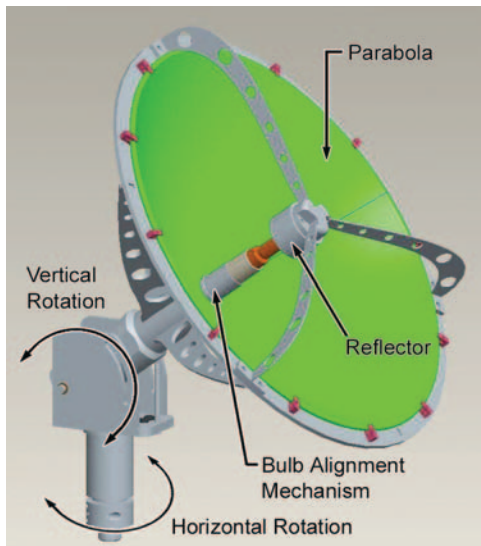


Figure 2. Details of a single projector.



Figure 3. Complete system ready for delivery to launch pad.

line bellows and bracket area. The system provides ice mitigation service to within 15 minutes of T-0. The system delivers 330 W/m^2 (approximately $1/3$ solar) of evenly distributed IR energy in a minimum 10-ft-diameter circle at a distance of 380 ft during normal operation. The system does not exceed 550 W/m^2 (approximately $1/2$ solar) of evenly distributed IR energy in a minimum 10-ft-diameter circle at a distance of 380 ft during normal operation. This sacrificial system is required to operate only once in the launch environment (permanent damage acceptable).

Key accomplishments:

- A prototype halogen-light parabola/reflector system was designed using software programs (see "Ray Trace Math Model and Windows Software Implementation for a Focused Infrared Lamp Projection System") to optimize the amount of IR radiation that can be generated from off-the-shelf components.
- The light filament and parabola of each operational IPA was aligned and tested at 380 ft to obtain the maximum IR radiation from each unit (Figure 2).
- The final configuration (Figure 3) consisted of 12 custom 3-ft parabolas mounted on a skid with a power supply system. Persistent polishing of the parabola reflecting surface was required to meet focusing specifications. The complete system was delivered to United Space Alliance.

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