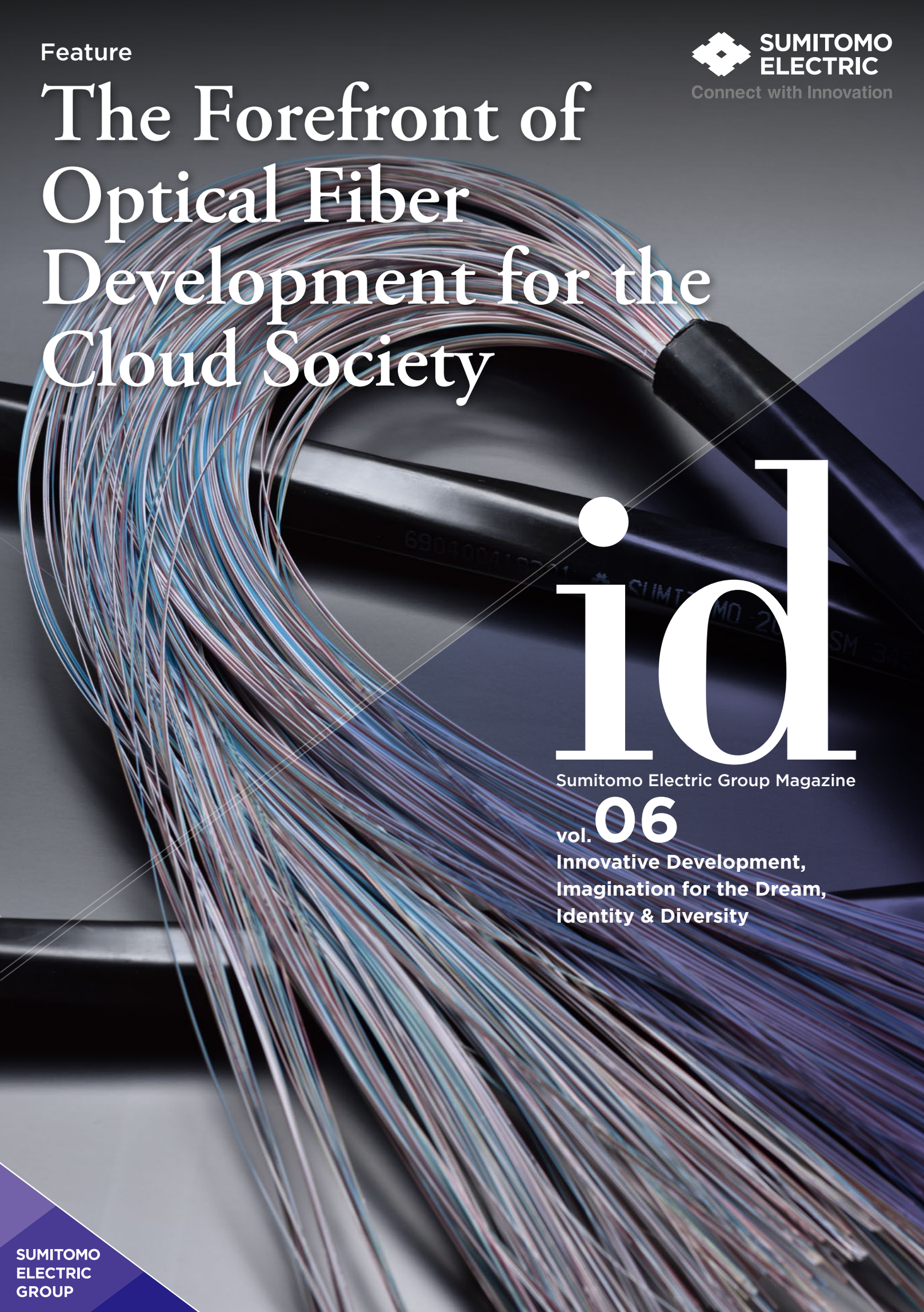
Feature

The Forefront of Optical Fiber Development for the Cloud Society



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Connect with Innovation

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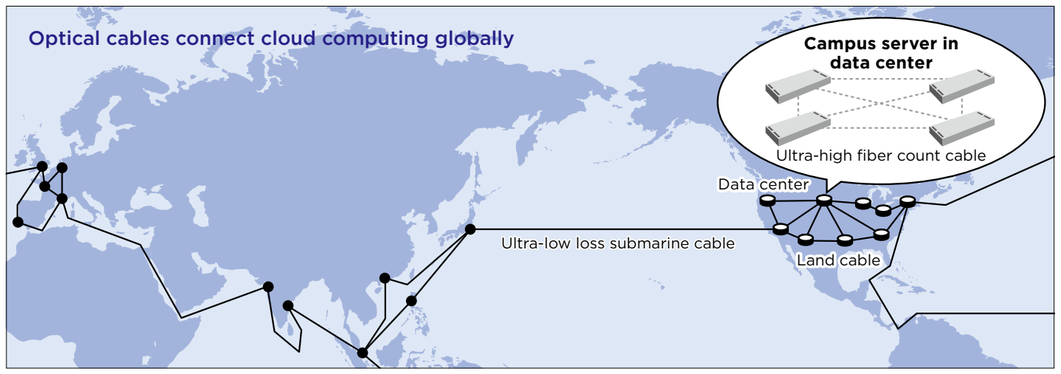
**Innovative Development,
Imagination for the Dream,
Identity & Diversity**

SUMITOMO ELECTRIC GROUP

Future of the Cloud Society

–A revolutionary impact is changing society and business



Recently, a new paradigm called “cloud computing” has emerged in the rapidly developing world of ICT. Cloud computing (“cloud”) is a generic term for services that offer various IT resources such as database, storage and software as needed via the Internet. Thanks to these services, a new social and life infrastructure underpinned by a huge amount of data has been emerging. It connects various things, information and social activities. Its impact is not limited to increasing operational efficiency and reducing the cost of business. It will bring about a fundamental change in human society and herald a new era.

Various computing services including cloud are offered to the global market by IT giants that are based in North America and operate globally. Data centers play the key role in achieving these services. They store and utilize a huge amount of data using large-scale data storage and large-capacity data transmission equipment. Hyperscale data centers (hyperscale DCs), which are complexes of huge data center buildings, are deployed globally at multiple locations. Large-capacity optical fibers are required for high-speed transmission of a huge amount of data between the locations. The Sumitomo Electric Group has attracted public attention as a pioneer of optical fibers and cables for its capability to globally offer the ultra-high fiber count and ultra-low loss technologies that are required to achieve large-capacity optical fibers with the best quality. This feature story focuses on the active efforts made by the Sumitomo Electric Group to help create the new paradigm (cloud society) and the history of the development to achieve the ultra-high fiber count and ultra-low loss technologies.

World's first ultra-high fiber count (3456-fiber-count) optical cables developed by Sumitomo Electric

Optical Cables Underpin the Cloud Society

–Meeting the needs for larger transmission capacity

Business domains of standard optical fibers, submarine optical fibers and optical cables

Optical fibers are the core components of networks that underpin the cloud society. They are thin fibers made from silica glass and plastics. An optical fiber has a double-layer structure: a core in the center and cladding around the core. It serves as a medium to transmit optical signals within the core using a phenomenon called total internal reflection. Optical fiber communication is characterized by stable data transmission with no influence of electromagnetic waves and capable of large-capacity long-haul transmission. Starting to manufacture optical cables in 1974, the Sumitomo Electric Group has developed and offered various products for more than 40 years.

At present, the Sumitomo Electric Group operates mainly in three optical communication business domains of standard optical fibers, submarine optical fibers and optical cables. In the standard optical fiber business and submarine optical fiber business, the Sumitomo Electric Group manufactures optical fibers whereas in the optical cable business, it manufactures optical fiber cables that fit in any environment both indoors and outdoors by stranding very thin glass fibers and coating them with a jacket. Obviously, these products have different markets. Standard optical fibers are commodities traded globally, while optical cables are customer-oriented products closely related to the region. The Sumitomo Electric Group has offered optical fibers as global products, but has conventionally offered optical fiber cables basically for the Japanese market. The submarine optical fiber business is a domain that has been pioneered by the Sumitomo Electric Group's original technologies. In fact, the Sumitomo Electric Group has the top share in the global market.

Shigeru Suemori
General Manager of the Optical Fiber & Cable Div.
Infocommunications Business Unit

Ultra-high fiber count and ultra-low loss transmission technologies make a difference in the global market

In Japan, the replacement of copper cables with optical cables started in the early 1980s, and has almost been completed across Japan. The main market target market of optical fibers will shift to markets outside Japan, where the optical fiber market has been steadily growing. The growth rate is particularly high in the Chinese market. During the past 10 years, the Sumitomo Electric Group's sales ratio outside Japan exceeded that of Japan. Today, about 75% of the optical fibers and cables are for the markets outside Japan. The Chinese market also contributes significantly to the profit. The Sumitomo Electric Group's share of optical fibers is among the highest in the world, but expansion of market share is not the only objective. Shigeru Suemori, General Manager of the Optical Fiber & Cable Div., states that it is essential to meet the needs of society and customers.

"Optical communication systems will be required to fulfill three requirements: large capacity, low latency* and high reliability. Our mission is to achieve these requirements at high levels. For example, to fulfill the large-capacity transmission requirements, it is important to minimize transmission loss to the utmost limit. Low transmission loss improves the receiving sensitivity, which helps transmit more optical signals. The transmission capacity can be efficiently increased by accommodating many optical fibers in a single cable. This idea is embodied as ultra-high fiber count optical cables. To achieve large transmission capacity, it is crucial to realize ultra-high fiber count and ultra-low loss technologies simultaneously. This is the key point of differentiation from competitors. Sumitomo Electric has been focusing its resources on mastering these technologies."

* Latency: End-to-end signal transmission time on a transmission line

3456-fiber-count optical cable awaiting shipment (left: Takehiko Okada, General Manager of the Cable Manufacturing Dept., right: Tsuguo Amano, General Manager of the Engineering Dept.)

A paradigm shift in the market: Cloud services and data centers

Suemori's statement reflects a dramatic change in the market. Conventionally, the main users of optical cables were communication carriers. In this changing time, however, a paradigm shift is occurring. Cloud computing has been spreading, and data centers are being operated by providers that offer cloud services. These service providers are IT giants that are based in the U.S. and operate their businesses globally by taking full advantage of their cutting-edge IT solutions. They have emerged as users who own and operate optical cables. They distribute a huge amount of information and offer IT resources such as software, storage and servers. In this context, the information is big data that can be used as important resources in business strategy. Most of the data centers that they own have tens of thousands (or even hundreds of thousands) of servers. This is the reason why they are referred to as hyperscale DCs. The complexes of local data center buildings are connected by large-capacity optical cables, namely, the ultra-high fiber count optical cables that Suemori mentioned. The next chapter will describe the Sumitomo Electric Group's specific efforts to develop ultra-high fiber count optical cables.

Members of the Data Center Solution Sales Div.

Photo taken when the 3456-fiber-count optical cable, which embodied the efforts of all the members, was shipped

Opening up a new world by achieving ultra-high fiber count optical fibers
–Optical cables that connect data centers

Resolute developers of the 3456-fiber-count optical cable

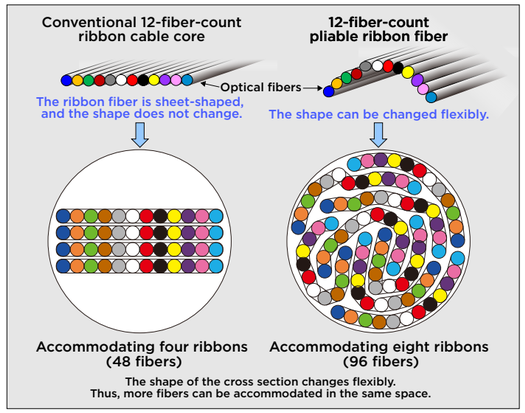
Taking on challenges to develop ultra-high fiber count high-density optical cables to meet the needs at an extraordinary development and manufacturing speed

To achieve high fiber counts, the number of fibers used must be increased. Optical fibers are glass fibers as thin as a human hair and coated with a thin layer of resin. In general, the outside diameter is about 0.25 mm, and the necessary number of fibers is stranded as discussed earlier. The strand is jacketed with robust plastic materials to manufacture optical cables. Obviously, the capacity can be increased by accommodating more fibers in a cable at high density. Previously, the average fiber count of optical cables was about 100. In Japan, which is an advanced country in using high-fiber-count cables, the maximum fiber count that is generally used is about 1000. Sumitomo Electric made efforts to reduce the outside diameter of cables with the same fiber count, and accumulated technologies to achieve high density. However, new customers for optical cables emerged, and their needs were completely different from the conventional ones. It all started in the winter of 2014. Nobuyuki Suzuki, who is currently the president of Sumitomo Electric Lightwave Corp. (SEL) that serves as the strategic company in the optical communication business in the U.S. market, was affiliated with the Optical Fiber & Cable Div. in Japan and was engaged in a project to increase the fiber count and develop technologies for new cables. Suzuki was informed by SEL that a customer needed a high-fiber-count cable that was friendlier to use at data centers. At that time, the maximum fiber count of cables used in the U.S. was 864.

Suzuki recalls, "I asked why the fiber count needed to be increased more. They explained that the data centers were expanding rapidly but there was a shortage of conduits to install the cables. Their immediate issue was to store higher-density optical cables in the limited conduits. So, we presented a prototype 1152-fiber-count optical cable. They came to Japan immediately, and showed keen interest in our technologies and solutions. We launched full-scale development efforts. We developed, manufactured and delivered 1152-fiber-count optical cables in about five months. The customer then requested 3456-fiber-count optical cables, whose conceptual image had been presented to them earlier. We had only seven months to deliver the 3456-fiber-count optical cables. In general, such a development project requires several years. However, we promoted the development and manufacture of 3456-fiber-count optical cables at an extraordinary speed."

Development of a high-density 3456-fiber-count optical cable with a pliable ribbon fiber and slotted core cable structure

When the development process of the 3456-fiber-count optical cable is discussed, it is necessary to understand the ribbon fiber and pliable ribbon. A ribbon fiber refers to fiber array in which multiple optical fibers are arranged in parallel and coated together. It is characterized by excellent implementation efficiency compared to a conventional single fiber. The time required for the splicing work can be reduced significantly because mass fusion splicing can be performed for each ribbon fiber. A newly developed 12-fiber pliable ribbon that had partial slits between fibers (slotting a 12-fiber-count ribbon which was the mainstream outside Japan) was employed. Suzuki's partner in this development project was Tsuguo Amano, who is currently Engineering General Manager of the Optical Fiber & Cable Dept.



"The technical issue was how to accommodate optical fibers at high density in the limited space while maintaining the transmission characteristics. A pliable ribbon attains both flexibility and ribbon alignment during mass-fusion splicing. This pliable ribbon was employed in combination with optical fibers with bending loss insensitive property and an excellent non-preferential bending slotted core cable structure design with a central tension member (which relieves the tension that is applied to optical fibers during installation). As a result, the fiber density in the cable core was improved dramatically. These designs were developed patiently through trial and error, but the development process was speedy. As a result, the fiber counts doubled compared to the conventional products of the same outside diameter. Amazingly, this was equivalent to 1728 fiber counts for 1.5-inch cable ducts and 3456 fiber counts for 2.0-inch cable ducts, achieving world-class ultra-high fiber counts.

In line with these development efforts, the manufacturing capabilities of the production sites that were refined through many years of operation were demonstrated at an extraordinary speed. The world's first 3456-fiber-count was delivered at the beginning of 2016.

Implementing the comprehensive solutions in line with the rapid development of the business

Conventionally, the optical cable business of the Sumitomo Electric Group focused on the Japanese market. For this reason, the business inevitably became sluggish as the market matured. It was innovative for the optical cable business to develop the ultra-high fiber count cable and open up new markets outside Japan. Suemori clearly remembers the customer saying "crazy" when he presented the 3456-fiber-count optical cable. The word showed surprise at the quick development of the high-density cable, and was the ultimate compliment.

SEL (led by President Suzuki) approached the customer who operated hyperscale DCs in the U.S. Senior Vice President Barrett Mills (sales supervisor) points out that the business cycle of hyperscale DC operators is very fast.

"At present, we can offer cutting-edge products by developing products through close cooperation between SEL and Sumitomo Electric. However, we are not sure about the customers' needs and market situation in two years. The advancement of customers' businesses has been accelerating. Under these circumstances, we must maintain a certain level of presence based on ultra-high fiber count optical cables. To this end, we must offer comprehensive solutions, including both ultra-high fiber count optical cables and peripheral equipment for optical fibers, for customers' networks. Meanwhile, we will strengthen our relationships with construction contractors to further enhance our support system for customers."

Sumitomo Electric pioneered the field of ultra-high fiber count optical cables, but the competition has been intensifying as competitors have caught up. To maintain a certain level of presence and continue to support the cloud society, the Sumitomo Electric Group has been taking on new challenges with the next generation in mind.

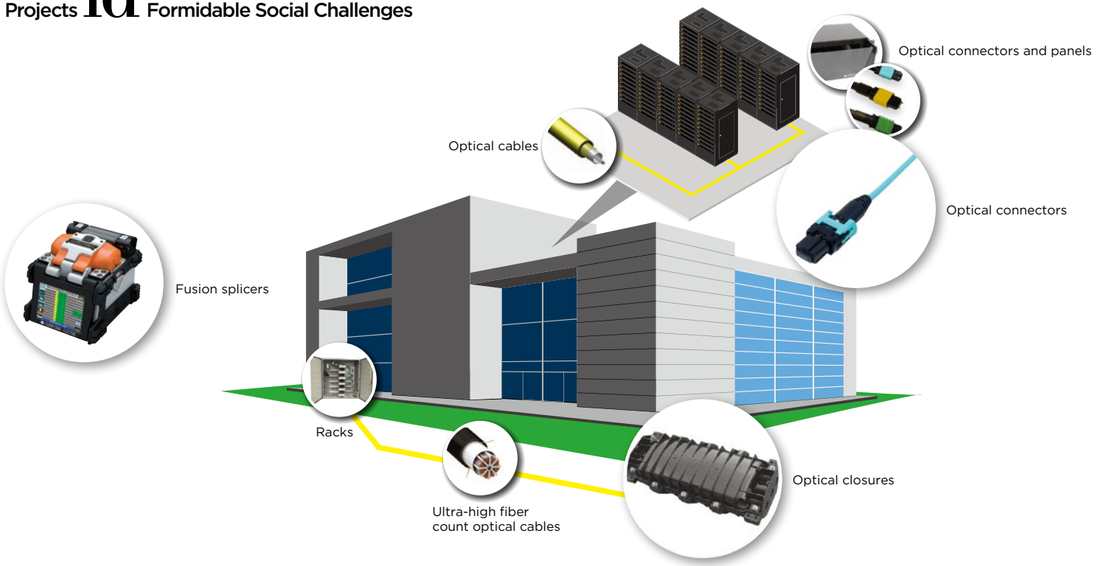
David Bachinsky, SEL Sales Director
"I can say that we have the biggest advantage. There is no doubt that Sumitomo Electric's optical fibers and cables are of the highest quality. We will leverage this advantage to steadily build a foundation and take on new challenges."

Lauren Deloatch, SEL Sales Representative (on the right)
"The sales activities targeting hyperscale DC operators are very exciting and creative. To build a sustainable relationship with customers, I will ensure closer collaboration with construction contractors."

Barrett Mills, SEL Senior Vice President (on the left)

SEL head office in the U.S.

SEL President Nobuyuki Suzuki



Ensure the reliability of optical communication

–Implementing optical wiring solutions

Commitment to meeting customers' needs for high-density storage at data centers

The Sumitomo Electric Group developed the 3456-fiber-count optical cable, but various types of optical connector products had to be developed concurrently with the development of these cables. The ultra-high fiber count cables installed in data center buildings are distributed using various types of optical connector products and related equipment for optimal storage and wiring; such equipment is required for data centers to achieve high-speed and large-capacity optical communication and to offer cloud computing services. A high-capacity optical closure is one such piece of equipment. When optical cables are connected in the outside, the closure stores the splicing point of fibers. Optical cables installed in the data center building are terminated in racks (main distribution frames) and distributed to respective areas in the building. An optical connector is another piece of important equipment. These various types of equipment had to be developed for the innovative ultra-high fiber count environment. Tomohiko Ueda, Manager of the Data Center Engineering Dept., Lightwave Network Products Div. says, "We are closely supporting customers and identify their issues through in-depth interviews. We are designing and developing optical connector products to solve these issues. The key point is how to store 3456-fiber-count optical fibers at high density and achieve optimal wiring. To increase workability, ensure reliability and improve functionality and expandability, we held a lot of discussions with customers and offered our solutions based on appropriate customization."

In the process of offering the optical wiring solutions, Ueda and other members have developed the optical connector with world-class low connection loss. They also have developed automatic measuring equipment to conduct inspections for ensuring reliability after connection. These products are highly valued by customers.

Suetsugu Yoshiyuki, General Manager of the Lightwave Network Products Div., Infocommunications Business Unit

Tomohiko Ueda, General Manager of the Data Center Engineering Dept., Lightwave Network Products Div., Infocommunications Business Unit

Strategy to meet the strong demand from globalizing data centers

Data centers have been expanding rapidly in the U.S. Recently, data centers have been increasingly globalized.

"The number of data centers has been increasing not only in the U.S. but also in Europe and Asia. The demand for ultra-high fiber count optical cables is highly likely to continue to increase rapidly. We must meet the strong demand properly. The key is to achieve short delivery time and low cost. To this end, it is necessary to consider reorganizing our design centers and production facilities globally. Conventionally, we served as a developer of optoelectronics equipment and worked to meet the needs. But now we are expected to serve as a global manufacturer as well." (Yoshiyuki Suetsugu, General Manager of the Lightwave Network Products Div.)

The Sumitomo Electric Group's ultra-high fiber count optical cables are highly evaluated by data centers around the world. The reputation is underpinned both by the ultra-high fiber count technology and advanced optoelectronics equipment.

The Forefront of Optical Fiber Development for the Cloud Society

Transatlantic and Transpacific Submarine Optical Fibers

–Taking on challenges to develop the world's best ultra-low-loss optical fibers

Submarine cable installation (photo courtesy: NEC Corporation)

Breakthrough in optical fiber manufacturing, creating the new era of optical communication

The revolutionary idea of communicating via optical fibers came up about 60 years ago. In the 1960s, full-scale research on optical fibers was launched, and in the 1970s, there was a growing momentum toward commercial implementation. Under these circumstances, NTT (then Nippon Telegraph and Telephone Public Corporation) and three cable manufacturers including Sumitomo Electric established a joint research system for optical fibers. In this process, an optical fiber manufacturing method called the vapor-phase axial deposition (VAD) Method was invented. This was an excellent technique for mass production. In the 1980s, this method was improved and advanced to a level where optical fibers of higher quality and lower loss could be mass-produced, leading to the full-fledged commercialization phase.

Optical fibers are made by heating porous silica glass rod and pulling it up in the axial direction. The key point was to make a large-diameter preform that enabled the creation of a long, thin optical fiber to help increase production efficiency.

In addition to this, high quality (i.e., low loss) optical fibers were achieved because preform made by the VAD Method contained minimal impurities. The establishment and advancement of the VAD Method were milestones in the era of optical communication.

Development of Z-fiber, a low-loss optical fiber that surprised the world

Achieving low loss, or optical attenuation improvement, was a major technical issue in establishing the VAD Method. When light is transmitted through an optical fiber, part of the light is scattered outside the fiber after a certain distance or is absorbed by impurities contained in the glass, resulting in optical attenuation. High optical attenuation makes it difficult for the optical signals to be transmitted over long distances, resulting in poor transmission with low communication quality and reliability. (An optical amplifier is used to recover the attenuated optical signals.) Thus, the achievement of low-loss optical fibers was the biggest technical challenge for the optical fiber engineering team of the Sumitomo Electric Group. Masashi Onishi, who is currently the Manager of the Planning Dept., Optical Fiber & Cable Div., was one of the engineers.

"To achieve low loss is to improve the glass transparency. In the VAD Method, we tried to remove impurities as far as possible, but germanium was an essential additive while also an impurity. An optical fiber consists of a core and cladding. There must be a refractive index difference between the core and the cladding to transmit optical signals through an optical fiber. To increase the refractive index of the

core, it was inevitable to add germanium. However, Sumitomo Electric was seeking to achieve high glass purity for ultimate low loss. Thus, our predecessors made efforts to develop an optical fiber without using germanium in the core. To maintain a refractive index difference, fluorine was added to the cladding in order to reduce the refractive index, and germanium-free pure silica core optical fiber was developed. This new optical fiber was named Z-fiber and put on the market in 1986."

The typical transmission loss of conventional optical fibers was 0.20 dB/km, while that of the Z-fiber was 0.154 dB/km on the research level and 0.17 dB/km on the product level.* This ultra-low-loss optical fiber surprised the optical communication industry.

Eventually, the engineering team found an ideal target field for their low-loss optical fibers. Low loss characteristics were particularly advantageous for long-haul communication systems, and among those submarine cable systems were the largest in scale. In 1988, optical fibers were introduced in the 8th transatlantic communications cable (TAT-8), and in 1989, in the 3rd transpacific cable (TPC-3). These developments dramatically improved communication environments, putting international telephone communication into widespread use. Technical study was continued to improve the transmission capacity further, and in 1992, the Z-fiber-based 4th transpacific cable (TPC-4) was constructed and doubled the transmission capacity compared to TPC-3. It should be highlighted that the importance of low-loss optical fiber was recognized widely although the transmission capacity improvement was achieved not only by the low-loss optical fiber but also through progress in transmitting/receiving optical devices.

* dB (decibel) is a unit of transmission loss. "0.17 dB/km" means the loss of 0.17 dB per km. The transmission loss of an entire transmission line can be estimated by multiplying it by the length of the transmission line.

Across the Pacific Ocean Coping with difficult issue chromatic dispersion

While low-loss optical fibers were used for submarine cables, a new issue started to emerge: chromatic dispersion. The wavelength of optical transmission became longer from 0.8 μm (micrometer), 1.3 μm to 1.55 μm with the progress of the semiconductor laser. In particular, the advent of the 1.55 μm band brought a significant impact. The 1.55 μm band was considered to be the most suitable band for long-haul transmission because the transmission loss of optical fibers is/was lowest in the band. The Z-fiber of the Sumitomo Electric Group was the lowest in the 1.55 μm band loss optical fiber, but its chromatic dispersion was not small enough in the 1.55 μm band. Chromatic dispersion is a phenomenon in which the speed of light transmission varies by wavelength. This causes a broadening of light pulses, which in turn limits the overall number of pulses that can be sent per unit of time and thus makes large capacity transmission difficult. The Sumitomo Electric research team launched efforts to eliminate the chromatic dispersion in the 1.55 μm band without compromising the low loss characteristics.

"The question was how to control and minimize the chromatic dispersion. It was necessary to change the refractive index profile of the core and cladding by using additives and thereby change the chromatic dispersion characteristics. We worked desperately, but transmission loss increased no matter what we tried. Unfortunately, we had no choice but to give up the development."

The use of optical fibers in submarine cables continued to expand, but they were different from low-loss optical fibers achieved by the Z-fiber. They were designed to minimize the chromatic dispersion in the 1.55 μm band by using germanium.

World's best ultra-low-loss optical fibers achieved by a strong belief

The submarine optical fiber business of the Sumitomo Electric Group remained sluggish for about 10 years from 2002 due partly to the economic disruption in the IT industry. However, the Group made continuous efforts to develop ultra-low-loss optical fibers based on a belief, which was passed on from predecessors, that low-loss optical fibers would significantly benefit society. The situation changed completely in around 2010 due to the advent of the digital coherent technology, which was designed to receive optical signals distorted by chromatic dispersion and to compensate for the distortion by the calculation of the signal processing circuit. As this technology was set to become commercially implementable, the chromatic dispersion requirements for optical fibers were dramatically relaxed and reduction of transmission loss was strongly required. At this timing, the Sumitomo Electric Group put additional resources into the development, and the efforts bore fruit in 2013. Masaaki Hirano, who is currently working in the Market & Engineering Dept., Optical Fiber & Cable Div., was one of the key members of the development project.

"To minimize transmission loss, we focused on improving the glass transparency. In general, the refractive index of the optical fiber glass is considered to be uniform, but there is a fluctuation in reality and it is not uniform. We worked to minimize the fluctuation in the order of nanometers. We were convinced that improving glass transparency by minimizing the fluctuation was the only way to go."

In 2013, Hirano and other members developed an optical fiber of 0.154 dB/km on a product level. Sumitomo Electric's optical fibers attracted global attention again and the business started to recover dramatically. The development accelerated further, and in 2017, they attained a transmission loss of 0.142 dB/km on a research level and 0.150 dB/km on a product level, breaking the world record for transmission loss of optical fibers. Their successful development helped boost the shipment of low-loss optical fiber products for submarine cable projects. Eventually, Sumitomo Electric attained the top share in the global submarine optical fiber market.

Delivering unique products based on original technologies and commitment to excellence

The efforts to develop next-generation optical fibers have also been accelerating. Takemi Hasegawa, who is working in the Optical Transmission Media Dept., Optical Communications Lab., is one of the members.

"At our laboratory, the development of ultra-low-loss optical fibers is a never-ending theme. We will break the world record again and again in the course of meeting customers' needs at improved costs and productivity. Meanwhile, the transmission capacity of an optical fiber is reaching its theoretical limit. To cope with this issue, we will take on challenges to develop new products such as multi-core optical fibers with a larger number of cores."

Yasushi Koyano, who works for both the Optical Fiber & Cable Div. and the Optical Communications Lab., closely monitors R&D activities and market trends. He is responsible for increasing the presence of the Sumitomo Electric Group in the global optical fiber market.

"It is important to visit customers and hold interviews with the future vision in mind. Obviously, low loss is the key technology of Sumitomo Electric's optical fibers, but customers ask for both quality and reduction in total cost. We hope to lead in technologies and offer best optical fibers for customers. We will actively open up new markets in the world."

The Sumitomo Electric Group's optical fibers have a history for about 40 years. Onishi says: "Many predecessors never gave up on development." Their commitment and belief have been successfully passed on to us. The steady efforts to create unique products based on original technologies will open up the future.

The Forefront of Optical Fiber Development for the Cloud Society

Laying a submarine cable (photo courtesy: NEC Corporation)

Masaaki Hirano
Specialty Fiber Group Leader
Market Development & Engineering Dept.
Optical Fiber & Cable Div.

Takemi Hasegawa
Optical Transmission and Applications Group Leader
Optical Transmission Media Dept.
Optical Communications Lab.

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The submarine cables manufactured are loaded in the cable tank of a cable ship. (photo courtesy: ❶ OCC Corporation, ❷❸ NEC Corporation)

Masashi Onishi
General Manager
Planning & Administrative Dept.
Global Marketing & Engineering Dept.
Optical Fiber & Cable Div.

Ultra-low-loss optical fiber developed by Sumitomo Electric

Yasushi Koyano
Senior Manager
Market Development & Engineering Dept., Optical Fiber & Cable Div.
Optical Transmission Media Dept., Optical Communications Lab.

Sumitomo Electric
The Professionals

“Computers are just convenient tools.
Our job is to infuse life (i.e., software) into them.
Software programs are written by people.
Personal skills are tested in our job and are reflected in the software.”

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Featured person

Takeshi Hachikawa

General Manager
Business Promotion Dept., Mobile Solution Div.
Sumitomo Electric System Solutions Co., Ltd.

1995: Joined Sumitomo Electric
1999–2002: Joined project for introducing a U.S. electronic clinical record system to the Japanese market (in the U.S.)
2004: Sent to Toshiba Sumiden Medical Information Systems Corporation
2013: Started to work at Sumitomo Electric System Solutions Co., Ltd.
2018: Assigned to the current position

Software must be created by passion.

The work is facilitated by personal ties.

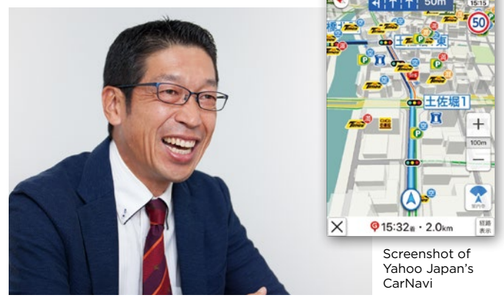
Engineering capability nurtured in the development of hospital information systems, and passion for manufacturing

I developed an interest in computers when I was a junior high school student. As a child, I felt the big potential of computers to open up the future. Thus, I chose information science when I went to university and graduate school. In graduate school, my research theme was computer simulation to improve solar heat power generation efficiency. I hoped to create something that could be commercially implemented and would contribute to society. By taking advantage of what I learned in graduate school, I wanted to do a job to offer new added value through systems rather than selling systems. I chose Sumitomo Electric because its efforts in the information communication field matched my vision and were very attractive.

I was in charge of creating hospital information systems, mainly electronic clinical record systems, for 18 years after I joined Sumitomo Electric. I could acquire various basic skills of manufacturing while I was engaged in the highly reliable system infrastructure, electronic clinical record indication systems and overall system architecture design. I was also engaged in offshore software development in China (outsourcing to companies outside Japan) for five years. This experience helped raise my awareness as an engineer. My mission was to manage a project involving up to 120 engineers as a project leader. The project reminded me of the importance of personal ties. Obviously, it was difficult to develop products through collaboration with people with a different cultural background and values. However, the project provided many opportunities to feel the passion, enthusiasm and deep personality of the respective engineers. I was convinced that software must be created by passion.

A new challenge in the telematics business
Development of Yahoo Japan’s CarNavi application for smartphones

In 2013, the hospital information system business was reorganized, and I was assigned to the telematics business department. This was the chance of a lifetime because I had been considering taking on challenges in a new field as an engineer. In fact, this transfer was a turning point for my career as an engineer. Telematics, which I assumed as a new mission, is a word coined from telecommunication and informatics. It aims to offer services to mobile objects such as vehicles by using mobile communication such as mobile phones. Specific services include traffic congestion forecasts and provision of information about optimal routes, distribution of map information, secure and safe functions for cars and transport vehicles such as safe and eco-friendly driving support software and improvement of convenience by information distribution. In the future, telematics will play a role in Intelligent Transport Systems. Total solutions related to the road traffic will be offered to improve the infrastructure toward achieving automated driving. In the broad spectrum of operations, I was assigned the task of developing a car navigation application for smartphones.



Screenshot of Yahoo Japan’s CarNavi

At that time, Sumitomo Electric’s telematics business was stagnant. The company was seeking a new source of profit by taking on challenges in new businesses. Sumitomo Electric entered the telematics market early, and was highly evaluated in terms of its technology such as car navigation, maps and server software (e.g., route search and distribution of traffic information). Based on these results, a development kit was offered for smartphone applications. The strategy was to spread the telematics technologies to new users and ensure competitiveness.

The customer was Yahoo! JAPAN, a portal site operator. I was in charge of team management and negotiations with customers as a project leader. We focused on high-precision positioning, high-speed route calculation and high-frequency map update to differentiate from other car navigation applications. We also endeavored to take actions at an ultra-fast speed from proposals of car navigation software development environments to commercialization of car navigation functions. We frequently visited the customer for direct communication to fully understand their intentions and requests from every aspect, and worked closely with the customer to embody the service. These efforts led to the development of the application, which was eventually released as Yahoo Japan’s CarNavi in July 2014. It recorded 14 million downloads in total in August 2018.

Improving personal skills to become attractive persons
This is the source of motivation to make progress in manufacturing.

Yahoo Japan’s CarNavi has been continuously upgraded to advance the car navigation functionality.

This project won the Glorious Excellent Award (the best award) at the Global Award Ceremony of Sumitomo Electric, which is held every five years, for creating a path toward new business.

I was appointed manager in April 2018 to be responsible for promoting the entire mobile solution business including the logistics systems and mobile big data business. We aim to produce and develop the core business in our operations. Currently, we focus on vehicle mobility, but we hope to create highly convenient solutions for entire human mobility in the near future.

System and software engineers are most pleased when they are told that their products are helpful. To receive as much such feedback as possible, we will not only improve the engineering capability but also create a team of members with high personal skills.

Software is created by people, so it is necessary to enhance personal skills, value personal ties and become attractive persons. This is the core of manufacturing.

Delivery of Contact Wires for the Dedicated Freight Corridor Construction Project in India

— Contributing to building the logistics infrastructure to achieve further economic growth

With the second largest population in the world, India achieved a real GDP growth rate of 8.2% in the first quarter of FY2018. Its economic growth is very high compared to other countries. Due to the rapid economic development, the freight transport volume has been increasing by 10 to 12% per annum. To achieve further economic growth in India, it is imperative to improve and strengthen the freight railroad network. Against this backdrop, the Indian government has been promoting the Dedicated Freight Corridor (DFC) Construction Project between Delhi and Mumbai (Western DFC) and Delhi and Kolkata (Eastern DFC). The Japanese government decided to support the project, and the Western DFC Construction Project is financed by yen loan.

Construction of the Western DFC is being undertaken by Dedicated Freight Corridor Corporation of India Limited, a subsidiary of the Indian Ministry of Railways. The Sojitz-Larsen & Toubro Limited (India) consortium received an order for the electrification of the Western DFC. Sumitomo Electric received an order from the consortium for contact wires for a section of about 1,340 km of the corridor (total length: about 3,400 km), and has started to deliver the products. This was the largest order received by Sumitomo Electric in terms of railroad projects outside Japan. The consortium decided to use Sumitomo Electric's contact wires because of the superior durability and heat resistance as well as the track record of delivery to railroad markets in and outside Japan. Sumitomo Electric's contact wires will be used to electrify the corridor between Rewari and Jawaharlal Nehru Port (JNPT port).

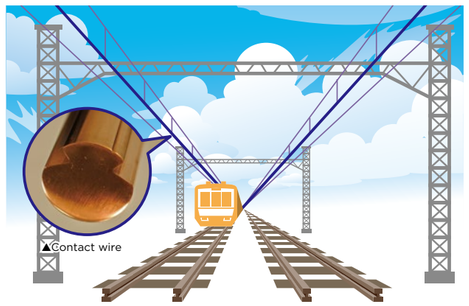
This is the first time for Sumitomo Electric to deliver contact wires to the Indian market. Sumitomo Electric will help build the logistics infrastructure for the further economic development of India by offering high-quality contact wires stably.

In addition to DFC, India will continue to actively promote railroad development and improvement projects, including a high-speed railroad development project based on Japan's Shinkansen bullet trains technology (the entire section will come into service in 2023), a metro construction project in Mumbai, and a project to electrify the existing national railroad network. With this delivery as a start, Sumitomo Electric will offer its products and services to India's railroad development and improvement market that is expected to expand further in the future.

What are contact wires?

Contact wires are used to feed power to moving vehicles such as rolling stock, trucks, transport equipment and cranes via pantographs.*

Sumitomo Electric has been manufacturing and selling contact wires since 1914 by taking full advantage of the copper processing technology that has been developed over many years of operation. The contact wires manufactured at the Osaka Works of Sumitomo Electric have been used for railroad including Shinkansen bullet trains, subways, monorails and automated people movers around the world.



*Pantograph: an instrument attached on the roof of trains and electric locomotives to receive electric current from overhead lines

QUARTERLY

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Topics from the future-shaping Sumitomo Electric Group

Data storage and analyzer for the AI-based PLC string monitoring system for photovoltaic power plants

— Supporting stable power plant operation over decades

As global energy demand has been increasing rapidly, there has been growing interest in renewable energy resources such as photovoltaic and wind power generation to achieve an environment-friendly and sustainable society. Photovoltaic power generation systems (which have been increasingly introduced) are designed to operate for more than 20 years after installation. To maintain the stable power generation amount over the long term, it is crucial to detect problems and take actions immediately. In general, monitoring systems are introduced to detect abnormalities.

Conventional monitoring systems mainly used thresholds (limit value) for determining abnormalities. For example, a power output below a certain value was determined as an abnormality and was notified to the manager of the photovoltaic power generation system. However, the power output varies depending on various factors such as the season, time zone, installation region and the environment around the power plant. The abnormality determination based on thresholds was not highly reliable. In most cases, the operation required human analysis and judgment based on the results of abnormality determination.

Against this backdrop, Sumitomo Electric developed an artificial intelligence (AI)-based string monitoring system that judges abnormalities in the measured string electricity value and notifies the cause of abnormality depending on the level of urgency.

Abnormality detection is difficult in photovoltaic power plants where many photovoltaic panels installed in a large area are in operation.

Specifically, when the string monitoring system detects a decrease in power generation, it determines the cause (e.g., abnormality in the fuse or breaker, shadows of plants, deterioration of photovoltaic panels), and notifies the abnormalities depending on the level (immediately or daily). The system judges the abnormality for each string (minimum unit of photovoltaic power generation) and color-codes abnormal locations on the overall map of a power plant depending on the level of urgency. This helps identify abnormal locations visually and makes it possible to give instructions to on-site workers easily.

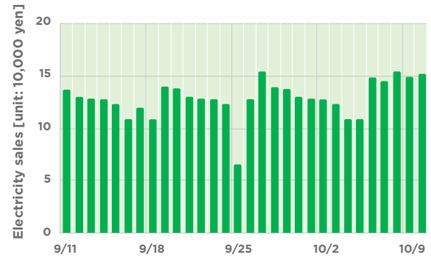
Sumitomo Electric`s monitoring system employs power line communication (PLC) technology that utilizes the existing power lines as communication lines, eliminating the need for installation of additional communication lines when introducing the system. It can also be introduced easily to existing power plants in operation. The new abnormality detection, judgment and notification system enables quick actions against abnormalities related to power generation. It contributes to reducing the operation and management cost of photovoltaic power plants and maximizing the power generation amount.

Example of daily power generation report

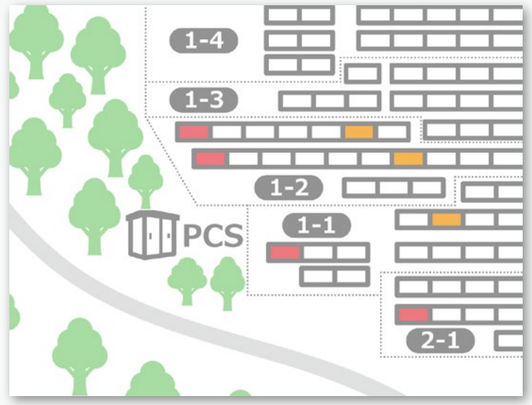
Power generation status	Power output today	No. of major abnormalities	No. of minor abnormalities
☹	3,573kWh	4	3

Power output evaluation

Electricity sales during the past 30 days



Example of indication of abnormal locations in a power generation reportreport



▲Abnormal locations are indicated on the overall map of a power plant based on the judgment results. Major abnormalities: 4 (red), minor abnormalities: 3 (orange)

A Picture of Sumitomo Electric in Those Days

1947

Sumitomo Electric Making A New Start

Emperor Hirohito observing the ultra-high pressure experiment room. (President Bekku is on the right.)

Rebuilding Japan as a Cultured Nation

In June and July 1945 (during the last months of the Pacific War), the Osaka Works of Sumitomo Electric was hit by four air raids, causing 30% of the facilities to be burnt to the ground. The raids caused heavy casualties among the employees.

On August 17, two days after the end of the war, then President Sadatoshi Bekku summoned all employees to a communication cable plant that had survived the firebombing and thanked them for their hard work. He said, “Japan will have to be rebuilt as a cultured nation. Our products will play a key role ... so I ask for your commitment to production of electric wires and cables. We must manufacture as many products possible to fulfill the mission.” Sumitomo Electric made a step forward to reconstruction.

The Company was overcoming challenges such as restoration of production equipment, shortage of materials and soaring prices in 1947, when Emperor Hirohito’s visit to the Kansai area was decided. Sumitomo Electric was chosen as one of the destinations.

It was perfectly fine on the day of the visit. The Emperor arrived in front of the building of the ultra-high pressure experiment room, and President Bekku explained the Company’s history and current situation. The Emperor gave an encouraging message: “You are doing important work, so I hope you will do your best.” He also visited the casting plant, wire plant and coated cable plant, and offered many inspiring messages to employees.

The year 1947 fell on the 50th anniversary of Sumitomo Electric’s founding, and marked a new start for the Company, which had revived to a level that deserved the Emperor’s visit.

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