Feature

Reflections on Postwar Technical Exchanges between Japanese and French Railways

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Birth of Shinkansen and TGV in Japan and France

The completion of the 515-km Tokaido Shinkansen connecting Tokyo and Osaka in 3 hours and 10 minutes at a maximum speed of 210 km/h just 20 years after WWII brought Japanese railways to the immediate attention of railways worldwide. Coupled with the successful 1964 Tokyo Olympic Games, this world-beating high-speed railway was a source of national pride and a sign of things to come. Moreover, it revolutionized the railway business by proving that the so-called 'declining' railways could compete with automobiles and aircraft if sufficient investment was made in technology.

1981 saw the confirmation of this technological revolution when the southern section of the TGV SudEst railway was completed to link Paris and Lyon, the second largest city in France. But the TGV also pushed the technology envelope further by increasing the maximum speed to 260 km while the Tokaido Shinkansen had only increased its maximum speed by 10 km/h to 220 km/h in the 18 years following its debut. Subsequently, the TGV's maximum speed rose to 300 km/h when France completed the TGV Atlantique in 1989–90 and the TGV Nord in 1993 as part of the planned EU high-speed network.

Japan and France had created a spirit of friendly competition and cooperation in building commercial high-speed railways typified by Hideo Shima (1901–98), the technical father of JNR's shinkansen (*see JRTR* 3, pp. 45–48) saying, 'I am truly happy to see the success of the TGV. I want to celebrate it in the same way as they celebrated and were proud of the success of the shinkansen. It shows that the railways still have plenty of room for progress and improvement, if we can just leave behind some of our old ways.'

Likewise, Fernand Nouvion, the senior engineer who took the lead in developing electric traction technology for the postwar French National Railways (SNCF) said, 'Every year I receive a New Year greetings card from Hideo Shima, who is now President of the National Space Development Agency. This year he had written on it, in his own hand, a message of congratulations on the success of the French TGV, (and) we have no reason to doubt him.' These statements by Shima and Nouvion underline the importance of the technical exchange between the two countries.

SNCF's early AC locomotive Class CC14100 hauling a heavy coal train in northern France (H. Suzuki Collection)

Exchange of railway technology between Japan and France

It could be said that the friendly postwar competition between Japan and France is the reason that the two countries now have two of the most advanced high-speed railway systems in the world.

Jean Bouley (1927–97), UIC Secretary General, spoke of it very honestly saying, 'France's SNCF walked in the path pioneered by JNR. Ever since the shinkansen appeared in Japan, Fernand Nouvion has been thankful for it, and has praised its role. I still clearly remember the stirring speech he gave to the SNCF Rolling Stock Division staff on his return from Japan in March 1962, entitled "The electrification of Japan's railways and the Tokaido main line." At that time my conclusion was that what Japan had borrowed from France, it had now been able to return faithfully. Japan had succeeded in building a high-speed railway, and in doing that,

it released a healthy spirit of creative competitiveness.'

French railway AC electrification technology

Let's take a brief look at exactly what Bouley meant by '...what Japan borrowed from France... .' He was speaking of French railway technology that was indispensable to the completion of the shinkansen. Nouvion said, 'In 1955, five officials from JNR attended an international conference in France. They told us, "At this conference, we have learned that it is possible to increase railway speeds, and that the best method of railway electrification is to use alternating current at industrial frequency." The Japanese made their conclusions extremely quickly after this conference, and their final product was the Tokaido Shinkansen.' Shima also said, 'The experience that we gained in AC electrical driving was the decisive factor in achieving the Tokaido Shinkansen.' AC electrification technology was '...what Japan borrowed from France... .'

I want to examine this AC electrification technology, which was used in France after WWII and publicly discussed at international conferences in Annecy in 1951 and Lille in 1955, to clarify how JNR made the technology its own and incorporated it into Japan's railways and shinkansen. After learning about AC electrification at these two conferences, the AC Electrification Investigation Committee led the effort to succeed in domestic production of an AC electric locomotive. In the 1960s, Japan successfully exported domestically produced AC electric locomotives to India. This pattern of introducing technology from overseas, creating a new item using the technology and then exporting it, typified the industrialization of postwar Japan.

Visit to France by AC Electrification Investigation Group

From 1945–51, Japan was occupied by the Allies under the leadership of General Douglas MacArthur (1880–1964), Supreme Commander for Allied Powers in Japan (SCAP). The General Headquarters (GHQ) pressed ahead with various reforms of the Japanese economy and political system based on democracy, land reform, labour reform, breaking up the *zaibatsu* (big business group), etc. The Americanization of Japanese society was well underway. The Japanese thought that electrification was essential for modernizing their railways, but GHQ did not appreciate its significance.

Shiro Seki, a talented electrical engineer who played a key role in the electrification of Japan's railways in the postwar period, said, 'Even though the war is over, we are still engaged in a struggle with America.' Less than 6 months after the war's end, work started on DC electrification of the 125-km Takasaki–Nagaoka section of the Joetsu Line. This was completed in 1947. Following this, work started to DC electrify the Numazu–Hamamatsu section of the Tokaido main line and Fukushima–Yonezawa section of the Ou Line but an order to stop work was issued by GHQ. In response to this, JNR submitted requests to GHQ from civilians in the relevant areas for electrification of the lines and the work was approved.

GHQ opposed the electrification because it did not understand the extent to which Japan depended on electricity due to poverty of natural resources such as coal and oil. In addition, diesel locomotives were popular in the USA at this time and the American occupation forces had brought several General Motors (GM) diesel locomotives to Japan with the probable intent of selling them. But GM diesel locomotives did not capture the Japanese market because JNR was quick to realize the importance of electrification and energetically introduced knowledge about AC electrification from France in an effort to find an economic method of electrifying the main lines.

GHQ Railway policy

GHQ's main concern was not to build new lines nor to implement electrification, but was instead to achieve the greatest effect for the lowest cost by improving existing railways and rolling stock. In 1948, MacArthur ordered the elimination of loss-making operations by the government railways for the sake of the nation's economic security. According to SCAP's Plan for Economic Stability, the order was designed to stop the government railways' purchase of unnecessary electric locomotives. SCAP also gave orders for construction of highways to replace railways. As a result, except for a new 90.2-km link connecting a steelworks at Kamaishi in Iwate Prefecture with the main line to Tokyo after the existing route was destroyed by a huge typhoon in 1948, there was no new construction from April 1946 until late 1950.

The electrification plans were suspended until 1947 due to depleted resources and were then only permitted if they could be justified economically. Since SCAP felt the need to ensure coal supplies, electrification was only permitted if there was a surplus of electricity and it was cheaper than coal. After the first electrification of the Hamamatsu–Numazu section of the Tokaido main line, the amount of electrified track increased from 6.6% in 1946 to 8.4% by the end of 1950.

According to the *GHQ/SCAP History of the Nonmilitary Activities of the Occupation of Japan 1945 through March 1951*, despite Japan's small land area, it had a relatively high potential for hydroelectric power generation with very few regions that could not use electricity.

Both coal and electric power were important sources of energy for Japanese industry. The entire Japanese mining industry and most manufacturing industry used electric power. The demand for electricity for domestic use was also increasing. Looking at the electricity consumption figures for 1946–49, industry used 47%, households used 19%, lighting used 7%, and railways used a mere 5%. The use of electricity for non-industrial purposes was fiercely restricted unless there was a very good reason.

In occupied Japan, the Economic Stability Headquarters Resources Committee submitted a report to Shigeru Yoshida (1878–1967), President of the Economic Stability Headquarters, entitled 'Counsel on Electrification of Railways,' demonstrating just how passionate people were regarding railway electrification.

Earliest encounters with French AC electrification technology

The JNR Centennial History notes the importance of France's role in the introduction of AC electrification technology to Japan. According to this record, SNCF took the results of prewar AC electrification experiments at Höllental and Dreiseenbahn in SW Germany, and succeeded in using industrial-frequency AC electrification in an experiment on the Annecy Line in the Savoie region in 1951. As a result, they announced that industrial-frequency AC electrification was viable economically for railways. At the time, Japan was under great pressure to electrify railways due to coal shortages, but was faced with difficulties due to the costs of constructing substations and other infrastructure required for DC electrification. As a result, JNR specialists were strongly drawn to the more economical AC electrification methods demonstrated by France.

So who was the first to introduce French AC electrification to Japan? According to Seki, 'President Sonosuke Nagasaki (1896–1962) of JNR visited France and had a meeting with Louis Armand, President of SNCF. At that time, they were in agreement over the future electrification of railways. Shortly after he returned, Nagasaki established an AC Electrification Investigation Committee in JNR. Given these facts, it could be assumed that the start of AC electrification of Japan's railways happened when Louis Armand recommended it to President Nagasaki.'

However, looking more deeply into the matter, Seki also tells us that, 'The first Japanese to technically investigate the SNCF experimental Annecy Line to Chamonix was Yasuo Yayama, who at the time was Deputy Controller of JNR's Tohoku region, in 1952.' According to Yayama, as soon as the San Francisco Peace Treaty was signed in September 1951 and Japanese could travel overseas, he was one of a group of five people sent by JNR on a trip to Europe, the first since the war. Yayama heard general explanations of AC electrification while at the Paris HQ of SNCF and then, '...stayed in a town at the foot of Mont Blanc called Annecy, where I studied real electric locomotives, electric power lines and infrastructure, and the French taught me ever so much.' At this time, Yayama recorded his impression. 'The infrastructure (for AC electrification) was extremely simple. The locomotives, however, seemed extremely complex.'

SNCF was convinced of the economic viability of AC electrification and '...in order to announce to the rest of the world that it was to use (AC electrification methods) earnestly,' hosted a conference entitled *Journèe d'Information sur la Traction Electrique par Courant Monophasè de Frequence Industrielle* from 12 to 15 October 1951 in Annecy. From Japanese records, we do not know if anyone from Japan attended this conference but the data and theses discussed at the conference became one of the fundamental resources of the AC Electrification Investigation Committee.

To summarize the conference conclusions, the first point in the report stated that based on current research results, 50-Hz single-phase AC electrification was immediately suitable for implementation; that the various problems relating to the fixed installations had been solved; and that the project was economically feasible. Additionally, the report stated that there was a system in place for mass production of different types of AC locomotives with the same or better performance in terms of efficiency and maintenance costs than other locomotives. As a result, the savings provided by fixed installations would mean that AC electrification would provide immediate economic advantages.

The second point in the report was that the technical progress in the years preceding the conference should not stop there. Standardization on 50-Hz single-phase AC power would assure progress into the future, especially if Europe came to need a standard electrification system.

France already had some DC electrification during the 1920s on the Paris–Orléans, Paris–Lyons–Marseilles, and other lines (all nationalized into SNCF during the 1930s). However, although the technology was complete, the system was extremely expensive due to the need for many electrical substations and overhead cables. It was uneconomic on all but busy main lines, because it required a huge initial investment. In a search for some solution, the engineers realized there were substantial savings to make by using industrial-frequency 50-Hz AC power that was being supplied to all regions of France. The test results showed that using 50-Hz single-phase AC electrification could save up to 40% of the cost of fixed installations. The system was better in terms of both technology and economy, and captured the souls of everyone

working on railway modernization. Several locomotive manufacturers like Alsthom, Oerlikon, and Westinghouse had accepted the challenge of mass-producing AC electric locomotives.

The four main technical sessions Annecy Conference were on: The Role of Industrial-Frequency 50-Hz Electrification in Unifying Europe's Railways (keynote speech by Armand); Fixed Installations; Traction Locomotive Engines; Report on Traction Engines including Oerlikon-Winterthur CoCo 6051, Alsthom CoCo6052, Alsthom BoBo 8051, Westinghouse Z 9055, and Deutsche Bundesbahn (DB) and AEG 50-Hz locomotives. The fifth session was a discussion and wrapping up session.

In his keynote, Armand said, 'The extremely practical purpose of the Annecy Conference is to investigate electric traction and the possibilities for the direct use of industrial-frequency AC for traction. In addition, the conference aims to give consideration to the achievement of the greatest possible results with the smallest possible investment, given the railways' unquestionable need for technological modernization in the face of competition from automobiles and aircraft in particular since the WWII. Three energy sources can be considered for the railways—coal, oil and electricity. Given, however, Europe's lack of oil resources, electricity (particularly hydroelectric power) is the most suitable and best source of energy, with its potential for unlimited supply and its non-polluting properties. Compared with the USA, where diesel engines are the most common, electric traction is the truly economical way forward for oil-poor Europe. The distinguishing features of the Annecy electrification experiments are not so much a revolution as an evolution of technological improvement. The purpose of this conference is to announce the results of those experiments to the participating countries, and to investigate the suitability of industrial-frequency single-phase AC electrification for use in the rest of Europe.'

Armand's statements show a philosophical understanding of not just France on her own but rather the whole of Europe. Perhaps he was ambitious to see all Europe's railways unified to the industrial-frequency AC electrification system' that France had defined. Armand saw 'A fascinating manifestation of the European mentality not just the shape of the railway of the future.' Having announced plans for railway electrification in northern France, he spoke of the necessity of electrifying railways on a European level, explaining how southern Italy was planning industrial-frequency 50-Hz electrification. He also explained that although Belgium had already completed 3-kV DC electrification of its domestic railway network, it was investigating introducing AC electrification in the Belgian Congo.

Germany sent 32 delegates to the conference and played a particularly important role. At the time of the conference, SNCF and DB were creating a cooperation plan to use the same electrification system. The French plan was to connect the northern mining and manufacturing areas to the Lorraine Valley. In Germany, a section of line connecting Mosel with Loure via Koblensk had been selected for electrification.

Armand also touched on the efforts of electric locomotive and machinery makers such as Siemens, Oerlikon, Alsthom, AEG and Schneider-Westinghouse, giving an outline of the particular features of each of their products. This conference was important not only for railway experts from SNCF and other countries, but was also an opportunity for railway manufacturers looking to sell their products.

AC Electrification Investigation Committee's European visit

JNR President Nagasaki established the AC Electrification Investigation Committee in JNR on his return from France in August 1953 for the purpose of investigating the potential for AC electrification of the JNR network. The Committee dispatched a working group of five for 73 days to Europe with the following three objectives:

- To participate in the Lille Conference discussing industrial-frequency single-phase AC electric operations
- To investigate 50-Hz AC electrification
- To select appropriate AC electric locomotives for purchase and negotiate transport to Japan

Although they visited France, Belgium, Switzerland, Britain, Norway, Sweden and Germany observing 42 railways and 22 private works, the majority of the time (45 days) was spent in France visiting facilities and negotiating the purchase and export of electric locomotives which was the focus of their visit. They ranked the potential of the different companies as shown in Table 1.

Based on this data, the group believed there were three companies (with straight As) whose locomotives were suitable.

Table 1 Potential Locomotive Suppliers

	Technical level	Manufacturing activities	Manufacturing facilities / technology	Product	Overall
Schneider-Westinghouse	A	Active	A	A	A
Alsthom	A	Active	A	A	A
Jeumont	B	Active	B	B	B
Oerlikon	A	Relatively inactive	A	A	A

Eventually, it was decided to ask Schneider-Westinghouse to produce the ignitrons which were combined with Alsthom-built bogies and traction motors. It was also decided to ask Oerilikon to produce a direct-motor locomotive running on single-phase AC commutator motors.

Subsequently, the group spent a significant amount of time and energy in negotiations with SNCF between 16 May and 12 July to purchase the locomotives. JNR was hoping that SNCF would negotiate on their behalf with the French manufacturers, but since SNCF could not legally act as a go between for private French companies, SNCF asked JNR to negotiate directly. SNCF was also of the opinion that, although Japan was planning to purchase one unit each of two locomotive models, if JNR was to test electrification on the Senzan Line, it would need a minimum of two units of each locomotive, and so should purchase four. Clearly, the opinions of SNCF and JNR on the number of locomotives to be purchased were in disagreement and negotiations broke down. The reason only became clear later when the group's interpreter Sukehiro Hirakawa, published his memoirs *Eastern Mandarin, Western Orange*. According to Hirakawa, 'The meeting broke down as expected. Everyone got overheated and they returned to the hotel. Unfortunately, the interpretation was rather overheated as well and the whole conversation ended in confusion.'

Three negotiations with Oerlikon were carried out from 3 June to 12 July. The Japanese side insisted that it needed only one locomotive to test electrification of the Senzan Line, but Oerlikon needed a minimum of 10 units for a special order for Japan. The idea of a manufacturing license was also discussed and Oerlikon produced a suggested contract but the two sides could not agree on price and no formal deal was signed.

Two face-to-face negotiations were carried out with the French manufacturers in June and July with Japan wanting to purchase a single ignitron Alsthom locomotive with the ignitron made by Schneider-Westinghouse. It was also explained that Japan intended to purchase an Oerlikon direct motor locomotive. Schneider-Westinghouse expressed dissatisfaction at the idea of a joint project with Alsthom, and the French manufacturers also expressed displeasure at the idea of buying a direct motor locomotive from a Swiss maker. The French side also wanted a contract for a minimum of 10 units, with two for immediate purchase and an option on the remaining eight when tests on the Senzan Line were completed and the decision was taken to implement AC electrification. Japan insisted that it could only purchase one ignitron locomotive at first plus four locomotives for the second stage, so negotiations broke down once again.

The group report says 'Since Japan currently only wants to import one unit of each locomotive type, they (European side) are afraid that these are simply going to be used as so-called "samples," and, as a result, set the cost of both the locomotive and manufacturing license at a highly disadvantageous level. They seem to believe the rumour that Japan is extremely good at copying technology from various sources and are being very careful with regard to exports.'

However, the main reason that JNR was forced to restrict its purchase to one unit of each type was undoubtedly economic. A budget of ¥250 million had been allocated for purchase of locomotives, which was all that was possible from the foreign currency allocation of the Ministry of International Trade Industry (MITI). (It may seem unbelievable, but at that time, Japan was short of foreign currency and the government controlled the small amount it had.) This budget was just sufficient to purchase two electric locomotives, so there was no way an agreement could be reached between French locomotive manufacturers looking for export opportunities and Japan, which at that time was almost a developing country hoping to import locomotives as the first step in introducing new technology.

As a result, the group left Europe without fulfilling its third objective and its final report said, 'In regard to the purchase and import of AC electric locomotives, we spent more or less 2 weeks in negotiations on the subject but were unable to come to any conclusions and were forced to return without results. We were extremely sorry that the conditions set for purchase of the locomotives were going to cause difficulties. However, we are extremely grateful for the good intentions of SNCF, who worked tirelessly on our behalf, and for the efforts of Schneider-Westinghouse and M. F. Oerlikon.'

But there was a positive note to the breakdown in the purchase negotiations—during the group's visit, a telegram had arrived stating that JNR had nearly completed its own AC electric locomotive. The failure to import an electric locomotive fuelled the desire to manufacture locomotives domestically and JNR finally succeeded in manufacturing and exporting its own AC electric locomotives to India in the 1960s.

1955 Lille Conference

Issue 506 of the French railway magazine *La Vie du Rail* includes a photograph of the five Japanese delegates to the 1955 Lille Conference sitting in formal attire listening attentively to the speeches. The caption reads, 'The Japanese delegation was always extremely attentive.' In fact, the Japanese delegates themselves were the focus of much attention.

This conference was intended to discuss the progress in AC electrification in the 4 years since the 1951 conference as confirmed by the success of SNCF's 50-Hz AC electrified line between

Valenciennes and Thionville.

When Armand opened the Lille Conference, he emphasized its adhesion theme, saying that the improvement in adhesion by using industrial-frequency AC electrification was extremely important. It was well known that heavy loads requiring double-heading by 4-axle steam locomotives could be hauled by a single 6-axle DC locomotive or a 16 2/3 Hz AC locomotive (such as used in prewar Germany). But the same load could even be hauled by a 4-axle single-phase 50-Hz AC locomotive weighing much less than 8- and 6-axles. As a result, the wear and tear on the rails is much reduced in turn cutting the cost of infrastructure, maintenance and the locomotives.

After Armand's speech, the conference continued for 4 days, discussing electric power, signalling and communications, locomotives and electric engines, and many other topics. Participants also visited the facilities and locomotives at Lille Station, which consisted of two BB locomotives and two CC locomotives.

Implementing AC Electrification

AC Electrification Inquiry Committee

This committee was established in August 1953 and was composed of JNR engineers, university professors, public officials and representatives from private manufacturing companies. During the relatively short two and a half year period between September 1953 and March 1956, it concurrently surveyed the literature, made overseas visits and tested prototypes. Its findings were published in May 1956 and it was disbanded in February 1957, having fulfilled its objectives.

The report reached the following conclusions. 'The electrical substations and rail lines required for industrial-frequency 50-Hz single-phase AC electrification being used by France's SNCF are significantly simpler than those required for DC systems used until now. As a result, they have been shown to be economically viable and display superior potential. This electrification has now been implemented on a wide scale. The AC Electrification Inquiry Committee has, based on these results, carried out careful consideration regarding implementation, and also on the geographical and climatic characteristics of Japan, and the current conditions of rail transport here, as well as our levels of technology.... As a result, we conclude that industrial-frequency single-phase AC electrification is the way forward for JNR.'

Class ED44 locomotive testing AC electrification on Senzan Line near Sendai in north Honshu
(*JNR Centennial Photo History*)

Experiments on Senzan Line

The AC Electrification Inquiry Committee also performed some AC electrification experiments on the 28-km Sendai–Sakunami section of the Senzan Line linking Sendai and Yamagata in north-east Japan. The first phase of experimentation and research was on paper only. It involved collecting and analyzing documents and published data dealing with examples of electrification overseas, and determining whether such systems would be suitable for Japan. Approximately 10 months were spent on this from August 1953 to June 1954. The results of this document research were as follows:

- AC electrification was considered advantageous for Japan.
- There were still some problems with implementing AC electrification on a large scale and on main lines.
- To solve these problems tests would be necessary.
- The electrical system for testing should be single-phase 50–20 kV AC.

At this point, the second phase of laboratory research into prototypes of locomotives and fixed installations (substations, lines, signalling and communications equipment was carried out with the cooperation of JNR's Railway Technology Research Institute (RTRI).

The third practical experimentation phase of the research was implemented between September 1954 and March 1956. This practical experimentation was divided into three parts: static testing of fixed equipment such as substations, railway lines and signalling/communications equipment; dynamic testing, in which domestically produced AC electric locomotives were test run to check their capabilities; and second dynamic testing, in which imported locomotives were to be tested.

However, since negotiations to purchase locomotives from France had failed, the domestically produced direct motor ED44-1 locomotive (Hitachi) was tested in

August 1955, and the ED45-1 rectifier locomotive (Mitsubishi Electric) was tested in September 1955. Both gave successful results.

The Hitachi ED44-1 was a so-called direct locomotive using AC commutator traction motors. After use in the JNR AC electrification experiments, these locomotives went into commercial service on the Senzan Line.

JNR Electrification and French response

France's rail industry responded objectively to the report issued by the Japanese AC Electrification Inquiry Committee. The December 1956 issue of *Revue Générale des Chemins de Fer* (*RGCF*) reported that, 'Japan National Railways has revealed that they intend to use industrial-frequency AC electrification methods for electrification of their 3000 km of rail network. At this point, there is presumably a need for a simple overview of the progress of electrification, and a clarification of the reasons behind Japan's decision to use AC electrification systems for its national railway.' Subsequent to this introduction, the state of the electrification of Japan's railways is recorded over two pages, with maps. There is no mention of the failed negotiations to buy locomotives from France. The fact that Japan succeeded in domestically producing two locomotives and testing them to achieve these results is included. According to the article, Japan had started work on electrification of its railways as early as 1906, so that by 1956, approximately 10% of JNR's 20,000 km of railway lines was already electrified using direct current, and electrification had also been carried out in Korea. However, all of this was DC electrification and it was only after WWII that Japan began to show interest in France's AC electrification systems.

In the January 1958 issue of the same magazine in, a three-page article introduces the AC Electrification Inquiry Committee with no sense of criticism and states approvingly that SNCF had published its findings that AC electrification was far more economical than DC and that JNR had at that point decided to adopt the same system.

Asian Railways Conference

Nouvion tells us the following about the AC electrification of India's railways. 'After the 1955 Lille Conference on the AC electrification of railways using industrial-frequency power supply, and after witnessing France's SNCF achieving the world speed record of 331 km/h, the chairman of Indian Railway (IR) requested SNCF to visit India, carry out a survey and produce a report into the most suitable methods for the electrification of her railways.' This report was produced by a team comprising Boulogne, Lemaire and Nouvion, who spent several weeks in India studying the railways and submitted a report to IR. The report's recommendation was that India should adopt industrial-frequency AC electrification, and IR agreed to this.

In May 1957, India put a plan to electrify 669 miles of its railway using the French AC electrification methods out to international tender. In negotiations, Europe formed a joint venture comprised of the UK, France, Germany, Switzerland and Belgium and submitted a tender for AC electric locomotives at ¥70 million each. Japan submitted a bid based on collaboration between Hitachi, Toshiba and Mitsubishi for AC electric locomotives at ¥100 million each. Japan and India's negotiations were carried out in London in October 1957, involving Karmail Singh, Chairman of IR, and Shiro Seki, JNR's Deputy Director of Engineering. Seki told Singh that 'Japan intends to assist India so that she can carry out this electrification by herself,' but the Japanese were outbid by the European joint venture. In October of that year, the Indian government ordered 100 AC electric locomotives from Europe and 10 from Japan.

After the 1956 report issued by the AC Electrification Inquiry Group, JNR pushed forward with AC electrification of lines across Japan, drawing the attention of other Asian countries when it succeeded in AC electrification of the Sendai–Sakunami section of the Senzan Line in September 1957 and the Tamura–Tsuruga section of the Hokuriku main line in October of the same year. Under the initiative of JNR President Shinji Sogo (1884–1981), the Asian Railways

One of the first three Japanese DC locomotives (3000 V, 3600 hp) exported to the Indian Railway in 1958 (Hitachi, Ltd.)

Conference was held in Tokyo in May 1958. Singh attended and discussed Japanese cooperation in modernization of railways with Sogo.

By June 1961, Japan's 10 AC electric locomotives had gone into operation without breakdown, gaining the trust of India and the subsequent number of locomotives exported from Japan to India reached 101. Interestingly, between 1957 and 1960, while Japanese manufacturers were building the first 10 locomotives to be shipped to India, SNCF engineer Nouvion, visited Japan frequently to observe the manufacturing project. He praised the cooperation between the Japanese team of Hitachi, Toshiba and Mitsubishi by saying, 'Japan is lucky. They have no problems in communication between team members, in checking instruction manuals, or in achieving accurate teamwork. In contrast, the European group is comprised of people who all speak different languages, and so there are differences of interpretation regarding the instruction manuals. Also, it takes such a lot of time just getting between one location and another!'

Louis Armand visits Japan

At the behest of Nouvion, former SNCF President Armand visited Japan in April 1960 during the crest of the high-growth period. He visited Hitachi's Central Research Institute, RTRI, JNR's Kawasaki Generating Plant and Oi Works, Toshiba's Tsurumi Plant, Mitsubishi's Electrical Manufacturing Plant and Sony's Plant, affording an opportunity to see Japan's manufacturing industry at its most active. Having retired from SNCF by now, Armand was Chairman of the Ecole Polytechnique and the Euratom Committee, in which role he also attended an unofficial meeting with Japan's Atomic Energy Committee.

For Shima, JNR's Director of Engineering, the moment in which he explained the plan for the Tokaido Shinkansen to Armand and gained his understanding and agreement was one of the greatest of his life. It was Armand who had recommended AC electrification to JNR President Nagasaki during their visit to France in 1953. The opportunity for Shima to explain the Tokaido Shinkansen to Armand typified the mutual respect and competitive spirit between French and Japanese railway engineers that drove the development of high-speed railways in both nations—truly something to celebrate. ■

Note

Part of this article was presented at the National Academic Conference of Economic History held in 1998 at Rikkyo University, Tokyo.

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