CHAPTER-III

THE REFRIGERATION AND AIR CONDITIONING INDUSTRY IN INDIA
IMAGINE LIFE WITHOUT ice cream, fresh fruit, ice-cold beer or frozen entrees. Imagine having to go to the grocer everyday to make sure your food was fresh. Imagine no flowers to sent to that special someone or medicines or computers.

Over the last 150 years or so, refrigeration’s great strides offered us ways to preserve and cool food, other substances and ourselves. Refrigeration brought distant production centers. It tore down the barriers of climates and seasons. And while it helped to rev up industrial process, it became an industry itself.

In prehistoric times, man found that his game would last during times food was not available if stored in the coolness of a cave or packed in snow. In China, before the first millennium, ice was harvested and stored.

Hebrews, Greeks, and Romans, placed large amounts of snow into storage pits dug into the ground and insulated with wood and straw. The ancient Egyptians filled earthen jars with boiled water and put them on their roofs, thus exposing the jars to the night’s cool air, in India, evaporative cooling was employed. When a liquid vaporizes rapidly, it expands quickly. The rising molecules of vapor abruptly increase their kinetic energy and this increase is drawn form the immediate surroundings of the vapor. These surroundings are therefore cooled.
The intermediate stage in the history of cooling foods was to add chemicals like sodium nitrate or potassium nitrate to water causing the temperature to fall. Cooling wine via this method was recorded in 1550, as were the words 'to refrigerate'. Cooling drinks came into vogue by 1600 in France. Instead of cooling water at night, people rotated long-necked bottles in water in which Saltpeter had been dissolved. This solution could be used to produce very low temperatures and to make ice. By the end of the 17th century, iced liquors and frozen juices were popular in French society.²

The first known artificial refrigeration was demonstrated by William Cullen at the University of Glasgow in 1748. Cullen let ethyl boil into a partial vacuum; he did not, however, use the result to any practical purpose. Ice was first shipped commercially out of Canal Street in New York City to Charleston, South Carolina in 1799. Unfortunately, there was not much ice left when the shipment arrived. New Englanders Frederick Tudor and Nathaniel Wyeth saw the potential for the ice business and revolutionized the industry through their efforts in the first half of the 1800s. Tudor, who became known as the "Ice King", focused on shipping ice to tropical climates, he experimented with insulating materials and built icehouses that decreased melting losses from 66 percent to less than 8 percent. Wyeth devised a method quickly and cheaply cutting uniform blocks of ice that transformed the ice industry, making it possible to speed handling techniques in storage, transportation and distribution with less waste.
In 1805, an American inventor, Oliver Evans, designed the first refrigeration machine that used vapor instead of liquid. Evans never constructed his machine, but one similar to it was built by an American Physician, John Gorgerin in 1842, the American physician John Gorrie, to cool sickrooms in Florida hospitals, designed and built an air-cooling apparatus for treating yellow-fever patients. His basic principle—that of compressing a gas, cooling it by sending it through radiating coils, and then expanding it to lower the temperature further—is the method most often used in refrigerators today. Giving up his medical practice to engage in time-consuming experimentation with ice making, he was granted the first U.S patent for mechanical refrigeration in 1851. ³

Commercial refrigeration is believed to have been initiated by an American businessperson, Alexander C. Twinning, in 1856. Shortly afterward, an Australian, James Harrison, examined the refrigerators use by Gorrie and Twinning and introduced vapor-compression refrigeration to the brewing and meatpacking industries. Ferdinand Carre of France developed a somewhat more complex, system in 1859. Unlike earlier compression — compression machines, which used air as a coolant, Carre’s equipment contained rapidly expanding ammonia. (Ammonia liquefies at a much lower temperature than water and is thus able to absorb more heat.) Carre’s refrigerators were widely used, and vapor compression refrigeration became, and still is, the most widely used method of cooling; However, the cost, size and complexity of refrigeration systems of the time, coupled with the toxicity of their ammonia coolants,
prevented the general use of mechanical refrigerators at home. Most households used iceboxes that were supplied almost daily with blocks of ice from a local refrigeration plant.⁴

Beginning in the 1840's refrigerated cars was used to transport milk and butter. By 1860, refrigerated transport was limited to mostly seafood and dairy products. The refrigerated railroad car was patented by J.B. Sutherland of Detroit, Michigan in 1867. He designed an insulated car with ice bunkers in each end. Air came in on the top, passed through the bunkers, and circulated through the car by gravity, controlled by the use of hanging flaps that created differences in air temperature. The first refrigerated car to carry fresh fruit was built in 1867 by Parker Earle of Illinois, who shipped strawberries on the Illinois Central Railroad. Each chest contained 100 pounds of ice and 200 quarts of strawberries. It was not until 1949 that a refrigeration system made its way into the trucking industry by way of a roof-mounted cooling device, patented by Fred Jones.

Brewing was the first activity in the northern states to use mechanical refrigeration extensively, beginning with an absorption machine use by S.Liebmann's Sons Brewing Company in Brooklyn, New York in 1870. Commercial refrigeration was primarily directed at breweries in the 1870s and by 1891, nearly every brewery was equipped with refrigerating machines. Natural ice supply became and industry unto itself. More companies entered the business, prices decreased and refrigeration-using ice became more accessible. By 1879, there were 35 commercial ice plants in America, more
than 200 a decade later, and 2,000 by 1909. No pond was safe from scraping for ice production, not even Thoreau’s Walden Pond, where 1,000 tons of ice was extracted each day in 1847. However, as time went on, ice, as a refrigeration agent, created a health problems, says Bern Nagengast, co-author of Heat and Cold; Mastering the Great Indoors (published by the American Society of Heating, Refrigeration and Air-Conditioning Engineers), “Good sources were harder and harder to find. By the 1890’s, natural ice became a problem because of pollution and sewage dumping.” Signs of a problem were first evident in the brewing industry. Soon the meatpacking and dairy industries followed with their complaints. Refrigeration technology provided the solution: ice, mechanically manufactured, giving birth to mechanical refrigeration. 5

Carl (Paul Gottfried) von Linda in 1895 set up a large-scale plant for the production of liquid air. Six years later he developed a method for separating pure liquid oxygen from liquid air that resulted in widespread industrial conversion to processes utilizing oxygen (e.g., in steel manufacture).

Though meat-packers were slower to adopt refrigeration than the breweries, they ultimately used refrigeration pervasively. By 1914, the machinery installed in almost all American packing plants was the ammonia compression system, which had a refrigeration capacity of well over 90,000 tons/day. Despite the inherent advantages, refrigeration had its problems. Refrigerants like Sulfur dioxide and methyl chloride were causing people to die. Ammonia had an equally serious toxic effect if it leaked. Refrigeration engineers
searched for acceptable substitutes until the 1920s, when a number of synthetic refrigerants called halocarbons or CFCs (Chlorofluorocarbons) were developed by Frigidaire. The best known of these substances was patented under the brand name of Freon. Chemically, Freon was created by the substitution of two chlorine and two fluorine atoms for the four hydrogen atoms in methane (CH₄); the result, dichlorodifluoromethane (CCl₂ F₂), is odorless and is toxic only in extremely large doses.  

In metalworking, for instance, mechanically produced cold helped temper cutlery and tools. Iron production got a boost, as refrigeration removed moisture from the air delivered to blast furnaces, increasing production. Textile mills used refrigeration in mercerizing, bleaching, and dyeing. Oil refineries found it essential, as did the manufacturers of paper, drugs, soap, glue, shoe polish, perfume, celluloid, and photographic materials.

Fur and woolen goods storage could beat the moths by using refrigerated warehouses. Refrigeration also helped nurseries and florists, especially to meet seasonal needs since cut flowers could last longer. Moreover, there was the morbid application of preserving human bodies. Hospitality business including hotels, restaurants, saloons, and soda fountains, proved to be big markets for ice. In WWI, refrigeration in ammunition factories provided the required strict control of temperatures and humidity. Allied fighting ships held carbon-dioxide machines to keep ammunition well below temperatures at which high explosives became unstable.
The basic components of today's modern vapor-compression refrigeration system are a compressor; a condenser; an expansion device, which can be a valve, a capillary tube, an engine, or a turbine; and an evaporator. The gas coolant is first compressed, usually by a piston, and then pushed through a tube into the condenser. In the condenser, the winding tube containing the vapor is passed through either circulating air, which removes some of the heat energy of the compressed gas. The cooled vapor is passed through an expansion device to an area of much lower pressure; as the vapor expands, it draws the energy of its expansion from its surroundings or the medium in contact with it. Evaporators may directly cool a space by letting the vapor come into contact with the area to be chilled, or they may act indirectly—i.e., by cooling a secondary medium such as water. In most domestic refrigerators, the coil containing the evaporator directly contacts the air in the food compartment. At the end of the process, the warmed gas is drawn toward the compressor. 

But the engineering principle on which it is based, mechanical refrigeration, has had even more far-reaching effects. Through both refrigeration itself and its close cousin, air conditioning. Taken together, these cooling technologies have altered some of our most fundamental patterns of living. Our daily chores are different. What we eat and how we prepare food have both changed. The kinds of buildings we live and work in and even where we choose to live across the whole length and breadth of the Country all changed as a result of 20th century expertise at keeping things cool.
By the end of the century all that had changed. Fresh foods of all kinds were available just about anywhere in the country all year round – and what wasn’t available fresh could be had in convenient frozen from, ready to pop into the microwave. The milkman was all but gone and forgotten, and the butcher now did his work behind a counter at the supermarket. Indeed, many families concentrated the entire week’s food shopping into one trip to the market, stocking the refrigerator with perishables that would last a week or more. And on the air-conditioning side of the equation, just about every form of indoor space – office buildings, factories, hospitals, and home – was climate-controlled and comfortable throughout the year, come heat wave or humidity. New homes looked quite different, with lower rooflines and ceilings, porches that were more for ornament than practicality, and architectural features such as large plate glass picture windows and sliding glass doors. Office buildings got a new look as well, with literally acres of glass stretching from street level to the sky scraping upper floors. Perhaps most significant of all, as a result of air conditioning, people started moving south, reversing a northward demographic trend that had continued through the first half of the century. Mechanical refrigeration, whether for refrigeration itself or for air conditioning, relies on a closed system in which a refrigerant – basically a compound of elements with a lower boiling point – circulates through sets of coils that absorb and dissipate heat as the refrigerant is alternately compressed and allowed to expand. In a refrigerator the circulating refrigerant draws heat from the interior of the...
refrigerator, leaving it cool, in an air conditioner, coils containing refrigerant perform a similar function by drawing heat and moisture from room air.

This may sound simple, but it took the pioneering genius of a number of engineers and inventors to work out the basic principles of cooling and humidity control. Their efforts resulted in air conditioning systems that not only were a real benefit to the average person by the middle of the 20th century but also made possible technologies in fields ranging from medical and scientific research to space travel.

Prominent among air-conditioning pioneers was Willis Haviland Carrier. In 1902, Carrier, a recent graduate of Cornell University's School of Engineering, was working for the Buffalo Forge Company on heating and cooling systems. According to Carrier, one foggy night while waiting on a train platform in Pittsburgh he had a sudden insight into a problem he had been puzzling over for a while – the complex relationship between air temperature, humidity, and dew point. He realized that air could be drier by saturating it with chilled water to induce condensation. After a number of experimental air conditioning installations, he patented Dew Point Control in 1907, a device that, for the first time, allowed for the precise control of temperature and humidity necessary for sophisticated industrial processes. Carrier's early air conditioner was put to use right away by a Brooklyn printer who could not produce a good color image because fluctuations of heat and humidity in his plant kept altering the paper's dimensions and misaligning the colored inks. Carrier's system,
which had the cooling power of 108,000 pounds of ice a day, solved the problem. That same principle today makes possible the billion-dollar facilities required to produce the microcircuits that are the backbone of the computer industry. Air conditioners were soon being used in a variety of industrial venues. The term itself was coined in 1906 by man named Stuart Cramer, who had applied for a patent for a device that would add humidity to the air in his textile mill, reducing static electricity and making the textile fibers easier to work with. Air-conditioning systems also benefited a host of other business, enumerated by Carrier himself: "Lithography, the manufacture of candy, bread, high explosives and photographic films, and the drying and preparing of delicate hygroscopic materials such as macaroni and tobacco." At the same time, it did not go unnoticed that workers in these air-conditioned environments were more productive, with significantly lower absentee rates. Comfort cooling, as it became known, might just be a profitable commodity in itself.8

Carrier and others set out to explore the potential. In 1915 he and several partners formed the Carrier Engineering Corporation, which they dedicated to improving the technology of air conditioning. Among the key innovations was a more efficient centrifugal (as opposed to piston-driven) compressor, which Carrier used in the air conditioners he installed in Detroit's J.L. Hudson Department Store in 1924. The first department store so equipped. Office buildings soon followed. Even as Willis Carrier was pioneering innovations in industrial air conditioners, a number of others were doing the same of comfort cooling. Beginning in 1899, consulting engineer Alfred Wolff
designed a number of cooling systems, including prominent installations at the New York Stock Exchange, the Hanover National Bank, and the New York Metropolitan Museum of Art. The public was exposed to air conditioning an masse at the St. Louis World’s Fair in 1904, the result of innovations in theater air conditioning by Fred Wittenmeier and L. Logan Lewis, with marqueses proclaiming “It’s 20 degrees cooler inside. “Frigidaire engineers introduced a room cooler in 1929, and they, along with other companies such as Kelvinator, General Electric, and York, Pioneered full air – conditioned homes soon after.  

Other companies, chief among them Kelvinator and General Electric, added their own improvements in a quest for a share of this obviously lucrative new market. By 1923 Kelvinator with automatic temperature control, held 80 percent of market share, but Frigidaire regained the top in part by cutting the price of its units in half – form $1,000 in 1920 to $500 in 1925. General Electric ended up as industry leader for many years with its Monitor Top Model – named because its top – mounted compressor resembled the turret of the Civil War ship – and with innovations such as dual temperature control, which enabled the combining of separate refrigerator and freezer compartments into one unit. 

Small but incrementally significant improvements continued as the century unfolded, making refrigeration and air conditioning systems steadily more efficient and more affordable – and increasingly widespread. The range of applications has grown as well, with mechanical refrigeration playing a role in everything from medical research and computer manufacturing to space travel.
Without, for example, the controlled, air-conditioned environment in spacecraft and spacesuits, humans would never have made it into space – or walked on the Moon – even with all the other engineering hurdles overcome. But most of us don’t have to go quite so far to appreciate the benefits of keeping cool. They’re right there for us, each time we open the refrigerator door and reach for something cold to drink.

**Safety First**

Despite the inherent advantages, refrigeration had its problems. Refrigerants like sulfur dioxide and methyl chloride were causing people to die. Ammonia had an equally serious toxic effect if it leaked. Frigidaire discovered a new class of synthetic refrigerants called halocarbons or CFCs (chlorofluorocarbons) in 1928, then part of General Motors, sewed up all the patents. It released CFCs in 1930. And despite its original intent to keep its patents proprietary, this was too big an invention to keep to itself, not to mention it didn’t have its own manufacturing facility. The entire industry was allowed to use the patents and refrigeration technology switched to these new “safe” agents like Freon (which have since been banned for harming the ozone layer).

Without the discovery of CFCs, says Nagengast, “Refrigeration wouldn’t have been pervasive”.10
Considering the size of India’s population of 1 billion plus, the size of the HCAC & R industry is relatively modest. Marketing gurus and economists estimate the population of the middle class with disposable income, anywhere in the region of 75 million to 150 million. These are the people who are buyers of refrigerators and more recently room air conditioners for the residential sector.

The “services sector” consisting of restaurants, small offices, banks, software centers are the major buyers of ductable split air conditioners and mini splits. Industry- nuclear power plants, large hotels, modern hospitals, shopping centers and office complexes are of central or “applied air conditioning equipment including centrifugal, screw, reciprocating chillers are units.

The dairy, chemical and pharmaceutical industries are the largest users of refrigeration plants while the vegetable storage, milk chilling and processed food sector are the major users of cold stores with equipment.11

Market research companies such as Francis Kanoi etc. have carried independent surveys but eventually they all have to depend on manufactures, their dealers and a large number of small man contractors, too numerous and spread out to get an accurate market. The figures given have been estimated from several sources and there can be small difference estimated by some companies.
The commercial refrigeration market is driven by the food and processed food sectors. Since these sectors are at an early stage of development and likely to expand, the commercial refrigeration market is poised for growth. Although India is one of the largest producers of fruits and vegetables in the world, it is estimated that more than 30% of this produce is wasted due to inadequate cold chain facilities. The Government is taking initiatives to develop the cold chain infrastructure, which will result in a steep rise in demand for refrigeration products.

Certain segments such as branded dairy products, ice-creams, soft drinks, bottled water, seafood and processed have grown sharply. Hotels, restaurants and national fast food chains are coming up in large numbers. The industry is undergoing a revolution with the emergence of shopping malls and large food stores selling all kinds of food items. With these encouraging developments the average growth rate of the refrigeration market, commercial and industrial, is expected to be 10%.
PIE-DIAGRAM 3.1

Refrigeration in India – Market Size

1850
400
1130
1250
4905

### Table 3.1

**Business of refrigeration in India**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Products</td>
<td>Rs. In Crores</td>
<td>Rs. In Crores</td>
</tr>
<tr>
<td>Cold Storages*</td>
<td>125.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Coolers (All Types)</td>
<td>490.5</td>
<td>390.0</td>
</tr>
<tr>
<td>Freezers (All Types)</td>
<td>113.0</td>
<td>98.0</td>
</tr>
<tr>
<td>Transport Refrigeration</td>
<td>40.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Industrial Refrigeration</td>
<td>185.0</td>
<td>245.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>953.5</strong></td>
<td><strong>853.0</strong></td>
</tr>
</tbody>
</table>

Source: [www.ramaindia.org](http://www.ramaindia.org). Accessed on 12/12/06
The approximate breakup of above main items is as follows:

**Table 3.2**

**Details of refrigeration business**

<table>
<thead>
<tr>
<th>Commercial Refrigeration</th>
<th>Rs. In Crores</th>
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<tbody>
<tr>
<td><strong>Cold Storages</strong></td>
<td></td>
</tr>
<tr>
<td>Halocarbon Refrigeration Systems only</td>
<td>50.0</td>
</tr>
<tr>
<td>Ammonia Refrigeration Systems only</td>
<td>75.0</td>
</tr>
<tr>
<td><strong>Coolers</strong></td>
<td></td>
</tr>
<tr>
<td>Drinking Water</td>
<td>110.0</td>
</tr>
<tr>
<td>Bottled Water</td>
<td>45.0</td>
</tr>
<tr>
<td>Visi (Display Type)</td>
<td>240.0</td>
</tr>
<tr>
<td>Bottle (Chest Type)</td>
<td>60.0</td>
</tr>
<tr>
<td>Reach – In – Refrigerators</td>
<td>2.0</td>
</tr>
<tr>
<td>Beverage / Juice Dispensers</td>
<td>10.0</td>
</tr>
<tr>
<td>Display Cases</td>
<td>5.0</td>
</tr>
<tr>
<td>Milk</td>
<td>15.0</td>
</tr>
<tr>
<td>Chocolate</td>
<td>1.0</td>
</tr>
<tr>
<td>Mortuary</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Freezers</strong></td>
<td></td>
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<tr>
<td>Deep (Chest Type)</td>
<td>90.0</td>
</tr>
<tr>
<td>Softy Ice Cream</td>
<td>3.0</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Hard Ice Cream (Batch Type)</td>
<td>2.0</td>
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<tr>
<td>Hard Ice Cream (Continuous)</td>
<td>4.0</td>
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<tr>
<td>Blast</td>
<td>10.0</td>
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<tr>
<td>Spiral</td>
<td>4.0</td>
</tr>
<tr>
<td>Transport Refrigeration &amp; Bus AC+</td>
<td>40.0</td>
</tr>
<tr>
<td>Total – Commercial Refrigeration</td>
<td>768.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industrial Refrigeration</th>
<th>Rs. In Crores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water / Brine Chiller packages up to 25 ton for industry</td>
<td>75.0</td>
</tr>
<tr>
<td>Environmental Test Chambers for temperature, RH &amp; Altitude</td>
<td>20.0</td>
</tr>
<tr>
<td>Water / Brine Chiller Packages up to 500 HP</td>
<td>90.0</td>
</tr>
<tr>
<td>Total – Industrial Refrigeration</td>
<td>185.0</td>
</tr>
<tr>
<td>Total – Commercial and Industrial Refrigeration</td>
<td>953.5</td>
</tr>
</tbody>
</table>

Source- www.ramaindia.org. Accessed on 12/12/06
COMPANY PROFILES

The sample companies’ viz., Voltas Limited, Blue Star Limited, Carrier Aircon Limited, Thermax Limited and Tecumseh Products India Limited. All are into refrigeration and air conditioning manufacturing side. These are popular with their own USP and also all of them are ISO Certified. The brief details of the five sample companies which are in top 10 positions in refrigeration and air conditioning industry. They are maintains the highest standards at national and international levels and simultaneously manufacturing and promoting refrigeration and air conditioning products.

VOLTAS LIMITED:

Voltas Limited, a Tata Enterprise was incorporated in 1954. Today, Voltas Limited is one of India’s premier Air – conditioning and Engineering Products & Projects companies with a global presence, offering engineering solutions for a wide spectrum of industries.

The Company’s strength lies in design and manufacture of industrial equipment, management and execute air conditioning and public work projects, sourcing, installation and servicing of technology – based systems, representation of global technology leaders, serving diverse industrial sectors and applications.

Voltas possesses total capability in the manufacture of room/split air conditioners, industrial air conditioning refrigeration equipment, water coolers, refrigerators, visicoolers, freezers, forklift trucks and large water pumps. Voltas is well known internationally as an engineering, procurement and construction
(EPC) contractor for electro mechanical projects, specializing in heating, ventilation and air conditioning, building management systems, lighting, communication systems, water management and pollution controls.

The sourcing and marketing operations of the company cover textile machinery, machine tools, mining construction equipment and industrial chemicals.

**Sales Turnover**
- Turnover for FY 2001–2002: Rs. 9,170 million
- Turnover for FY 2002–2003: Rs. 12,340 million
- Turnover for FY 2003–2004: Rs. 13,421 million

**Employee Strength**: 3935

**Office Locations**: Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Jamshedpur, Koch in, Kolkata, Lucknow, Mumbai, Pune.

**Overseas Offices**: Abu Dhabi (UAE), Doha (Qatar), Hong Kong, Singapore

**Factory Locations**: Thane, Dadra, Hyderabad.

**Operations:**

Volta’s operations have been organized into four business clusters. Each of these commands its own well defined infrastructure for market coverage and service to customers.
Unitary Cooling Products for comfort and commercial use:

- Cooling Appliances
- Commercial Refrigeration & Contract Manufacturing

Electro-Mechanical projects & Services:

- Air Conditioning and Refrigeration
- Electrical, Mechanical & HVAC Solutions
- Water Management & Treatment

Engineering Agency & Services:

- Machine tools
- Mining & Construction Equipment
- Textile Machinery

Others:

- Materials Handling Solutions
- Chemicals trading
- Engineering Products Trading
- Civil Construction

Air-Conditioning & Refrigeration Business Group:

AC & RBG enjoys a position of recognized leadership in comfort and industrial air conditioning. It has the distinction of being the only one in this field offering lifetime support for products as well as entire systems.

Voltas has set up air conditioning and refrigeration installations for automatic energy plants, chemicals and fertilizers, computer facilities,
electronics, hospitals, information technology parks, mercantile ships, multiplexes, naval warships, ordnance factories, pharmaceutical production, power plants, research laboratories, shopping malls, synthetic fiber plants, telecommunication facilities ... In fact, every conceivable application. Today, the division's key assets are its accumulated knowledge base in design, systems engineering, project management and installation expertise; as well as its well-established reputation in every sector of its extensive market.

That competitive advantage is maintained by incorporating the most advanced technologies through alliances, global leaders, and expanding in core competency areas such as building management systems, clean air, hygienic and several others.

The division offers the expertise to provide customized cooling solutions through a wide range of micro process controlled products, ranging from 5.5 tons to 1000 tons, which can be freely customized for virtually any application.

**International Operations Business Group:**

In its 19 years of operation, this Division has executed a multitude of successful integrated electro-mechanical contracts, in the Middle East market, in the former USSR and several other countries. Meanwhile, ventures have been set up in UAE, Saudi Arabia and Oman, draw strongly upon the Division's technical and managerial resources.

The roster of prestigious projects spans airports, hospitals, hotels, convention centers, technoparks, research and training centers, district cooling plants, commercial complexes, paled townships, railway complexes and

65
embassies. The Division undertook a detailed engineering process and then procured, installed, tested, commissioned a variety of equipment related to heating, ventilation and air conditioning, electrical, public, fire-fighting, integrated building management systems and specialized systems.

A recent triumph, demonstrative of the Division's prowess, was the engineering, supply, installation and testing of the air conditioning, electrical and hydraulic systems at Hong Kong's Check Lap Kok airport, valued at US $60 million. Another milestone was the Rs. 962 million Abu Dhabi World Trade Center project, covering the entire electric contract for phase 1. A couple of other prestigious projects executed in the recent past are, the KCRC - West Stations at Siu Hong and Tuen Mun, Conference Palace and Hotel Complex, Abu Dhabi, Al Udeid Air base Prc Qatar.

**Unitary Products Business Group:**

**Cooling Appliances:**

Voltas is the pioneer of cooling appliances in India. In fact, the Voltas name is often synonymous with air conditioners. Over the past four decades, over a million customers have put their trust and confidence in the Voltas range of air conditioners. This is a feat unmatched in Indian markets.

The company is constantly extending its range of activities, sharpening its professionalism and intensifying the personal touch, resulting in strong consumer loyalty for its products.

A range of window, split and Sensicool air conditioners are manufactured for the institutional and the retail segments. The range includes “Vectra”, the
economy model, and 'Vertis Dx', the premium brand, positioned as 'AC with IQ', the value-for-money best telling model, offering international quality at a very affordable price. All these are manufactured in a joint venture between Voltas and Feeders International Inc. of USA.

Voltas also markets a range of direct cool refrigerators under the 'Coldcel' brand name, as well as the Queer range of water coolers and dispensers, manufactured at the state-of-the-art plant at Hyderabad.

For all its ranges, Voltas has a service package that supports them. It offers a lifeline service, through its national wide network of service centers. Well - trained engineers, technicians and a fully computerized network respond system support each center. Additionally, Voltas enjoys the wholehearted support of a 270 – strong dealer base 700 retailers, whose good will and trust have been earned over the past four decades.

**Commercial refrigeration and contract manufacturing:**

Since its entry into the field in 1995, Voltas has achieved market leadership inc commercial refrigeration preservation, with a sophisticated manufacturing facility at Hyderabad which is opening new frontiers in low refrigerator manufactures for itself and some of the leading companies in India.

Voltas manufactures its own range of refrigerators, coolers and freezers, marked under the Coldcel brand. It also manufactures a range of direct – cooled refrigerators for Samsung India Electronics Ltd. And LG Electronics India Limited. The manufacturing unit is further equipped with a modern in –
house R & D infrastructure supports Samsung and LG in their product development.

BLUE STAR LIMITED

Blue Star Limited was founded in 1943 by late Mohan T. Advani, an entrepreneur of exemplary vision and drive. It started as a modest three-man operation, which was engaged in reconditioning of refrigerators and air conditioners. In 1969, Blue Star became a public limited company with its corporate headquarters in Mumbai.

Today, Blue Star is one of India’s largest central air conditioning companies, with an annual turnover of Rs. 6000 million, a network of 29 offices, three modern manufacturing facilities and around 1825 employees. It fulfills air conditioning needs of a large number of corporate and commercial customers and has also established leadership in the field of commercial refrigeration equipment ranging from water coolers to cold storages.

Blue Star’s other businesses include marketing and maintenance of hi-tech products. Blue star has business alliances with world renewed technology leaders such as York International, USA; Kalpak, USA; Vest frost, Denmark; and many others, to offer superior products to the customers.

Sales Turnover

<table>
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<tr>
<th></th>
<th>Turnover for FY 2001-2002</th>
<th>Rs. 5170 million</th>
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<tr>
<td></td>
<td>Turnover for FY 2002-2003</td>
<td>Rs. 6010 million</td>
</tr>
<tr>
<td></td>
<td>Turnover for FY 2003-2004</td>
<td>Rs. 7160 million</td>
</tr>
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</table>

Employee Strength : 1798
Office Locations: Bangalore, Bhopal, Bhubaneshwar, Chennai, Chandigarh, Goa, Indore, Jaipur, Kochi, Kolkata, Lucknow, Mumbai, Nagpur, New Delhi, Pune, Secunderabad, Vadodra, Thiruvananthapuram, Visakhapatnam.

Factory Locations: Thane (Maharastra), Bharuch (Gujarat), Dadra

Manufacturing Facilities:

The company has three modern plants, which are integrated with an ERP system that ensures operational efficiency. The plants make extensive use of IT to enhance productivity and product development capabilities.

Dadra Plant:

This state-of-the-art automated plant manufactures packaged air conditioner, ducted split air conditioners; mini split AC's, window AC's, vertical air handling units and fan coil units. The plant is also an OEM supplier to other companies who sell under their own brand names in the domestic and export markets.

Thane plant:

The plant manufactures a wide range of chillers – reciprocating, scroll and screw for central air conditioning applications. It also manufactures PUF panels and refrigeration units for prefabricated cold storages and mortuary chambers.
**Bharuch Plant:**

The plant manufactures a wide range of drinking water coolers for local and export markets and both single as double as skin air handling units for central air conditioning systems. The plant has recently initiated manufacturing deep freezers for commercial applications.

**Turnkey Contracting of HVACR System:**

The Company adds value of its wide range of manufactured products providing turnkey customized cooling solutions for all types of commercial, institutional and industrial buildings such as offices, shopping malls, multiplexes, the software industry, hotels and healthcare.

In the refrigeration field, the company provides turnkey solutions for all sizes of cold storages and refrigerated warehouses, including controlled atmosphere storage rooms, by utilizing its resources for manufacturing PUF insulated panels as well as refrigeration equipment.

**Maintenance and Services of HVACR Systems:**

The company provides comprehensive service facilities to all its customers for:

- Central Plants catering to large air conditioning systems, which were mainly designed, engineered and installed directly by the Company
- Packaged Air conditioners including ducted splits mostly through the Company’s dealer network.
• Room Air conditioners, split air conditioners, water coolers, deep freezers and cold storages through a network of dealers and service associates.

As part of its after-sales service offerings, the company provides regular preventive maintenance, life-long enhancement services, revamping and retrofitting.

CARRIER AIRCON LIMITED:

The air conditioning industry started with Carrier, Willis Carrier founder of Carrier Corporation invented air conditioning in 1902. Carrier Corporation, U.S today is the pioneer leader in air conditioning in the world with operations spanning over 171 countries with 108 plants across continents and 20 key engineering centers.

Carrier today, is India’s leading air conditioning company and complete air conditioning solutions. The Carrier promise is one of high quality air conditioning solutions through technologically superior products backed by unbeatable service.

Quality:

50 quality checks on every air conditioner: Carrier believes in total focus on quality. Stringent quality cont carried out on components to ensure low maintenance costs. Over 50 quality checks are conducted on a single Conditioner.
Complete Air – Conditioning Solutions:

Wide Range of Options: Carrier ensures that their consumers have options in all segments of the Indian air conditioning market through a comprehensive range of products.

The Carrier products span Window Air – conditioners, Ducted splits, Non-ducted splits and chillers with capacities ranging from 0.75 tone to 750 tones and have been designed to meet every consumer’s air – conditioning needs.

Reliable Products:

Carrier offers products, which are energy efficient, have state of the art features, uni-cooling power and highest quality standards thus providing unquestionable reliability to the consumers.

Global Technology:

The cornerstone of the Carrier promise is its continuous pursuance of better technology, Carrier products are designed with global technology that has tested and customized to deliver the performance in the toughest of Indian conditions. Today, the company offers state of the art of technology, which includes rotary, reciprocating and screw compressors.

Customized to local needs:

The Carrier products are supported by intensive R & D investments in technologies. In India, The Willis Carrier Engineering Center has been set up innovate and develop new proc and upgrade existing ones according to local conditions to ensure that they deliver the best performance.
**Widest Service Network:** Carrier strives to provide unbeatable service and a quick response to its through a unique network of exclusive dealers, highly trained service engineers and strong selling and service points in all regions of the country.

Carrier has the widest service network in India of highly skilled, well-trained and experienced engineers. Carrier personnel strive to provide excellence in service.

**Training and Guidance:**

The Carrier Training Institute provides training to Carrier and dealer service continuously to enhance their technical skills and capabilities. The Carrier servicing team focuses on meeting needs of the consumer without any compromise.

**Largest Network:**

Carrier has the largest network of air conditioning dealers in India and is present in multi-brand outlets too.

**Partnership and support:**

Carrier thrives on proactive participation between management, employees, channel partners and customers. Distribution model is based on feedback, support and recognition, which allow them to hear the needs of consumer and consistently deliver highest standards of service.
Comfort Points:

Carrier has introduced the concept of Comfort Points in India. These are showrooms, which exclusively show and provide guidance and service Carrier products.

Sales Turnover : Turnover for FY 2001–2002 : Rs. 3180 million
                Turnover for FY 2002–2003 : Rs. 3030 million
                (Till December - 2002)

Employee Strength : 925

Office Locations : Chandigarh, Delhi, Kolkata, Pune, Mumbai,
                   Ahmedabad, Bangalore, Chennai, Lucknow,
                   Hyderabad.

Factory Locations : Gorgon, Daman, Bangalore

HVACR Activity : Manufacturing, Marketing, Maintenance,
                 Service

Manufacturing Activities:

The company manufactures a wide range of air conditioning and refrigeration products and equipment at its manufacturing plants in Gorgon (Haryana) and Bangalore. The Gorgon plant manufactures products & equipment for air conditioning applications while the Bangalore plant manufactures products for refrigeration applications.
THERMAX LIMITED

Thermax Limited is a technology driven US $ 150 million conglomerate which specializes in providing complete solutions in the areas of Energy, Energy conservation & Environment preservation. For over three decades, there is one of the few companies in the world that offers innovative integrated solutions in the core sector of energy environment. It strongly believes in the philosophy, “The Environment and the Economy’s prime mover – En can be considered as the two sides of the same coin”.

Thermax enables corporate to be energy efficient and environment – friendly thus contributing to the industry bottom line and the growing global effort towards sustainable development.

**Process Heat Division:** The boiler and heating business of “ Thermax provides heat for industrial and commercial requirements.

**Absorption Cooling Division:** This division deals with the Vapor Absorption Technology, which takes care of cooling needs of the customers.

**Water and Waste Management Division:** The Division at Thermax offers single window alternatives ecological treatment of air pollution, industrial waste and residue. Through pioneering technology.

**Chemical Division:**

The Chemical Division specializes in manufacturing chemicals that acts as adjuvar ingredients that better a production process. The division has over a decade of experience with various industry needs. With technological expertise
in manufacturing and research, the division is proficient to offer a wide range of chemical suitable to a spectrum of industries.

**Thermax National Network:**

- Kolkata
- Mumbai
- Ahmedabad
- Baroda
- New – Delhi
- Chennai
- Bangalore
- Hyderabad

**Thermax Worldwide Networks:**

In order to cater the customers Thermax has wide network of Services Centers as well as Sales Offices in India as well as Overseas. We have offices in the following places.

- USA
- U.K
- Russia
- Dubai
- Saudi Arabia
- Kenya
- Nigeria
- Indonesia
- Bangladesh
- Sri Lanka

**Sales Turnover** : Rs. 7000 Million (Group Turnover)

**Employee Strength** : 1200

**Exports** : USA, Europe, Middle East Asian Countries
Joint Ventures: Babcock & Wilcox, Culligan International & Energy Performance System

Tie Ups: Kawasaki Thermal Engg. Co., Japan, Eco-Tech, Canada, Bloom Engg., Germany, Honeywell, USA, Sruther Wells, USA

Main Activities:

- They are manufacturing and marketing of Vapor Absorption Machines only.

- Through their wide network and experience we provide Maintenance and service of our machines.

Manufacturing Activity:

Starting with a factory of 5000 square feet, as Wanson India Limited in 1967-68, today the total manufacturing area is around 1,45,000 square meters spread over 14 plants. Vapor Absorption Chillers are manufactured as its manufacturing plant at Chinchwad, Pune. The plant is well equipped with state-of-the-art facilities for plate bending, cold rolling, hot rolling MIG/MAG/TIG/Spot/Submerged arc and other welding processes, CNC coordinate drilling/milling and physical, chemical and non-destructive testing facilities. The manufacturing plant conforms to the national and international standards such as ASME, ‘R’, ‘S’, ‘U’, stamps and codes like ISQ, IBR, DIN, GOST, BS, ABS etc., The manufacturing facilities have been inspected by renowned agencies like Lloyds, Bureau veritas, SGS, EIL & TUV. A group wide TQM movement was initiated in 1993 and it received ISO9001, ISO9002 &
ISO9003 certifications as a result of this integrated approach towards quality assurance and environmental managing system.

**TECUMSEH PRODUCTS INDIA LTD.**

**History & Profile:**

Tecumseh Products India Limited (TPIL) is a fully owned subsidiary of Tecumseh Products Company – USA (TPC);

TPC entered India through acquisition of SIEL Compressors Limited and the Compressor Division of Whirlpool India Limited in July 1997.

Since acquisition, TPC has invested about US $ 85 million in India.

Tecumseh Products India Limited (TPIL) is the largest independent manufacturer of both Air- Conditioning Refrigerator Compressors in India. Tecumseh Products India Limited is the largest manufacturer of compressors in the country. It has two state-of-art manufacturing facilities at Hyderabad (Andhra Pradesh) and Ballabgarh (Haryana).

The plant at Hyderabad manufactures compressors for air-conditioning applications with a current capacity of million per annum which has been expanded to 0.6 million. Its new US $ 30 million facility at Ballad Manufactures compressors for refrigerators. This manufacturing facility for eco-friendly non-CFC based proc currently has a production capacity of 1.5 million units per annum.

Both plants have ISO 9001 Certifications. The AW ranges of air-conditioning products also have UL and VDE proc certifications.

Tecumseh India is a 100% subsidiary of Tecumseh Products Company (TPC), USA, which is the world’s only line, independent manufacturer of
compressors. The US $ 1.4 billion company, TPC has 29 manufacturing locations in 4 continents. In India the company has 20 sales offices and an extensive network of over 200 dealers and than 640 registered small-scale manufactures.

Tecumseh has notched up significant increase in business volumes and expanded customer base in the last years, including overseas customers.

**Sales Turnover** : Turnover for FY 2001-2002 : Rs.3500 Million  
(US $ 75 million)

**Employee Strength** : 2111

**Office Locations** : Hyderabad, Delhi, Mumbai, Calcutta, Pune,  
Chennai, Chandigarh, Ahmedabad, Silvia,  
Bangalore, Cochin, Nodia, Bhubaneshwar,  
Pondicherry, Nagpur.

**Factory Locations** : Hyderabad (Andhra Pradesh),  
Ballabgarh (Haryana)

**Main Activities:**
- Manufacturers and market hermetically sealed compressors for Air-Conditioning and Refrigeration application.
CHALLENGES FOR AC & REFRIGERATION INDUSTRY

Competitiveness is defined as the ability to add value better than the others in the globalised economic environment. In other words, for the Indian AC & R industry to succeed, it should be able to add value better than its competitors across the globe. Despite the poor infrastructure, there is growing sentiment that India can do it. They have made rapid strides in manufacturing and service sectors, and international community in admiring many of Indian companies. They indeed believe that India can become the global economic powerhouse, and can rival China as the world’s factory. They believe that India can become a major exporter of the AC & R equipment.

A recent report by McKinsey comprehensively addresses the status of the global and local trends, and an action plan for the industry to achieve rapid growth. It also outlines what the Government can do to promote growth of this vital industry. So that it can fulfill its potential to preserve food, increase productivity and contribute to the quality of life. But, the challenges are many. Compared to the stature our industry has it most countries including the developing Asian Countries, the Indian AC & R industry still has a long, long way to go. To become a major exporter, we need, primarily, scale of manufacture. To acquire scale, we need a large domestic market, which they need to build.

Just take a look at some of the numbers. The penetration of household refrigerators in India, the fifth largest consumer durable in terms of penetration, is 13% compared to well over 90% in Malaysia, Australia, Singapore, Hong
Kong and Korea; around 80% in Thailand; close to 40% in Philippines and China and 20% in Vietnam and Indonesia.

The penetration of household air conditioners is abysmally low in India at around 1% compared to 20% in Indonesia, 24% in China, 40% in Thailand, 45% in Malaysia.

Commercial refrigeration has low penetration, commercial ACs has moderate penetration and cold chains are still at a nascent stage. People will get a better feel of what they are talking about what people compare the annual commercial sales of HVAC and refrigeration equipment in the US at US $200 per capita and in China at US $3 per capita with a dismal US $ 0.25 per capita in India.

The McKinney report recommends that for unlocking the huge potential in this huge tropical country, they have to make the air conditioners more affordable. This would mean bringing down the initial as well as running cost.

There is a need to bring down the excise duty from the current level of 32% to 16%. Just look at China. In China, in the last decade alone, the market for air conditioners grew from 6 to 22 times of the Indian market and today, China is the largest manufacturer and exporter in the world with a CAGR of 46% in the last 11 years. China in leading due to the economic reforms, dominance of domestic brands, export competitiveness due to large – scale operations for domestic market itself, and above all lower prices leading to increased affordability. The lower prices are possible, since in China there is a single VAT of 17%. As against this, in India, the total tax component is 46% of
the market-operating price. They have assured the Government that reduction of excise duty on air conditioners from 32% to 16% will be tax positive for the Government, as they have demonstrated in the past.

There is yet another issue related to the legislation. Through an amendment to the CST, Government has withdrawn the sales tax concessions earlier granted to industries setup in backward areas such as Dadra. On the other hand, excise duty exemption is being granted at J & K, Assam and Himachal Pradesh. For the growth of the industry and its competitiveness, fragmentation is detrimental. Instead, the Government must encourage large-scale operations.

The Refrigeration and Air – Conditioning Manufactures’ Association (RAMA) is committed to the recent legislation of Energy Efficiency, and is in the process of finalizing the testing procedures with The Bureau of Energy Efficiency. However, the non-availability of proper testing facilities will hamper their progress in the long run.

Let them look at the Commercial Refrigeration market. Cold chain infrastructure in the country is poor, and horticultural produce worth Rs.30,000 cores is wasted annually. It is strange that the Water Cooler market is stagnant for over a decade. The quality and affordability of Bottled Water is questioned, and the market for Bottled Water Dispensers is very small in comparison, with global standards.

They have a long way to go in terms of customer education. The usage and application of products itself is questionable. They come across retailers
using deep freezers for storing bottles as well as butter and many other products, which are not supposed to be stored in the freezers. The consumers do not use several innovative features that are available.

Yet another area of concern is the unorganized service industry. The importance of service itself will have to be highlighted to the consumers and they have to transform the industry, to an organized one with educated trained technicians, proper tools and tackles and safety equipment.

The country also lacks standards in terms of building codes such as ceiling heights. It is not only the Government, which will have to act, but also the builders, architects, consultants and industry players.

By their working together, they are confident that they can grow this industry at least 3 to 5 times faster than it has grown in the past.
REFERENCE:


11. Cold and chilled Storage Technology Edited by Clive V.J. Dellino published by Blackie and Son Ltd. Glasgow, U.K.