EMFI Government Field Program
August 8 – 13, 2011

Trip Summary

The 2011 EMFI Government Field Program began on Monday, August 8, with an orientation breakfast at the Hotel Monaco in Denver, Colorado. **Gary Baughman**, Director of the EMFI and of the Office of Special Programs and Continuing Education at the ***Colorado School of Mines***, introduced the EMFI staff **-- Dixie Termin, Tim O'Leary, Tom Sladek, Jim Burnell,** and **Paul Quinn --** and reviewed the "rules of the road."

The participants introduced themselves and identified their respective affiliations. Some represented offices in the legislative and executive branches of the federal government, and some represented State agencies of Colorado. Dr. Baughman then provided an overview of various operational details of the trip, ranging from the importance of punctuality and attendance at all scheduled activities, to the use of the communicators and EMFI's proprietary "All-a-Board" device, to the ban on cell phone use during instructional portions of the trip. The final introduction of the morning was **John Akers,** the bus driver from Gray Line Tours, in whose hands we placed our lives and limbs for much of the remainder of the trip.

The tour began with a presentation on energy production and use in Colorado by **Stacey Simms**, Associate Director of Programs at the ***Colorado Governor's Energy Office.*** Stacey discussed how Colorado's coal mines, petroleum fields, wind farms, solar arrays, and biofuel plants deliver energy to the state's five million people, plus a substantial surplus for export to other states. The State is committed to increasing the importance of renewable resources in Colorado's energy mix, and the Energy Office has many programs underway to facilitate that increase. Last year, for example, the Office released the *2010 Colorado Utilities Report*, which documents the generation resources, operating data, and governance structure of Colorado's 65 electric and gas utilities.

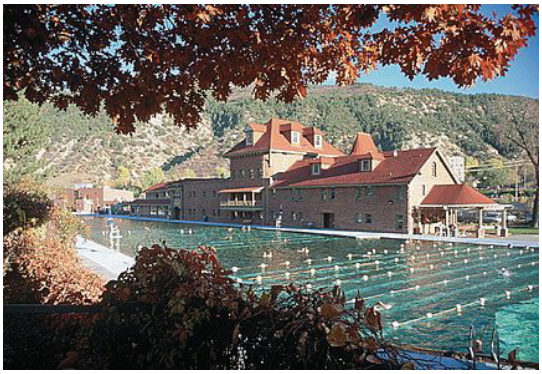
A short walk took us to the Denver headquarters of ***Xcel Energy Inc.***, for a tour of Xcel's dispatch center. Our guides were **Michael Boughner** and **James Dominick** who work on generation control, dispatch, trading, and market operations for Xcel's service area, which includes many of the densely populated portions of Colorado. The dispatch center, which resembles a trading floor on Wall Street, plays a crucial role in the utility's operations. The staff monitors forecasts of temperature, wind, and precipitation and attempt to satisfy predicted demands for electricity with supplies from power plants, energy storage facilities, and the interconnected power pools, such as the Western Area Power Administration. The increasing importance of wind power and solar energy has presented some challenges, because the output from the renewable energy facilities can vary substantially with time of day and season. Xcel compensates for this variability, in part, by using energy storage facilities (such as the Cabin Creek pumped hydro project near Georgetown) and peaking plants (such as the Rifle Generating Station in Rifle).

These plants can respond rapidly to changes in power demand. Rifle Station, for example, can go from zero output to full load in only a few minutes. The response of Cabin Creek is almost instantaneous.

Vestas Wind Turbines -
Nacelles on towers behind blades

We then boarded our Big Red Bus and drove 25 miles north for a tour of a wind machine factory near Brighton. Our host was **Susan Innes,** Senior Manager of State Government Relations for ***Vestas Americas***. Danish-based Vestas is one of the world's largest producers of wind turbines and developers of wind energy projects. Vestas has nearly 22,000 employees and has installed more than 43,000 wind turbines in 66 countries, including 11,435 machines in the United States. Vestas has invested about $680 million in its four Colorado plants, which employ about 2,450 people. Plants in Brighton and Windsor manufacture blades, and a plant in Pueblo makes towers. The Brighton plant we visited makes nacelles – housings that sit atop towers and contain the equipment that converts the mechanical energy of the rotating blades into electricity. The factory assembles about 1,400 nacelles per year from components procured from more than 30 states.

We then drove west on I-70, through the Eisenhower Tunnel, past the ski areas of Summit and Eagle counties, and through splendid Glenwood Canyon to Glenwood Springs. Jim Burnell introduced the participants to the geology of this portion of the Rocky Mountain region and commented on the importance of geology to construction of roads and tunnels, the natural hazards of the area, and the methods for dealing with landslides, rock slides, and floods. An informal group dinner was held at the Glenwood Springs Adventure Park, and we spent the night at the Hot Springs Lodge.



Glenwood's Hot Springs Pool,
viewed from Hot Springs Lodge

Tuesday August 9 began early with a presentation over breakfast by **Duane Zavadil** of ***Bill Barrett Corporation***. Duane discussed his company's tight gas sands development activities along the Colorado River west of Glenwood and explained the directional drilling technology being used. Directional drilling allows the completion of numerous wells from a single drilling pad and is allowed (or dictated) by the complex lens-shaped gas reservoirs. He also discussed how the whole process is regulated by State and Federal agencies. Directional drilling is widely employed in the gas producing areas in the West, and it will be used by Barrett to extract gas from under the Roan Plateau, which is an elevated section of the Piceance Basin in northwestern Colorado. Issuance of gas

leases for "the Roan" was required by the Energy Policy Act of 2005. Leases were sold in August 2008.

Leasing affects only a small portion of the Roan's surface, specifically the land formerly occupied by Naval Oil Shale Reserve No. 1, one of three oil shale reserves set up early in the 20th century to secure fuel oil supplies for the U.S. Navy, which was then converting its ships from coal to oil. Barrett purchased all of the leases from the winning bidders and is currently negotiating a development plan with the U.S. Bureau of Land Management (BLM) and the State of Colorado.

Duane rode with us on the bus to a drilling site near Silt, Colorado. He described the several stages in the drilling operation and provided an up-close view of the drilling platform and the ancillary systems for handling drilling mud and mounting the many lengths of drill stem on the string.

We then drove to the ***Battlement Mesa Activity Center***, an attractive facility overlooking the oil shale cliffs near the town of Parachute, for lunch and a panel discussion on energy development along the Colorado River and in the Piceance Basin. The Battlement Mesa community was a product of the oil shale boom of the late 1970s and the bust of the early 1980s. Our presenters were **Keith Lambert** (Mayor of the ***City of Rifle*** and a Rifle resident throughout its several boom/bust cycles) and **Glenn Vawter**, Executive Director of the ***National Oil Shale Association***, who summarized the history and status of oil shale development around the world, with an emphasis on current field programs in Colorado and Utah.

Cleaning a turbine at Rifle Generating Station. Combustion residues are blasted loose with dry ice.

After lunch, we drove east to the ***Rifle Generating Station***, a peaking power plant owned and operated by Tri-State Generation & Transmission Association. Our host was **Mr. Lynn Richardson**, plant manager. The plant burns natural gas in a combined cycle generating system. It has a total capacity of 85 MW, including 15 MW from each of three gas combustion turbine generators and 40 MW from one steam turbine. It was built in 1986, in response to the incentives provided by the Public Utility Regulatory Policies Act of 1978. PURPA required a regulated utility to purchase electricity from an independent power project if it met designated efficiency standards or produced useful heat in addition to electricity. The heat from Rifle Station's turbines was used to heat a greenhouse which produced, at various times, tomatoes, shellfish, and other foodstuffs. Tri-State acquired the plant in 2002 and uses it as an intermediate peaking resource, meaning that its energy would be dispatched after plants that burn cheap coal but before less efficient simple-cycle gas plants. The greenhouse is no longer used.

We then moved to the adjacent West Garfield campus of ***Colorado Mountain College*** for a tour of the new biofuel processing center. Our hosts were **Barbara K. V. Johnson**,

Instructional Chair, and **Jon Prater**, Associate Professor and Program Coordinator for Process Technology. The college is a member of the Western Colorado Carbon Neutral Bioenergy Consortium, along with Colorado State University, the City of Rifle, and Flux Farm Foundation. The Consortium's goal is to identify low-input materials such as perennial grasses that might be grown on some of the 150 million acres of pasture land in Western Colorado and used in the cost-effective production of chemicals and fuels such as butanol. The college has tested a variety of potential feedstocks in its laboratories and is building a pilot plant to validate and improve the production processes. The enthusiasm and commitment of the Center's staff and the college's administration were most impressive. Following the tour, we returned to Glenwood Springs for a free afternoon and evening. We slept again at the Hot Springs Lodge.

On Wednesday August 10, we rose early and drove south from Glenwood Springs along the Roaring Fork and Crystal rivers, past Carbondale and Redstone, to Somerset, where we divided into groups to tour three underground coal mines: Arch Coal's ***West Elk Mine***, Oxbow Mining's ***Elk Creek Mine***, and the ***Bowie No. 2 Mine*** of Bowie Resources Ltd. Our hosts were **Sherry Braslin** and **Doug Nolte** at West Elk, **Rob Thurman** and **Randy Litwiller** at Elk Creek, and **Jim Abshire** and **Jake Wilson** at Bowie. We received training in the use of respirators and other safety gear and the processes for emergency evacuation. Each of us was equipped with hard hat, light, respirator, coveralls, gloves, and formidable rubber boots, and we entered our assigned mine in a diesel truck.

Longwall mining began in England in the 17th century and became relatively widespread in the 1950s and 1960s. It is now a very important technology for the large-scale extraction of bulk minerals such as coal and trona. More than half the coal mined in the United States is produced by longwall mines.

Roof Supports (Shields) for Longwall Mining

The first step is to create a tunnel with boring machines or continuous miners. Bolts are installed in the ceiling of the tunnel to prevent rock falls, and a large number of roof supports, or shields, are placed along the length of the tunnel, facing the panel of coal which is to be removed. A conveyor belt is installed in front of the shields, together with a track on which a cutter wheel, or shearer, moves. The shearer passes along the face of the panel, breaking the coal and dropping it onto the conveyor, which transports the coal beyond the panel area and drops it into haulage vehicles, which carry the coal to other conveyors, which move it out of the mine. When the cutter has completed its pass, hydraulic systems move the shields forward, into

the mined-out area, and the process is repeated until the whole panel has been removed. The mine roof collapses behind the shields.

A coal shearer in action.
Shields above and to the right. Conveyor below.

Longwall operations are highly mechanized and very big. A panel may be two miles long and 800 feet or more in width. The longwall system will use dozens of individual shields. About 80% of the coal in a panel can be recovered, compared with about 60% for more traditional room-and-pillar mining. Longwall can also be used for deeply buried seams, where room-and-pillar is impractical. However there are concerns. Subsidence is immediate and, over time, it can disturb the surface above the mine, which could be problematic if that surface has structures on it or is otherwise valuable.

Following an excellent box lunch and a Q&A session at West Elk, we boarded the bus and headed southwest towards the town of Delta and then north across beautiful Grand Mesa to Rifle, for our overnight stay at La Quinta Inn & Suites. After dinner, **Jim Burnell** of the ***Colorado Geological Survey*** discussed the essential link between mineral extraction and the technologies for producing energy from renewable resources and for reducing reliance on conventional fossil fuels. He spoke at length about the importance of the 17 rare-earth elements (the lanthanide series elements plus scandium and yttrium) which are widely used in electronics manufacturing and have special significance for renewable energy development and advanced battery technology.

On Thursday August 11, we drove straight north from Rifle for about 90 miles to the ***Trapper Mine,*** near the town of Craig. **Forrest Luke**, Environmental Manager, described the history of Trapper Mine and its present operations, with help from **Jim Mattern** and **Graham Roberts**. Much of the presentation was focused on environmental planning and the reclamation programs that Trapper Mining employs and how pleased they are with the results. After a Q&A session, we rode the bus to an active mining area where we observed one of Trapper's three huge draglines, which strip overburden from above the coal seams. A dragline's bucket can move the equivalent of 1-1/2 truckloads of dirt and rock in one gulp. We also had the opportunity to peer over the edge of a working face, where coal was being extracted and loaded into large trucks.

On the ride back to the Trapper office, the group observed the results of the land reclamation programs. This included seeing antelope and deer grazing on top of what was once an exposed coal seam. And while coal mining has a checkered past in the West, the

Trapper people pointed out that their environmental efforts are more normal than exceptional in the modern industry.

Our next stop was the nearby ***Craig Station***, a coal-fired power plant run by Tri-State Generation and Transmission Association. Following lunch and an introductory presentation by Operations Superintendent **Marve Weible**, we were treated to a comprehensive tour of the 1,304-megawatt facility, including a peek at the firestorm inside an operating boiler and an elevator ride to the roof, where we viewed the coal storage yard, the plant's flue gas desulfurization units, Trapper Mine (which supplies most of the station's coal), the town of Craig, and the high voltage transmission lines that carry electricity from Craig to the more populous areas of Colorado. Our tour guides were Mr. Weible and his associates **Ron Gauthier, Tim Osborne,** and **Bryan Gayle**. We then drove 42 miles east to the ski town of Steamboat Springs for dinner and overnight lodging at the Steamboat Grand Hotel.

On Friday August 12, we drove 50 miles southeast to the small town of Kremmling, to visit a wood pelletizing plant. The plant was established by ***Confluence Energy LLC*** in response to Colorado's "red tree" problem. Red trees are pine trees that have died because of infestations by pine bark beetles. The beetles chew holes through a tree's bark and lay their eggs within. The beetles carry a fungus, which grows in the holes and eventually chokes off the tree's circulatory system. The fungus leaves a blue stain in the wood, which some consider decorative, but it is the red needles – denoting a dead pine tree – that have attracted the most attention. Foresters predict that 95% of Colorado's lodgepole pines may soon be dead or dying. The dead trees present a serious fire hazard, and when they fall they will create a major impediment to travel through the forests, especially for people and other large animals.

Some Colorado communities have taken advantage of the epidemic, by using the dead and dying trees as a fuel source, replacing expensive fossil fuels, especially propane. For example, the middle school in Oak Creek replaced an aging coal-fired heating system with a modern system that burns wood pellets made from beetle-killed pine. Those pellets are manufactured 50 miles away, at the Confluence Energy facility.

Plant manager **Brant Webb** showed us how 200 tons per day of wood (mostly from trees killed by the beetles) is shredded and dried and pressed into pellets. The pellets are about ¼-inch in diameter and a few inches long. They are sold in bags in retail markets from Nevada to Pennsylvania and delivered in bulk to larger users, such as the Oak Creek school. Confluence Energy is also seeking non-fuel applications for the pellets, such as in natural gas drilling and environmental remediation.

Another 40-mile drive took us to the town of Grand Lake and the entrance to ***Rocky Mountain National Park***. The park occupies 415 square miles and is surrounded by national forests. It contains the headwaters of the mighty Colorado River, and the Continental Divide runs through it. There are more than 60 named peaks taller than 12,000 feet, and the tallest – Longs Peak – rises to 14,259 feet. Nearly three million people visit the park each year, making it the 6th most popular national park. In May

2010, TripAdvisor.com named the Park as the No. 2 Outdoor and Adventure Destination in the World. No. 1 was the Queenstown area in New Zealand, where the Lord of the Rings trilogy was filmed.
Our guide to the park was **Vaughn Baker**, Park Superintendent. He pointed out many of the Park's outstanding natural features and discussed the research activities conducted and managed by the Park's scientists and their contractors. These include a multi-year study of the effect of nitrogen deposition on the Park's ecological systems. Much of the nitrogen is released to the environment as emissions from fossil fuel power plants and production sites.

We left the Park and passed through the town of Estes Park on the way to our final tour site: the 45,000 kW ***Estes Powerplant***, which was completed in 1950 as part of the Colorado-Big Thompson Project operated by the U.S. Bureau of Reclamation. Our hosts were **Kara Lamb** of BuRec's Eastern Colorado Area Office and **David Burke**, Manager of the Estes Powerplant.

Our tour began with an exhibit on the Colorado-Big Thompson Project and continued into the generation, control, and interconnection areas. Colorado-Big Thompson is one of the largest and most complex natural resource developments undertaken by the Bureau. It consists of more than 100 integrated structures that gather and divert water from the western slope of the Rockies to the eastern slope for use in irrigation and for municipal and industrial purposes, hydroelectric power production, and recreation.

The historic Stanley Hotel in Estes Park, Colorado

After our tour, we drove a short distance to the historic Stanley Hotel in Estes Park, for dinner and an overnight stay. The Stanley was built by the inventor of the Stanley Steamer (an early automobile) and opened as a summer resort in 1909. It has hosted the glitterati of many eras since then, including the travelers in the 2010 EMFI and Stephen King, who was inspired to write his horror story *The Shining*. The Stanley was not depicted in either King's novel or in Stanley Kubrick's 1980 film. However, a 1997 TV miniseries version of the book was filmed there. Kubrick's film plays in a continuous loop on the hotel's cable system. Future visitors should <u>not</u> watch it if they hope to sleep well.

Saturday began late, with an 8:30 breakfast at the Stanley. A very useful group wrap-up session followed, during which participants commented on the sites we had visited and the content of the program and suggested mechanisms to ensure continuation of the EMFI. We then drove the 75 miles to Denver International Airport, where most of the

group left the bus to catch flights back home. We dropped a few stragglers in downtown Denver and continued to Golden, where we unloaded the bus and declared the end of another successful and rewarding Energy and Minerals Field Institute.