

REFRIGERATED RAIL CARS INQUIRY UNIT - TEACHER BACKGROUND INFORMATION

OVERVIEW

The refrigerated rail car was not simply a railroad innovation, but one significant component of centuries-long efforts to chill and preserve perishable foodstuffs. It can be understood in the historical context of refrigeration, agribusiness, meat packing, global trade, food transport, and consumerism. Furthermore, the impact of widespread use of refrigerated rail cars can be seen in population shifts evident in census reports since the late 19th century.

Teachers are encouraged to use the following notes as they prepare for this unit. In addition to the many excellent resources listed at the end of this document, *Refrigeration in America: a history of a new technology and its impact*, by Oscar E. Anderson (Princeton: Published for the University of Cincinnati by Princeton University Press, 1953), is a very succinct history of the refrigerated rail car and its place in the world. An online version may be found here: <https://babel.hathitrust.org/cgi/pt?id=uc1.b3428844;view=1up;seq=26>

HISTORICAL BACKGROUND

Preserving Food

For millennia, householders stored food in dug out pits beneath their homes or in sacks on riverbanks, though these methods did not protect the food from mold, insects or other predators. The alternative techniques for preserving foods were smoking, canning, pickling, or salting. However, these methods changed the character of the foods, and was not as good a solution as eating a varied diet of fresh foods.

As populations around the world grew and people migrated across geographical boundaries, the acquisition and storage of fresh foods became a major objective. Access to foods previously unavailable in certain regions or climates meant that more people could have a more varied, healthier diet. Simultaneously, merchants saw potential profit in selling meat, fish, dairy, fruits, and vegetables to distant regions of their own countries as well as to foreign markets. The food trade expanded during the Industrial Revolution, when merchants and cargo companies were already profiting from shipping a variety of manufactured products around the world. The challenge was preventing spoilage of produce during transport to market or in maintaining effective temperatures in storehouses, and this, and the desire of consumers to have ice on hand in warmer months led to the ice trade.

Ice Houses

In areas where rivers and lakes froze over in winter to a depth of several inches or more, ice could be harvested in large blocks and stored in bunkers called ice houses. These structures pre-date the refrigerator rail car by at least 300 years. The first ice houses were built underground to prevent quick melting, and additives such as sawdust were used to maintain the temperature. Heavy-walled brick, stone, or wooden sheds were built over the entrances to protect the ice and keep the sun out. Before 1700, ice harvesting and delivery were already a major activity, though mainly to serve the wealthy. For example, an [ice house at the Boboli Gardens in Florence Italy](#) was built in the mid-1500s. In 1637, King Charles I of England granted Sir William Berkeley (1605-1677) a patent “to gather, make and take snow and ice and keep the same in such pits, caves and cool places as he should think fit,” effectively giving Berkeley (later the first governor of the Virginia colony) a monopoly on the sale of snow



[Thomas Jefferson's ice house at Monticello](#) (roof under reconstruction in the 1950s)

and ice for cooling food in England. (Berkeley, 16; 270-271.) Berkeley's patent was renewed by Charles II in 1665. In America, George Washington was directly involved in [building the ice house on his property](#) in Mount Vernon, New York, and Thomas Jefferson was inspired to have an ice house built on his estate (Monticello) after studying plans for them in Italy and Virginia the late 1700s. The 1803 ice house was the second one he had built. In England, [Moseley Park](#) near Birmingham, was built around the end of the eighteenth century or early nineteenth century. Archaeologists working at the [Beaulieu site](#) of the Beaulieu Palace House, a residence of the English Lord Montague built around 1872, discovered an ice house on the property using a Light Detection and Ranging (LIDAR), a system of pulsed laser beams to detect variable distances.

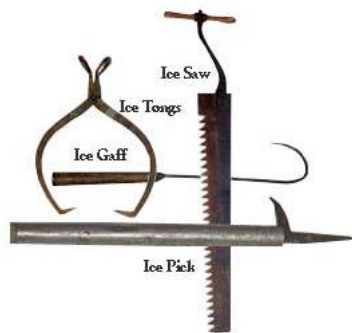
Indoor Refrigeration

Although Jefferson had an icehouse at Monticello, in 1804 he purchased a [small refrigerator designed by Thomas Moore](#) who thought its advantage was its portability.

In 1824, [Mary Randolph](#) (1762-1828) published *The Virginia Housewife*, in which she [described and illustrated her idea for an indoor refrigerator](#) , noting that it would be "more convenient than an icehouse." The idea for consumer refrigerators was circulating by the early 1800s, when harvested ice could be delivered to shops, hotels, and homes for a subscription fee.

Natural Ice Harvesting

The first use of harvested ice for which we have any evidence was approximately the first millennium BCE in China. In the regions around the Mediterranean Sea, including Greece, Italy, and North Africa, the wealthy had ice and snow harvested from nearby mountains to chill their drinks and food. During this period, people in numerous regions around the world were using an [evaporation method to make ice-Ice and Refrigeration-1904-Page 4](#) overnight in shallow clay pans of water covered with straw.



The practice of cutting ice from frozen bodies of water (rivers, lakes, streams) and using it to store food, seeds and other perishable necessities in human-built huts was well established during c 1300-1850, a period of climate change referred to as the "Little Ice Age." Over time, a number of tools were developed to facilitate extraction and loading and to standardize the slabs of ice for stacking and transport or storage. Harvested blocks of ice were carried by cart over roads to the estates of the wealthy or to businesses, to be stored in ice houses for use during the summer months. Wagons were also used to move harvested ice to docks for shipping to other ports around the world.

The Ice Trade

The harvest of natural ice was such a common practice in the 1800s that Henry David Thoreau described his personal observation of it in his book, [Walden](#):

To speak literally, a hundred Irishmen, with Yankee overseers, came from Cambridge every day to get out the ice. They divided it into cakes by methods too well known to require description, and these, being sledged to the shore, were rapidly hauled off on to an ice platform, and raised by grappling irons and block and tackle, worked by horses, on to a stack, as surely as so many barrels of flour, and there placed evenly side by side, and row upon row, as if they formed the solid base of an obelisk designed to pierce the clouds. They told me that in a good day they could get out a thousand tons, which was the yield of about one acre. – "The Pond in Winter," p 333



Historic Location Marker: Frederic Tudor Ice Company in Fresh Pond, Concord Ave. and Moulton St., Cambridge, Ma.

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Frederic Tudor, the “Ice King”

In the 1800s, ice was being transported by cargo ships from the Northeastern United States, the Great Lakes region, and from Norway to distant locales in the southern United States, the Caribbean, India, Europe, Asia, and Australia. Among the first to commercialize long distance ice delivery was Frederic Tudor (1783-1864), dubbed the “Ice King,” who [began shipping ice](#) to Cuba and other islands in 1806. Tudor’s business suffered temporarily, during the Napoleonic Wars, when the American shipping was halted with the [Embargo Act](#), and again during the War of 1812. In 1833, he partnered with Samuel Austin and William Rogers to export almost one hundred tons of harvested ice from the U.S. to Calcutta, India, where, after a four month journey, it was well received. Tudor was shipping natural ice to Sydney Australia by 1839. According to the Founders archives, when Tudor died in 1864, his company had depots around the

world including in Brazil, Cuba, India, Jamaica, and Singapore as well as Boston and New Orleans and Tudor Ice Company was worth over a million dollars. Even after refrigerator rail cars were introduced, refrigerated cargo ships continued to play an important role in the ice and food trade.

Other sources of Ice Trade



It has been estimated that at the end of the nineteenth century, a million tons of ice were [exported from Norway](#) annually, mainly to Germany and England.

A number of people made their living from harvesting and selling ice for the fishing industry. For example, in England, J. Marr a fish and ice merchant during the late 1800s, acquired ice from the glaciers of Norway or from British fields flooded specifically to make and harvest ice. The Fylde Ice and Cold Storage

Company was founded in 1908 to manufacture ice for fishermen. Fylde built its first large cold storage facility to serve fish merchants in 1927. In 1987, inspired by the American party ice business, they began producing and selling bagged ice to consumers. Today the business that became [The Ice Company](#) in 2010 is the largest ice supplier in Europe.

Refrigerated rail cars, commonly referred to as “Reefers”

The development of the steam engine to pump water out of coal mines in the eighteenth century presented not only the opportunity to use engines to manufacture a variety of products, but to move goods and people across long distances by rail. With the expansion of the steam railroad after the 1830s, food merchants considered the advantages of transporting their goods over established rail lines, rather than in open or covered wagons. The first cars were cooled by packing insulation material such as sawdust, felt, or animal hair in the space between the inner and outer walls of the car. Ice was packed with the food, in ice chests on the floor of the car or in bunkers above the car. Salt was sometimes added to the ice to slow the rate at which the temperature of the cooling agent rose, especially in warm weather. In 1842, the *American Railroad Journal* reported new insulated freight cars in use by the Massachusetts-based Western Railroad. (Danes-Wingett, 1) The compartment that resulted from false walls built several inches inside the outer car wall was packed with a combination of ice plus 4” of powdered charcoal, which was cheaper than ice itself.

National expansion of the railroads coincided with the development of the meat packing industry in the United States. In the years before the Civil War in America, attempts were made to add perishable train cars to the young railroad system, but these were generally unsuccessful, either due to a lack of ventilation or a lack of a stable refrigerant. After the end of the American Civil War, a number of people filed patents for the design of improved ice box cars or for particular methods of cooling their contents, or improvements to the original ideas. For example, J. B. Sutherland's *Improved Refrigerator Car*. U.S. Patent 71,423, issued 26 November, 1867 described the use of two ice chests, one at either end of the car, each holding approximately eight hundred pounds of ice, and space between inner and outer walls to hold insulating material such as felt, hair, or sawdust, and pipes running along the roof of the car to hang fresh meat, so that the cold air, recirculated through the car, would keep it fresh. The design by David William Davis described in [US Patent 272,124](#), 13 February, 1883 for the owner of a meat packing company, George Hammond, was also meant to improve air circulation.

Joel Tiffany Summer-Winter Cars

Joel Tiffany's (1811-1893) *Improvement in Refrigerator Cars*. U.S. Patent 193.357, issued July 24, 1877 was one of the most famous, successfully commercialized patent designs. It used a clerestory – an ice chamber situated above the normal roof-line of the car - with a pan to catch condensation, and “air flues” - a closed circuit pipe system to circulate air through the ice chest and then around the car. The improvement was in reclaiming space in the car normally used for the ice chests. By January, 1879, the Tiffany Company had ninety-five reefers in service in the United States and seven more in Europe. Tiffany sold one hundred cars to the National Despatch Refrigerator Line and had another one hundred on order that year.

Early resistance

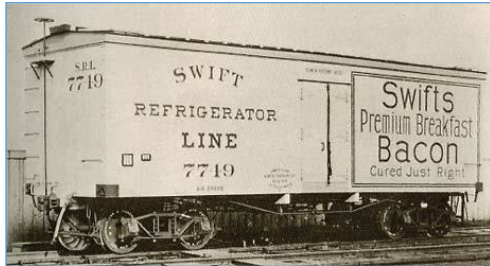
Despite the logic of shipping dressed meat and fresh produce both across country and from ships bearing produce from international ports, rail lines initially resisted adopting refrigerator rail cars. The specialized cars were more costly: a regular box car could be purchased for eight hundred dollars in the 1880s, while a refrigerator car cost one third more: about twelve hundred dollars. Furthermore, railroad operators already had inventories of cattle cars used to ship live animals, and had already invested in ancillary facilities such as stock yards and feed; the expense of the extra cars, without a guarantee of safe delivery of perishables was not an incentive. This had to do with the cars themselves: the addition of false walls for insulation and ice bunkers reduced the capacity of the cars, so more cars were needed for larger, more profitable shipments. Furthermore, the cars were more complicated and labor-intensive to use than regular box cars. Finally, reefer cars were usually one way carriers –that is, they might return to the original point empty. Consequently, railroads charged higher fees for running refrigerator cars on a rail line. One response from meat packers was to develop their own rail fleets. By 1883, Chicago meat packer Philip Armour established the Armour Refrigerator Line to transport the company's dressed meats across country.

Swift & Co.

Traditionally, live cattle that had been shipped east by rail were slaughtered and butchered close to the point of sale. However, this was an expensive and risky practice: some of the cattle would fall ill, infect other cattle, and die en-route. The animals took up a lot of space, requiring many “cattle cars,” and had to be “warehoused” (kept in pens) and fed until slaughter on the other end. Gustavus Swift (1839-1903) who was buying cattle in Chicago to send to his family's beef business in Massachusetts, reasoned that dressed meat butchered at the point of slaughter could be shipped to distant markets more effectively. Meat merchants had realized that it would be more cost effective to send dressed meat across country earlier, but it was impossible to do this year-round. For example, Swift's first attempt to ship dressed meat was to run a chain of rail cars during the winter with the doors removed, assuming cool air would circulate and keep the meat chilled throughout the journey. However, this method did not yield optimum results. Swift hired Andrew

Chase to design a useful refrigeration system that included a “clerestory” or compartment above the rail car to hold the ice, along with a method of keeping the meat from sliding around in the car, and a ventilation system. Soon, Swift was supplying dressed meat from Chicago to the Eastern ports via a fleet of his own refrigerated rail cars. In 1885, his company was incorporated as Swift & Co. and was one of the major suppliers of meats from the mid-western United States.

Expansion: In the late 1800s, more than thirteen million tons of ice per day cooled perishables shipped across the U.S. alone in one type of refrigerated rail car.



Resource:

American Antiquarian Society exhibit of [Swift operations \(Rail cars, slaughter and packing houses, publicity cards\)](#)

Before he died in 1903, Swift, J.O. Armour (son of Philip D. Armour) and other giant meat packing companies formed the National Packing Company. What came to be called the “Beef Trust” was dissolved in 1905 after the U.S. Supreme Court ruled in *Swift v the United States* 196 U.S. 375 (1905) that the government could regulate trade where trusts were monopolizing interstate business. At the time, the companies in question owned 6/10 of all the meat industry through price fixing and other methods. In his finding, Supreme Court Justice Holmes referred to the transport of meat by rail. At the time, the main method of shipping dressed meat to other States was by refrigerated rail cars, owned and controlled by these companies.

Fruit exchange

By the 1880s, the shipment of produce was a major money-making activity for the railroads. In addition to citrus and other fruits and vegetables shipped from the South, Bananas were being shipped from South America to Chicago via New Orleans on the Illinois Central Railroad. The story of the fruit business is a complex one that is tied into international corporate history, labor history, and fruit shipping. The two largest entities shipping fruit in the late 19th and early twentieth centuries were United Fruit and Dole. Their history is briefly covered in a [Financial Times article, “Rotten Fruit” by Peter Chapman](#).

Adolphus Busch Reefers

One of the most famous merchants to adopt the idea of refrigerated rail car was Adolphus Busch, a partner in the Anheuser Busch Brewing Company, makers of Budweiser beer. In the 1860s, Busch began employing the pasteurization process to preserve beer in transit and storage so that he could expand the business from the typical local brewery to national and eventually international scale. In 1876, he began using refrigerated rail cars to transport fresh beer to markets from St. Louis to other cities. The scale of the shipping operation is evident in this [contemporary photo of the company railroad fleet](#).

Improvements in Refrigeration

A significant advance in the science of refrigeration was the move to mechanical refrigeration from natural ice cooling, though this improvement was gradual and not without setbacks. Experiments with chemicals such as ether and sulfuric acid were attempted, though they were abandoned due to their explosive nature. Ammonia cooling under closed circuit compression became the choice for mechanical cooling and was widespread in the early 1900s. By the 1940s, blower fans attached to the axle of the rail car by belts were

developed to keep cold air circulating, and in the 1950s, electric drives were introduced and were operating in at least a third of the reefers.

In time, improvements in car design, the development of devices that allowed trains to change gauge to connect to different lines, and eventually the standardization of rail gauges, along with the practice of companies owning and running their own fleets, made refrigerated rail transport more attractive to all. At the beginning of the twentieth century, increased consumer demand for fresh foods created anticipation of higher revenue for moving the produce, and railroads began investing more seriously in acquiring refrigerated cars. By the World War I era, the cold chain had been organized so that reefer fleets were kept in rail yards near the point of meat processing or harvest and routing schedules were set up for regular, reliable movement of perishables to point of purchase. The use of telegraph and later phone systems were integrated into the cold chain and often orders could be placed or altered on the fly.

In the 1960s twenty-eight million tons of food were carried across country, though by then the insulated cars were driven by diesel-electric power. These electro-mechanical refrigeration systems could keep food frozen, not just chilled, and the business of ice suppliers dwindled. During the second half of the twentieth century, as a result of government funding for interstate highways, cooled tractor-trailer transport increased, and the number of reefer cars used to carry perishable goods declined. Consequently, individual cars were integrated into freight trains that transported a variety of goods, rather than in reefer fleets. As with other products, the reefer cars were owned by the companies that shipped the goods. For example, Tropicana owned a fleet of bright orange reefers emblazoned with its logo that transported orange juice from Florida to the Northeastern United States.

Cold Storage

The availability of chilled produce transported from ship to rail, and the development of the cold storage warehousing along with mechanical cooling, allowed grocers to carry more fresh and frozen food, and periodicals related to the perishable foods industry included both information about new technological developments, but magazines and books geared to the grocery trade. For example [*The Grocer's Encyclopedia*](#) (1911) included advice on the minimum and maximum temperatures for storing a variety of foods.

Decline in Rail Transportation

The railroad system created in the mid-1800s to link regions was competing with interstate highways. Consequently, while earlier, between 800 and 1200 reefers once traveled the tracks across country daily, by the 1960s, much of the perishable items they once carried were being moved by tractor trailers.

Suggested Excerpts or for more information:

Chapman, Peter. "[Rotten Fruit.](#)" *Financial Times* online 15 May, 2007.

Cummings, Richard O. *The American Ice Harvests: A Historical Study in Technology, 1800-1918*. U Cal. P, 1949. See: Chapter 5 "Food from the Far West," pp. 65-78 (half-pages) on rail cars and equipment.

Danes-Wingett, Linda. "[The Ice Car Cometh: A History of the Railroad Refrigerator Car.](#)" (Newsletter) *The San Joaquin Historian*. Lodi, Ca: The San Joaquin County Historical Society, Inc., winter 1996, 109.

Rees, Jonathan, *Refrigeration Nation*: See: "The Principles of Mechanical Refrigeration," pp. 35-37, and "Four Refrigerants," pp. 39-43.

Rodrigue, Jean-Paul and Theo Notteboom. [“The Cold Chain and its Logistics.”](#)
Emergence of Cold Chain Logistics (includes global, not just US transport. Info.)

GLOSSARY

Cold Chain – *Methods of regulating the temperature of perishable items from the point of acquisition through processing, transportation, storage, and distribution came to be known as **the cold chain**.*

Cold Chain Logistics – *the system employed for coordinating the perishable supply chain.*

Dressed Meat – *Once such parts of an animal as the head, feet, tail, intestines, and internal organs have been removed, the meat is said to be “dressed.” Refrigerated transport allowed meat distributors to send dressed meat across country, rather than having to ship live animals via railroad “cattle cars.”*

Dry Ice – *solid carbon dioxide (CO₂) The advantages of using dry ice are that the temperature of solid CO₂ is -109.3°F/-78.5°C) - far colder than water-based ice, which freezes at 32°F/0°C in normal environments; and rather than melting, dry ice turns to gas as it breaks down, so that it leaves no wet residue in the container.*
[More on dry ice here.](#)

Fleet – *A large number of vehicles owned and operated by the same company. For example, Swift, Anheuser-Busch, and Tropicana all owned fleets of reefers.*

Ice Bunker – *An enclosed space for storing ice. In reefers, this was either the space created between the outer and inner (“false”) walls of the car, or a “clerestory” – a raised section of roof running down the center of a railroad car, or a box set into the car.*

Ice Cutter – *a special saw-like tool designed for cutting large sheets or chunks of ice from lakes or rivers; also, a worker employed in harvesting natural ice.*

Mechanical refrigeration – *Storage or transport compartments are maintained at a low temperature using fluid chemicals or compressed air circulating through pipes.*

Refrigerated rail cars/“Reefers” - *Railroad boxcars designed to carry chilled perishable foodstuffs over long distances between source and market were known as “perishable trains” and commonly referred to as “reefers.” Originally, they kept food cold through the insertion of ice (often with addition of insulators such as charcoal, straw, or sawdust) between double walls of the cars, and the ice was refreshed at designated points along the route. Gradually, ice-cooled reefers were replaced by mechanical refrigerated cars, and eventually by electric refrigerating units.*

CONTEMPORARY SOURCES

Gifford-Wood Company. *How to Harvest Ice*. Boston: Hamilton Printing, 1912. This 1912 c. pamphlet is a later edition. The original was published in 1890 and reprinted several times. As the company was established in 1814, it is possible that there are even earlier editions. Nevertheless, this one is instructive of the importance of harvested ice during the 19th nd 20th centuries, and contains some great pictures of the tools and storage facilities. [This copy](#) comes from internetarchive.org and since it was published in the US before 1923 it is in the public domain.

Railroad Gazette: A Journal of Transportation, Engineering, and Railroad News. Volume 9, January – December, 1877. New York and Chicago: Writ and Forney, 1877. (Public Domain. Access Google Books:
<https://play.google.com/books/reader?id=bk2NVNYIHXEC&printsec=frontcover&output=reader&hl=en&pg=GBS.PP5>

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White, John H. Jr. *The American Railroad Freight Car: From the Wood-Car Era to the Coming of Steel*. Baltimore: Johns Hopkins University press, 1993.

The Great Yellow Fleet: A History of Railroad Refrigerator Cars. San Marino, Ca: Golden West, 1986.

MUSEUM SITES

American Antiquarian Society exhibit of [Swift operations \(Rail cars, slaughter and packing houses, publicity cards\)](#)

Illinois State Museum ["The Ice Harvesting Process"](#) (includes images of tools shown above)

Mid-Continent Railway Museum ["Tiffany Refrigerator Car Company"](#) (includes an image of Tiffany advertisement and an engraving of Tiffany's original "Summer and Winter Car")