Evaluation Criteria 3

There are three principal performance criteria that the power source used for the Burnt Mountain Observatory must meet: high reliability, safe and environmentally benign operation, and reasonable life-cycle cost. An overview of these evaluation criteria is presented in this chapter, and the discussion of radioisotope thermoelectric generators (RTGs), propane-fueled thermoelectric generators (TEGs), and photovoltaic (PV) systems and their ability to meet these requirements appears in subsequent chapters. The reliability and cost characteristics of the power systems are assessed in chapter 4; the safety and environmental characteristics are examined in chapter 5.

RELIABILITY

The importance of the Burnt Mountain station's mission and the difficult access to the site require that the monitoring and communications equipment and their power sources be very reliable. It was this need for high reliability that led to the use of RTGs as the power source for the site in the first place. The reliability of RTGs derives from their lack of moving parts and their ability to provide continuous power over a very long period without refueling. The RTGs at Burnt Mountain have all been in service at the station for over eight years and could conceivably power the seismic sensing equipment for another 15 to 25 years (see table 2-1). In addition, RTGs require little maintenance.

Though a highly reliable power system is certainly very important and very desirable, a certain risk of power outages can be tolerated. The station collects and transmits signals from five seismic devices. Loss of one of the five signals should not deteriorate the data signal a great deal, and probably can be endured for a short time. As mentioned earlier, the Air Force has considered letting one of the signals cut off permanently as a means of extending the life of the station.[1] This indicates some

[1] Col. Terry A. Schmidt, Technical operations Division, McClellan Air Force Base, letter to the Air Force Technical Applications Center on the status of Burnt Mountain radioisotope thermoelectric generators, 1992.

willingness to accept a slightly degraded signal caused by a power problem, but new Comprehensive Test Ban Treaty mission requirements (described in chapter 2) may force a revision of the data requirements toward higher reliability. Note, however, that the system powering the communications equipment must meet a higher standard of reliability than the other power systems at the station. An outage at the communications link means the loss of all five of the signals, not just one.

When considering alternative power technologies, the need for high reliability puts a high premium on proven technologies. The field experience of technologies in Arctic conditions is of great importance in establishing their reliability.

SAFETY AND ENVIRONMENT

The safety and environmental characteristics of the RTGs and alternative power systems for the Burnt Mountain Seismic Observatory are of paramount importance. They were the major impetus for this study. Risks to the local population and to Air Force personnel that maintain the station are both of concern. The principal safety and environmental risks of the power systems under consideration stem from:

. exposure to radioactive material (Strontium-90) from RTGs,
. fires and/or explosions connected with propane from TEGs, and
. exposure to toxic fumes and heavy metals from the batteries in PV systems.

Each of the power systems would no doubt be designed to keep the risks associated with these events low. However, the safety and environmental risks would not be eliminated; small risks would remain. The level of risk that can be attained is primarily a question of engineering and economics. The level of risk that can be tolerated is determined socially and politically.

COST

One of the most important determinants of cost is the configuration of the power sources. In a distributed configuration, each remote terminal (RT) has its own power source. In a central configuration, there is one main power source and the power is transmitted to the RTs via cable. Because of power losses in the transmission stage, the generator in a centralized system must beat least 50 percent larger than the sum of those in a distributed system.

The present energy system at Burnt Mountain uses a distributed configuration, with two generators located at each of the five monitoring/communications sites of the station. A centralized power system for the observatory, presumably located near the remote operating facility (ROF), would require a network to distribute power to the five RT sites. Transmission cables could be strung along the rights-of-way already established for the data cables, either surface laid or buried. The Air Force study recommends that if a centralized system were implemented, the power be transmitted at 120V direct current (DC) to minimize resistive losses. Even so, there would be significant losses associated with stepping the voltage up to 120V and then stepping it back down after transmission. The voltage conversion at each end is on the order of 75 percent efficient. The Air Force is investigating more efficient conversion technologies for this application.

The principal constraints on the operation of power sources are the site's climate and remoteness and its lack of sunlight in the winter. The remoteness and the inclement weather make maintenance of the site costly. There is a premium placed on keeping site visits, especially those with large cargo (e.g., fuel or batteries), to a minimum. This is not only for cost reasons but also for safety reasons. The difficult y of transport also makes extensive construction of power system apparatus at the site very costly.