

# 04

## Innovative Technology

### The Best Memory Partner for Our Customers

"Innovation" is one of the driving forces for Nanya Technology Corporation's growth and competitiveness as well as one of our four core values. We shall strengthen product research, development, and manufacturing to satisfy customers' diverse demands and become one of the best DRAM provider for smart world.

**5.7%**

R&D expenses accounted for 5.7% of revenue, which demonstrates the importance of technology development is to NTC



**90.5** points

The customer satisfaction rate score was 90.5 points which exceeded the target of 87 points set for the year



**502** patents

Obtained 502 patents, a record high in recent years



53 R&D and Innovation

57 Customer Service

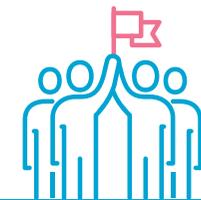
## Strategy and Achievement

○ Unachieved ✓ Achieved ★ Surpassed

| Material issues    | Strategies                                                                                                                                                                                                                                                                                                                                                                                                | 2019 Goals                                                                                  | 2018 Targets                                            | 2018 Achievements                                       | Target achievement status |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|---------------------------|
| R&D and Innovation | <ul style="list-style-type: none"> <li>• Design next-generation products</li> <li>• Develop 10nm process technologies</li> <li>• Entered the high-density server module market</li> <li>• Smart factory</li> </ul>                                                                                                                                                                                        | Complete Critical Design Review of DDR5 products                                            | New KPI in 2019                                         |                                                         |                           |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                           | Complete verification of 10nm technology for product specifications and yield rate          | Complete verification of yield rate for basic functions | Complete verification of yield rate for basic functions | ✓                         |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                           | Complete customer qualification for four main server customers.                             | 1                                                       | 1                                                       | ✓                         |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                           | Establish high-efficiency production lines with AI-assistance: Project completion rate: 40% | 20%                                                     | 20%                                                     | ✓                         |
| Customer Service   | <ul style="list-style-type: none"> <li>• <b>Design and tests:</b> Use global engineering support services to resolve customer design and test issues.</li> <li>• <b>Production and sales:</b> Implement rigorous control of quality and improve delivery efficiency.</li> <li>• <b>After-sales services:</b> Use the customer complaint management system to quickly resolve customers' issues</li> </ul> | Customer satisfaction score: 88 points                                                      | 87 points                                               | 90.5 points                                             | ★                         |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                           | Customer platform parameters measurement services: 920 cases                                | 800 cases                                               | 1,074 cases                                             | ★                         |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                           | Customer technical exchange and courses: 80 sessions                                        | 80 sessions                                             | 88 sessions                                             | ★                         |

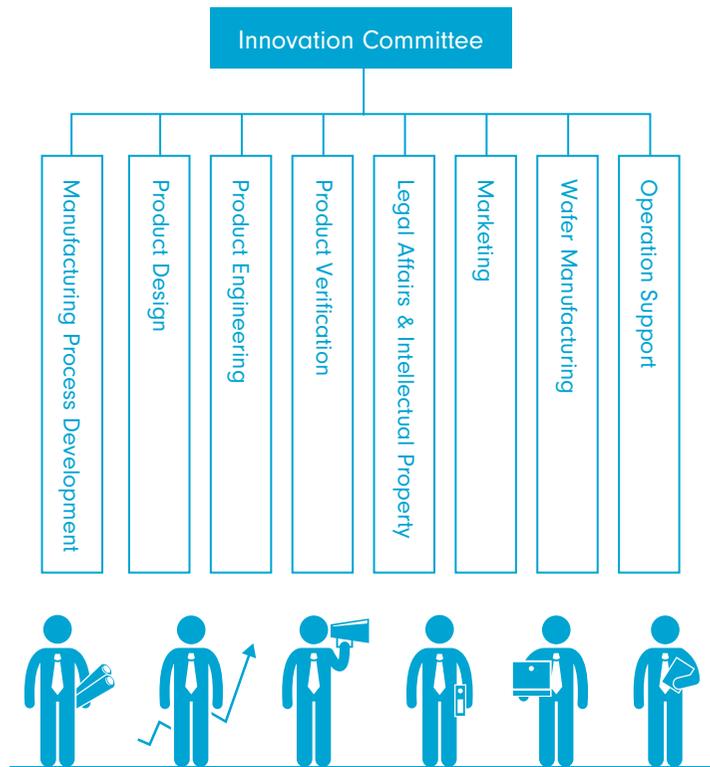
## R&D and Innovation

Smart products have improved the quality of life for human beings and helped energy conservation & carbon reduction. Every year, NTC invests a lot of resources in technology development of new types of DRAM products, next generation processes, and advanced 3D stacked packaging, provides customers value-added services, and reinforces protection for intellectual property and trade secrets, accelerating the move towards product diversification and smart factory. Moreover, we have set a vision for innovative development to introduce 10nm DRAM process into mass production in 2021, develop next-generation DDR5 products, enter fast-growing markets (artificial intelligence (AI), data centers, automotive and the Internet of Things), and set up high-efficient production lines with an AI-aided system.



### Innovation Committee

In order to implement innovation management, create a culture of innovation, and enhance the company's innovative energy and value, NTC especially set up the Innovation Committee, a cross-departmental unit, formed by the senior management and chaired by Executive Vice President (EVP). The Innovation Committee is positioned to coordinate and plan the overall innovation strategy, setting short, medium and long-term goals. The Committee holds regular meetings to review the progress of various major projects. Designs, mass production, and sales for three 20nm new products have been smoothly completed, and these products are the main products of the sales in 2018. In the meantime, the progress of 10nm DRAM development and verification of 20nm low power products have been achieved.



### Investment and Output of Innovative R&D

Unit: NT\$ billion

| Item                                         | 2015  | 2016  | 2017  | 2018  |
|----------------------------------------------|-------|-------|-------|-------|
| Revenue (A)                                  | 43.8  | 41.6  | 54.9  | 84.7  |
| Appropriation for Innovative R&D (B)         | 1.95  | 2.48  | 3.67  | 4.88  |
| <b>Investment in Innovative R&amp;D</b>      |       |       |       |       |
| B/A                                          | 4.4%  | 6.0%  | 6.7%  | 5.7%  |
| Total number of employees (C)                | 2,469 | 2,679 | 2,984 | 3,219 |
| Total number of innovative R&D personnel (D) | 289   | 312   | 430   | 501   |
| D/C                                          | 11.7% | 11.6% | 14.4% | 15.5% |
| <b>Output of Innovative R&amp;D</b>          |       |       |       |       |
| Number of patents awarded                    | 259   | 478   | 471   | 502   |

### R&D of Low Power Consumption Products

At the stage of new product development that NTC starts considering the impacts on environment incurred by product life cycles, actively researching and developing new-generation low power DRAM products so as to reduce energy consumption of end electronic products and lower greenhouse gas emissions. If the 2-year new product life cycle is used to calculate the energy consumption of end electronic products in use, the low power DRAM products sold by the company in 2018 save approximately 701.02 million kWh on electricity consumption and reduce CO<sub>2</sub>e emissions of 388,000 tons, making concrete contributions to a greener earth.

### R&D Policy of Low Power Consumption Products

NTC cooperates with major chip customers, adopting the method of multi chip package (MCP) to reduce the number of back-end assembly and testing as well as energy consumption.

NTC continues developing advanced manufacturing processes, so the energy consumption of new generation products developed by new processes is less than about 15% than that of the previous generation.

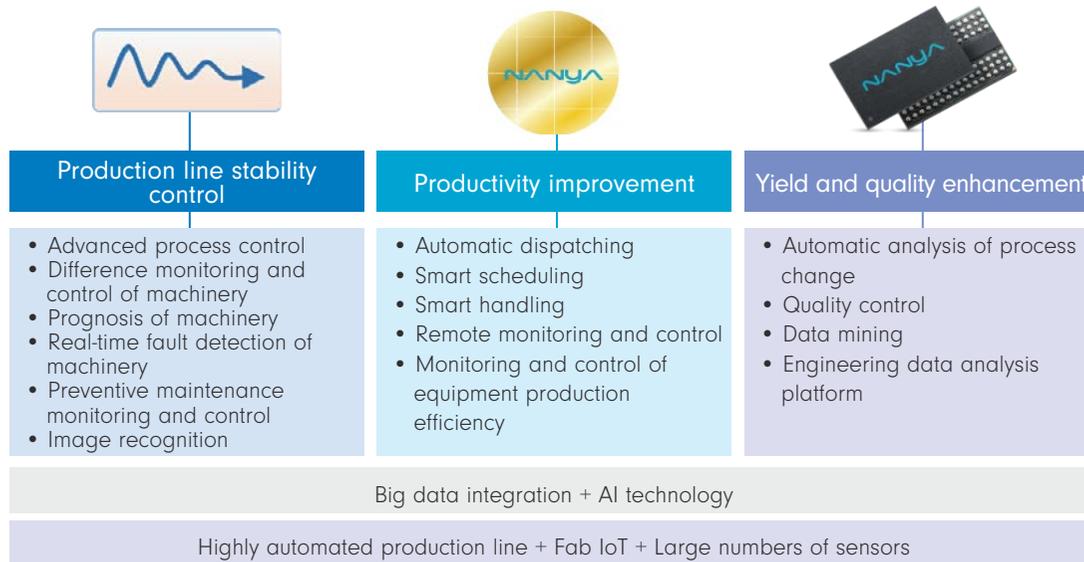
NTC Strengthens development of low power product lines and enlarges product portfolios in order to satisfy the need of various mobile devices and electronic products.

### Smart Factory

In order to enhance manufacturing processes and capacity so that the production process and yields can be more smooth, currently, NTC has developed a number of innovative production line applications, including the prognosis of machinery, advanced process control, optimization of production schedules, projections of work in process, improvements in the efficiency of handling system, wafer probe testing, defect image recognition, and pattern recognition of wafer yield. These applications can effectively enhance the entire operational efficiency of production lines, so the efficacy of three important aspects, i.e. wafer output, yields, and qualities, is greatly enhanced. The current 12-inch wafer fabrication plant has all the necessary infrastructure that a smart factory requires, including highly automated production lines, Fab IoT, large numbers of sensors, big data integration, and AI technology.

In response to new-generation advanced processes and diverse product portfolios, NTC has set a three-year blueprint for AI development, planning long-term goals regarding five main topics: precision control of processes, optimization of production schedules, AOI quality inspection, yield analysis technology and prognosis technology of machinery, in order to enhance the overall efficiency and capacity of processes.

#### ► NTC smart factory - three major applications

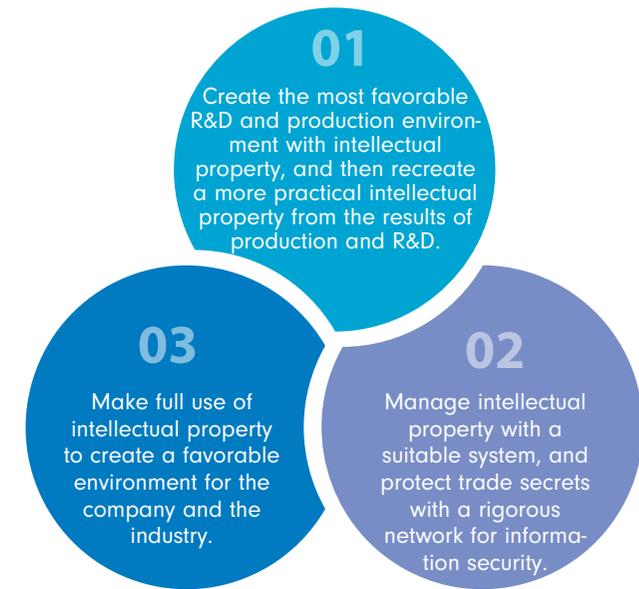


Nanya Technology has built a number of advanced intelligent systems, which are applied to three important links: production line stability control, productivity improvement, and yield quality improvement.

### Status and Strategy of Intellectual Property

NTC has created many patents through the cooperation with world-class entities, technology transfer, and joint execution of R&D plans, and taken out these patents, which is hugely beneficial to R&D and production. Meanwhile, in relation to protection of our trade secrets and trademarks, we have also established a complete protection system. Moreover, regarding continuous profits and risk prevention, we have set up complete operating mechanisms.

#### ► NTC intellectual property strategy



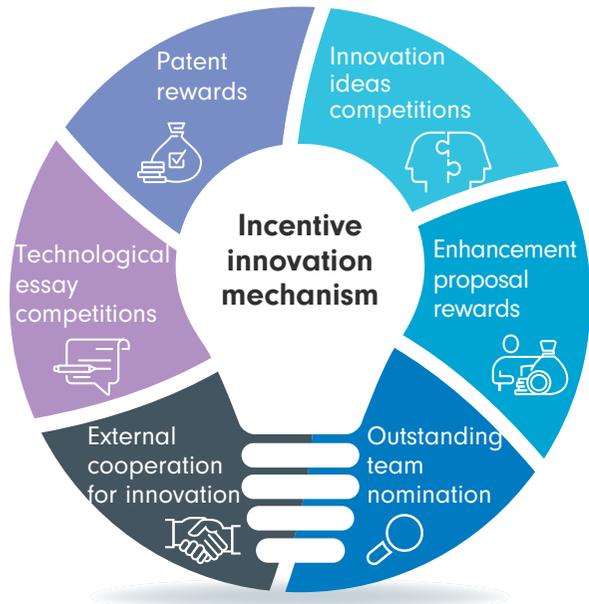
In addition, in the face of increasingly intense business competition and challenges of globalization, the protection of trade secrets has become an increasingly important subject for an enterprise to maintain its core competitiveness. Trade secrets include technology, methods, processes, recipes, programs, and design or other information that can be used in production, sales or operation, complying with the requirements for secrecy, economic value, and confidentiality measures that have been taken. In recent years, NTC has actively introduced advanced process technology, new product development, and innovative sales models, so the number of trade secrets has also increased year after year. In order to ensure NTC's long-term competitive advantages, NTC will introduce ISO 27001 Information Security Management system in 2019 to minimize the risk of leaks.

► Number of NTC trade secrets

|                         | 2016  | 2017  | 2018         |
|-------------------------|-------|-------|--------------|
| Number of trade secrets | 3,274 | 4,172 | <b>5,056</b> |

Incentives for Innovation

"Innovation" is the driving force for NTC's technological growth and competitiveness enhancement, serving as one of our core value as well. In recent years, we have constantly promoted various innovative activities, hoping that our employees will internalize the spirit of innovation. Every year, NTC holds innovative activities, such as patent rewards, creative competitions, rewards for improvement proposals, essay competitions, and the best team competitions, and cooperates with external entities on development of basic research and processes, launching open innovation programs annually in order to achieve the goals of product diversification and smart factory as soon as possible.



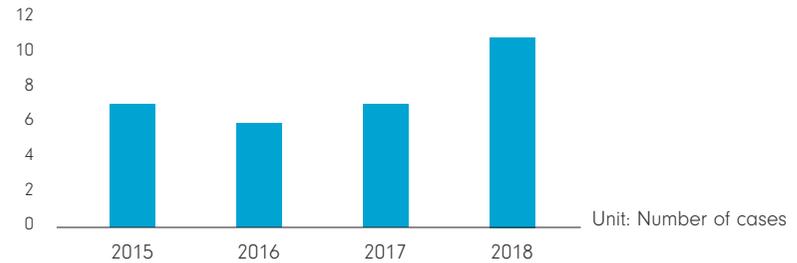
► Results of innovative activities

Unit of reward: NT\$

|                                   |                           | 2016       | 2017       | 2018       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------|---------------------------|------------|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Patent Rewards                    | Number of Patents Granted | 478        | 471        | 502        | NT\$ 50,000 for each granted patent.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                   | Rewards Issued            | 23,900,000 | 23,550,000 | 25,100,000 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Rewards for Improvement Proposals | Number of Proposals       | 44         | 47         | 51         | After reviewed by the jury according to expected benefits, creativity, application range, level of completion, and quality contribution, rewards are issued based on the scores ranging from NT\$ 300~20,000.                                                                                                                                                                                                                                                                     |
|                                   | Rewards Issued            | 64,300     | 62,400     | 128,350    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Technological Essay Competitions  | Number of Entries         | 47         | 46         | 58         | <ol style="list-style-type: none"> <li>1. The competition is held once a year, and each entry is award with NT\$1,000.</li> <li>2. The competition is divided into two groups: technological essay group and practical creation group, and the top three and two honorable mentions are taken out from each group. The rewards for the top three are NT\$ 30,000, NT\$ 20,000, and NT\$ 10,000 respectively, while the reward for the honorable mention is NT\$ 5,000.</li> </ol> |
|                                   | Rewards Issued            | 180,000    | 177,000    | 196,000    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Best Team Competitions            | Number of Entries         | 6          | 7          | 15         | The competition is held once a year, and the top three and two honorable mentions are taken out. The rewards for the top three are NT\$ 90,000, NT\$ 50,000, and NT\$ 20,000 respectively, while the reward for the honorable mention is NT\$ 5,000.                                                                                                                                                                                                                              |
|                                   | Rewards Issued            | 170,000    | 170,000    | 170,000    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

We are also open to collaborative innovation, interact with external agencies to explore new territories. For example, professors from National Taiwan University, Chang Gung University and ITRI's Electronic and Optoelectronic System Research Laboratories worked together on the design of next-generation memory and foundation research, collaborated with manufacturers of masks and machine tools to develop processes and materials of the next-generation DRAM, teamed up with downstream system developers to expedite development of multiple application product through customization of wafer-class packaging. Over the past four years, 6-11 open innovation projects were launched. From 2018 onward, we will promote wider external collaboration in coordination with the development of 10nm-class process technology, product diversification and smart factories to ensure that our goals are achieved as planned.

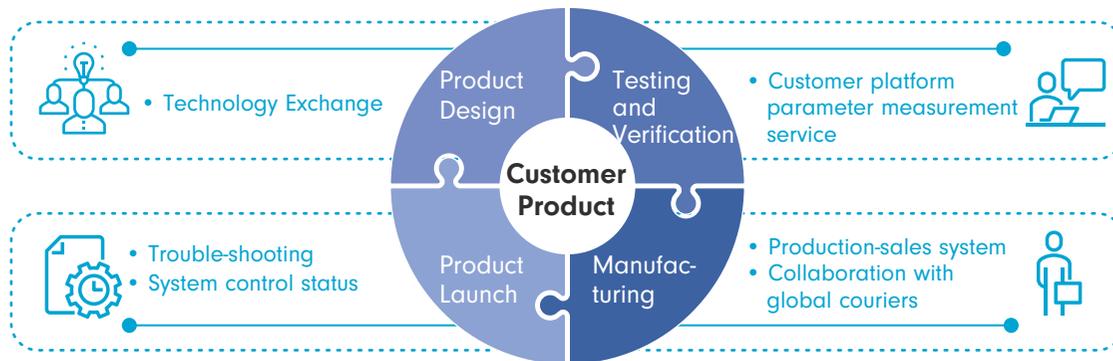
► Open innovation program



## Customer Service

NTC is committed to providing the best customer service and is convinced that quality and timely customer service are crucial to the maintenance of customer relationship. Good customer relationship will help us build customer loyalty, and the deeper the customer loyalty is the more business we are able to gain, helping to consolidate the good partnership with customers. Our vision is to become the best memory partner in the smart era as well as a service-oriented enterprise. Through close cooperation with MCU makers and customers, we strengthen product development and manufacturing in order to satisfy diverse requirements and provide customers comprehensive product and system solutions. We are committing ourselves to striding toward this goal.

► Customer Service Process



### Product Design, Testing and Verification Stage

In order to improve the efficiency and frequency of customer service and effectively build close relationships with customers, the Field Application Engineering Division provides technical supports to customers in Taiwan, China, Southeast Asia, Europe, the United States, Japan and South Korea, organizing irregular technology exchange events to meet the technical needs of customers. In 2018, the Division held a total of 88 events, providing technical supports and assisting customers' engineering personnel to solve problems in design and testing.

In addition, through the highly efficient, intensive, and high-quality customer platform parameter measurement service, of which 1074 cases were completed in 2018, NTC assisted customers to understand the characteristics of their product platforms so that the new product development progress and verification cycles of customers were significantly accelerated, reducing investment risks and helping end products to be launched timely in the demand market.

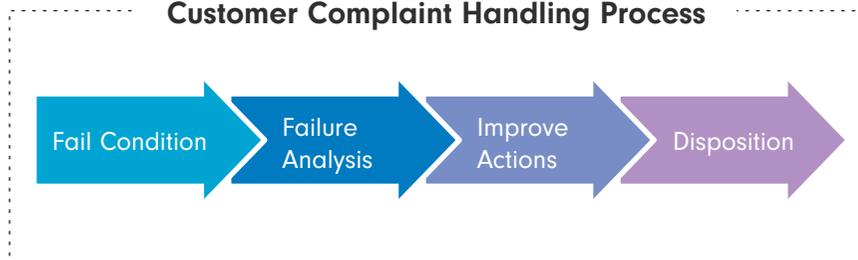
### Manufacturing and Sales Stage

NTC has been certified for ISO 9001:2015 and IATF 16949:2016 quality system. The Quality Assurance Division monitors and controls product quality as well as implements improvements, making sure that all production processes are fully optimized. Moreover, the Division includes each stage of production process into a good and tight control system so as to manufacture the products that meet customers' requirements. Sales personnel continuously communicate with our customers and weekly report customers' future forecasts to the headquarter. The head office consolidates the forecasts from global sales personnel before converting these projections into production plans through the production-sales system. Production plans are constantly adjusted based on the weekly feedback from our sales staff in order to make sure the production meets customers' needs.

### After-sales Service Stage

NTC continue to enhance product quality and responding to customers' quality issues to meet their expectations. In order to accelerate the efficiency of problem analysis, NTC would fully understand the problems reported by customers first, provide failure analysis report to customers based on failure analysis plans, and replies customers with corrective actions and disposition when case closure. Through the cooperation among the divisions of Field Application Engineering, Quality Assurance, Product Engineering, and Manufacturing Process along with the process management conducted with a customer complaint handling system, over the years, NTC has been able to reply to over 90% of customers' complaints within target deadlines.

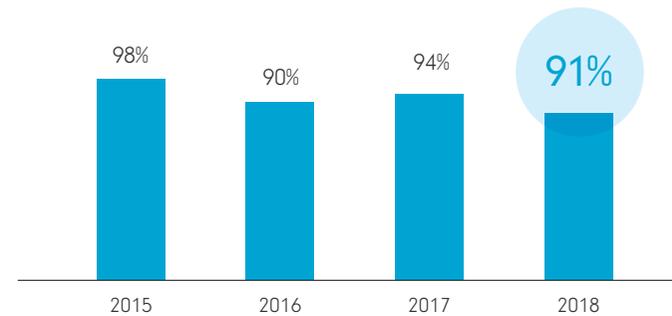
### Customer Complaint Handling Process



### TAT Meet Rate of RMA Cases

In 2018, NTC achieved to reply 91% of RMA cases within target deadlines. Those were not replied within deadlines mainly owing to new product technology, which increased the difficulty of failure analysis or required to work with customers for platform analysis, resulting in longer turnaround time. In the future, NTC will work with customers closely for continuous improvement.

#### ► TAT Meet Rate of RMA Cases



### Customer Privacy Protection

Customers are extremely important partners for NTC. Therefore, we are obligated to rigorously safeguard their privacy and confidential information as of our own. To ensure confidential information is well protected, NTC has formulated the Confidential Information Management Procedure. Regarding the documents provided by customers, after internal filing procedure and the confidentiality classification, these documents are archived in the document control center. In the future, if employees require access to these documents, they have to go through the document application procedure, and based on the level of document confidentiality and the purpose of use, receive approval from corresponding supervisors so that the document control center will authorize and distribute the documents to the applicants. In 2018, no case involving violation of customer privacy has happened. If a customer suspects or discovers evidences indicating leakage of information, a complaint can be lodged through the NTC Grievance Mailbox and Grievance Line.

### Customer Satisfaction

NTC strive for continuous improvement, working in a practical way, with a spirit based on exceeding our customers' requirements in quality, delivery and service. In relation to customer satisfaction, NTC employs an impartial third-party consultancy company to conduct satisfaction survey for direct and end-customers through the internet or interviews, that NTC can understand customers' needs from a fair and objective perspective. The content of the survey includes the dimensions of "Product", "Delivery", "Quality", "Technical service", "Communication", "Commercial" and "Comparison with competitors". With regard low performance items, relevant departments are responsible to review and proposed corrective action. In addition, the results of customer satisfaction survey are submitted and reported at the top management meeting, while the sales personnel are going to reply customers with improvement results or continuous improvement plan, and continue to improve customer satisfaction. In order to improve customer satisfaction, NTC has established a review platform to give priority to handle and improve customers' requirements.

In addition to the customer satisfaction survey, Customers regularly conducts business and technical review meetings with NTC's service team, NTC is able to keep close relationships with customers and provide better service. We will commit ourselves to strengthening the collaborative cooperation among internal relevant divisions in response to urgent or sudden demands from customers. Moreover, we will continuously strive to improve product quality and the timeliness and efficiency of communication on quality issues with customers while keeping smooth communication with customers, making every effort to satisfy customers' requirements.



In 2018, the overall satisfaction average score is 90.5 points and exceeding the target of 87 points, the target score for 2019 is 88 points. The target setting of the customer satisfaction survey is to consider the fluctuation of the industrial characteristics and the annual regular review of the performance and benchmarking, and set a reasonable target, submitted to the President for approval by the Quality Assurance Division. In regard to the NTC's scores and the results of comparison with competitors, customers highly recognize the NTC's performance on delivery, technical service and communication, Mainly NTC assists the client in accelerating the verification of new products and technical exchanges during the product design, testing and verification phase.

In addition, there is still room for improvement in the performance of product technology capabilities and quality. Based on the supply and demand of the market and product application, we will strengthen customer communication and improvement with positive attitude, insisting on product quality control and improvement according to customers' feedback. This year, there was no product recall events.

### Results of Customer Satisfaction Survey

