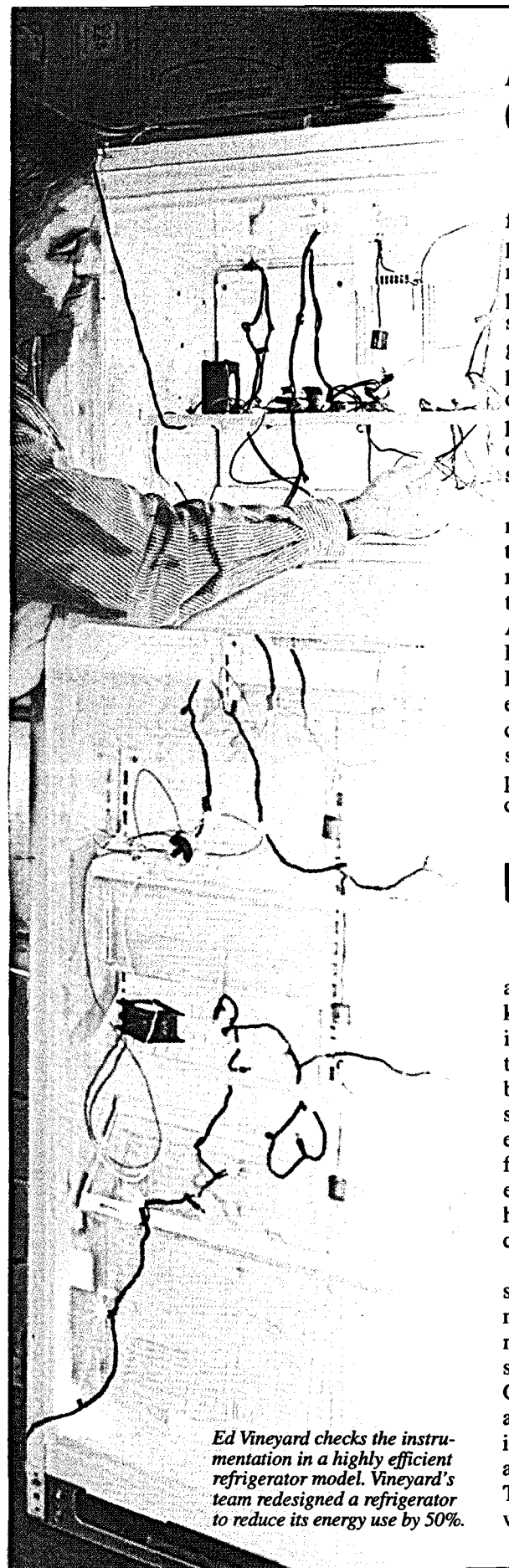

Ed Vineyard checks the instrumentation in a highly efficient refrigerator model. Vineyard's team redesigned a refrigerator to reduce its energy use by 50%.

ENERGY EFFICIENCY

Cooling More with Less

In the past three decades, ORNL has spearheaded the development of refrigeration systems that use less energy and pose less of a threat to the environment. The motivations have been the rise in energy prices since the 1970s because of unstable supplies of imported oil for fuel; the recent goal to reduce the need for coal-fired power plants and thus cut climate-altering carbon dioxide emissions; and the mandate to replace conventional refrigerants containing chlorofluorocarbons, to preserve the stratospheric ozone layer protecting us.

ORNL engineers have worked with major appliance manufacturers to improve the energy efficiency of refrigeration equipment and to investigate ozone-friendly alternative refrigerants. In collaboration with Arthur D. Little, Amana, Maytag, General Electric, Sub-Zero, Sanyo, DuPont, Frigidaire, and Whirlpool, ORNL researchers designed more-efficient refrigerators, compressors, and supermarket refrigeration systems. In the early 1980s, they built a computer model still used to design energy-efficient refrigerators. In the late 1990s, relying on computer analyses and input from appliance manufacturers, researchers led by Ed Vineyard altered the design of the refrigerator-freezer to reduce energy use by 50% to one kilowatt-hour per day.

A team at ORNL's Buildings Technology Center worked with DuPont to identify ozone-safe refrigerant blends and suggest system changes that allow new blends to increase energy efficiency. Partly as a result of ORNL's refrigerant tests and computer modeling, chlorine-free HFC-134a is commonly used in new refrigeration systems.

ORNL researchers led by Van Baxter influenced the design of supermarket refrigeration units, which now have improved microprocessors and their own compressors (rather than potentially leaky lines to a central compressor). These changes cut supermarket energy consumption by 30% and annual electricity costs by $4 billion.

ORNL's refrigeration work was recently cited by the Department of Energy as the second-highest-rated accomplishment among 100 DOE-developed technologies that have most improved consumers' lives.

Heating More with Less

The earth stores almost half the energy it receives from the sun—at least 500 times more energy than humankind needs each year. By exploiting this impressive energy storage capability, geothermal heat pumps (GHPs) warm and cool buildings and provide hot water. Using a system of underground pipes containing an environmentally friendly heat-exchange fluid, a GHP transfers heat from the warmer earth to a building in the winter and moves heat from a building in the summer for discharge into the cooler ground.

An Environmental Protection Agency study recently showed that the GHP is the most energy efficient, environmentally benign, and cost-effective space-conditioning system available. Despite their potential, GHPs were still regarded as "new" in 1990, and their delivery infrastructure was still in its infancy. Careful research and technical assistance provided by ORNL's Buildings Technology Center cleared the way for widespread acceptance and implementation of GHPs in federal facilities and helped usher GHPs into the mainstream of the U.S. heating and cooling industry.

Since the late 1970s, ORNL's Patrick Hughes has researched, field-tested, and improved the engineering of GHP systems. During the mid-1980s, Van Baxter, Vince Mei, and others at ORNL helped upgrade component technologies for GHP systems. Hughes and John Shonder documented the energy- and cost-saving benefits of GHPs in an evaluation of a 4000-home GHP retrofit at the U.S. Army's Fort Polk Joint Readiness Training Center near Leesville, Louisiana. The study found that electricity use was reduced by 33% in the retrofitted homes, and summer peak electricity demand was cut by 43%.

In 1998 the Federal Energy Management Program launched a program, supported by Hughes and Shonder's team, to make GHPs available to federal agencies. Since then, the annual federal investment in GHPs continues to grow, reaching $76 million in 2001.

1985

Fatty acid labeled with iodine-123 developed for medical scanning diagnosis of heart disease

UT-ORNL establishes Science Alliance

Gelcasting developed; now used commercially to form ceramic parts for microturbines

1986

ORNL determines when Chernobyl nuclear plant accident occurred, and why it released so much radioactivity

1987

High Temperature Materials Laboratory opens as user facility for industrial researchers seeking to build energy-efficient engines