

NEW DEVELOPMENTS IN REFRIGERATOR CARS SINCE 1958*

Chas. Ahern
Vice President & General Manager
Pacific Fruit Express Company

It is a pleasure and a privilege to participate in this 5th Conference on the Transportation of Perishables and I want to thank Gordon Mitchell for giving me the opportunity to outline to you today the forward strides Pacific Fruit Express Company has made in transporting perishable products since 1958 and other important developments we now have under consideration for our refrigerator cars. PFE is jointly owned by Southern Pacific and Union Pacific railroads and it is quite proper to say that they and other railroads and refrigerator carlines have also kept pace and made very beneficial advances in handling perishable products since 1958, such as faster schedules, the instituting of incentive rates for heavier loading with resultant lower transportation cost per unit or package, and other improvements. So, while my remarks will mostly concern what PFE is doing, I can assure you the railroad industry as a whole has sought and is continuing to seek ways and means of serving the perishable industry to the greatest benefit of all.

Prior to 1958 PFE Company built approximately 700 mechanical refrigerator cars, all of which were designed and built essentially for handling frozen foods. They were of the so-called "envelope design" which allowed the refrigerated air to circulate around the load, and while many improvements were made in the refrigeration equipment since the first ones were built in 1953 the car design remained essentially the same up until 1958.

In 1958 PFE designed and built its first mechanical cars for handling fresh commodities. We built one thousand cars during this year, 500 of which were 50-ft. 50-ton capacity cars and 500 were 40-ft. cars of 40-ton or 80,000 lbs. capacity. The 500 50-ft. cars were designed with the thought they would be used for both frozen and fresh commodities and the 40-ft. car would become the standard mechanical car for handling fresh products. Subsequent events have proven that we were somewhat wrong in these conceptions. The two years since these cars were built have shown us how fast conditions change that result in completely different concepts in design.

The superstructure of these cars was a steel riveted design of conventional type. The underframes were an all-welded design that embodied several engineering improvements to make them more suitable for modern-day railroad handling. Insulation of the cars was of conventional thickness; that is 7" in the floor and walls and 10" in the ceiling. Two types of insulation that have been used to some extent in the past were used extensively in these cars. A multi-air layer type insulation composed of alternate laminations of glass fiber and corrugated aluminum foil was used in combination with conventional glass insulation in the side walls and roof. The floors were insulated with a rigid foamed plastic insulation applied in slabs in the car floor. The new "foamed-in-place" urethane insulation was used to a limited extent in certain parts of the car that were difficult to insulate with conventional materials. Also a few cars had the floors insulated with "foamed-in-place" insulation and one car was insulated completely with "foamed-in-place" insulation as an experimental application.

*Paper presented at 5th Transportation of Perishables Conference, University of California, Davis, California, March 28 and 29, 1961

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The cars were equipped with single piece 6-ft. sliding doors and were the first ones equipped with our present herringbone design floor rack with Phillippine mahogany slats on aluminum stringers. We believe this to be the best all-purpose floor rack yet developed for refrigerator cars and it is being used on our present new equipment. This group of 1000 cars was completed early in 1959.

Before the last mentioned group of cars was finished we were working on the next model which went on the construction line in the first quarter of 1960. This order was for 1,025 cars, the last of which have just been completed at our Los Angeles shop. Total cost of these cars runs in excess of \$26,000,000. The first 1000, known as Class R-70-12, producing temperatures in range below zero to 70° F., are 70-ton cars equipped with mechanical refrigeration equipment quite similar to that used in previous classes with one major exception. These cars were designed to operate at modulated speeds under control of the thermostat. Thus, they operate at high speed when the sensing element indicates that the car needs higher capacity refrigeration; then cutting down to lower speeds when the additional capacity is not required. This has resulted in more economical operation and considerable reduction in fuel consumption.

A new approach was used in the car design and the superstructure became an all-welded steel shell with the structural members needed for strength located outside the insulated space. This allowed considerable improvement in the matter of applying the insulation with a consequent increased thermal barrier to give better performance and place a lighter load on the refrigeration equipment. Our engineers tell us the big advantage of this design is that it creates a reasonably air-tight skin on the outside of the car that is impervious to moisture migration.

We had been having difficulties with underframe construction in our cars over the past several years. The underframes of the 1000 latest cars have a new type construction that incorporates use of cast steel ends. The entire end of the underframe is cast in one piece which includes all of the various parts that used to be welded and riveted together to make up this portion of the car. The underframe is then completed by welding a conventional center sill between the two castings and adding some of the intermediate parts that are necessary to support the floor and other parts of the structure.

The other 25 cars of the 1,025 order, designated R-70-11's, are being equipped for experimental purposes with special cushion type underframes for extra protection of fragile loads and these cars are designed for handling fresh commodities in temperature range 32° to 70°. We are also testing various types of insulation in these 25 experimental cars. Ten cars will be insulated with conventional insulation and will be applied in the same manner as on previous cars. Five cars will be insulated with a rigid foamed plastic material applied in a conventional manner for this type material. Particular attention is being given to sealing the cars against air leaks and to the use of new type adhesives. Five cars will be insulated with a multi-air layer insulation which is made up of alternate layers of glass fiber insulation and sheets of corrugated aluminum foil. This type material has been used in special application in previous cars in conjunction with other materials. However, in these five cars it will be used exclusively in a special application worked out for applying the material to the entire car. The remaining five cars will be insulated with prefabricated wall and ceiling sections made up by foamed-in-place polystyrene bead type insulation foamed in conjunction with plastic side wall lining. The plastic lining is corrugated to provide air circulation down the wall, and the engineers have designed some fancy waves in the corrugation to avoid having cartons hang up on the lining. These prefabricated panels are then applied to the car in sections, forming a completed wall as the panels are applied. It is anticipated this design will give

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a better insulating effect and at the same time reduce weight and cut installation cost. We expect to gain data from the various insulation applications in these 25 cars concerning heat transfer characteristics of the different materials, moisture migration into the insulated wall, and the stopping of convection currents, together with various other factors involved in the overall insulating effect of the car structure.

In previous cars we found the 6-ft. sliding doors to be so popular with the shippers we decided this time to go to 8-ft. doors for easier and freer operation of lift trucks. However, a sliding door of this size built in the conventional way would have required two men to operate it, which was considered undesirable. It became necessary therefore to lighten the door so it could be operated by one man. This was accomplished by the development of a so-called plastic plug or liner for the door. This liner is made by forming a thermal plastic in a vacuum mold and then insulating it with a polystyrene bead type foamed-in-place insulation. Many problems were encountered in the development of this door liner, however, they were overcome as the design progressed and we believe we have an excellently designed door.

It was also decided to equip all 1,025 of these cars with load dividers and considerable work both by PFE and the various manufacturers involved went into the design of the four types of load dividers used. As always with a new device, a few mechanical problems developed; however, none of them has been insurmountable and the present designs are proving to be very satisfactory. As the load dividers are a new accessory, they are not always used to the best advantage and we are now preparing a complete brochure covering the function and proper use of the load dividers for distribution to shippers and receivers.

All of our cars built since 1958 have been equipped with roller bearing trucks. The trucks are also equipped with long-travel springs and modern snubbing devices to give them an easy ride. We have used steel wheels on our new cars for the past number of years; however, the cars built during 1960 were equipped with a new design two-wear steel wheel which we believe will give longer life and reduce our maintenance cost in this direction.

One of the most noticeable features of the new cars and which shows up from a great distance away, is the "new look" so far as our paint job and stenciling are concerned. (Show photograph if desired). While this does not increase the efficiency of the car or give us any better refrigeration capacity, we believe it is more eye-appealing and as they say on TV commercials, it has an esthetic and photogenic look.

These new cars represent the last word in a modern refrigerated car and the best mechanical refrigeration units available on the market at the present time. However, some people seem to expect miracles from a mechanical car, and as long as they know the diesel engine is running in the end of the car they feel that it can take any quantity of field heat out of the load and make up for any inadequacies in the precooling of fresh produce or the freezing and storage of frozen foods. It should be remembered in this regard these cars are essentially a transportation medium and the car as well as the mechanical unit are designed to provide "protective service." This means we are equipped to protect the lading inside the car from the elements whether or not this requires refrigeration or heat. The cars have a certain built-in safety factor; however, they are definitely not designed to take excessive field heat out of the load nor are they designed to complete an inadequate freezing job. When perishable products, whether fresh or frozen, are packaged and stowed in a

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transportation vehicle, whatever the type, this is the wrong time to try to take heat out of the product. Those little btu's down in the center of a peach in the middle of the load are pretty hard to take out under the best conditions and this job should be done before we are asked to protect it during transportation.

Following is a summary of some of the features and recent improvements in mechanical refrigeration equipment:

Refrigerating Units: Developments have been in the direction of single compressors equipped with cylinder unloaders for capacity control in place of the former use of two separate compressors. Compressors themselves are now the hermetic type with the motors encased in the compressor housing and cooled by the flow of Freon refrigerant rather than by air circulation as in the past. This eliminates the need for a shaft seal or any other external opening to the refrigerant system.

Other refinements in refrigeration units include coil designs which provide better heat transfer and reduction in the quantity of refrigerant required in the system. There have been improvements in many components such as use of an air switch for measuring the frost on the coil and determining when to defrost, improved electric relays and overload devices to protect the electric motors from burnout and use of refrigerant dehydrators with visual indicators to determine the presence of moisture which would cause damage to the refrigeration system.

Thermostats: Systems are now controlled by an accurate mechanical type of thermostat with a mercury filled bulb actuating a series of electrical switches in response to temperature change. These are rugged devices, easily serviced and calibrated, are independent of electrical power source for operation and are well suited to the rigors of transportation application.

Power Plant: The engine-generator set has been predominantly of the diesel type and improvements have been directed toward sizing the engine for the service required and protecting it against failures induced by the environment encountered in railroad operation. Some of the improvements include indicating type fail-safe devices which tell at a glance whether the engine stopped because of high temperature or low oil pressure, more efficient mufflers which reduce noise level without sacrifice of power, air cleaners of the dry type which are more efficient and less costly to service than the oil bath, use of multi-viscosity lubricating oil to permit all-weather operation without the nuisance of changing oil, use of temperature detecting switches to remove the load from the engine during momentary overloads, and the use of the brushless type generator with a voltage control containing no moving parts. These have resulted in smaller more compact and more efficient power plants tailored to the requirements of the application.

As heretofore indicated, the engine generator sets now in use have modulated two-speed operation which provides 60-cycle power during periods of greater demand with reduction to equivalent 40-cycle speed during light demand. Since the demand is lighter when the car temperature has been reached, this allows the majority of a car trip to be at low speed resulting in decrease in wear and tear on the engine and moving parts in the refrigeration system, substantial reduction in noise level of the system, decrease in overall fuel consumption of at least 20% and improved control of both car temperature and humidity by providing a means of closer capacity control.

Another improvement in equipment connected with the power plant has been the development of a rectifier type battery charging system containing very few

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moving parts, replacing the belt driven battery charging generator and voltage regulator which have been a continuing source of operating difficulty and high maintenance costs. Nickel cadmium batteries are used for long life and trouble-free starting of engines.

Air Distribution: Along with improvements in the refrigeration system have been arrangements of the air distribution to more efficiently carry the air throughout the car and supply the refrigeration where it is actually required. This has entailed application of an improved ceiling duct with slots for measuring the air uniformly to all parts of the car and increasing the ratio of air flowing throughout the lading compartment to that which flows in the wall flues around the lading. With proper loading of the commodity this will allow refrigeration to reach all parts of the load when transporting fresh perishables which generate heat within themselves, while at the same time providing sufficient air flow around the load in the envelope type wall duct system when tightly packed frozen loads are carried which require only intercepting the heat leak through the walls of the car.

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The most recent improvement in use of refrigerator cars with ice bunkers as a source of refrigeration is the addition of diesel engine driven fans which run continuously regardless of car motion, and which are thermostatically controlled to produce the proper amount of refrigeration from the ice bunker to maintain the desired temperature. We have termed these "Ice-Tempco" cars. Temperature control is accomplished either by starting and stopping the fans which circulate air through the ice bunker and close the openings with dampers, or by varying the fan speed to effectively stop the flow. A recirculating fan runs constantly to hold the car temperatures uniform and sweep the thermostat bulb with air representing the average car temperatures. These cars will provide the high refrigeration capacity required in the cooling and holding of fresh perishables while at the same time providing the degree of temperature control required to maintain the quality of the product. PFE is equipping 1000 40-ft. ice bunker cars this year with the Ice-Tempco unit, all of which should be in service by August. This car will not only provide controlled temperatures but will provide 10% greater loading space which is most attractive under incentive rates for heavier loading. Incidentally, speaking again of incentive rates and as an indication of how the shippers have responded to this reduced transportation cost per unit or package, in 1958 PFE handled 17,930 cars with heavy loads under the incentive rates from the California-Arizona territory, in 1959 61,747 and 68,386 in 1960.

We also have in full swing the testing of 4 undercar refrigeration units for conversion to mechanical of some of our latest ice bunker cars which were constructed in a manner permitting such conversion. Thus far these units have not proved to have the reliability necessary for the service we require but the experiments are being accelerated to obtain the answers in the shortest period of time. The development of a successful unit will serve two important purposes -- it will give us a completely modern refrigerator car at a relatively moderate cost as compared to cost of a new car, and it will provide greater loading space for use under incentive rates.

Speaking of tests and testing, over the years PFE has tested the insulating efficiency of its cars and their refrigerating capacities in commercial hot rooms in the East and Midwest. However, these tests were necessarily intermittent due to

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time and distance involved and we found it desirable to provide our own hot room or test chamber to make sure our cars are providing the necessary protection for transporting perishable products. This test chamber was recently completed, being a 2-car capacity cell located at Roseville, California, where atmospheric conditions can be simulated to test various features of car construction and refrigeration equipment, making us less dependent upon road tests which are time consuming and do not always impose the same operating conditions and ambient temperatures upon different cars being tested.

Other possible future developments in the refrigeration and perishable transportation field are the use of liquid nitrogen as a refrigerant, new types of insulating materials, smaller and more efficient engines like the gas turbine, fuel cells and even developments in atomic power. Our engineers are keeping abreast of developments in these fields so we will be ready to take advantage of them if they prove to be more efficient and satisfactory than materials, units and refrigerants now in use.

I am sure all of you are familiar with a popular word that has been coined in the past few years in railroad circles -- "piggyback". Lately it has acquired a brother and sister -- "fishyback" and "birdyback", all of which add up to trailers or containers handled via railroad, steamship and in the air. Some railroads and carlines have already gotten into the "piggyback" transportation of perishable products with insulated and refrigerated trailers. While PFE has not yet entered this mode of transportation, we are now actively engaged in studies of the operational and economic factors for this type of service in areas we serve. It is not my opinion, however, that piggyback trailer or container service on flat cars for perishables will entirely supplant the refrigerator car, and particularly the large mechanical car. There are many inherent advantages to the refrigerator car in many markets and it should continue to find a prominent place in transporting perishables.

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If any of you desire more particulars regarding the developments in the areas of refrigerator car construction or refrigeration mentioned in this paper, shall be glad to furnish them upon request. Likewise, if any of you have suggestions or ideas toward providing a more efficient and satisfactory railroad vehicle for transporting perishables, they will be welcome and will be given full consideration. In closing, I would like to invite all of you at an opportune time to visit our car shop and ice plant at Roseville to see firsthand how PFE helps to keep the larders of the Nation filled by providing facilities and equipment for the transportation of all kinds of food products.

time and distance involved and we found it desirable to provide our own hot room or test chamber to make sure our cars are providing the necessary protection for transporting perishable products. This test chamber was recently completed, being a 2-car capacity cell located at Roseville, California, where atmospheric conditions can be simulated to test various features of car construction and refrigeration equipment, making us less dependent upon road tests which are time consuming and do not always impose the same operating conditions and ambient temperatures upon different cars being tested.

Other possible future developments in the refrigeration and perishable transportation field are the use of liquid nitrogen as a refrigerant, new types of insulating materials, smaller and more efficient engines like the gas turbine, fuel cells and even developments in atomic power. Our engineers are keeping abreast of developments in these fields so we will be ready to take advantage of them if they prove to be more efficient and satisfactory than materials, units and refrigerants now in use.

I am sure all of you are familiar with a popular word that has been coined in the past few years in railroad circles -- "piggyback". Lately it has acquired a brother and sister -- "fishyback" and "birdyback", all of which add up to trailers or containers handled via railroad, steamship and in the air. Some railroads and carlines have already gotten into the "piggyback" transportation of perishable products with insulated and refrigerated trailers. While PFE has not yet entered this mode of transportation, we are now actively engaged in studies of the operational and economic factors for this type of service in areas we serve. It is not my opinion, however, that piggyback trailer or container service on flat cars for perishables will entirely supplant the refrigerator car, and particularly the large mechanical car. There are many inherent advantages to the refrigerator car in many markets and it should continue to find a prominent place in transporting perishables.

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If any of you desire more particulars regarding the developments in the areas of refrigerator car construction or refrigeration mentioned in this paper, shall be glad to furnish them upon request. Likewise, if any of you have suggestions or ideas toward providing a more efficient and satisfactory railroad vehicle for transporting perishables, they will be welcome and will be given full consideration. In closing, I would like to invite all of you at an opportune time to visit our car shop and ice plant at Roseville to see firsthand how PFE helps to keep the larders of the Nation filled by providing facilities and equipment for the transportation of all kinds of food products.