History and current development of steam turbine production in Brno
Dear Readers,

You are now opening a new edition of a book that I personally love and I believe that you will share my feelings about the book.

We always look forward in our plans. We imagine what we will do, how and when, what we would like to achieve and we often forget about what has already been achieved, what we have participated in or what we can read about in memoirs that can be an important part of our lives - lessons learned from the past.

The moment when my predecessors and colleagues first got the idea to publish this book was a fortunate one and I dare to say that it should be included in the overview of important events you will further go through.

We are very proud that we can inform you about the unique company that produces and maintains turbines and that is today a respected part of the top Siemens concern.

Regrettably, not all the colleagues you will read about in this book are still among us. However, they left an unforgettable legacy and I think it is our responsibility to maintain and develop this legacy for future generations in the same way so that our successors may proudly profess to this excellent plant as we do.

The context and relations of the events in the company to the events in our country and in the world have their significance. We are all influenced by what is happening around us and we also influence our surroundings in the same way. When I look at the history of our company I see that the influence of our company has always been positive thanks to its innovativeness, human potential and top work performance. As our products that have left the gate of our plant have found use on all inhabited continents, I believe that I can say that we have also helped develop various industries in countries where our products have been installed.

It has been a long time since the “century of steam” ended but we wish that technology also finds its significant application in the current one.

I wish you pleasant reading and a lot of success in implementing your plans.
FIRST TURBINES USED IN INDUSTRY

1885–1898  Charles Algernon Parsons, Newcastle-upon-Tyne, England
1895–1898  Carl Gustav de Laval, Stockholm, Sweden
1897–1898  Auguste Rateau, La Courneuve, France
1896   Charles Curtis, General Electric, USA
1900   BBC-Baden, Parsons system, Switzerland

Charles Algernon Parsons created a double-flow fifteen-stage reaction turbine (10 PS, 17,000 rpm) in 1884. Later, the speed was reduced to allow direct power output. The practical use of turbines had begun.

Giovanni de Branca directed a steam jet onto a bladed wheel in 1629, thus inventing an impulse turbine.

The priests of ancient Egypt used the so-called Hero’s globe, which operated on the reaction principle, as early as 320 B.C.

Carl Gustav de Laval invented a single-stage impulse turbine in 1883. The turbine operated at 36,000 rpm with a circumferential speed of 400 m/s. de Laval’s turbine was used in a practical application much later.
Fundamental socio-economic changes occurred in the second half of the 19th Century in Moravia and Silesia, the eastern part of the Czech Kingdom of the Austro-Hungarian Monarchy. The originally agricultural lands became industrial-agrarian areas. Two new industrial centres were established – one in Brno and the other in Ostrava. Due to the mining of quality black coal and iron ore, the Ostrava region developed into a centre for the iron and steel manufacturing and the heavy machinery industry. As early as the second half of the 19th Century, Brno was renowned for its textile industry, with the engineering industry growing extremely rapidly around 1900. The link to the main railway lines and roads to Vienna and Budapest provided another powerful stimulus for rapid industrial development of the city and the surrounding areas. The opening of the German-Czech Polytechnic in Brno in 1850, which was later converted to a German university, and the establishment of a Czech technical university with a mechanical engineering faculty in 1889, had a significant impact on the further development of industry. At that time Brno became a recognised developed industrial centre with the corresponding cultural and social infrastructures.

První brněnská strojírna (PBS) was established at that time and is connected directly with our story of manufacturing steam turbines. The beginnings of the company date back to 1814, when a small engineering workshop specialising in the repair and manufacture of textile machinery was established in Slapanice u Brna in a converted local textile factory. Its founders, Jan Reiff and Jindřich Luz, came from Württemberg. The engineering factory soon extended its production programme to include the manufacture of other equipment, mainly steam boilers and steam engines. In 1824 Jindřich Luz produced the first steam engine, a model of which is exhibited in Brno's Technical Museum. Output of the early manufactured steam engines was around 8 PS at 40 rpm and the pressure of the inlet saturated steam up to 6 bar. Luz also made the first steam boiler in the same year. In 1837 Luz moved the plant from Slapanice to Brno, where he significantly expanded the production programme. In 1872 Luz's plant merged with Bracegirdl Engineering and became a joint stock company called První brněnská strojírna (First Brno Engineering Works). The excellent technical level of its products, rapid industrialisation and commercial success helped the company to expand rapidly.

In 1900 the company merged with Wannicke Engineering and PBS became the largest engineering company in Brno. After further mergers with Pauker of Vienna and Röck of Budapest, PBS grew to become one of the leading engineering corporations in the Austro-Hungarian Monarchy. The company made top level equipment mainly for the food, chemical and power-generation industries. It was the largest manufacturer of steam boilers and steam engines in the Austrian Empire and later also became the largest manufacturer of steam turbines.

Starting on January 1, 1900, a new currency, the Crown, was introduced in the Czech lands to replace the former Zlaty. At the beginning of the year, Czech coal miners went on an all-out strike: 80,000 miners were on strike and the strike lasted until the end of March. The new government led by E. von Koerber focused on solving economic problems, but language and cultural issues were neglected. At the end of 1900, elections to the Reich Chamber took place with little interest of voters; no major changes in the composition of the Chamber resulted.
Our story about turbine making in the city of Brno is one hundred years old. It all started back in 1900. At the Paris World Exhibition held under the Eiffel Tower, several inventors introduced the enthusiastic crowds to their functional steam turbines of various designs and construction. These were no new inventions, as the Swede Carl Gustav Patrick de Laval had patented his design based on nozzles positioned opposite a single impeller in an impulse turbine back in 1883, and the Briton Charles A. Parsons had constructed a turbine of fifteen blade stages arranged in series and placed in two casings, where steam went through from the centre to both ends in 1884. At the Exhibition, a French engineer named A. Rateau introduced a multiple-stage steam turbine which he had patented in 1896. And just a year earlier an American, Charles Curtis, patented an impulse turbine with two or three impulse stages and a vertical axis of rotation, which worked with a large heat drop. Steam turbines became the absolute hit of the Paris Exhibition.

Since that time steam turbines started forcing out reciprocating steam engines, until then used to drive dynamos and generators. In spite of all its design limitations compared to the steam engine, the steam turbine had better efficiency and output. The new mechanical drive design, based on the rotary principle, was a revolutionary solution.

In 1900, at the beginning of our story, První brněnská strojírna (PBS) already had a history of successes. At the Paris Exhibition the company was awarded a Gold Medal for a steam engine with a new regulation system, designed by the Brno inventor Hugo Lentz. However, PBS engineers were fascinated by the reaction turbine exhibited by C. A. Parsons. By 1896, Parsons had already manufactured in Great Britain 60 turbines with a total output of 40,000 PS. The first steam turbine in Continental Europe was installed in 1900, and it used the Parsons’s concept. PBS managers Lohenstein and Hnevkovski and their colleagues had already realised before the Paris Exhibition the development potential and benefits of the steam turbine. There was practically no limit to the increase of the nominal output. Turbines could use steam of considerably higher pressures and temperatures and achieve better efficiency. The exhaust steam was clean – it did not contain oil – and thus could be used in technological processes. Not only did they offer lower operating and maintenance costs, but also the new machines lasted longer and were more reliable. The PBS representatives reacted quickly and even at the Paris Exhibition started negotiating a licence agreement with C. A. Parsons. Encouraged by their past successes in the manufacture of machinery and power generation equipment in one of the largest engineering factories in Moravia, the PBS representatives were convinced that they would be able to master the production of new steam turbines.
The First Turbine Produced in Brno

Parvni brněnska strojírna (PBS) representatives had started licencing negotiations immediately at the World Exhibition in Paris with C. A. Parsons and thus they got ahead of other European producers that still did not believe in steam turbines. As early as August 20, 1901 Parsons signed a licence agreement on founding a new company Österreichische Dampfturbinengesellschaft - the Austrian Steam Turbine Company. This document authorised the company to produce and deliver steam turbines of the Parsons system to the lands of the Austria-Hungarian Empire and the Balkans. The company, whose chairman of the board of directors was PBS’s director Ludwig Lohnstein, assigned all the rights resulting from the licence agreement to Prvni brněnska strojírna in Brno.

Immediately after the contract had been signed, work started on the design. The first steam turbine of the P (Parsons) system was produced in 1903. It was introduced at the General Industrial Exhibition in Ústí nad Labem where it greatly interested visitors and led to the first business contacts. After the exhibition, this turbine was installed in the testing room in the “Vañkovka” plant where it remained in operation until 1930.

PBS had already established an excellent reputation from their good results from their steam engines. They helped the company to win the confidence of customers in their steam turbines. In 1903 the company won orders for 10 turbines with a total output of 7,150 PS and in 1904 for 17 turbines with a total output of 33,070 PS.

The introduction of turbine production had a big impact on PBS’s production level. Turbines laid greater demands on precision for production and erection. Unlike steam engines, the turbines required brass and bronze turbine blades, which were fixed in rotors. Compared with other machines of the time, the high rotor speeds resulted in problems with balancing and vibration. Other features included rotor bearings, contactless seals and the very small radial clearance between rotor and stator. After a short training period for several technicians and workers at Parsons in Great Britain, the quality of turbine production in Brno exceeded that of the parent plant.

What is the meaning of PS abbreviation?

We have used the unit “PS” in the text as the output unit used by turbine designers in Brno until 1925. The following represents horse power: 1PS = 0.7355 kW.

A blading plan from 1902.

A Parsons’ condensing steam turbine.

Ludwig August Lohnstein
The Managing Director

August Hnevkovski
The General Director

Minerva technologies laid the foundation of many future outstanding experts famous all over the world.

“Rusalka”
(A Water Nymph)
composed by Antonín Dvořák
directed by Karel Kovařovic had its opening night in the National Theatre in Prague in March 1901.

The first Czech sportsman to beat a world record was František Janda-Suk, an athlete and discus thrower, who threw 39.42 meters.

G. B. Shaw wrote “Pygmalion” in 1905.

Henry Ford established the Ford’s Automobile Works. He constructed his famous Model T in his assembly line in 1908. It was an automobile, which had, according to legend, one gusset beneath the body and which started the spirit of mass motoring in the U.S.A.

A German Graf Zeppelin carried out the first airship flight on July 2, 1900.

The Lumier Brothers developed the first three-colour photograph in 1903.

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Output of 150 PS, 3,500 rpm, inlet steam 9 bar/180 °C.

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Hubert Booth invented the first practical vacuum cleaner in 1901.
A Czech doctor Jan Janský discovered four basic blood types in 1907 making blood transfusion possible.

The Emperor Francis Joseph I approved a set of the voting laws in 1907, by which universal and equal suffrage was introduced throughout Austro-Hungary.

The Czech Hockey Confederation was founded on November 8, 1908. It associated 12 clubs, 10 of which were based in Prague. In January 1909 a seven-member team composed of Prague hockey-players participated in the ice-hockey tournament in Chamonix for the first time.

Viktor Ponrepo, proper name Dismas Šlambor, opened “A Theatre of Live Photographs” in Prague in 1907. He therefore founded the first permanently operating cinema in the Czech lands.

Hollywood was established in Los Angeles, California in 1907. Several interconnected film studios grew into the factory for entertainment and dreams over the next few years.

Lord Baden Powell founded the Boy Scout Movement in 1907. After initial distrust of the conservative British scouts gained backers all over the world by their stress to honesty, fairness and love to God and nature.

Rudyard Kipling, the author of the Jungle Book, became the laureate of Nobel Prize for Literature in 1907.

The first transfer of a photograph by using an underwater cable between Paris and London was carried out on November 8, 1907.

Who was Aurel Stodola?

Professor Aurel Stodola was employed in Eidgenössische Technische Hochschule in Zürich, Switzerland. He was born in Slovakia in Liptovský Mikuláš. After he graduated in Budapest and Zürich and after practical experience in the Bohemian-Moravian Engineering Plant and the company Kastian a spol. in Prague. His career culminated in his work at the Technical University in Zürich in 1882 where he lectured on thermal machines until 1929. While working at the Technical University, he contributed, in his theoretical and experimental works, to the development of steam and gas turbines including control systems more than anyone had done before him. Due to his publications and influence on developments in the turbine industry, he is considered as the authority on turbine to this day. His best-known book was “Dampf und Gasturbinen” (Steam and gas turbines) issued in many publications.

Steam Turbine of the PB – První brněnská System

BIS soon became independent in designing steam turbines. Licensed turbines, i.e., purely reaction multi-stage turbines were too long and for example they could not fit transversely in the machine hall of the power plant in Vienna where they should have replaced the existing steam engines. In 1907, therefore, the chief designer of turbines Julius Fürstenau replaced several first reaction stages of the Parsons turbine with a Curtis-wheel. Thus, an original design of the PB – První brněnská came into existence and was favourably appraised, e.g. by Professor Aurel Stodola. It was soon used by other foreign firms as well and later was extended in numerous applications.

A detail of the blading plan with a Curtis wheel of the PB – První brněnská System. A detailed drawing of 1907.

Blading is the main part of the turbine steam path. It consists of stages. Each stage includes two blade rows: the stator blade row and the rotor blade row. Kinetic energy arises in nozzles by means of separation of the flowing medium. Nozzles ensure speed and definite direction of the medium. Kinetic energy of the medium is transferred to active surfaces of the rotor blades where the forces and moments are imparted to the turbine rotor resulting in its rotating movement. Turbine stages of two principles are used in practice: the impulse stage with fixed and adjustable nozzles, and the reaction stage with a drum rotor. In the impulse stage, expansion of the medium occurs only in the stator blading. Rotor blades utilise the kinetic energy of the flowing medium. In the reaction stage, expansion of the medium occurs only in the stator blading. Rotor blades utilise the kinetic energy of the flowing medium. In the reaction stage, expansion of the medium occurs only in the stator blading and the rotor blades.

Comparison of the turbine rotor lengths of the Parsons reaction turbine and the PB První brněnská turbine with a Curtis wheel.

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A Frenchwoman Elise de Laroche took off with her twin-engine airplane Voisin to become the first woman to fly an airplane. On October 22, 1909 she succeeded in flying a distance of 300 meters. Elise de Laroche was also the first woman to obtain a pilot’s license and the license to fly an airplane.

In 1910 the South American tango was becoming increasingly popular in the U.S. and Europe. Slavery was abolished in China in 1910.

From 1905, steam turbines were also installed on ships and for example the passenger steamer Carmania was at that time equipped with a turbine with an output of 21,000 PS on a propeller shaft. This use of steam turbines did not escape notice in the firm either.

According to special licence agreements, Parsons provided the Austrian steam-turbine company with the rights to produce steam turbines for the navy and the commercial fleets of the Austro-Hungarian Empire. These rights were later acquired by TBS as well. The Brito-Engineering Company had partly transferred the licence rights to an Italian firm Stabilitonimento Tecnico Frascati and between 1940 and 1918 together they delivered 133 marine steam turbines for Austro-Hungarian battle ships, cruisers and commercial ships with a total output of 150,000 PS. This gives us the opportunity to direct our attention to the considerable increase in output. Turbines intended for direct drives had a maximum output of 25,000 PS and 350 rpm, turbines for auxiliary purposes had an output of max. 500 PS max. and they drove on-board DC electric generators.

The technical specifications of steam turbines for marine systems contained a number of requirements for design, production and tests in factory testing rooms. The manufacturers had to resolve the problems of turbine operation under null and pitch and in reverse mode.

Well-known ships included cruisers of the Viribus Unitis class – the Viribus Unitis itself, the Prinz Eugen, the Szent István and Tagetthoff. The ships were 152 m long, 24.3 m wide with a draught of 8.8 m. Displacement was 20,013 tonnes. The ships were driven by Parsons turbines. Each was equipped with 12 coal-fired boilers and turbines with a total output of 27,000 PS. Driving units enabled ships to reach a speed of 20.3 knots. The ships’ range between refuelling was 4,200 nautical miles. The appearance of the Austrian ships - dreadnoughts - was very elegant. The main deck ran in a single line, deck structures were closed, ships had two chimneys standing close to each other in the ship centre and two symmetrically located combat masts.
The Brno Engineering Company drew extraordinary world attention in 1911 by design of the combined-blading turbine, designated as PBP – První brněnská Parsons. Designers Karl Krischke and Franz Lösel replaced the Curtis wheel and several of the reaction stages that followed with impulse stages with full admission. The low-pressure section continued to be of reaction design and the length of the rotor was shortened. The design utilised the advantages of impulse as well as reaction principles of turbine stages. The nozzle groups control with partial admission was implemented, thus the turbine reached a high efficiency at a partial output as well. Prof. Aurel Stodola described the PBP system and rated it as the best in the world.

In March 1916, PBS published the results of measurements from operation on a 1 MW turbine and in September 1917 on a 12 MW turbine in the Simmering power plant in Vienna. Internal efficiency reached values above 75 % and for the low-pressure section up to 80 % for condensing turbines with an output of over 5 MW.

The principle of the combined-blading turbine is used in the Company and other turbine producers in many versions to this day, particularly for condensing turbines and turbines with controlled extractions. The drum rotor was hollow and rigid with its critical speed sufficiently high above operating speed. Its bolted design was patented. The balance piston according to Prof. Fullagar and the external rotor seals were contactless – of the labyrinth type. Progress had also been made developing the condensers. The fixing of rotor blades with a shaped pressed root and a brass spacer was also patented.

From 1906, turbines using exhaust steam from steam hammers, induction turbines using high pressure and low-pressure steam, back-pressure turbines and condensing turbines with heating extraction were also developed and produced in addition to condensing turbines. The unit output of turbines was increasing and for condensing turbines using 12 bar/300 °C for inlet steam it reached 12,000 PS at 1,440 rpm in 1911 and 20,000 PS at 2,880 rpm in 1918.
Development of Co-generation Equipment

Co-generation, or the parallel, simultaneous, combined generation of electricity and heat, was a concept promoted by PBS since the first decade it started manufacturing steam turbines. Although the first steam turbines were designed to generate electricity in industrial and public power plants only as early as 1906 the Brno Engineering Company made the first dual-pressure turbines utilising waste steam from steel works, and the first back-pressure turbines supplying not only electricity to local grids, but also steam for technological processes in sugar mills, paper mills and chemical plants. These were followed by condensing turbines with bleeds for heating and boiling, and from 1909 onwards also by condensing turbines with controlled extractions. When co-generation for the utilisation of heat became widely accepted in Europe in the 1920s and 1930s, PBS was there again. An example is the combined Brno Heat and Power Plant, initiated by Vladimir List based on his experience in the Helgate Heat and Power Plant in New York. The new plant, designed and built in 1929–1930, supplied the city with heat and replaced 68 obsolete industrial boiler houses. The Brno Engineering Company supplied the new plant with two boilers and two back-pressure turbines with the output of 4.5 MW each, driven by 65 bar/450 °C steam with 9 bar backpressure, one 6 MW, condensing turbine driven by 9 bar/220 °C steam, and other accessories. The advantage of PBS was that it had its own manufacture of steam boilers and other power plant accessories and its own designers. Thanks to these advantages, the company was able to offer clients solutions to their energy requirements at a top international technical and economical level. This was proved by the number of industrial co-generation units supplied for technological processes, municipal heat and power plants, co-generation plants combined with supplies of heat for industrial technologies and for the service sector.

After four years of cruel and hopeless war, the autumn of 1918 brought the Armistice. The Allies had won, ending the insane bloodshed of the innocent, civilian victims and soldiers, and bringing new hope to small Central European nations, who fought for their national states. The Czechoslovak National Council led by T. G. Masaryk and his colleagues, E. Beneš and M. R. Štefánik, fought for a free Czechoslovak state abroad; during October, the Council was recognised by France, Great Britain and Italy as the provisional government led by T. G. Masaryk. A National Committee fought for the sovereignty on Czech territory. It consisted of representatives of political parties; their proportions corresponded to the last pre-war parliamentary elections. On October 27, the Austro-Hungarian Minister of Foreign Affairs, C. Andrassy, sent a note to US President, W. Wilson, which assented to the conditions proposed by the US Government on October 18, which de-facto meant the capitulation of the Habsburg monarchy and the end to the First World War. A day later, the National Committee took the Military Corn Institute under its control and at the same time, applauding crowds filled the streets of Prague, celebrating the end of the war and newly gained national independence.

In the evening, the National Committee issued its first law, which declared a new state. Slovakia joined on October 30, based on the Declaration of Slovak Nation. On November 11, 1918, Emperor Karl I. awarded the Member of Secret Council titles for the last time, approved the orders and his own abdication. He left of the royal residence of the Schönbrunn in Vienna, symbolising the definitive demise of the Austro-Hungarian Empire. The newly-established states could start to develop their policies and economies.
Steam Turbine of the BB – Bauart Brünn System

Requirements for increasing the thermal efficiency of steam turbines increased after the First World War. The firm of Engineering Company reacted to these requirements by developing a new concept of turbines – the Bauart Brünn system with multi-stage impulse blading. This new approach meant a major diversion from the tradition of reaction Parsons, or combined-blading turbines. Its inventors started from their own analysis of known energy losses in blade stages and tried to decrease them stage with a greater pitch diameter of blades. For smaller volume flows they had to use very short blades below 10 mm with high total losses. Designers considered the BB system to be particularly suitable for high-pressure sections of turbines for which they designed and patented an original barrel turbine casing without a horizontal casing split. The Bauart Brünn system and its details were protected by a number of worldwide patents, some of which gave rise to long-term disputes with competitors. However, considering the necessity of using the multicasing design of turbines, all the advantages of the new concept appeared to be insufficiently proved. The designers and inventors of Bauart Brünn turbines Franz Lösel and Karl Krischker sparked a worldwide debate due to their patents, leading to efforts to improve the efficiency of turbine stages and particularly the quantification of energy losses in the operating stages. They organised guarantee and research measurements on a turbine prototype installed in the sugar mill in Neštěmice. They invited a world authority in the fields of steam and gas turbines Professor Aurel Stodola, representatives of technical testing rooms of the Swiss Electrotechnical Association and a number of representatives of competitors as well as customers to be present at the testing. A detailed description of the tests and expert analyses survive in the archives.

Advantages of the barrel casing

The casing split is a horizontal bolted connection that divides the casing into two halves. This solution enables access to blading, easy removal of rotor and carriers with diaphragms and thus easier turbine maintenance as well. On the contrary, the casing split is a source of leakage. The design of the casing split affects not only tightness under operation but also turbine loading rate. Connecting bolts in the casing split are very highly stressed requiring great attention in design and erection. Barrel casing differs from commonly-used casings in the fact that it has no horizontal casing split and thus none of the disadvantages associated with it. Sealing is easier and the cylindrical shape enables the rapid startup and loading of the turbine. The barrel casing can be more easily manufactured as a weldment. These great advantages are offset by the relative difficulty of axial assembly of the rotor and diaphragms.
The economic advantages of high pressure and temperature steam for steam boilers and turbines were supported in the theoretical work of many authorities. První brněnská strojírna was an established pioneer in this field when in 1925 it designed as a world’s first a high-pressure turbine with – at that time – high output and an original concept of blading according to the Bauart Brünn system for the Karolína power plant. Although they did not succeed in putting its high-pressure section into continuous operation at the maximum steam inlet parameters this attempt preceded the other world producers by a number of years.

The turbine had a number of further new details - steam sealing strip labyrinths, milled blades, design of diaphragms and their fixing in carriers, etc. What was more important was the original, and from 1922 to 1924 having the world-wide patented design of the barrel type of turbine casing without a horizontal casing split and its complex bolted connection. It presents one of the greatest contributions of the Brno Engineering Company in the design of steam turbines.

It is used to the present day by world producers particularly for high-pressure turbines with high outputs for its structural and operating advantages (e.g. for ALSTOM Power turbines based on VAX and KR types). To create a riveted barrel casing, designers of turbines were inspired by boiler technologies of a high level, particularly with the forming and riveting of thick plates that were by then being used in the production of boilers.

The gland steam system distributes steam between the turbine casing seals. From the high-pressure seals steam is led via a control valve to the low-pressure (vacuum) section or prevents air from entering into the condenser. Steam from the low-pressure seals is led to a gland steam condenser, which acts as a tube heat exchanger. A slight vacuum is maintained by a fan that extracts non-condensables from the gland steam condenser into the atmosphere.

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The high-pressure barrel type casing of a four-casing condensing steam turbine with an output of 20 MW, 3,000 rpm, 121 bar/500 °C inlet steam, ordered in 1925 for the Karolína power plant in Ostrava.

The high-pressure barrel type casing of a four-casing condensing steam turbine with an output of 20 MW, 3,000 rpm, 121 bar/500 °C inlet steam, ordered in 1925 for the Karolína power plant in Ostrava.
Single Stage Steam Turbines

A separate group of turbines in the production program included single-stage turbines with a maximum output of 1 MW. A number of types directly coupled to a driven machine were gradually developed as well as a number of high-speed types with a gearbox for turbo-generators, feed-water pumps, fans, lighting turbo-dynamics, etc. Most commonly there were two-row or three-row Curtis wheels, axial or radial, overhung on a shaft or a pinion of the gearbox.

Where simplicity is preferred rather than efficiency and where it is necessary to utilise as much of the heat in the steam in a few stages, it is possible to gain an advantage by using the Curtis stage – known as a C-wheel.

The Curtis stage is the designation for a stage with one row of stator blading (or nozzles) and multiple rows of rotor blading. Reverse rows are inserted between the rows of rotor blading. Since the steam pressure drop practically occurs only in the nozzle and then only the change in the velocity vector is utilised, the Curtis stage is also referred to as the velocity stage.

Common applications of the Curtis stage include simple single-stage turbines with a low output. Sometimes the C-wheel is used as a control stage for multi-stage turbines in order to reduce the pressure inside the casing and to reduce the number of stages.

Where simplicity is preferred rather than efficiency and where it is necessary to utilise as much of the heat in the steam in a few stages, it is possible to gain an advantage by using the Curtis stage – known as a C-wheel.

The Curtis stage is the designation for a stage with one row of stator blading (or nozzles) and multiple rows of rotor blading. Reverse rows are inserted between the rows of rotor blading. Since the steam pressure drop practically occurs only in the nozzle and then only the change in the velocity vector is utilised, the Curtis stage is also referred to as the velocity stage.

Common applications of the Curtis stage include simple single-stage turbines with a low output. Sometimes the C-wheel is used as a control stage for multi-stage turbines in order to reduce the pressure inside the casing and to reduce the number of stages.
In line with development strategy, the production of steam turbines was gradually moved from Vlašská workshop to the new workshop founded by Luz on Olomoucká Street. In 1912 and 1913, a new pattern shop and heavy boiler production workshop were built there and a heavy press workshop was completed in 1919. The construction of a new engineering workshop commenced in 1928; the workshop was to be equipped with mostly new machine tools. The machine tools were suitable for the general manufacturing programme, especially the production of rotating blade machines.

The layout of the new engineering workshop encompassing 18,000 m² and with an annual production capacity of approximately 50 multi-stage turbines allowed a continuous production process for steam and gas turbines and turbo-compressors up to 60 MW.

For the last stage of the production process there were two big assembly halls and a test room for turbines and their parts, including balancing equipment. The workshop included an industrial heat and power plant which provided enough steam to test even the biggest multi-casing turbines under no-load or partial-load conditions. The new workshop ranked amongst the biggest and best equipped specialised engineering workshop in Central Europe.

The economic crisis at the end of the 1920s and the beginning of the 1930s reduced standards of living and brought high unemployment: the crisis hit the Czechoslovak Republic as well. Before the crisis, Czechoslovak agriculture and industry were growing strong; in 1929, Czechoslovakia accounted for 1.4 % of world production, ranking as the tenth in the world. During the good years, the average wage of an industrial worker was CZK 850 – 900 and there were only 42,000 unemployed. One year later, the number of unemployed had increased two-and-a-half times. In August 1930, the state began a feeding programme for unemployed workers who were not members of unions and were employed for at least three months after January 1, 1930. Each single person received a coupon for the purchase of food equal to CZK 10 each week, while each married person received a coupon for CZK 20. People called these coupons ‘beggar’s coupons’.

The Fascist movement, the leading political idea in Germany and Italy of the time, gained its followers in Czechoslovakia as well. Followers of J. Štítábí established a political party with a fascist programme called the National League. Czech fascism, which was fighting German fascism, did not gain mass support. At the same time, Slovak ‘Ludovci’ led by A. Hlinka declared Slovak autonomy as their main political programme.

On December 1, 1930, a second census was carried out. Czechoslovakia, consisting of Bohemia, Moravia, part of Silesia, Slovakia and Ruthenia, had a total population of 14,729,536. Prague had 849,000 inhabitants and was the largest city, followed by Brno with 272,000 inhabitants.
Turbines of the Combined -blading Concept

During the worldwide depression in early 1930s, engineers were, with full enthusiasm and expectation of a boom, preparing new designs for condensing and back-pressure steam turbines, and especially types with controlled steam extractions.

For high inlet steam parameters for driving feed-water pumps.

To speed up the development, the Brno Engineering Company introduced the production of a new concept of back-pressure turbines of 10,000, 12,000 and 15,000 rpm with Professor Röder. The operating characteristics of the high-speed turbines were very dependent on the quality of the gearboxes, which were not produced by PBS. The overall results of applications of these turbines were positive and they were produced in ever-increasing numbers.

The basic concept of the Röder system turbines meets the operating requirements for high inlet steam parameters:

- Radial axial symmetry of operating medium mass flow and temperature distribution around the axis of rotation and thus symmetry of thermal expansion.
- Minimum radial clearances between stator and rotor in blading and seals.
- High efficiency.

What are direct-drive turbines?

Direct-drive turbines are connected directly to the driven machine without a gearbox. Because this technique is only occasionally used in turbines for mechanical drives, direct-drive turbines are almost exclusively used with generators. In Europe, two-pole generators at 3,000 rpm are the most common; therefore direct coupled turbines are almost exclusively turbines operating at 3,000 rpm.

On March 21, 1933, a law was passed on Work Loans. A state investment lender was to create a reserve to cover the state budget deficit and to provide the funds for increasing state support for the unemployed.

Tomáš Garrigue Masaryk was elected President of the Czechoslovak Republic for the fourth time on May 24, 1934.

Ernst Franzetich, a remarkable Czech musician, writer, actor, avant-garde theorist and illustrator, founded the D34 Theatre in 1933. His shows were characterized by topicality, scenic use of poetry and especially modifications and adaptations of foreign texts, which he used to great dramatic effect.

The Czechoslovak national football team beat Austria 2:1 in Vienna in April 1933. In doing so, they brought off a remarkable victory against an undefeatable “wonder-team” who had not lost a match for 3 years.

The British artist Salvador Dalí painted “The Persistence of Memory” in 1931. This piece of art is usually seen as the prototype for surrealism.

The first 60 pedestrian crossings appeared on the streets of London in 1934.

The Czechoslovak national football team beat Austria 2:1 in Vienna in April 1933. In doing so, they brought off a remarkable victory against an undefeatable “wonder-team” who had not lost a match for 3 years.

The British aviators the Marquis of Clydesdale and Lieutenant McIntyre flew over Mount Everest at the height of 11,000 meters on April 3, 1933.

The Spanish artist Salvador Dalí painted “The Persistence of Memory” in 1931. This piece of art is usually seen as the prototype for surrealism.

Al Capone, gangster, was sentenced to 11 years in jail in 1931 for tax evasion.

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Steam Turbines with Controlled Steam Extractions

The ongoing further development of steam turbines after 1930 was focused on reduction of the number of casings and operating stages and using combined blading. Single-casing types for outputs above 30 MW were used more frequently. The first (control) stage of impulse section was typically a “U-wheel”, i.e., a nozzle ring and impulse blade row with partial admission and with a greater pitch diameter than the following row stages. Two-row Curtis wheels were again used later, particularly for high inlet steam parameters.

At this time, condensing steam turbines with controlled extractions became a brand product of PBS throughout the range of outputs, inlet steam parameters, pressure, and mass flow of extraction, back pressure and vacuum. The firm gradually acquired a leading position in designing, producing and delivering steam turbines and boilers as well as delivering complete industrial and municipal heat and power plants in co-generation mode. The beginning of PBS's production of turbines with controlled extractions stretches as far back as the first decade of the 20th century.

Turbines with outputs of about 10 MW were at that time produced as single-casing turbines. They were equipped with a Curtis wheel with a large diameter followed by reaction blading. Turbines with outputs from 10 to 25 MW were also single-casing turbines but they had several impulse stages after a C-wheel especially for high heat drops and thus had a shorter axial length than using reaction stages. It was a typical combined-blading concept with optimum blading and high thermodynamic efficiency.

Turbines with outputs above 25 MW were dual-casing turbines with high-pressure impulse sections, which had rotors forged and machined from one piece, with low-pressure sections that had hollow rotors bolted together from three parts. Each rotor had its own axial thrust bearing and rotors were coupled to each other by means of gear- or jaw-type flexible couplings.

Designs which were noteworthy and also characteristic at that stage of development were direct-drive condensing and back-pressure turbines with one or two controlled extractions. Frequently for two inlet steam parameters (use of low-pressure steam from the process), and with non-controlled extractions for process heat or feed and service water heating.

The results for inlet and controlled extraction steam parameters, mass flows and outputs were very good.

In addition to turbines with non-controlled extractions, where a portion of steam during expansion, i.e., in the steam path is led out of the turbine, there are also turbines with controlled extractions. These advantage is that the extraction pressure is controlled, i.e., maintained at a constant level.

This can be utilised in technological processes, for heating and other such uses. Surfaces are technically feasible with one or two controlled extractions. In practice, extraction turbines can be imagined as two or three turbines, mechanically linked in one or more sections.

The first and second stages are back-pressure, while the last can be condensing or back-pressure. The integration of these turbines means higher requirements for calculations, control and particularly for turbine design. Therefore, most producers are capable of designing a turbine with one controlled extraction as a maximum. A few belong to and still belong to a small number of producers of turbines with two controlled extractions.
War – Changed in the Mood of the Time

During the Second World War, PBS was engaged in the German Reich’s industrial system and production was based on its requirements. An extensive and technically demanding task was the development and production of new types of power generation units for armament, chemical and metallurgical industries.

The first jet plane, the Heinkel He 178, took off in 1939.

The first jet plane, the Heinkel He 178, constructed by Walter von Ohain, took off in 1939.

The world trend in increasing the unit output of power plant turbines affected the Brno Engineering Company as well. For example, in 1939 it delivered two condensing turbines with an output of 32 MW to the power plant for the steelworks in Linz. They had a typical combined-blading type with an impulse high-pressure section and a double-flow low-pressure section with the possibility of operation over a wide range of cooling water temperatures.

During the Second World War, the design team changed. Several German-speaking designers of Jewish origin were deported to concentration camps. Younger designers of German origin had to go to the front. Czech designers filled some gaps, mostly in auxiliary positions. The design office worked this way until 1944, when even the Czech designers had to dig trenches – first at Moravská Brána, later on (as the front approached) in Brno. Brno suffered air bombing. Air raids were announced by sirens when the American bombers passed Styria and Vienna. There were no shelters around the Brno Engineering Company and the designers quickly assessed the position of “ground zero” and used their bikes to leave the city. After the bombing, during the Spring of 1945 (when PBS was hit), work was suspended. The front was expected to reach the city.

Over the period from 1943 to 1944, PBS’ two largest condensing turbines were designed and partly manufactured for power plants in Upper Silesia with outputs of 54 MW and 56 MW. However, after the war they were not completed due to a change in the customer’s investment program.

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The machines room with six turbo-sets in the industrial heat and power plant in Chezy, Zafary u Mostu.

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The Czech Design School

The first production programme to be developed was the manufacture of spare parts for (and repairs of) damaged turbines. New orders started coming in 1946. First, the turbines were completed whose production had started during the war. Later new types of turbines were added to the production programme. One of the first post-war turbines was a 20 MW condensing turbine for the Doicesti Power Plant in Romania.

A 40 MW condensing turbine with steam reheating, already produced during the war years, was erected and commissioned in the Karolina Power Plant. The commissioning was accompanied with certain problems. Salt deposits on the turbine blades caused an unacceptable increase of the axial forces acting on the high-pressure rotor, leading to repeated failures in the axial bearing. This gave rise to research into the functioning of segmented bearings, the development of a higher load-bearing capacity, new patented designs and ultimately to the establishment of more broadly-conceived research. An R&D steam turbine department was established at PBS. This created new foundations for the PBS engineering school in the difficult years of limited contact with advanced foreign competitors and professionals.

At the end of March, 1945, the representatives of the four most important Czech political parties and the Slovak National Council met in Moscow to create the programme of a new government. It was based on the communist proposal. The newly nominated government of the National Front led by Z. Fierlinger approved the so-called Košice government programme, which encompassed the basic political, social and cultural issues. The Red Army, which included the 1st Czechoslovak tank battalion, gradually liberated the whole of Czechoslovakia. On April 18, American soldiers led by General Patton entered the west of the country also as liberators. On May 1, a spontaneous rebellion against German occupants started – by May 5, it had reached Prague. On May 8, the domestic resistance organisation, the Czech National Council, and the military command of Prague concluded an agreement on the removal of German troops from Prague. A day later, advanced troops of the 1st Ukrainian Front entered Prague and extinguished the last centres of German resistance.

The Decrees of new President, E. Beneš, issued at the end of May, introduced a national administration of the assets of Germans, Hungarians, traitors and collaborators; some asset-related acts dating to the period of occupation were annulled. Later, such assets were confiscated. The heightened post-war atmosphere saw the relocation of local Germans, which sometimes involved unnecessary violence. Other Presidential Decrees dealt with the punishment of Nazi criminals by extraordinary common courts, the nationalisation of mines, banks, insurance companies, foundries and all firms employing over 500 people. He also introduced the compulsory requirement to work and the new Czechoslovak Crown. A monetary reform was enacted at the end of October and the beginning of November. The government ceded Ruthenia to the Soviet Union, which had supported it during the war.

The Czech Design School

For the Brno engineering company, the Second World War ended in tragedy. Three days before the front reached the city, the German employees of the factory together with the German Army destruction corps burnt out the most important buildings – the steam turbine engineering department with its archives, the main and assembly workshops and the test facility. Luckily, the turbine calculation department survived. The extent of the damage raised doubts as to whether the company could be rebuilt. The backup drawing archives were taken as the spoils of war by the Soviet Army, and despite all the efforts, were not returned. Out of the 59 turbine design engineers working at the factory in 1944, 47 either emigrated or were expelled. Only 12 Czechs remained, who formed the core of the new engineering department – Josef Svanda, Jiří Nevole, Stanislav Hep, Jaroslav Kozáček, Miroslav Liska, František Míchlek, Bedřich Sevčík, Jan Hoblík, Ludmila Mlynářová, Miroslav Brána, Jaroslav Balis and Jaroslav Punčochář.

A new drawing archive was established based copies of drawing found in the departments which escaped damage, and drawings acquired from former customers/turbine operators. A number of foremen and workers brought their vast experience of many years to the renewed production. In the meantime, repairs continued on the factory workshops and machine tools.

The first Czech manager of the turbine engineering department was Josef Svanda. Step by step, the Brno Engineering Company managed to renew completely the steam turbine manufacturing programme. By 1947, the number of staff in the turbine design engineering department reached 55. First department managers and chief designers were appointed in November 1947.

PBS was nationalised by the Decree of the Minister of Industry of December 27, 1945. In 1946, a national enterprise, První brněnská a krašová sklovarna, was established, which took over all assets of 4 companies – První brněnská Krašová sklovarna, Bruna and Gefia.

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The Beginning of Applied Research

In the initial phase of steam turbine production before 1945, the research and development of turbines and turbine parts had no special organisation. It was primarily based on measurements performed on prototypes delivered to customers, or on test equipment installed in PBS premises. In 1947 a new research group was established to solve problems with thrust bearings and to collect and clarify experience from operations which could be used for further designs. The designs became much more complicated and that generation of Czech designers continued to follow world trends.

In 1953, the Power Generation Equipment Research and Development Institute was founded, focusing on steam and gas turbines, research on the strength and thermodynamic problems of turbine blades, the strength of rotors, casings and bolts at high temperatures, under dynamic operation, of combustion chambers of gas turbines and of turbo-compressors of superchargers for engines. The institute worked closely with the Brno Technical Institute, while PBS experts worked as external teachers for professional courses.

Today, such tests are frequently replaced by FEA (Finite Element Analysis) calculations, which become more important as more computing power and increased knowledge of material elasticity and strength becomes available.
1950 – Specialisation in Steam Turbine Manufacture in Czechoslovakia

At the beginning of the fifties, the communist government decided that the development and production of steam turbines would be divided between Skoda Pilsen, ČKD Praha and PBS Brno. The programme was also centrally controlled by the government. One of the by-products of the Iron Curtain was an embargo placed on import of steam turbines, resulting in an increased pressure to design and manufacture “tailor-made” turbines, primarily for other COMECON countries. This led to piece or occasionally low-batch production, with the demand to satisfy as many client requirements as possible.

The growing demands on the manufacture of steam turbines of various types forced an expansion of both manufacturing and design capacities. Many prototypes were made during this period, and the production volumes exceeded the prewar levels several-fold.

All other manufacturing programmes of PBS were terminated by this government order – the manufacture of pumps, turbo-compressors, sugar mills, breweries, refrigeration equipment, construction machinery and piston engines were all handed over to other state-owned firms. The turbine development programme was also centrally controlled by the government.

The problem of control valve actuation was resolved. The oil actuators situated on top of each control valve were replaced, because of fire safety considerations with several single-seat diffuser valves freely mounted on a cross beam. These valves were adjusted vertically by two spindles, attached to one end of a two-sided rocker arm. The piston rod of the main oil actuator, which was mounted on a pedestal, was connected to the other end of the rocker arm. A prototype of this combined hydraulic-mechanical control was used for the first time in the T-12-15/1.2 turbines with controlled extractions.

Among other new products, 15 types of condensing turbines with controlled extractions were designed for turbo-compressor drive and exported to the USSR.
Deutsche Gramophon introduced the first long-playing record onto the 33 rpm market in 1951.

The first artificial heart was transplanted into a patient in a Pennsylvanian Hospital in 1952, which prolonged his life by 80 minutes.

The Japanese company Sony supplied the first transistor radio to the market in 1952.

The absurd play by Samuel Beckett “Waiting for Godot” was first published in 1952.

Turbine designers were faced with a serious problem requiring an urgent solution. The problem concerned the drum design of the turbine rotors – the feasible manufacture and quality of the forgings from which drum rotors were produced. The new methods of ultrasonic, radiography and chemical testing indicated hidden defects which were difficult to evaluate.

Metal works demanded that the forgings be smaller. Therefore the designers used bolted disc rotors. Later the technique of control stage discs welded to the drum rotors was developed, and finally drums welded from several rings were used. The first fully-welded rotor was used in a 10 MW condensing turbine made for the Nováky Power Plant.

The government adopted measures against the potato beetle in 1951.

The black horse Salvátor won the 62nd Great Pardubice Steeplechase on October 21, 1951. He was ridden by the 60 year-old jockey Hejmovský.

The radio station Radio Free Europe based in Munich started its regular broadcasting to the Czechoslovak Socialist Republic in 1951.

Welding the root of the weld on a drum rotor.

Welded drum rotor – cooling the rotor after welding.

Welded drum rotor – preparation of machined rings for welding.

Special design of welded drum rotors allowed compensation for dimensional changes caused by welding.

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Welders had to meet increasingly difficult requirements; they had to pass the highest grade tests. The turbine section of the Brno Engineering Company employed 60 welders both in its assembly halls and at sites. Since many trained welders were required, the PBS Welding School was established in Brno. Jaromír Suchánek was involved with its founding; he was also known for the papers he had published. His contributions, among others, made the school one of the best. The school trained welders for the whole Czechoslovak Republic. It issued its own textbooks. The classrooms had modern equipment, including overhead projectors. Four full-time instructors and ten external teachers worked for the school. Around 250 people completed basic courses and passed official qualification tests every year.

Unalloyed, low-alloy and high-alloy materials were welded – sheets, pipes and pipelines.

Pavel Bartoník

Welded Drum Rotors

Part of an assembly hall – fixing of blades to welded rotors.
Building a New Testing Facility

Between 1953 and 1955 all the technological equipment at the manufacturing plant in Olomoucká Street was overhauled and converted to a continuous production process facility specialising in the manufacture of steam and gas turbines with an output range of 60 to 80 MW. The original character of the specialised manufacturing centres, the product flow and the transportation system were preserved, but obsolete machine tools were decommissioned and replaced by modern ones. Intermediate production stores were re-arranged, with the focus on the smooth and effective manufacture of steam and gas turbines. A new testing facility was built which allowed up to 50 multi-stage turbines to be tested per year, when especially required with a maximum brake output of 5 MW.

The testing facility was equipped with its own oil system, condensing equipment and data acquisition system. By contemporary standards, turbine no-load operations were tested, as well as the safety systems where the turbine was tripped by an overspeed governor at trip speed, by thrust-bearing displacement protection and relative rotor displacement safety devices, by lubrication oil pressure and temperature protection and by controlled extraction pressure protection. Measurements were taken of thermal expansion and vibrations in the turbine casing, its control functions and oil system. If specified by the client, tests of partially-loaded turbines could also be performed.

All turbines produced before 1945 and also after WWII were tested in the test stand under no-load or partial-load conditions. Since the testing facility had insufficient capacity and auxiliary equipment, a new testing facility was built in 1953-1955 during the reconstruction of the premises; it had three test stands with adjustable support beams, a fourth stand was built later. The capacity available for testing of steam and gas turbines thus increased; e.g. in 1937, 35 steam turbines and 20 gas turbines were tested. Gas turbines were tested at loads up to 6 MW and the output power of generators was wasted to the water evaporators. After 1963, the old testing facility, used mostly for testing small turbines, was closed down. Thanks to new ABB turbine technology, new turbines were not tested in the testing facility; only selected parts are tested, especially the oil system.

The test room saw some memorable turbines, e.g. 30 MW and 60 MW turbines for Kuopio (Finland), which are still in operation, a 50 MW turbine for the Oslavany power plant, tested in 1962, and a 32 MW condensing turbine with a controlled extraction designed for the direct drive of turbo-compressors in an ammonia plant in the Soviet Union, which was tested in the Brno Heat and Power Plant.

Management of PBS in 1957; led by the Managing Director, Josef Pešl.

PT 55 MW turbine in the testing facility.
Development of Gas Turbines

The development of gas turbines took place on a limited scale in parallel with the development of steam turbines. It started shortly after the war and was concentrated in a group led by Jaroslav Balas, Milan Kousal and Zdenek Rícaínek. At the beginning it focused on the development of a 1 MW gas turbine. After successful laboratory tests, the machine was installed in the Bratislava Heat and Power Plant.

At the same time prototypes of exhaust gas driven turbocchargers for supercharging diesel engines were developed and tested, together with prototypes of low-temperature expansion turbines for the chemical industry.

In 1968, the USSR ordered 90 gas turbines to drive turbo-compressors in the compressor stations of long-distance natural gas pipelines, requiring the turbines to be made in accordance with a licence supplied by Nyevesky Zavod (NZL). PBS quickly became acquainted with the manufacture of these gas turbines, arranged the load testing of every turbine produced, remote electronic measurements and test evaluation by computer. Starting in 1972, the company produced nearly thirty gas turbines a year and became one of the four largest manufacturers of these machines in Europe.

An interesting project conducted between 1969 and 1973 was the development of a 16 and a 30 MW package using aircraft jet engines from the TU 104 airliner. However, due to the shortage of powerful aircraft engines, this project too had to be stopped.

Joseph Stalin and Klement Gottwald both died in 1953 and this led to a slight improvement in social conditions. The death of Stalin led to hopes as the world held its breath in expectation. "The world knows that the death of Josef Stalin means the end of an era," said US President Dwight Eisenhower. However, the political orientation of neither the Soviet Union, nor its satellite Czechoslovakia changed. The improvement was extremely slight. On May 1, 1954, the so-called Auxiliary Technical Battalions ceased to exist – these parts of the army consisted of 60,000 people, mostly those who were disliked by the regime, e.g. antikommunistes, church officials, sons of former landowners or company owners. In the middle of June, the 10th Meeting of the Communist Party of Czechoslovakia was held in Prague. This meeting approved the policy of a "gradual stabilisation and increase in living standards". At the time, the production of tractors and other agricultural machinery was developed. However, in the autumn the Czechoslovak and Soviet governments negotiated the modernisation and refit of the Czechoslovak army. At the end of November, elections to the National Assembly took place after six years. The elections, however, were only a "comedy" because of the system used. Single-mandate constituencies were introduced with only one candidate. The candidate had to be approved by the Central Secretariat of the Communist Party of Czechoslovakia. According to the results published, 97.89 % of voters voted for these candidates.

Of the other gas turbines produced, the low-temperature expansion turbines (EXT) for special technological purposes deserve a mention. Their development also included helium EXTs. Development and production of damp-air EXTs between 1987 and 1990 proceeded in accordance with special aeronautical requirements and resulted in the delivery of six turbines to a rocket motor testing centre in the USSR.

In the 1990s, after it merged with ABB, the Brno Engineering Company abandoned the development and production of gas turbines altogether, concentrating fully on steam turbines.

The worldwide trend of increasing the power output and efficiency of gas turbines and the attempts to burn residual inhibited petroleum distillates in the late 1950s and early 1960s gave momentum to the development of 6 MW, 14 MW and 25 MW prototypes. However, the tests were not completed and the prototype development programme was terminated.
The Soviet Union launched Sputnik I into orbit in 1957, the first orbiting satellite in the world. A month later Sputnik II was launched, this time with a dog called Lajka on board.

Important strategic design projects included a prototype for new types of dual-casing 25 MW and 50 MW turbines with controlled extractions. An R&D group consisting of Miroslav Budin, Jiří Nevole, Stanislav Tauer, Jurij Širokorad and Ladislav Fiala led the design work, other employees performed thermal and strength calculations and technology verification.

The basic prototype of the PT-25-90/10/1.2 condensing turbine, its parameters and original design concept were all new. New design features included its counter-flow layout of both the high-pressure and low-pressure turbine sections (reducing the axial load of rotors), only three radial bearings and one common axial bearing for both rotors connected by a rigid coupling, welded rotor of low-pressure section, mechanical control of high- and medium-pressure control valves, the control diaphragm for low-pressure extraction, a new oil system and the ability to use the high-pressure section as a single-casing back-pressure turbine. PT-25-90/10/1.2 steam turbines were very successful in operation.

Some customers still required single-casing turbines in the 25 to 30 MW range. The Brno Engineering Company offered these markets the existing proven turbines of the combined-blading type with updated functional modules (higher inlet steam parameters, which meant increased efficiency, hydraulic-mechanical control, multiple non-controlled and controlled extraction, new blade profiles and their strength dimensioning, improved quality of welded rotors). A 35 MW newly-modified steam turbine was also delivered to the Sundsvall Power Plant in Sweden.

The TV network of the Soviet Union showed the first live TV broadcast on November 7, 1954 – a live broadcast of a rally the Old Town Square (Staroměstské náměstí) in Prague.

Building was begun in Brazil on building a new capital city for the nation, Brasilia, in 1956. This event was a significant example of urban planning on a large scale.
The cosmonaut Yuri Gagarin became the first man to orbit the Earth in 1961.

The American satellite Tiros was launched on April 1, 1959. Tiros was the first satellite designed for weather observation.

One of the exceptional types and prototypes of steam turbines developed in Brno was the K-50-130 three-casing turbine with 130 bar/565 °C admission steam heated to 535 °C (world-beating steam parameters), designed and made for the Oslavany Power Plant unit equipped with a once-through cyclone boiler also made by PBS. The development of this turbine was a reaction to the global trend in increasing the efficiency of power plants, even those with lower outputs, by steam reheating. Thanks to this type, the government extended První brněnská strojírna's permitted range from 25 MW to 50 MW.

A 50 MW steam turbine with steam reheating in the Oslavany Power Plant.

In this design type, the high-pressure part had a counter-flow arrangement with steam admission in the middle of the double casing, the stator blading was fixed in blade carriers. Emergency stop valves and control valves were located alongside the turbine and were equipped with their own oil actuators. Rotors were rigidly coupled and assembled in three radial bearings, the middle one being combined with a thrust bearing. The low-pressure rotor was welded from several sections. Reaction blades had new profiles, tested for aerodynamic properties and strength at the PBS Research and Development Institute test laboratories.

The Czechoslovak pavilion won the world exhibition Expo 58 in Brussels.

Czechoslovakia became the 49th state of the United States of America on January 3, 1959. In the same year the islands of Hawaii also became part of the U.S.

The following years focused on the development of controlled-extraction turbines with a maximum power output of 50 or 60 MW for co-generation plants. The basic PT-50-130/131.2 was developed. Because of the large volume flow and high inlet steam parameters combined with the large mass flow of the controlled-extraction steam, the designers used proven elements as well as those used by major world producers of 120 to 150 MW power generation steam turbines. A whole series of steam turbine types were later derived from this concept.

The complete electrification of Czechoslovakia was finished in 1960.

The first heart operation in Czechoslovakia where the cardiac valve was replacing by prosthesis was performed out in Brno in 1963.
Back-pressure Steam Turbine Drives for Turbo-compressors

Suppliers of turbo-compressors demanded an exceptionally operation-reliable back-pressure turbine with long MTBF (mean time between failures) and lifetime for the production of soda.

Of the proposed solutions, the winner in a tough competition was a unique-concept dual-flow reaction turbine with a radial control stage, developed by engineers in Brno.

The radial control stage in the compressor-driving turbine was an A-type dual-flow symmetrical stage with partial admission. The control-stage rotor blades were twins fixed by a tree root.

The designers made use of the advantages offered by the radial stage – direct inlet steam admission to the stator blades, high steam velocity, positive effect of the Coriolis forces on the avoided heat drop, large heat drop and high stage efficiency, plus the advantages offered by axial back-pressure blading in other stages – drum rotor and simple blading.

The advantage of the Brno turbine design was the low stress of the relatively short blades and their frequency tuning over a wide range of operation speeds. The turbines drove natural gas turbo-compressors.

In 1964 the Brno Engineering Company was assigned a task by the designers of nuclear power plants in the USSR. The order was to develop and deliver condensing turbines with a controlled heating steam extraction of top operating reliability for the Bilibino Nuclear Power Plant, situated beyond the Arctic Circle on the Chukotka Peninsula. The slightly radioactive steam with which the turbines were to work, required an increased leak-tightness of rotor and spindle packing. The project was further complicated by extremely difficult accessibility. The locality was accessible only by air or, for a limited period during the year, by the Eastern Siberian Sea shipping route.

The advantage of the Brno turbine design was the low stress of the relatively short blades and their frequency tuning over a wide range of operation speeds. The turbines drove natural gas turbo-compressors.
Power Plants

The ongoing process of turbine enhancement required machines to be incorporated into the heat cycle, where all their modern features could be utilised. Turbine accessories and their erection and maintenance meant that these tasks needed to be handled by experienced specialists closely familiar with these machines, and conversant with all their operating conditions. PBS management realised the importance of this and in the 1960s started paying increasingly more attention to power plants.

Machines were offered together with other power generation equipment and accessories. Some of the equipment was manufactured in Brno, while other items were purchased.

Gradually, the Brno Engineering Company got to the stage when it was in the position to offer turnkey power generation solutions. Such projects required preparation of the power plant concept, mass flow and heat balance, selection of all components, integration of all parts, designing subcontracting, manufacturing and delivering the equipment to the construction site, assembling it, and commissioning the plant.

Power plants were constructed in various parts of the world with very different climatic, technical, business and social conditions. With the growing technical excellence of the turbines used, the quality of design and construction gradually improved. Many of these turbines are still working in power plants and heat and power plants throughout the world.

Simultaneously with the growing complexity of developing power plant projects, the department in charge of these works also developed its position within the company organisation chart as well as its internal structure changed several times. It underwent its last major reorganisation when it was incorporated into the Power Generation group where, in close collaboration between turbine and power plant specialists, projects capable of satisfying even the most demanding clients are executed.

In the 1960s the atmosphere in the country started to relax slightly. Unfavourable circumstances forced the ruling Communist Party to liberalise the conditions for economic development as well as in other spheres of life. Serious problems such as the fabricated political processes of the 1950s were publicly discussed. Criticism of the regime culminated at the Conference of Writers. Although its participants were severely punished, the developing crisis in society could no longer be stopped, giving rise to the so-called ‘Prague Spring’. Some of the communist leaders attempted to reform the regime.

First, Antonín Novotn˘ was removed from his post as the First Secretary of the Central Committee of the Communist Party of Czechoslovakia (CPC) and replaced by Alexander Dubãek. Later Antonín Novotn˘ also abdicated as President and was replaced by General Ludvík Svoboda, a World War II hero.

Members of the “orthodox” wing of the Communist Party sent a secret letter to the Soviet Union, asking their comrades to intervene militarily. The invasion, which followed took place during the night of August 20/21, 1968.

People demonstrated against the brutal invasion in the streets of cities and towns and attempted to stop the invading armies’ tanks with their bare hands. The reform wing of the CPC was forced to fly to Moscow and accept the terms dictated by the leadership of the Soviet Communist Party. All attempts to democratise the country were suppressed and its protagonists punished. The process of the so-called “normalisation” started.
The American astronaut Neil Armstrong from the crew of Apollo 11 became the first man to set foot on the surface of the Moon in July 1969.

The role of the Brno Engineering Company in the project was to provide licensing for the manufacture of 1.5 to 18 MW industrial turbines, provide technical assistance when putting the Indian plant into operation and training approximately 250 Indian workers and technicians in Czechoslovakia.

In 1975, the engineering company took part in the programme aimed at extending the plant’s capacities to meet the needs of the developing Indian power generation and other industries. The Hyderabad plant was one of the most modern engineering workshops in India. When launching the plant into operation, PBS supplied BHEL with 33 turbines with various levels of co-operation and a number of other components and semi-finished products.

In 1968, the song “Modlitba pro Martu” (“Prayer for Marta”), sung by Marta Kabrtová, becomes the symbol of the Prague Spring.

Between 1969 and 1972, fourteen 1.5 MW to 15 MW turbo-sets for generator drives were installed in sugar mills, textile mills, chemical plants and steelworks in various parts of India. In addition, six turbines for compressor drives were installed in the largest steelworks in India, BOKARO. Trained workers first assembled each turbine in Hyderabad. Initially, the parts were imported from the Brno engineering company, but gradually their production was transferred to BHEL.

The complexity of the products (boilers, steam turbines and other equipment) meant that the production of parts was transferred to India step by step. Several dozen Indian employees – workers and engineers – acquired their first experience in the production plants of Czechoslovakia, including our company in Brno. Operating conditions were very demanding. Most turbo-sets supplied power to a separate electricity grid and had to maintain the grid’s frequency even during large fluctuations in output and unstable steam supply. Most of the power generated was used for the operation’s own consumption, electricity to the public grid was supplied only exceptionally.

Around 1973, BHEL employees were able to start manufacturing power-generation equipment without the presence of our experts.

In 1969 the first Nobel Prize for economics was awarded. Ragnar Frisch from Norway and Jan Tinbergen from Holland won the prize.
Steam Turbines for Chemical Plants

Requirements for the reliability of turbines used in chemical processes, which are dictated by their essential function in the technological systems, have always been exceptionally stringent. This is because of the need for resistance against aggressive substances, operational safety in explosive and flammable environments, precision and the degree of control. New steam turbine concepts designed for these purposes were based on previous designs with lower output, inlet steam parameters and on the state-of-the-art designs of foreign manufacturers. Functional parts and modules proven in heating-plant turbines were used in the prototypes, although certain parts such as blades and rotor bearings required special design and complex calculations and tests.

In chemical plants, steam turbines were used wherever there was a need to compress a large quantity of gases to high pressures in turbo-compressors or where it was necessary to provide drive for various machinery even after a failure in the power-distribution system. The machines were supplied to chemical factories producing ammonia, ethylene, methanol, soda, petrochemical products, metallurgical products, sugar and paper.

In 1971, the Czech writers Josef Škvorecký and Zdena Salivarová founded the Czech exile publishing house in Canadian Toronto in 1971 – “Sixty – Eight – Publishers”. “The Tank Battalion” by Josef Škvorecký was the first books to be published.
In early 1975, the Brno Engineering Company founded a subsidiary for blade production in Mikulov, a historical town near the Czech-Austrian border. The quantity requirements for these very important steam turbine components justified the construction of a specialised plant. Expectations for the demand for gas turbine blades were also high.

The new Mikulov plant commenced test operation in 1978. The modern factory was equipped with powerful machinery by contemporary standards. The first products made there were blades for gas turbines. Later on, steam turbine blades were added to the production programme, and in 1978 also the manufacture of parts for the whole steam path section of gas and steam turbines, both for new machines and for servicing. The plant also produced some first-class specialists, allowing parts of production programmes to be transferred there from Brno, Motorlet Jinonice and Škoda Plevna.

During the first half of the 1990s, when PBS became part of ABB, the Mikulov plant underwent extensive modernisation. The factory was equipped with state-of-the-art CNC machines and the Mikulov plant became the manufacturing centre for turbine blades not only for Brno, but also for ABB Group companies abroad.

The modern machinery considerably simplified and speeded up the turbine blades manufacturing process. While in the past the process of making one blade required around 60 operations, after modernisation it was only between 12 and 15 operations, depending on the shape of the blade. The modern CNC machines are able to mill the whole blade root in one setting and the twisted part of the blade in a second setting.

The Czechoslovak government under Gustav Husák was unquestionably subservient to Moscow’s orders, but in spite of this loyalty the country did not manage to achieve the degree of independence enjoyed for instance by Poland or Hungary. The government and Communist Party leadership suppressed any potential disintegration under the auspices of the Warsaw Pact, a process which culminated in their participation in the preparations for military intervention in Poland in the early 1980s. People who fought against the establishment and the abuse of power by the communists united in a movement, the manifesto of which became Charter 77. Members of the Charter challenged the representatives of the ‘normalisation’ regime to an open discussion on a legal platform. The movement tried to monitor the compliance with human rights in Czechoslovakia, show illegal conduct and breaches of the Communist Constitution and attract publicity for these cases abroad.

The period which started with the Soviet invasion and ended in November 1989, can be characterised among other things by the absence of justice and the passivity of the population, who pretended not to know anything about it to protect their families, or, as the Czechs say, ‘to play a dead beetle’.
There was an ongoing demand for single-stage back-pressure turbines up to 1.5 MW output as back-up as well as permanent drives for pumps, blowers, compressors, mills, and other machines including generators. In 1950 a specialised design group led by Rajmund Svoboda and Jan Kalod started developing a model series based on pre-war designs. The M, PC, and PCPL lines were developed.

**Single-stage Back-pressure Steam Turbines**

In the M Series, equipped with a membrane control system, the turbines were directly coupled to the driven machine. New models had welded bearing pedestals patented by PBS.

Output range: 20 to 700 MW
Speed: 1,500 to 4,000 rpm
Admission steam: 9 to 45 bar/425 °C
Backpressure: 1 to 16 bar

**Single-stage steam turbine series**

- **M**: C-wheel with membrane control system
- **Mv**: C-wheel with bellows control system
- **Md**: C-wheel with membrane control system and horizontal casing split
- **PC**: Back-pressure C-wheel
- **PCP**: Back-pressure C-wheel with gearbox
- **PCPL**: Back-pressure with gearbox - C-wheel overhung on the shaft

Low-output steam turbines frequently work with high pressure and temperature of the admission steam. The speed of the shaft usually corresponds to the synchronous speeds of 3,000 or 3,600 rpm. The back-pressure steam is used in technological processes. The conditions described above led to the design of light and reliable turbines of the M and PC type without a gearbox, having a large diameter of the moving wheel and a minimal blade length, which worked with small partial admission. Although in some cases the advantages offered by the two-row or three-row Curtis stage could be utilised, these machines had a very low thermodynamic efficiency. The company, being aware of these limitations, was one of the first manufacturers in Europe to design PCPL turbine types with an integral gearbox and with a 400, 550 or 700mm diameter moving wheel. These turbines are characterised by the rotor overhanging on an extension of the pinion shaft located inside the turbine casing, which is an integral part of the gearbox. This means that the turbine does not need separate bearings, and there is no need for a coupling between the turbine and the gearbox. This concept has significantly reduced the turbine’s weight, increased its speed, and reduced its diameter.

Stanislav Kubíš

**Back-up drives**

Backup turbines are a special category of steam turbines. They are used wherever there is a need to keep the driven machine running even after a total failure of the power supply in the factory. This applies especially to chemical plants, where there is a danger of explosion or contamination by dangerous substances if pumps or compressors were to stop. These machines are also used to power emergency equipment - fire extinguisher pumps and air blowers.

These turbines need to have a simple design, must be easy to control and have a very quick start-up. The latter prerequisite is particularly important, as it is necessary to guarantee that the drive change-over does not interrupt the powered machine’s functions. Both drivers are usually coupled to the machines they drive with a free-wheel clutch.

- **Output range**: 40 to 1,800 kW
- **Speed**: 2,500 to 3,300 rpm
- **Admission steam**: 30 to 90 bar, 200 to 535 °C
- **Backpressure**: 16 bar max.

**1980**

- **The film by Miloš Forman “The Takeoff”, shot according to the book “One Flew Over the Cuckoo’s Nest”, gained five Oscars in 1976.**
- **Vladimír Remek became the first Czechoslovak citizen to fly in Space in 1978.**
- **Czechoslovak tennis players – Ivan Lendl, Tomáš Šmíd, Pavel Složil and Jan Kodeš won the Davis Cup for the first time for Czechoslovakia in 1980.**

**The Nobel Peace Prize was awarded to Mother Theresa for her work with the disabled in the slums of Calcutta in 1979.**

**John Lennon (born on October 9, 1940 in Liverpool), the British musician who co-founded the Beatles, plus film actor and a record producer, was assassinated on December 8, 1980 in New York.**
Unified Modular Concept

The principles of the modular concept were established in response to client requirements and experience with the manufacture and servicing of several thousand turbines. The development was done by a team led by Oldřich Mazánek and Bohuslav Svoboda. It is worth mentioning the use of reaction-blade shrouding – both riveted and integral shrouding. The introduction of both methods was the idea of the groups led by Vlastimil Nezval and Jiří Rezníček.

A three-member British group led by Sir Ranulph Fiennes, finished the fastest and longest crossing by Sir Ranulph Fiennes, finished the Scott’s base in 1981 in 75 days and triumphed over 4,000 km.

IBM brought the first personal computer (PC) onto the market in 1981.

In February 1982, American scientists revealed six new moons of Saturn when it reached the space probe Voyager 2. This increased the total number of Saturn’s moons to 23.

In St Paul’s Cathedral in London, 64 VERSION PR

A 64 MW condensing version with an air-cooled condenser was supplied to the Iranshahr Power Plant in Iran. From a design point of view, the turbines were based on the Kuopio model, with a counterflow high-pressure section. The inlet was in the middle of the turbine. The concept allowed a better equalisation of the axial forces and the reduction of losses. The use of an internal nozzle box led to the simplification of the turbine casing design in spite of the high admission steam parameters of 130 bar/535 °C. The turbines for the Iranshahr plant were delivered in 1981.

The inlet was in the middle of the turbine. This concept allowed a better equalisation of the axial forces and the reduction of losses. The use of an internal nozzle box led to the simplification of the turbine casing design in spite of the high admission steam parameters of 130 bar/535 °C. The turbines for the Kuopio Paper Mill in Finland were used unified modules with proven points of the Brno design school, represented by the team led by Bohuslav Brezniček. The turbines used unified modules with proven operating reliability. To enhance their efficiency, they were also made with riveted blade shrouding. The shrouding became a standard feature.

The back-pressure turbine supplied to the Kuopio Paper Mill in Finland is a representative of the 40–60 MW group. The exhaust steam and non-controlled extraction is used for the dual-stage heating of water. This was the first turbine with reaction blading equipped with riveted shrouding to be produced in Brno.

In 1981, Computers in the 1980s

A de facto embargo on computers, the dramatic development and spread of which became a global phenomenon, resulted in Czechoslovakia lagging critically behind the outside world.

Engineers in domestic industries tried to overcome this barrier and obtain necessary computer hardware as part of other products, for instance measuring systems. In the early 1980s, designers primarily used mainframe computers off the plant’s premises. Compared to today’s computers, their capacity was incredibly low, while these mainframes, which employed scores of people, did not allow the flexible access so necessary for solving technical tasks.

Computer manufacturers the world over realised that technical applications required on-line access to the computer, and started developing and producing desktop computers. The very first such machine at PBS was an HP 9830 calculator which made it possible to programme a sequence of computing steps – algorithms. The engineers were so impressed that they literally lived at the office just to get an opportunity to use this new technology.

Another machine, this time already a desktop computer, was an HP 9835 in the programming language Basic, which the company acquired as part of a data acquisition system for the testing of gas turbines in the test laboratory.

The first CAD systems were acquired only in the late 1980s when the engineering community succeeded in persuading political representatives that the country’s lag in CAD applications might become critical. And thus as part of the programme called 2000 Automated Engineering Workstations, PBS acquired its first two CAD systems.

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A back-pressure turbine with a controlled extraction designed for pulp plants is an example of the 4–25 MW group.

The back-pressure turbine supplied to the Kuopio Paper Mill in Finland is a representative of the 40–60 MW group. The exhaust steam and non-controlled extraction is used for the dual-stage heating of water. This was the first turbine with reaction blading equipped with riveted shrouding to be produced in Brno.

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A prototype of a 32 MW turbine was ordered by the USSR. The turbine was used to drive three-casing turbo-compressors for synthesis gas in a methanol and ammonia producing plant. Thirty-five additional machines were to be ordered. The client requested that the turbine be tested under full load and speed. The test with extensive research measurements was carried out in the Brno Heat and Power Plant. Two hydraulic brakes were used to dissipate the output during the tests. For the first time static and dynamic stresses were measured in selected blades under load and rotation. The tests were performed by the Power Generation Equipment Research and Development Institute under the leadership of Marta Ošlaková. The P32 was also the first turbine with segmented tilting pad bearings.

In 1983, the P32 was awarded a Gold Medal at the International Engineering Fair in Brno.

The P32 had exceptional parameters:
- Inlet specific flow at 380 t/h input corresponded to a 120-150 MW condensing turbine.
- Controlled extraction at 380 t/h pressure 42 bar.
- Speed at 9,014–11,830 rpm.
- Output power of 32.5 MW.
- Air-cooled condensing system.

Mechanical drive turbines were designed for heavy duty applications in chemical plants, they were used to drive compressors in technological processes producing ammonia, ethylene, benzene, methanol, etc. In these plants, the main emphasis is on failure-free operation, technical reliability and long lifetime. Breakdown of turbine powering compressors means shutting down the entire technological process, which always means high operational losses.

The work on the development and production of the P32 were done under a government assignment called “High-speed Turbines for Driving Turbo-Compressors”, partially by the Turbine Design Department, but mainly by the District Heating Equipment Research and Development Department, which was transferred from the Power Generation Equipment Research and Development Institute and transferred to the Turbine Division.

A series of test measurements were conducted in the area of aerodynamics and blade dynamic using models in external test laboratories, but mainly in PBS’s own test facilities. A number of alternatives were tested, including simulations, for instance the loss of an interblade damping pin.

After completing the research and development works using component models, a prototype was built and a series of comprehensive tests were conducted in the Brno Heat and Power Plant. To perform the demanding test programme, a number of instruments, sensors and other equipment had to be purchased. The outcome of these comprehensive and demanding research and development tests was a confirmation of the turbine’s guaranteed parameters, its good mechanical behaviour, low levels of blade mechanical stress, reliability of the proposed technical solutions and a preliminary schedule of start-up and loading diagrams. The whole complex programme of developing high-speed turbines had come to a successful conclusion. With the assistance of PBS specialists, the turbine commissioning and loading diagrams were optimised and tuned to match the characteristics of the specific type of compressor and the client’s requirements.

Marta Ošlaková

Turbines in the ammonia production process

Ammonia is produced predominantly by a catalytic reaction from a synthesis gas, which contains one volumetric part of nitrogen and three parts of hydrogen, at a pressure of 20–100 MPa and a temperature of 500 °C in the presence of a catalytic agent (metallic iron with an admixture of aluminum oxide). A diluted aquatic solution of ammonia is known under the name of ammoniac. Turbines in the ammonia manufacturing process are used to drive high-pressure compressors compressing synthesis gas. Either condensing or backpressure steam turbines, sometimes equipped with a controlled extraction, are used. The extracted steam is used in the production process. High-pressure steam is generated either in steam boilers fired by coal, oil or gas, or it is obtained directly from the process by using heat from exothermic reactions.
**Privatisation**

During the years 1990 to 1992, in the period of economic transformation, complicated and difficult negotiations were conducted between PBS, foreign companies and the new Ministries of Industry and Finance, concerning the strategic objectives and the opportunities for continuing development in the area of steam and gas turbines and boilers in the new economic environment. The so-called "Czech way" of privatisation was also considered, i.e. retaining a dominant interest and management of the company in Czech hands, and the option of acquiring a foreign strategic partner and establishing a new joint corporation, in which the foreign partner would have a dominant position. General Electric, Siemens and ABB showed interest in the negotiations. Late in 1992, an agreement was signed between První brněnská strojírna and Asea Brown Boveri, to set up a joint corporation named ABB PBS.

The PBS top management led by the Managing Director, Richard Kuba, participated in all these negotiations, in which the future

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1. **Marketing and sales**
   - Engineering activities for the domestic market and allocated export regions
   - Manufacture, erection and handover
   - Servicing of turbines supplied by ABB and other manufacturers

The steam turbine production programme and its further development was reviewed in the new conditions to fit into the dramatically changed situation on the world markets, which opened to ABB PBS by signing the joint venture agreement. The main objective of the changes in ABB PBS, resulting from its joining the global manufacturer of power generation equipment was to incorporate the existing PBS production programme into a common production programme of all ABB PGI companies, to streamline sales, cooperate production and future technical and economic development, and increase the competitiveness of the group on the global power generation equipment market.

A significant contribution to the successful privatisation of První brněnská strojírna was made by its Managing Director, Richard Kuba. Thanks to his personal efforts to find a strategic partner the Brno engineering company is today one of the leading global manufacturers of power generation equipment.

Within the ABB multinational organisation ABB PBS was incorporated into the Power Plant Segment and within the Segment to the ABB PGI (Power Generation Industry) Division. Its main partners became ABB Turbinen Nuremberg (Germany) and ABB STAL in Finspong (Sweden). By that time ABB PGI had delivered to the world markets more than 10,000 steam turbines with power output ranging from 2 to 100 MW and of a total combined output exceeding 103,000 MW. The newly defined ABB PBS sphere of operations was steam turbines of up to 100 MW output and stationary gas turbines up to 30 MW.

ABB PBS became a PGI "ABB Technical Know-how Centre", assigned to develop its activities and reporting to the ABB Centre Manager in Finspong.

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Among the major activities to be performed by this centre were:
- Research and development as formulated by the ABB Lead Centre
- Marketing and sales
- Engineering activities for the domestic market and allocated export regions
- Manufacture, erection and handover
- Servicing of turbines supplied by ABB and other manufacturers

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The strategic partner implemented major changes at PBS not only in production, but also in all non-production and administrative processes. An era started, during which in the course of only a few years the original PBS structure was adapted to the organisational and manufacturing standards of the global manufacturer, the ABB multinational corporation.

A significant change was, for instance, the introduction of a new electronic information system covering all technical, financial and administrative activities of the company, equipped with servers and several hundred personal computers, connected to ABB's world-wide network. Changes in the manufacturing system also included introducing computer programs for thermodynamic calculations of turbine steam paths, and CAD systems for turboset design. An important step was also the implementation of 3-dimensional modelling using the PDMS software.

In parallel with these changes, concepts of sales, engineering activities, project execution, subcontracting and purchasing of materials and semi-finished products were formulated, and together with departments of other divisions moved to a modern building acquired by reconstructing the old "Sedan" manufacturing workshop.
An interesting application of the G&V system is an 84 MW turbine made for one of the world’s largest paper manufacturers, United Paper Mills in Finland.

As part of its contribution to the new joint venture, ABB made available its know-how of turbines known in the professional community as G&V technology. After a very short but difficult period of implementing technological procedures in the Brno plant, the conditions were created to commence production of these turbines, first for German contracts and later for the company’s own contracts as well.

The basic concept of the G&V steam turbines system was invented by the company ABB Turbinen in Nuremberg and was applied to all the types of mainly high-speed industrial turbines up to the output of 100–150 MW. After founding of ABB, it replaced the systems of BBC Bladen, PBS Brno, Go, and other producers. It was later also adopted by other owners Alstom Power and Siemens. The dominant feature of G&V turbines is the ability to optimise the steam path, while maintaining a high level of standardisation for the other turbine parts.

Compared to the previous PBS turbines, their technical innovation was mainly in their systematic utilisation of high speeds, allowing top parameters to be reached while at the same time reducing the number of blade stages. From the manufacturing point of view, due to the fact that many parts are standardised, G&V turbines were significantly simpler, although it was specifically in the manufacturing process that their close technological similarity to the products of the Brno turbine design school became apparent. The simplification of production resulted in a very desirable reduction in the machinery installed and in more effective use made of equipment.

The Nobel Peace Prize was awarded to the leader of the African National Congress, Nelson Mandela, in 1993.

The French President François Mitterrand and the British Queen Elizabeth II ceremonially opened the Channel Tunnel on May 6, 1994.

An 11 MW condensing steam turbine with a controlled extraction, designed for a waste incinerator in the Swiss town of Fribourg. A non-conventional installation method was used there. The entire turbine package (42 tonnes) was lowered through an opening in the roof by a crane; a spectacle which attracted the attention of the regional TV, the press and many onlookers.

In 2001, a 27 MW back-pressure, high-speed G steam turbine with a controlled extraction was supplied to Minnesota Power in Cloquet, USA – the first delivery ever of a Czech-made turbine to the United States.

The turbine is used to generate electricity supplied to the distribution grid. Part of the steam is extracted from the turbine and used in the technological process of the Cloquet Paper Mills.

The whole turbine including the base-frame, gearbox and generator, was designed and manufactured in only eight months and commissioned within one year of signing the contract.
1995

An example of a back-pressure machine is the 6.6 MW steam turbine with a controlled extraction supplied to a pharmaceutical company in Poland. The extraction steam is used in the technological process and the back-pressure steam in the heating system. The turbine design allows for the next development stage of the plant: the turbine output can be increased to 14.4 MW by simply re-blading its rotor, replacing the blade carrier and connecting a fourth nozzle group.

The Ministers of Trade and Industry from Hungary, Poland, Slovak and the Czech Republic signed the final declaration of the Central European Free Trade Association (CEFTA) on the February 4, 1994, committing their countries to liberalise trade within five years.

On December 13, 1995, the Veletržní palác (Exhibition Centre) was reopened after having been destroyed by fire in 1974. Moved to its premises are Modern Arts Collections within five years.

President Václav Havel awarded the Czech Republic’s first state decorations on October 28, 1995, the Czechoslovak Republic’s Independence Day.

The European Parliament accepted Finland, Norway and Sweden as new members of the European Union. The extraction of visitors at Kew Gardens. The two-metre tall plant, a Titan Aureum, exuded an evil smell similar to decaying fish and dead mice. It attracted hundreds of tourists.

District Heating Turbines

ABB’s extensive manufacturing programme also included industrial steam turbines – suitable for co-generation facilities.

The turbines are used to drive generators and to supply heating steam. The system makes use of the high economy of the combined generation of electricity and heat in a back-pressure or condensing extraction operation. The economy lies in the low heat consumption per one kWh generated by the back-pressure or extraction steam, because the heat of the outlet steam is used for boiling, heating and drying processes, and is not lost without being used in the condenser.

The turbines can also utilise the steam generated by waste heat from industrial processes – chemical, refrigeration, etc.

The wide range of their parameters allows these turbines to be used in a broad spectrum of industrial facilities and in the communal sphere.

- Output from 1 to 100 MW
- Inlet steam pressure from 1.5 to 135 bar
- Inlet steam temperature from 125 to 565 °C
- Backpressure from vacuum to 24 bar
- One or two controlled steam extractions

In condensing district heating turbines, the energy contained in the fuel is used to generate electricity and the back pressure steam is used either for industrial purposes or for heating. The turbine is controlled by back-pressure, and the electrical output depends on this parameter. The net heat entering the turbine is fully utilised. Losses are caused only by the efficiency of the mechanical and thermodynamic processes in the work cycle.

In back-pressure district heating turbines, the losses of condensation heat transferred to the cooling medium in the condenser is utilised to generate electricity and the extraction steam (0.7–24 bar) either for industrial purposes or for heating. The remaining steam is led to a condenser (0.05 bar) where it is condensed using cooling water or air. The turbine is controlled by back-pressure or extraction steam (0.7–24 bar) either for heating or for industrial purposes.

This 40 MW steam turbine is an example of a condensing machine: It has two controlled and two non-controlled steam extractions.

As of January 1, 1995, the European Parliament accepted Finland, Norway, Austria and Sweden as new members of the European Union. The Ministers of Trade and Industry from Hungary, Poland, Slovak and the Czech Republic signed the final declaration of the Central European Free Trade Association (CEFTA) on the February 4, 1994, committing their countries to liberalise trade within five years.

Yitzhak Rabin, the Israeli Prime Minister was assassinated on November 4, 1995 by an Israeli student who wanted to put a stop to the peace process in the Middle East.
Restructuring and Revitalisation

After its merger with ABB, the Brno Engineering Company emerged from isolation to find itself in an international market environment. At the beginning, the management focused its attention mainly on implementing new technology. However, it soon became obvious that if the company was to succeed, considerably more profound changes were necessary. The structure of manufacturing capacity and its internal processes bore the legacy of the years of a centrally-planned economy and the strictly-regulated Comecon markets. It became obvious that if the company was to function successfully in a market environment, not only its structure, but also the thinking and approach of all its employees had to be changed fundamentally. In 1996 Eduard Palíšek was appointed Managing Director of the Turbines Division and immediately launched an extensive restructuring and revitalisation programme. During the restructuring stage, a detailed and thorough analysis was followed by cutting back on all levels of non-productive activities. This allowed the organisational structure to be considerably optimised. The changes affected not only all departments, but also the top management.

The strategy of focusing on quality led to growing productivity as well as to a significant reduction in the overall manufacturing time. Logistics were enhanced by moving the manufacture of blades from the Mikulov Plant to Brno. The machinery layout was adapted to suit material flow. Other investments were made in CNC technologies and information technology. The restructuring only partly rid the company of the ills of socialism. Many of the processes were still considerably non-transparent and there was virtually no collaboration between departments. This was where the revitalisation stage was focussed. Changes in the management organisation created conditions for teamwork within departments as well as between them. One by one, all processes were described and formalised. A lot of emphasis was put on quality, both in the production and in all other processes including sales. Although the number of contracts signed declined temporarily, the processing of contracts focussed on quality, making sure that the newly signed contracts could be executed with profit and to the full satisfaction of the clients.

Eduard Palíšek

Following the completion of a successful certification audit in 1995, Bureau Veritas International Ltd issued ABB PBS their Quality Control Certificate, confirming that the quality control systems implemented in the Turbine Division had been audited and found compliant with the requirements of the ISO 9001 standards.
Development of ATP Technology

ABB formed international R&D teams. For instance in 1993 the R&D objectives for industrial turbines were set in the ATP 90-R&D task. For this specific task, a team of experts from the Swedish ABB STAL, German ABB Turbinen and Czech ABB FRS was established.

The objective was to develop a new modular series of steam turbines covering the whole range of required power output from 2 to 100 MW, using common platform components.

The outcome of this joint effort was steam turbines known under the model designation ATP 1 to ATP 4. The task structure for individual teams corresponded with the ambitious development tasks. Some groups concentrated on the development of new turbines, others on the development of a common control system, lubrication and control oil systems, control units and common design tools, i.e. software for turbine calculations and CAD systems.

The Brno Engineering Company had people in practically all the teams. Its engineers participated in the development of turbines in the Swedish town of Finspong and Nuremberg in Germany, while the team set up to develop blading worked on their task in Baden, Switzerland.

The results of the joint development efforts were symbolically announced by the company management in 1996 in Prague in the presence of the Segment’s Zurich-based management and all participating companies.

However, no technical development ends with the announcement of results and the manufacture of the first prototypes; it is an ongoing, endless process. Therefore this was not an end of the work on the ATP turbines. Shortly afterwards, the company reacted to new market requirements and started to develop the smallest of the ATP turbines – the ATPX, which was characterised by its simplicity and its low investment costs.

Assembling an 8.8 MW ATP2 condensing steam turbine for a waste incinerator in Madera, Portugal.

A characteristic feature of the ATP 1 & 2 turbines is that they are installed, together with the gearbox and generator, on a base-frame which also functions as the oil tank for the integrated oil system. This solution significantly simplifies installing the turbine at the site. This system was later adopted also for the G & V turbines.

A 7.8 MW condensing turbine with a controlled extraction made for Korea Zinc. This is basically a “hot-water turbine”. This, of course, is an exaggeration, but because of the very low inlet steam parameters and the high content of liquid water, the admission steam is not too far from being hot water. Hence more resistant materials had to be used and every rotating blade row had to be equipped with a drainage system.

The joint efforts in further development of ABB steam turbines was marked by certain weaknesses on the side of the Brno technicians. The main problem was that specialists had insufficient knowledge of English. Their inability to participate fully in discussions in English led some Czech engineers to refuse to fully participate in discussions in English. Another problem was that specialists had insufficient knowledge of English. Their inability to participate in meetings and, in extreme cases, even to leave the company.

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In 1993 the film “Toy Story” was released in the cinemas. The special thing about this movie is that it was completely created using computer technologies.

After negotiations relating to security, Madeleine Albright was appointed the first female Secretary of State of the United States of America in December 1996. She was born in Prague under the name of Jan Koubková.

In 1996, a woman with a transplanted kidney gave birth in a healthy child.
Modernisation of Turbosets in the Czech Republic

The new management of the Turbine Division focussed the attention of the sales and technical departments on modernisation of industrial power plants which were becoming obsolete. An emphasis was put on making proposals for modernising the heat and power plants in which old machines at the end of their useful lives could no longer perform their function and could not meet the requirements of availability, operating reliability and economy.

The purpose of modernising was to improve technical and economic parameters compared to the original solution. This was achieved by applying those new design elements and technological methods which progress had brought since the original installation in the areas of design and manufacture. The original basic machine parameters were maintained – pressure, temperature and flow of extraction and back-pressure steam, but the efficiency and output were increased, the control system features enhanced and the user-friendliness increased.

The economic benefits of the modernisation programme are obvious if we compare the technical and economic parameters of the turbine before and after the modernisation.

The first ATP turbine installed in the Czech Republic was a 29 MW back-pressure steam turbine for a heat and power plant in České Budějovice, which replaced a turbine made in 1963. The contractual requirement was to use the foundations and space left by the old turbine, which had an output less than half of the new turbine. The replacement was preceded by rehabilitating the boilers and upgrading their output.

Two 20 MW G&V condensing steam turbines were used in the modernisation programme of the Heat and Power Plant Ostrava. Both are deployed in continuous baseload service.

As in České Budějovice and Nová Huť, the alteration meant removing the top part of the turbine block and installing spring elements (insulators) on the foundation columns. The entire turbine module with an integral oil system in the base frame was then placed and installed on them. For all practical purposes, the frame replaced the top foundation slab.

An ageing 12 MW turbine was dismantled in the town of Otrokovice, and after some alterations replaced with a new unit of a significantly larger output and better operating parameters.
Combined Gas and Steam Turbine Cycles

An increasing emphasis on environmental protection has had a significant impact on the requirements made by clients in the power generation industry. More and more companies have started to prefer environmentally-friendly solutions using natural gas. For economic reasons the winner is often a solution based on combined cycle.

The ATP Series turbines have proved themselves as being suitable for combined cycle plants. The single-shaft aggregate configuration has been very successful, where the generator is driven by a steam turbine at one end, and by a gas turbine at the other. If such a plant also utilizes the extraction steam heat, the fuel energy utilization can be as high as 88%.

View of the Červený mlýn combined-cycle heat and power plant with a 24 MW back-pressure steam turbine with a controlled extraction. This plant represents a modern co-generation installation for the combined production of electricity and heat, based on the combustion of natural gas or light fuel oil. In either case, this is a very effective and environmentally-friendly method of combustion. An old coal-fired facility has been replaced by a modern plant, contributing to the reduction of noxious emissions and air pollution in the region.

Among unconventional projects which make use of this technology is a contract for a 55 MW steam turbine for a barge-mounted power plant that is anchored in the sea near the Indian city of Mangalore. The facility has four gas turbines, four waste heat boilers (HYUNDAI) and an ABB condensing steam turbine. To make its installation on the barge easier, the turbine is designed with an axial exhaust. The entire turbo-generator including accessories is mounted on a base-frame, which serves also as the oil tank for the integrated oil system.

A typical combined cycle - exhaust gases from the gas turbine are used in the boiler to generate steam. The steam is then used in the steam turbine to generate additional power.

Gold Medal won at the 1998 Brno International Engineering Trade Fair

Communal waste has become a nightmare for civilisation. With the gradual enhancements of the communal waste incineration technologies and the resulting cleaner emissions, the interest to utilise the heat generated in these processes in power generation has been growing. Waste incineration boilers of various designs produce enough steam to be used in the generation of electricity and heat. Here too, the requirements for the design of the steam turbine are very high. The machines must have an adequate efficiency even at lower steam temperatures and with fluctuations in the volume of extraction caused by the special processes in which incinerators operate. Often the turbine must be located in a limited space. An increased emphasis is also put on the degree of automation. Sometimes the requirements are so extensive that the entire plant including the turbo-generator must be controlled remotely from another location. It is worth mentioning that it was particularly in this market segment that the Brno Engineering Company acquired clients from around the world. A rotor for an ATP2 turbine designed and made for a waste incineration plant in the United Kingdom was awarded a Gold Medal at the 1998 Brno International Engineering Trade Fair.

A view of the Červený mlýn combined-cycle heat and power plant with a 24 MW back-pressure steam turbine with a controlled extraction. This plant represents a modern co-generation installation for the combined production of electricity and heat, based on the combustion of natural gas or light fuel oil. In either case, this is a very effective and environmentally-friendly method of combustion. An old coal-fired facility has been replaced by a modern plant, contributing to the reduction of noxious emissions and air pollution in the region.

NASA announced in March 1998 that its space probe Lunar Prospector revealed large deposits of water on the Moon.

Karel Loprais won the Paris-Dakar Rally in a Tatra truck in 1999 for the fifth time and he was ranked among the legends of this race.

The exhibition “Ten Centuries of Architecture”, held from April 5, 2001, presented all the great architectural styles in authentic interiors of the Prague Castle.

The Czech Republic, Poland and Hungary became members of NATO in 1999.

Vigra, the drug supporting male potency, was brought on the market in 1998.

American and Japanese scientists found the first evidence that neutrinos, very small particles smaller than an atom, have a mass.

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In 1998 American and Japanese scientists found the first evidence that neutrinos, very small particles smaller than an atom, have a mass.
The last years of the 20th Century, a period of growing globalisation, were characterised by mergers of large manufacturing enterprises. On March 23, 1999 two multinational corporations, ABB and ALSTOM, announced that they had decided to merge their power generation equipment manufacturing facilities into a single entity, each party holding a 50% share. The new corporation, ABB ALSTOM Power, became one of the largest manufacturers of power generation equipment in the world.

In industrial steam turbines, the new company became the largest company in the world for total delivered output.

In the past 10 to 15 years, power generation has undergone significant changes. In the 1980s, mostly solid fuels were used and the steam power plants built had ever increasing output. Environmental protection became a necessary part of the technology. Liberalisation and privatisation of the electricity and heating markets have imposed new requirements on the manufacturers of power generation equipment by the plant operators. These are mainly shorter delivery times, complete output reliability and efficiency of the equipment supplied and new requirements in servicing and maintenance.

Falling electricity prices also brought new pressure on the power generation equipment manufacturers, which can only be withstood by companies who are extremely efficient. The new company ABB ALSTOM Power managed to offer the new, dynamically-developing market, a broad spectrum of products and solutions including a comprehensive service, effective research and development at a high level and capital self-sufficiency.

And this still continues to apply after the next step, when in 2001, ALSTOM purchased ABB’s share in the joint venture and became the sole owner of the newly conceived giant among power generation equipment manufacturers – ALSTOM Power – incorporated directly into the ALSTOM organisational structure.

The Brno-based Industrial Turbine Segment became one of the major suppliers of industrial steam turbines within the new corporation. The remaining three suppliers are Finspong in Sweden, Nuremberg in Germany and La Courneuve in France.

Brno did not acquire this position by chance. It won the trust of the parent company thanks to its enormous technical and human potential, consistent restructuring, emphasis on quality and the good reputation and references, which it has gradually acquired on the markets of Western Europe, South-East Asia and North America.

Within the ALSTOM Power Group Brno became responsible for the worldwide market of steam turbines with a power output of 20 MW maximum.

In 1997 the Brno Engineering Company started sponsoring Czech handicapped sportsmen and women and became the official sponsor of the Czech Paralympic Team. The basic philosophy of the Paralympic movement is the principle that the handicapped sportsmen and women should possess abilities, experience and equipment equal to their non-handicapped counterparts. Therefore they must perform well enough to get into the national team and undergo demanding qualification heats in order to participate in major international competitions.

The sporting climax and dream of every handicapped sportsman and woman is to compete at the Paralympic Games or at the Deaflympics. The Paralympics history dates back to 1948, when the English neurosurgeon, Sir Ludwig Guttmann, organised the International Wheelchair Games which were held at the same time as the London Olympics. The First Global Games, the predecessor of the Paralympics as we know them today, were held in 1960 in Rome. Since 1992 this top event has been organised by the International Paralympic Committee. The Czech Paralympic Committee was established a year later.

Modern Paralympic are held in even years, always shortly after and at the same venue as Olympic Games. In odd years, the World Federation of the Deaf holds Deaflympics or the World Games of the Deaf, the beginnings of which date back to 1924.

The principle idea behind the Paralympic movement appealed to the Brno Engineering Company: “We appreciate the efforts of the Czech Paralympic Committee to promote the Olympic ideas and emphasising the fact that in goal achievement there is no difference between people, as long as they attempt to reach their goals by their own hard work and perseverance, and observe the principle of fair play.”

These were the words used by Dan Řok, the ALSTOM Country President, to express the motives behind the corporation’s decision to support the Paralympic movement. In 1997, in the year the Company became a sponsor of the Paralympic movement, the Czech team won four gold medals at the Summer Deaflympics in Copenhagen.
When ABB and ALSTOM Energy merged their activities in 1999, there was a considerable overlap on the industrial steam turbine side. Therefore our specialists have spent a considerable amount of time and effort selecting the best of the ALSTOM Energy products and the best of the ABB products and amalgamating them into a single product range. What they have done is apply a selective approach, reducing the number of turbines available from a group of 16 to a family of 6, covering 4 single casing and 2 dual-casing turbines, all of which are available in a number of configurations and module sizes. The turbines, called simply ST1 - ST6, cover the full range of customer needs up to 100 MW range. The streamlined production programme leads to an increased level of standardisation, which has a positive impact on the cost, lead times and reliability of the turbines.

In Brno, the consolidated manufacturing programme meant primarily an opportunity to extend the range to include the ST1 turbine which was originally a product of the French ALSTOM. The ST1 Series are single-casing turbines for small outputs from 1 to 10 MW, and low capital investment. The Brno engineers also started participating in new development tasks, mainly concerning the ST1 Series.
Brno turbines under the Siemens brand

At the end of 20th century the French engineering company Alstom suffered into financial difficulties. The crisis which the company experienced mainly because of the bankruptcy of its main customer for cruise liners, resulted in the decision to sell key profitable divisions: the Industrial Steam Turbines Division, of which also the Brno turbine works formed a part, and the Transmission and Distribution Division. The German group Siemens AG and the Japanese company Hitachi showed interest in the Industrial Steam Turbines Division.

Siemens evinced interest in purchase of the Brno machine works before, and on this second occasion in April 2003 the company was successful and so became owner not only of the Brno steam turbine plant, but also other sister companies in Great Britain, Sweden, Germany, Brazil and India. More than 500 employees of Alstom Power in Brno moved to employment in Siemens Power Generation (PG) group.

Siemens purchased the division from Alstom for 1.1 billion Euro and the whole transaction proceeded in two steps. The first phase included taking over of production of small gas turbines with headquarters in Lincoln, Great Britain. The second phase included purchase of facilities for middle-sized gas and industrial steam turbines in Sweden, Germany, and Czech Republic. For this acquisition it was necessary to obtain approval from the EU antitrust committee and also from the office of the Attorney General of the United States of America. Because of these matters, the Dutch company Demag Delaval with headquarters in Hengelo became temporary owner of the mentioned companies. Therefore for a certain period of time, the companies were presenting themselves under the name DDIT: Demag Delaval Industrial Turbomachinery. Siemens AG soon has became an owner of the Dutch company so the companies have became directly controlled by the German concern.

Klaus Voges – PG group president

"This acquisition is a superb opportunity for us. Gained products and services perfectly complete our production program," emphasized Klaus Voges, PG group president. "This way we obtained leading position on the worldwide market of industrial energetics and compressor machinery. We especially count with good opportunities in the area of oil and gas exploitation. This acquisition substantially contributes to realization of our strategy to provide complete offer of products and solutions for customers around the world in industry sphere," added Voges.

Dr. René Umlauft and Eduard Palíšek, MBA

Director of the Brno office PGI 2, Dr. René Umlauft addressing the meeting of employees on the integration of the Brno works into Siemens.

The coming of Siemens to the Brno machine works meant a turning-point in its history. For the first time the premises on Olomoucká Street had to be divided between two independent companies. With strong lines tied departments of manufacturing, engineering, sales, project executions and service were now experiencing big changes. It was necessary to divide also so-called shared services like units of controlling, human resources and marketing, which up to now had served to all segments or divisions together. Step by step all the conditions necessary for the independent existence of two different firms in the same premises were created and improved.

Based on a mutual agreement, new offices were created for Siemens by reconstruction of the U rybníku building which was added from the point of view of connecting with the adjacent turbine production hall.

The production of new machines and turbine service were after the purchasing by Siemens completely modernized and also extended. The Brno machine works became an equal part of the worldwide group not only for its very important position in the field of customers relationships, but also in the field of cooperation with other Siemens PG units all around the world, especially with Goerlitz, Finspong and Nuremberg.

Basically a modern company was born here, whose core is founded on quality proven over the years and tradition of production know-how.

Siemens AG – organizational structure

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On 27th April, 2004, a contract was signed for one of the biggest turbines ever made in Brno. The single cylinder steam turbine type VE 80 with radial exhaust and power output of 97MW has been successfully installed to replace two obsolete turbines in a heating plant in the suburbs of Warsaw – Žeraň.

February 27, 2005
In Japan, engineers finished blasting a 25.6 km long railway tunnel through a mountain in the Aomori prefecture. The tunnel is the longest in the world so far.

The Indian Ocean earthquake triggered tsunami on December 26, 2004, that killed more than 250,000 people.

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2005
One year later another contract was signed for the same customer. This time it was for two turbines at once, each with output of 110 MW. The contract date for putting into operation is the end of the year 2008. Thus new turbines with a record output for Brno will replace original units from the 70’s and will increase the efficiency and reliability of the Siekierki heating plant.

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Pope John Paul II. dies. On April 19 the Papal Conclave met and elected the new Pope Benedict XVI.

In January 2006 the 4 Hills Tournament victory was for the first time shared between two competitors: a fourth victory for Janne Ahonen with Jakub Janda sharing the title by obtaining his first Tournament success.

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The Czech National Library purchased a facsimile of Latin translation of Chronicle of Dalimil at an auction in Paris for 300,000 Euro.

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Certificate of Merit in Innovation Award

In the 2007 Innovation competition, the innovation of the turbine series SST-300 was awarded a certificate of merit. The basic criteria in this competition are the technical level of the design, originality, standing on the market, effectiveness, and environmental impact. The turbine series innovation achieved excellent results in all assessed areas.

The modular turbine series SST-300 offers a reliable and economically efficient solution for customers' specific conditions which is equivalent, as to efficiency, with "tailor-made" turbines without using standardization. After the innovation, 36 turbine alternatives can be assembled, differing in both their power and designation, by a combination of two unaltered turbine casing castings (see Fig. 1 and 2) with welded or cast outlet branches. Increasing this number of alternatives to another 72 was enabled by adding other types of input valve parts.

Another significant factor for the development of a new design of turbine casings was following the characteristics of all rotor sizes considered for this series. By meeting this criterion, the mechanical feasibility of the designed solution was guaranteed. If we take into consideration that within each of the 36 variants differing, particularly, in the bearing distance there are partial variants of the size of the rotor's foot diameter, the complex effect of the innovation on the entire product designated as SST-300 is evident.

Major improvements

- A change in the design of the original rigid cast turbine casing of the steam turbine series SST-300 for applications without or with a single controlled extraction. The previous maximum controlled admission steam parameters of 90 bar, 510°C were increased to 120 bar, 520°C.
- Development of a completely new cast turbine casing for applications with two controlled extractions. This casing is also designed for the above-mentioned increased admission steam parameters. Alternatively, the casing may be used for applications with five uncontrolled extractions (see Fig. 2).
- The original alternative of double-seated control valves was supplemented with a single-seated alternative with increased efficiency.

 Obtaining OHSAS 18001 certification

In relation to the occupational health and safety policy, the company's management decided to introduce and subsequently to have an Occupational Safety and Health system certified according to the international standard OHSAS 18001 (OHSAS = Occupational Health and Safety Assessment Specification). Apart from successful certification, the principal goal of this project was to create an efficient control system in this field. This system also includes the setting and fulfilling of targets resulting in minimizing risks and adverse impacts of working operations on employees' health. Occupational health and safety was, in 2007, and still is the company's priority.
**Solar power tower**

In 2009, the manufacture of the historically first turbine for the solar power tower of the eSolar project was started. The basis of the eSolar technology is several thousands of relatively small mirrors (approx. 1 m in height) which are divided into subfields oriented either to the north or south. The sun’s rays of several fields of mirrors are reflected onto the solar tower which functions as a heating unit for steam generation (see Fig.). The condensed steam is finally led back to the solar tower. For 49 MW of power, 16 solar towers are necessary, of which each has its north and south field and takes up a total area of 0.6 km². As in other solar-thermal power plants, the basis is a field with regularly distributed mirrors. However, in this technology it is not necessary to use oil which would be heated by solar energy and subsequently used as the heat energy source for steam generation.

**Changes in the production hall**

In connection with increasing the production capacity of the Brno plant and the change in the worldwide structure of Siemens, there has been a significant increase in investment in production since 2007. Not even through the economic crisis, which hit the global markets in 2009, did long-term investments end. Just in the financial year 2009/2010 investments amounted to approximately CZK 140 mil. The production hall obtained many new machines – horizontal milling and boring machines and a carousel. The new automatic welding machine enabled the manufacture of turbines with welded rotors which are especially in demand for service projects. The first successfully welded rotor is the low-pressure rotor from the Vesova project.

Modern machining centres also made it possible to produce blades for internal combustion (gas) turbines. Notionally, the plant resumes the production of internal combustion turbines which started there after World War II and was terminated in 1994 (a total of 406 turbines were supplied). Since 2009, blades for the compressors of internal combustion turbines SGT-100, SGT-300 and SGT-400 (see Fig.) have been made in Brno and they are further used for the manufacture of turbines in the affiliated company in Lincoln.

**Supporting S. K. Hobit**

The company supports the club of basketball players in wheelchairs, S. K. Hobit. The Siemens Basketball League for Wheelchair Users with international participation has been played for three years thanks to Siemens contributions. Our support of this sport did not go unnoticed. The company received the STI award for extraordinary support of basketball in wheelchairs from Zdeněk Škaroupka, the manager and member of the board of directors of the League for the Rights of Wheelchair Users at a gala evening. The award is represented by a sculpture of interwoven hands that embodies the award.
### Multi-stage steam turbines 1901–2010

#### North America
- **USA**: 22 units, 496 MW
- **Canada**: 6 units, 151 MW

#### South America
- **Brazil**: 52 units, 1 MW
- **Argentina**: 2 units, 44 MW
- **Peru**: 4 units, 40 MW
- **Mexico**: 3 units, 344 MW

#### Europe
- **Czech Republic and Slovak Republic**: 824 units, 6,268 MW
- **CIS (Russia before 2001)**: 396 units, 2,506 MW
- **Poland**: 232 units, 2,302 MW
- **Romania**: 58 units, 806 MW
- **Belgium**: 21 units, 507 MW
- **Hungary**: 42 units, 246 MW
- **Germany**: 45 units, 343 MW
- **Austria**: 129 units, 235 MW
- **Yugoslavia**: 26 units, 156 MW
- **Finland**: 7 units, 261 MW
- **Sweden**: 11 units, 231 MW
- **France**: 3 units, 18 MW
- **Netherlands**: 1 unit, 11 MW
- **Belgium**: 5 units, 46 MW
- **Netherlands**: 1 unit, 14 MW
- **United Kingdom**: 6 units, 59 MW
- **France**: 7 units, 14 MW
- **Spain**: 5 units, 20 MW
- **Portugal**: 5 units, 47 MW
- **Greece**: 2 units, 14 MW
- **Latvia**: 1 unit, 2 MW
- **Lithuania**: 2 units, 24 MW
- **Baltics**: 3 units, 52 MW
- **Serbia**: 2 units, 26 MW
- **Russia (after 2002)**: 20 units, 712 MW

#### References 1901–2010

Multi-stage steam turbines: 2,632 units, total output 20,228 MW

Single-stage steam turbines: 2,079 units, total output 555 MW

Total no. of supplied steam turbines: 4,711 units

Total output: 20,783 MW

Delivered to 66 countries
Top management

ING. VLADIMÍR ŠTĚPÁN, MBA  (* 3-13-1971)
He studied at Brno University of Technology, Faculty of Engineering. He started his professional career by implementing investment units in the petrochemical and chemical industry. He has been working for Siemens since 2000. In September 2007, he became the business manager of Siemens Industrial Turbomachinery s.r.o. He was appointed the general manager of the company on 1 October 2009.

ING. VIKTOR ČERMÁK, MBA  (* 4-24-1975)
He studied Process Engineering at Brno University of Technology. Later, he obtained his MBA title at the Economy University in Prague. He started his career in Project Execution dpt., and then he worked in Engineering and Business Development. Since 2011, he started working as a Head of Service Division in Brno.

ING. PETR HILL, MBA  (* 6-23-1954)
Mr. Hill graduated in Aircraft Design from University of Defence in Brno. He has worked for the company since 1981. He participated significantly in the development of ATP turbines, worked as a head of development of ATP turbines, then as head of turbine service, and currently he is the company’s Engineering Director.

ING. JAROSLAV MOŠAT  (* 12-25-1964)
Mr. Mosat graduated in Heating and Nuclear Machinery and Devices from VUT in Brno. He has worked for the company since 1988. He launched his career in engineering, then he worked in the purchasing department and project management. Later, he worked as Purchasing Manager and currently he is a Project Execution Director.

ING. Zbyněk Uher  (* 9-18-1964)
Mr. Uher graduated in Chemical and Food Machinery Design from VUT in Brno. He joined the company as a Quality Manager in 2002. Since 2003 he has worked as company’s Quality and Operation Services Director.

ING. Jaroslav Jirásek  (* 12-12-1966)
Mr. Jirásek graduated in Heating and Nuclear Machinery and Devices from the Faculty of Mechanical Engineering at VUT in Brno. He has worked for the company since 1994. From the beginning he worked as Project Manager and since 2007 he is the company’s Manufacturing Director.

ING. Erik Feith  (* 21-7-1976)
He completed Accounting and Financial Company Management at the University of Economics in Prague. He started working for the company in 2008 in the position of economic manager which he still holds.

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ING. ZDENĚK PETRKA  (* 12-12-1966)
Mr. Petrka graduated in Heating and Nuclear Machinery and Devices from the Faculty of Mechanical Engineering at VUT in Brno. He has worked for the company since 1994. From the beginning he worked as Project Manager and since 2007 he is the company’s Manufacturing Director.

Note: Between 1945 – 1958, PBS had a Technical Section, which was managed by a Chief Engineer, and a Production Section, which was managed by a Production Manager – there were no turbine and boiler sections.

ING. JOSEF MĚKUTA, MBA  (* 9-6-1962)
Mr. Mekuta graduated in Foreign Trade Economics from University of Economics in Prague. He worked on head positions in sales and marketing department in CKD Blansko Inc. He has worked for the company since 1996. At first he worked as a Head of Gas Turbines Department, later he worked as a Substituting Managing Director. Since 2002 he has worked as company’s Sales Director.

MILAN RICHTER  (* 1-11-1935)
He graduated from a high school of economics and industrial high school. He has been working in the company since 1959. He worked in planning and management of boiler production, later as a manager of the boiler production management. In 1984 he started working as a manager of economic divisions of Engineering Plant, Boiler Division and Supplier-Engineering Division. In 1996 he started working as the controlling manager and then as the financial manager in the Turbine Division. At present, he is an advisor and member of the company management.
History and current development of steam turbine production in Brno


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