



› GROWTH AND IMPACT

2019 ANNUAL REPORT

TNO innovation
for life

TNO.NL

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The original financial statements were drafted in Dutch. This document is an English translation of the original. In the case of any discrepancies between the English and the Dutch text, the latter will prevail.

GAME CHANGERS OF 2019

The boxed sections throughout this report highlight the game changers of 2019, i.e. technological innovations that TNO has developed together with its partners. For more background information on a game changer, simply click the box to go to the TNO website.

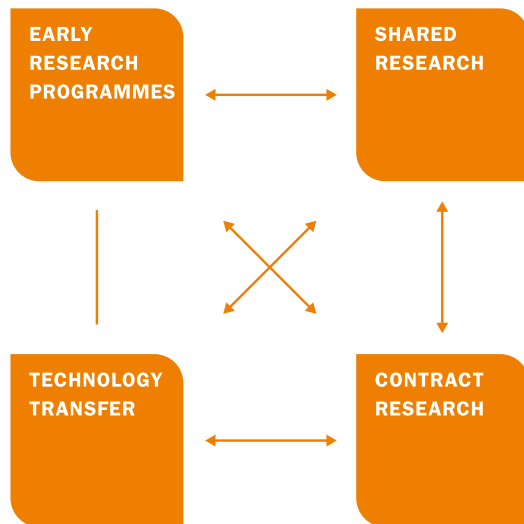
[2019 financial statements](#)



PROFILE AND MISSION

TNO connects people and knowledge to create innovations that boost companies' competitiveness and increase well-being across society in a sustainable way.

Besides in-depth expertise, this also requires skills in connecting and integrating the various knowledge domains, systems and sectors of society. As knowledge becomes increasingly dynamic and widely accessible due to advances in information technology and other areas, it is ever more important to harness knowledge in a way that is both smart and effective.



The power of innovation lies primarily in making smart connections across the boundaries between scientific domains and sectors of society. This is where TNO stands out: by being a multidisciplinary research organisation with dedicated people who work in dynamic partnerships, coalitions or alliances and by offering the kinds of solutions that our clients and partners are looking for.

We only work on innovative solutions when there is a crystal-clear answer to the question of who will be using it and what for. This is how TNO helps its clients and partners to be successful and works to make the Netherlands safe, healthy, competitive and sustainable, with excellent quality of life.

INNOVATION CYCLE

TNO's research can roughly be divided into knowledge development and knowledge application, which are two fields that differ from each other in terms of objectives, management and financing.

Knowledge development

Early Research Programmes (ERP)

Our Early Research Programmes are all about building and substantially innovating knowledge. In 2019, there were 21 such extensive research programmes ongoing. This kind of research is most closely related to the fundamental research done at universities and is the furthest removed from the market.

Shared Research

This is where knowledge is developed further through pre-competitive partnerships with public-sector and private-sector partners. Shared research includes Demand-Driven Programmes (DDPs) that are (partly) publicly funded. These collaborations generally materialise in the form of a Joint Innovation Centre (JIC) or public-private partnerships (PPPs).

Knowledge application

Contract Research

At the point where a client's and partner's needs become more specific and clearly defined and a need for customised research emerges, it is common practice for follow-up research to be handled within broader collaborations. In such cases, we offer contract research that is financed entirely by the client. This is where TNO gradually operates closer to the market.

Technology Transfer

Technology Transfer is the final step in TNO's innovation cycle. This phase sees TNO take knowledge to market by licensing it to existing companies and setting up spin-offs. TNO holds approximately 900 active patent families that are used in different projects and which are commercialised through licences. A number of these patents are used in the Technology Transfer programme.

The cycle of the four successive phases specified above enables TNO to create substantial value. For more detail on how TNO works, please visit our website (www.tno.nl), which is also where you will find more information about the use of the portfolio of intellectual property rights and our research programmes.

SPECIAL-PURPOSE FUNDING

TNO fulfils its role as an innovation leader for the Dutch Ministry of Defence, the Dutch Ministry of Social Affairs and Employment and the Dutch Ministry of Economic Affairs and Climate Policy in a unique way. Knowledge-intensive government duties (statutory duties) in the areas of defence, safety and security, labour force participation and geological surveying have all been delegated to TNO.

THE EXECUTIVE BOARD



THE EXECUTIVE BOARD IN 2019

FROM LEFT TO RIGHT:

- › PETER WERKHOVEN, CHIEF SCIENTIFIC OFFICER (CSO)
- › PAUL DE KROM, CHIEF EXECUTIVE OFFICER (CEO)
- › CIS MARRING, CHIEF FINANCIAL OFFICER (CFO)
- › MAARTEN TOSSINGS, CHIEF OPERATING OFFICER (COO)



REPORT OF THE EXECUTIVE BOARD

2019: A SUCCESSFUL YEAR FOR TNO

The Executive Board can look back on a successful year. In 2019, TNO actively contributed to the formulation and further pursuing of the Netherlands' mission-driven innovation policy. Additional government investment has enabled TNO to grow, step up its efforts in helping the country fulfil its missions (in the areas of sustainability, safety and health) and close the year with a budget surplus. TNO is well on track to achieving the strategic plan. New projects were launched (Petten site) and others were finalised (Ypenburg site). That said, we cannot afford to sit back and take it easy in 2020. Developments, including those in the technology domain, are rapidly unfolding all over the world. Impending trade wars, increasing international competition, major climate and energy challenges and less rosy economic prospects are calling for greater flexibility and alertness. One particular focus point is the level playing field with competitive institutions outside the Netherlands and with universities (in terms of funding, corporation tax and VAT).

IMPACT

It is TNO's mission to generate impact, i.e. to add value for partners and customers, and this is the central focus of the current strategic plan. [A study published in 2019](#) shows that collaboration with TNO has a significant positive impact on companies that innovate together. This study compares the value added for companies that have partnered with TNO and companies that have not. The value added by teaming up with TNO is estimated to be between 14% and 17%. A reputation and brand image survey has shown that TNO is a strong brand which outscores the average public-sector organisation.

On 11 November 2019, TNO signed a new Knowledge and Innovation Covenant (KIC) with other knowledge institutions, government bodies and industry partners in which TNO commits both funds and its best efforts to the further elaboration of the mission-driven policy. Aside from that, TNO was commissioned to work on politically and socially sensitive matters such as the investigation into the safety of the Stint cart and the fuel supply issues at Amsterdam Schiphol Airport.

In 2019, TNO developed a new brand strategy that revolves around impact. Thanks to TNO's unique and distinctive multidisciplinary structure, a 'unified TNO' is more than the sum of its constituent parts. The 'Zie het voor je' (Visualise it) campaign was launched to bring TNO's impact on society clearly into view. In 2019, TNO's operations were linked to the United Nations' Sustainable Development Goals to better define TNO's impact and make it clear for everyone to see. TNO actively takes part in the European Union's Responsible Research and Innovation Programme (RRI), which covers focus areas such as sustainability, ethics and integrity.

In 2017, the TNO Technology Transfer programme was launched to take TNO-developed innovations to market faster. TNO wants

to set up five to ten new companies every year based on TNO-developed technology and knowledge. The programme has meanwhile produced nineteen start-ups representing a total value of EUR 57 million and 128 new jobs, making TNO's Technology Transfer programme one of the most successful in Europe.

Examples of TNO-developed potential game changers include the conversion of CO₂ into methane using solar energy and the development of a thermal battery for home heat storage. Beating competition from parties such as Harvard, Princeton and MIT, TNO landed a call in the area of Sensible Artificial Intelligence (SAI) and small data. A programme for the development of laser satellite communications was launched, with great support from industry.

COLLABORATION IN THE NETHERLANDS AND INTERNATIONALLY

To be able to continue to operate at the forefront of technology development and innovation, it is crucial for TNO to have the right ties with the international innovation ecosystem. TNO operates in over 40 countries across the globe. When it comes to strategic partnerships, the focus is primarily on Europe. Talks with Germany's Fraunhofer Gesellschaft and France's CEA are meanwhile under way to strike up more strategic collaboration in Europe in areas such as artificial intelligence (AI) and energy and climate. These initiatives are set to be turned into specific programmes in 2020. The TNO branch offices on Aruba and in Singapore were closed in late 2019 and research activities there will continue in a different format.

At the same time, TNO is teaming up with partners for the further development of high-tech key technologies such as AI, quantum computing, nanotechnology, optomechatronics and space travel. TNO is one of the members of the Dutch AI coalition and played an active role in preparations for the Netherlands' National AI

Programme and the AI Task Force. A partnership deal was also sealed with Statistics Netherlands, which will see TNO and Statistics Netherlands partner in providing excellent AI services as an 'AI trusted partner of first choice'.

TNO's joint venture with Imec at the Holst Center in Eindhoven has been secured for at least another two years, thanks to Imec receiving a government grant. Together with various partners, TNO is working on a highly promising initiative (Brightsite) to move the Chemelot chemical site in Geleen towards sustainability. The Construction and Engineering Innovation Centre (*Bouw- en Techniek Innovatiecentrum*) that was initiated by TNO formally started operating in 2019. A Meaningful Control of Autonomous Systems (MCAS) initiative was launched in collaboration with the University of Amsterdam. TNO's call for parties to join the One Planet initiative in the Dutch province of Gelderland as founding partners - and invest in it - did not yield a single response, much to TNO's regret.

CORPORATE SOCIAL RESPONSIBILITY

TNO not only seeks to contribute to addressing major issues in society through its applied research, but also wants to take on its own corporate social responsibility. In 2019, a decision was made to boost the sustainability of TNO's operations as part of its corporate social responsibility. The actual policy for this will be formulated in 2020. When it comes to TNO's human resources policy, TNO is actively steering towards increased gender diversity and launched a programme in 2019 to improve employees' sustainable employability, while work has also gone into a new remuneration and performance appraisal system that will be implemented in 2020. 2019 saw the implementation of the Dutch Code of Conduct for Scientific Integrity (*Nederlandse Gedragscode Wetenschappelijke Integriteit*), which TNO has signed. Compliance in areas such as data protection (GDPR) and export control regulations was a further focus area in 2019.

TNO ORGANISATION AND PORTFOLIO

The evaluation of the new unit-based organisation that was implemented in 2018 showed that the new organisational structure is seen as a significant improvement. Employee engagement (as shown by the employee engagement survey) rose further in 2019. At a corporate level, a new risk appetite system was implemented.

The knowledge portfolio was partly overhauled, with several Early Research Programmes launched or reorganised. Implementation of the new portfolio management system was completed in 2019 and is intended to lead to more proactive and strategic management of the portfolio, with greater focus and drive and the associated use of funds.

FINANCIAL

Despite being an organisation that operates on a non-profit basis, TNO does target healthy results in order to be able to keep investing in knowledge and talent development and facilities and buildings, as well as to build up reserves and equity and ensure operational continuity. In 2019, TNO achieved a budget surplus on the back of growth (among other things), owing to extra government investment (government grant), a few exceptional income items and a positive result from participating interests. Although the overall result achieved is satisfactory, the operating results are not yet up to the target level set in the current strategic plan.

CHANGE TO THE COMPOSITION OF THE EXECUTIVE BOARD

In early 2019, Mr Wim Nagtegaal (COO) and Mr Jos Keurentjes (CSO) left TNO as their respective terms came to an end. On 15 March 2019, Mr Maarten Tossings, formerly of the Dutch Ministry of Defence, joined TNO as the new Chief Operating Officer and chairman of the Council for Defence Research (CDR), succeeding Mr Nagtegaal.

Mr Peter Werkhoven was appointed Chief Scientific Officer (CSO) on 1 May 2019, succeeding Mr Keurentjes. Mr Werkhoven has held various positions at TNO over the past 25 years, including that of Managing Director of Technical Sciences. Since 2006, Mr Werkhoven has also held a professorship at Utrecht University. The Executive Board and the Supervisory Board are extremely pleased to be working together with both new colleagues.

CHALLENGES IN 2019 AND GOING FORWARD

The Netherlands and Europe are facing major climate, energy, sustainability, safety, health and mobility challenges. The additional government grant awarded by the current government enables TNO to accelerate its work on solutions addressing major sustainability issues such as (thermal) batteries, renewable energy technologies and hydrogen. At the same time, TNO has seen that a significant part of the funding (nearly one third of the additional government grant during the current government's term of office) makes its way back to the treasury through VAT payments and corporation tax. This is unsatisfactory and naturally means that TNO has less money to spend on addressing pressing issues that are relevant in society today while also jeopardising TNO's competitive position. TNO wants to engage with the government on this.

AND FINALLY...

First and foremost, the Executive Board would like to thank all clients and partners, both in the public and the private sector, for placing their trust in TNO. And the Executive Board is proud of the approximately 3,500 employees who work with great passion, energy and dedication every day to fulfil TNO's mission. We also owe a great debt of gratitude to the Works Council, Supervisory Board and the members of the strategic advisory councils. The Executive Board looks forward to continuing and intensifying collaboration with all our stakeholders over the coming year.

CORONAVIRUS

At the time of preparation of this annual report, the coronavirus outbreak has pushed the world into an unprecedented disruptive situation. The impact this situation is having on society is unheard of and affects all organisations, including TNO.

TNO is adhering to the advice issued by the Dutch government and the Dutch National Institute for Public Health and the Environment (RIVM). We have set up a crisis team that comes under the direct management of the Executive Board and has been tasked with implementing the government-imposed measures. The excellent home-working facilities that TNO has been offering employees for several years now have been scaled up over the past few weeks. For those jobs that cannot be done from home, physical measures have been taken at various TNO sites in accordance with the national guidelines.

TNO's operational continuity is not at stake. The work currently in progress and the backlog at TNO are such that a temporary decline in orders will not lead to employees being left with nothing to do. It is, however, too early to estimate what impact this situation will have on our revenue and results in 2020, as that will depend greatly on how long the measures will be in place and whether any further measures will be taken by the Dutch government.

It is realistic to expect production output to fall due to rising sickness absence rates, workers having to take care of their children at home and other inefficiencies caused by the nationwide measures. Aside from that, order intake is expected to decline slightly, the impact of which will only be felt in the long term. The extent of this impact is currently uncertain. With sufficient buffer capital and a strong liquidity position, TNO will be able to absorb shocks. Salary payments will continue as normal and we are also able to meet our other payment obligations.

From now on, expenditures and planned investments will be subjected to continuous reassessment, which will involve weighing up their purpose and necessity in light of the external developments while also looking at financing possibilities and projected future earnings. The TNO organisation is closely tracking the developments and putting maximum effort into mitigating the impact.

Brains4corona

Shortly after the first outbreak control measures were implemented in the Netherlands, TNO launched the 'Brains4corona' initiative. All members of staff were called upon to come up with proposals for rapid-turnaround projects that contribute to the fight against coronavirus or that help ease the impact of the coronavirus crisis. It resulted in 21 projects covering several of TNO's expertise areas.

Examples of Brains4corona projects include the following:

- Helping the healthcare sector with advice on air conditioning and purification systems at ICUs (in collaboration with Eindhoven University of Technology, VCCN and RoyalHaskoningDHV).
- Data-driven models to predict the use of hospitals' ICU capacity.
- Testing surgical mask permeability after cleaning for reuse.
- Accelerated production of respirator systems.

Furthermore, TNO has offered the Dutch government the opportunity to conduct coronavirus testing at one of its labs, which would significantly boost the Netherlands' coronavirus testing capacity.

The organisation is brimming with creativity in coming up with specific contributions that can be put in place in the short term. Solutions are often found by combining different areas of expertise, which is precisely what TNO has always been about.

GAME CHANGER OF 2019

SOLAR FUEL: METHANE FROM SUNLIGHT

Chemical production and other processes generate a lot of CO₂ emissions. As part of the energy transition, it is key that we reduce those emissions as much as possible. TNO and Hasselt University in Belgium have been successful in converting CO₂ into a fuel (methane) at a low temperature using sunlight as a renewable source of energy.

This concept will also make it possible to use sunlight as a renewable energy source in order to make other chemical products and fuels. Future research will have to show whether this could include pharmaceutical products or syngas. With these advances, TNO is not only doing its bit in the transition to renewable energy but is also adding a whole new dimension to emissions reduction by producing something in the process.

[Read more.](#)



STRATEGY FOR 2018-2021

TECHNOLOGICAL SPEARHEADS

TNO's work in developing its technological spearheads, as specified in the [Strategic Plan for 2018-2021](#), will unfold in a number of steps.

Early Research Programmes

The first step is that of the Early Research Programmes. Each of these ERPs represents a significant scope and runs for several years. They combine various areas of expertise from TNO's different expertise groups. University research groups are also increasingly involved at this early stage, as are the future buyers of the technology under development in many cases. In 2019, there were 21 ERPs under way at TNO (16 four-year ERPs and 5 one-year ERPs).

The following five examples give a good idea of the current portfolio of ERPs:

1. Delft University of Technology and TNO are working on a major joint quantum computing initiative called QuTech. In 2019, excellent progress was made with Quantum Inspire, a quantum computing demonstrator that enables parties worldwide to learn about the possibilities offered by quantum computers. The hardware needed for this demonstration tool has meanwhile been built and tested. The first company to come out of the QuTech project will be commercialising control electronics for quantum computing. A quantum internet simulation program called Nedsquid has also been developed and released, and major steps have been made on the road towards QLink, a demonstration tool for quantum internet.
2. *Artificial intelligence (AI)* is a major, wide-ranging subject for TNO, as all TNO units have some involvement in this area. TNO is developing knowledge for hybrid AI, focusing on AI systems that issue the user with a declaration of the

conclusions drawn by the algorithm. Given that these systems use data in a verifiably responsible way, they can be defined as reliable and robust. TNO is researching how to integrate two different types of AI systems - those of model-based algorithms (based on explicit knowledge) and those of data-based algorithms (which have a self-learning capability). For all these aspects, demonstration tools were built in 2019 to showcase how these new principles work. In our AI research, TNO is specifically striking up partnerships with other parties, which have seen TNO sign agreements with parties such as Statistics Netherlands, knowledge graph developers Grakn.AI and Germany's Fraunhofer-Gesellschaft in 2019.

3. The ERP dedicated to submicron composites develops applications based on the special properties of composite materials. The fact that computer-controlled functionality can be added to these materials opens up an array of possibilities, such as switchable or smart glazing, i.e. windows with adjustable light transmission properties which deliver significant energy savings over a full year when compared to windows without such switchable coatings. In 2019, TNO ran lab tests which confirmed that the exact switching temperature at which the energy-saving effect is the greatest can be achieved through certain modifications to the composite material.
4. TNO and a large number of other parties worldwide are working on organ-on-chip-technology, which reduces the need for animal and human testing in pharmaceutical and medical research. Organ-on-chip technology sees tests conducted using small quantities of tissue that are applied to a chip. In 2019, TNO was successful in mimicking the three main processes that play a role in the development of nonalcoholic steatohepatitis (NASH, a liver disease) in a 'liver-on-chip' model. TNO has also made good progress in replicating

intestines using the inTESTine-on-a-chip model. This technology reveals the differences between the workings of healthy people’s microorganisms and those of people suffering from inflammatory bowel disease.

5. In the area of structural integrity, TNO focuses on large-scale structures such as bridges and buildings. The aim is to develop digital twin technology, i.e. using digital modelling and data from sensors on and in an existing structure to make an exact digital copy of something. In 2019, TNO made a digital twin of a bridge in the Netherlands in this way, based on data from acoustic and fibre-optic sensors showing the stress on the bridge with the passing of a heavy goods vehicle. This was done in collaboration with five companies, the City of Amsterdam and the German Bundesanstalt für Materialforschung und -prüfung (BAM). Digital twins make it possible to better monitor and predict the degradation of constructions so as to extend their lifespan without compromising on safety.

Demand-driven programmes

TNO was closely involved in the formulation of the Netherlands’ mission-driven innovation policy in 2019. In April, the Dutch government established 25 missions that capture the government’s ambitions within previously defined focus areas. TNO was involved in setting up many of these missions, supporting and inspiring government ministries. Based on these missions, the various high-profile industries in which the Netherlands is a global leader were asked to put together a Knowledge and Investment Agenda for each focus area. Again, TNO was able to make a considerable contribution to these efforts. After all, TNO research is programmed with a view to creating and unifying societal and economic impact, while also acting as a bridge between the public and the private sector. On 11 November, the State Secretary for Economic Affairs and

Climate Policy, Mona Keijzer, and the Minister of Education, Culture, and Science, Ingrid van Engelshoven, signed the 2020-2023 Knowledge and Innovation Covenant. TNO’s research programming is an essential part of this covenant.

The demand-driven programmes that TNO has lined up for 2020 will follow on from the programmes from 2019 and along the lines of the roadmaps used at TNO, which have a time horizon of several years for the impact aimed for. The programmes will be shored up by extra funds made available by the government.

In 2019, TNO ran several impactful research programmes for various high-profile industries in which the Netherlands excels and for certain societal focus areas, including the following:

- High-Tech Systems and IT
- Energy
- Life Sciences & Health
- Employment and Health
- Safety in Society
- Defence & Security
- Geological Survey of the Netherlands

STRATEGIC PRIORITIES

In terms of strategy, TNO rides the waves of major societal transitions in the areas of energy, decarbonisation, digitalisation and mobility. These are all topics that are characterised by a high level of complexity that touches upon different fields of scientific research. The power of TNO lies in its multidisciplinary and systematic approach, within which technologies such as AI and data in particular are potential solutions.

Developing and upgrading the knowledge portfolio

In July 2018, the Dutch government decided to adopt a mission-based approach for its innovation policy from 2020 onwards. The objective of the innovation policy is to shape innovative

and economically promising projects that help build a safer, healthier and more sustainable society. Key technologies such as photonics, IT, artificial intelligence, nanotechnology, quantum technology and biotechnology are of great importance in tackling today’s challenges in society.

In the coalition agreement for the third Rutte government, the coalition partners agreed to increase spending on applied research, which saw funding for TNO increase by EUR 35 million. These additional funds will be provided in three tranches: EUR 19 million in 2018, EUR 6 million in 2019 and EUR 10 million in 2020. The second and third tranche were developed in line with the government’s mission-driven innovation policy.

The following are some of the programmes that have meanwhile been launched using these new funds or which have received additional funding:

- Construction & Engineering Innovation Centre
- Space situational awareness
- Artificial Intelligence & Security Sharing (AISS)
- (Laser) satellite communication
- Road safety in Netherlands with smart mobility

Portfolio management

The implementation of the new portfolio management methodology that was started in 2018 was completed in 2019. This new methodology enables TNO to better manage and monitor the development process from idea to application in each of the research areas. Further professionalisation of portfolio management is intended to improve focus and strengthen the balance, allow for faster decision-making on whether to step up continue or abort programmes, enable early-stage focus on when and how to take TNO knowledge to market and make better use of the government grant. All of this will increase the societal and economic impact of our research.

Reputation and brand image survey

After the two previous surveys in 2015 and 2017, the third reputation and brand image survey was conducted in 2019. TNO came out of the survey as a strong brand that is defined, both internally and externally, using terms such as ‘integrity’, ‘reliable’, ‘lots of knowledge’, ‘high quality’ and ‘technologically oriented’.

All target groups surveyed gave TNO a score of well over 7 out of 10 (compared to the benchmark of 6.7 for public-sector organisations). TNO’s scores on likelihood to recommend as a collaboration partner (Net Promoter Score) and employee satisfaction (Employee Net Promoter score) have improved significantly since 2017. Points for improvement are TNO’s customer focus and attention to impact.

Knowledge position

To be able to meet the growing demand for applied research and innovation in the Netherlands, both today and in the future, having a strong knowledge position is an absolute prerequisite for TNO. And to guarantee the quality, impact and vitality of that position, each of TNO’s research groups is subjected to a Knowledge Position Audit in a four-year cycle, which is conducted by a committee of external experts.

In 2019, the following units were audited: Defence, Safety & Security, Traffic & Transport and Strategic Analysis & Policy. The research groups did extremely well on the audit, with four of them assessed as being of ‘world-class quality’.

The opinion on Traffic & Transport’s knowledge base was also highly positive. The scores were very good across the board. SA&P which was set up in 2018 as an independent unit with two research groups, is still under construction. The committee expressed its confidence in this group, believing that the

knowledge it already possesses, the importance of societal challenges and the countless opportunities in the outside world will enable it to increase and strengthen its position both internally at TNO and externally.

Closer collaboration

TNO has intensified collaboration with numerous partners while also embarking on new collaborations. In Nijmegen, for example, an innovation centre was set up for the integration and encapsulation of new generations of microchips. At this Chip Integration Technology Centre (CITC), TNO will be partnering with companies such as NXP, Ampleon and Nexperia, while Radboud University Nijmegen, Delft University of Technology and HAN University of Applied Sciences are also involved. The project is also backed by the Gelderland provincial authority and Nijmegen local council. Other new collaborations were already specified above in the Report of the Executive Board.

Consolidating our international position

TNO wants to contribute to the further development of the Netherlands as a global knowledge hub. In light of the globalisation of research, it is TNO’s ambition to further strengthen its international position, whereby the focus is specifically on partnering with fellow European research organisations to work on European technology developments that will lead to new economic activity and job creation in the Netherlands and Europe. TNO is increasingly participating in cross-border collaborations. The percentage of international employees at TNO is also rising, which is leading, among other things, to the increasing use of English alongside Dutch for communication. TNO already has successful operations outside the Netherlands. Including EU calls, TNO’s revenue generated outside the Netherlands totalled EUR 99 million in 2019. In the current Horizon 2020 framework programme for research and innovation, TNO continues to perform well in various fields.

EU research projects in partnership with partners from industry (including SMEs) are an essential addition to Dutch knowledge and innovation programmes and are key to the TNO network. More than ever before, it is about facilitating, strengthening and connecting innovation ecosystems in Europe. TNO is seen as an experienced, trusted partner in this area.

TNO’s approach of setting up Digital Innovation Hubs allows European companies to get advice and test out their digital innovations. Collaboration with other European organisations and companies leads to the kind of knowledge-sharing that is needed to elevate our excellence and impact to an international scale. In this respect, TNO focuses primarily on bolstering strategic partnerships with fellow institutions across Europe.

What is new is that collaboration in the field of defence research will also be stepped up. TNO is, for example, one of the key parties involved in the creation of the European Defence Fund (EDF). Furthermore, TNO is actively involved in preparations for the EU’s upcoming Horizon Europe (2021-2027) framework programme.

Strengthening account management

Given the aim of tightening relationships with partners and clients, TNO has broadened its account management services to its primary clients. For each of these relationships, a dedicated team has been set up which is led by an account manager who acts on behalf of one of the units and has a coordinating role that spans TNO in its entirety. The idea is to create a one-stop shop for partners and clients that is efficient, effective and client-driven.

TNO assesses the quality of its client relationships through client satisfaction audits. The overall satisfaction rating for contracts completed by TNO in 2019 reached 4.3 out of 5, staying roughly at the same level as in 2018. What clients are particularly positive about is TNO's 'knowledge and expertise', followed by 'flexibility' and the 'quality of the end product'.

In 2019, no complaints were received from TNO's clients through the external complaints-handling scheme.

Good financial health

Healthy finances are essential when it comes to guaranteeing TNO's continuity. A positive financial result is needed as a buffer to absorb setbacks, to ensure operational continuity and to be able to keep investing in the knowledge base and the portfolio. Launched in 2018 and completed in 2019, the programme intended to further strengthen the financial result and has ultimately produced a set of measures, both at corporate level and at each of the units, to get the financial result to the target level and keep it there.

TNO needs a surplus amounting to an average of 2% of revenue (currently approx. EUR 10 million) over multiple years to be able to (re)invest and compensate for inflation. Results in individual years may differ due to fluctuations in capacity utilisation and project results and in exceptional income or one-off charges.

Outlook

TNO's strategic outlook is affected by uncertainty regarding the impact of the coronavirus. How the resulting economic crisis will impact TNO is difficult to predict. It will initially affect the number of contracts from industry and other organisations, and we cannot rule out government spending cuts in the future either. This may, in the long run, lead to a reduction in government funding for TNO.



GAME CHANGER OF 2019

KEEPING WARM WITH A HEAT BATTERY

Demand for clean energy from the sun and wind continues to grow globally. But what happens when it's not sunny or windy and energy generation levels drop? And where do you store surplus energy for when the sun doesn't shine and the wind doesn't blow? TNO has succeeded in developing a unique material and a compact device for household thermal energy storage: the heat battery.

The principle is based on two components: water and a salt hydrate. When these two components are brought together, the salt crystallises in a reaction that produces heat. This battery will not only make it possible to heat homes during long periods without natural heat: it is also far more affordable than current solutions. The device is the size of a refrigerator and can hold enough thermal energy for an average-sized family to shower every day over a two-week period without sunshine or wind.

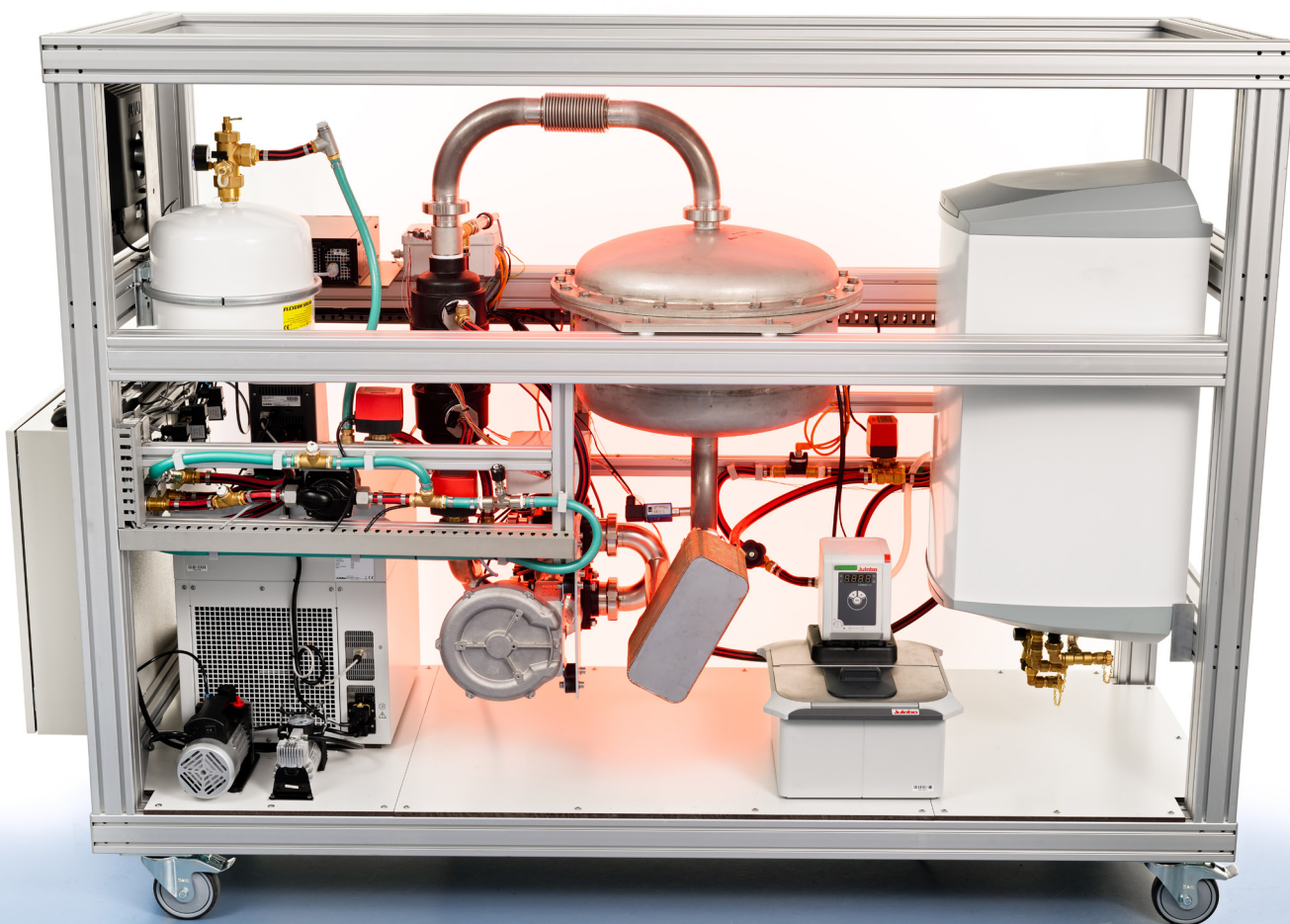
[Read more.](#)



INDUSTRY



BUILDINGS, INFRASTRUCTURE & MARITIME



SPIN-OFFS

Technology Transfer is the final step in TNO's innovation cycle. This phase sees TNO take knowledge to market by setting up spin-offs and licensing knowledge to companies.

In 2019, TNO published a booklet entitled '[TNO spin-offs in the spotlight](#)'. In it, the entrepreneurs behind all the TNO spin-offs set up between 2016 and 2018 share details of their products and what kind of impact they are seeking to have with their company.



The Technology Transfer programme produced the following six spin-offs in 2019.



Delta Diagnostics has developed a biosensor for quick blood protein level detection. With just one drop of blood, this device can determine whether someone has been exposed to a nerve agent, has an infectious disease or has had a heart attack. This compact device will be available in the future for all sorts of applications and to doctors and paramedics.

[Read more.](#)



The SHMNext spin-off produces wireless acoustic sensors to monitor the condition of infrastructure assets, such as to detect cracks in steel bridges. SHM stands for Structural Health Monitoring. Close monitoring of civil structures will give the authority in charge greater scope in choosing the best possible time for renovation or replacement and thus spread out peaks in maintenance and replacement work. It is also a way to prevent accidents, saving the authority a lot of money on maintenance and saving society the inconvenience and costs caused by lengthy traffic disruptions.

[Read more.](#)

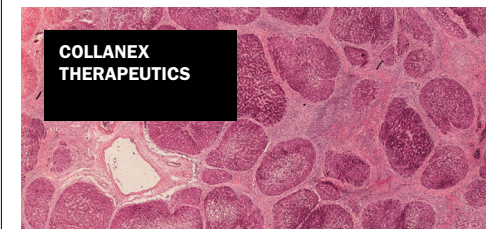


Valley Optics develops opto-mechanical tools for the optimisation of lens systems during the design process. It allows simultaneous optimisation of both the optical and mechanical aspects of a lens system.



The AMSYSTEMS spin-off has developed a method to increase the speed of the 3D printing process. This solution gives providers faster and higher resolution 3D printing capability. Possible applications of this solution include the printing of hearing aids, dental implants and moulds for the automotive industry.

[Read more.](#)



CollaneX Therapeutics has developed a series of models that provide insight into liver tissue formation mechanisms. Due to unhealthy lifestyles, liver fibrosis is an increasingly common condition in the western world. Drawing on their widespread knowledge of both this disease and the pharmaceutical market, CollaneX will be developing medicines that can cure liver fibrosis.

[Read more.](#)



Torwash's sludge treatment technology compresses sewage sludge at a high pressure and temperature, dewatering the sludge almost completely and reducing the mass of the sludge by 85%. This produces great savings when it comes to transporting and further processing the sludge. Aside from that, the liquid extracted from the sludge can be used to produce biogas, while the remaining sludge can be turned into fuel pellets. Torwash is a particularly interesting proposition for water boards, companies with their own water treatment systems and manure-producing companies. With a pilot at the Zuiderzeeland water board having meanwhile been concluded successfully, the time has now come to further scale up this solution.

[Read more.](#)

REPORT OF THE COUNCIL FOR DEFENCE RESEARCH

Security is not a given. Sometimes, peace is something you have to fight for. There is always a front line somewhere at which history is being made. On these front lines, knowledge and technology truly make the difference. Operations in the Defence, Safety and Security domain are changing rapidly on the back of technological advances in virtually all sub-areas. While new technology occupies much of our attention, existing technology continues to create opportunities and threats. Additionally, the domestic and global security environment is changing, with the most important trend being the further increase in instability as more and more complex threats arise. Amidst these developments, the Netherlands' and its security organisations' reliance on foreign organisations are increasingly called into question, in terms of both operational reliance in the procurement of resources and dependence in the areas of knowledge and technology. These changes are leading to a greater focus on defence, safety and security research in organisations such as the European Defence Fund and the Future Fund, as well as through the Knowledge and Innovation Covenant signed in November as part of the Mission-Driven Innovation Policy.

The surge in TNO research in the area of defence, safety and security, which started in 2018, continued unchanged in 2019 as demand from the Dutch Ministry of Defence for knowledge building increased. Plus, the greater number of materiel projects for the Ministry of Defence has added to TNO's workload, while TNO is also increasingly called upon as a strategic adviser. On top of that, yet more important steps were taken in ramping up collaboration with various players in the domain of the Dutch Ministry of Justice and Security. Growth, without compromising on quality, was therefore one of the main themes for the Council for Defence Research and TNO's Defence, Safety & Security (DSS) unit.

STRENGTHENING AND UPGRADING THE KNOWLEDGE BASE

In 2019, the Council for Defence Research's focus was specifically on Artificial Intelligence, Cybersecurity and Risk-Based Exploratory Research. To prevent fragmentation, AI is a broadly scoped research area that spans TNO in its entirety, with clear links to the realities of the Dutch Ministry of Defence and the Dutch Ministry of Justice and Security. In terms of Cybersecurity, extensive work went into setting up the chain that leads from knowledge to capabilities, while there was also attention on the issue of digital sovereignty. Risk-Based Exploratory Research focused on emerging technologies in areas ranging from autonomous systems, artificial intelligence and quantum technology to laser weapons, protective metamaterials and dealing with hybrid threats.

In 2019, 19 new special-purpose funding programmes for the Ministry of Defence were launched, concerned specifically with focus areas such as Counter Remotely Piloted Aircraft Systems, Joint Cyber Electromagnetic Activities in Military Operations and Hybrid Defence. These new focus areas are necessary to further develop and upgrade the defence-specific knowledge base. The portfolio for the Ministry of Justice and Security and the Police was also extended further in 2019. Additional grants received were used for the 'Technology and Security' (Ministry of Justice

and Security) programme, 'Space Situational Awareness' (Ministry of Defence) programme and 'Artificial Intelligence & Secure Data Sharing' programme to reinforce the TNO-wide AI programme.

The results of the concluded defence programmes with special-purpose funding were announced at the Innovation in Defence (IDD) trade show in December for the eighth year in a row. With nine TNO programmes completed, a solid foundation has been laid for materiel procurement and use (F-35, submarines, maritime mine countermeasures, passive above water self-defence, cyber capabilities and electronic warfare). Performance (netforce and operational network architecture) and the human factor (soldier capacity) also received a significant boost. At this same trade show, TNO, the Defence Materiel Organisation, the Royal Netherlands Aerospace Centre and Marin signed a declaration of intent for rapid and adaptive knowledge conversion into actual innovations.

In November, an international Knowledge Position Audit committee presented its assessment of and recommendations for nine of the DSS unit's fifteen research groups. The research groups did extremely well on the audit, with four of them assessed as being of 'world-class quality'.

A STRONG ORGANISATION

The Council for Defence Research has evaluated the consequences of the TNO-wide Impulse Reorganisation for the collaboration between the Ministry of Defence and TNO. Key outcomes of this evaluation are that efforts are focused on joint long-term programmes and theme-based programmes across different flows of funds, that the roadmaps are becoming increasingly important as a management tool and that good alignment of the DSS Knowledge Plan and the R&D plan will enable more targeted strengthening and upgrading of the knowledge base.

Recruitment has been stepped up in order to grow the workforce. We are looking into (shortening) the term during which employees can join, while new hire onboarding has been intensified and there has been a maximum focus on employee retention.

Partly on the back of the unit's growth, an internal need has emerged for a clearer picture of the unit's position and the associated culture, both within TNO and in the outside world. Several initiatives and activities have been developed across the entire unit for this purpose.

In the area of compliance, the new tightened export control set-up was rolled out at the DSS unit in March, a biometrics-based access control pilot was conducted at the Ypenburg site and the Council for Defence Research has cleared TNO to sign the new National Code of Conduct for Scientific Integrity (*Nationale Gedragcode Wetenschappelijke Integriteit*).

INTERNATIONAL

At an international level, the DSS unit operates in the domain of intergovernmental research collaboration, activities funded by international organisations and activities contracted by foreign clients. Important criteria in taking on such international commitments are the coherence of the subject matter and whether or not it serves the Netherlands' defence interests.

In 2019, TNO delivered the AI-based Military Decision research roadmap for the NATO Science and Technology Organisation (STO). This roadmap fits in with NATO's ambition to increase military relevance in R&D. Aside from that, one of TNO's employees won an AVT Panel Young Contributor Award. With seven representatives, TNO was well represented on the STO's scientific panels. The pilot phase of the Strategic Mutual Assistance in Research and Technology agreement with Norway continued in a structural collaboration. Furthermore, delegations from Belgium and the United States visited TNO's Ypenburg site to explore options for the further intensification

of collaboration. And finally, a new maritime engineering programme was added to the existing collaboration with Canada and Sweden.

The spotlight in 2019 was also on European cooperation on defence for research and development, with the founding of the Interdepartmental Coordination Group for European Defence Cooperation (ICG). The ICG's primary brief is to maximise the role that Dutch companies and knowledge institutions play in the European Defence Fund (EDF). The focus in this context is also on achieving the best possible alignment between the EDF and Dutch defence needs. Existing intergovernmental defence cooperation is a key starting point for coalitions around specific subjects. EU funding for EDF projects will primarily be awarded through competitive tendering procedures. In the second half of 2019, a start was made on three priorities: technologies and capabilities to be added, funding for costs not covered by the EU and preventing the need to apply for an export permit every time. All activities are geared towards maximising the opportunities for Dutch knowledge institutions and the involvement of Dutch companies in relevant projects, as well as towards making sure these activities help meet Dutch needs. In 2019, a start was also made on implementing the same policy, boosting chances to land projects and increasing the commercialisation of research for H2020 security projects.

Owing to the expected lasting (financial) vulnerability, a decision was made in 2019 to close the South East Asia Branch Office (SEA BO) in Singapore as of 31 December 2019.

ENGAGING EVENTS AND INNOVATIVE PROJECTS

In May, we had the festive opening of the TNO site in Ypenburg. This new complex gives TNO capabilities for world-class pyrotechnical and ballistic research. In her speech to mark the occasion, Dutch Minister of Defence Ank Bijleveld congratulated TNO on the new facilities and was very complimentary about TNO's relationship with the Ministry of Defence, saying things such as, 'Thanks to TNO, the Dutch Ministry of Defence has made it into the Champions League'

and 'The Ministry of Defence without TNO is like Ajax without Frenkie de Jong', referring to the creativity that TNO contributes.

There were also many other great moments and impactful projects, including the following:

- The special international AI project for the US Defense Advanced Research Projects Agency, which seeks to minimise the amount of data needed for artificial intelligence to work.
- The signing of the Manning & Automation collaboration covenant by the Dutch Ministry of Defence, industrial partners and knowledge institutions.
- The unveiling of the Soldier Innovation, Integration & Development (SOLIID) innovation centre, a joint project by TNO, the Defence Expertise Centre on Military Personnel and Materiel and the Dutch Ministry of Defence's Clothing and Personal Equipment Company.
- The signing of the collaboration agreement between TNO, the Dutch police, Johan Cruijff ArenA and the City of Amsterdam for the development of a digital security cordon in the area around Johan Cruijff ArenA in the run-up to the Euro 2020 football tournament.
- The Coastguard exercise MARISA Alert of the MARitime Integrated Surveillance Awareness (MARISA) H2020 project.
- Presentation of 'Half century of EU Research on Energetic Materials' to mark the 50th anniversary of the International Annual Conference on Energetic Materials.
- Together with the Dutch Ministry of Defence, the police, TNO and the Royal Netherlands Aerospace Centre, the Dutch National Coordinator for Security and Counterterrorism (NCTV) has launched a long-term knowledge programme called 'Counter Drones'.
- TNO and the company CyberDevOps entered into a licensing agreement in November to offer dark web monitoring as a service.
- The SECO Institute and TNO have signed an agreement that will make TNO's knowledge on the dark web available to a broader public.

- Investigations into the fuel supply disruptions at Amsterdam Schiphol Airport, into the robustness of the 112 emergency telephone number and into the nationwide NL Alert alarm system.
- In close collaboration with Germany's Diehl company, a small and sturdy electrical detonator - known as an 'exploding foil initiator' - has been developed for use in all sorts of new ammunition.
- TNO helps the Dutch Ministry of Defence in protecting ammunition storage facilities against lightning.
- Weapon classification tests were conducted for various weapon manufacturers in Brazil for the Brazilian police.

Like in previous years, TNO played an important role in the Dutch Ministry of Defence's materiel projects, including the following:

- Urgent Measures: this project commissioned by the Ministry of Defence's Defence Materiel Organisation (DMO) looks at what measures need to be taken to ensure the maximum protection of the armed forces against the threat of new chemical warfare.
- Commissioned by DMO, the Breeze Tunnel was developed to make it possible to carry out simulants of chemical weapon agents in an airflow and to enable full-scale testing of vehicles and other systems.
- DMO has also contracted TNO to support the Royal Netherlands Navy in designing the next generation of ships, both frigates and submarines, as well as in developing innovative vulnerability mitigation measures.

CHANGES TO THE COUNCIL

In 2019, the chairman, two other members and the council secretary were succeeded, either because they changed jobs or because they reached retirement age.

On behalf of the Council for Defence Research,
Maarten Tossings, Chairman (as of 15 March 2019)



*The Council for Defence Research, from left to right:
Harold Bousché, Marc Gazenbeek, Maarten Tossings, Hendrik-Jan van Veen, Auke Venema. Not pictured: André Steur.*

GAME CHANGER OF 2019

CONTROLLING CORROSION AND FATIGUE IN WIND TURBINE FOUNDATIONS

The steel foundation (monopile) of a wind turbine is constantly exposed to the elements. Offshore monopiles, in particular, are subject to degradation caused by a combination of corrosion and material fatigue. This means not only that these monopiles are high maintenance but also that costly measures are taken at the design stage to alleviate the impact.

TNO joined forces with Deltares, Delft University of Technology and partners from across the energy and offshore industries to create a more durable design by combining knowledge on the conditions in the North Sea with practical knowledge from industry. Based on lab tests and smart prediction models, the technical life of a monopile can now be determined more accurately. This, in turn, will lead to great cost savings in monopile manufacturing, installation and maintenance.

[Read more.](#)



BUILDINGS, INFRASTRUCTURE & MARITIME



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REPORT OF THE SUPERVISORY BOARD

Made up of seven members, the Supervisory Board is tasked with overseeing the policy pursued by the Executive Board and fulfilling an advisory role to the Executive Board. The Supervisory Board's duties are laid down in the TNO Act that governs the organisation.

As a rule, the Supervisory Board meets at various TNO sites. In 2019, these company visits gave the Supervisory Board yet more insight into the highly diverse and inspiring innovations and provided occasions to meet the enthusiastic and expert employees who are working with great passion in their respective fields to permanently strengthen TNO's role.

TOPICS

In a general sense, the Supervisory Board has overseen the policy pursued by TNO in 2019. The following section will outline a number of key topics that we focused on.

New Executive Board and Supervisory Board members

In 2019, two new members joined the Executive Board. In March 2019, Mr M. G. L. H. Tossings started as TNO's new Chief Operating Officer. The recruitment process for a new Chief Scientific Officer (CSO) was concluded in early 2019, culminating in the appointment of Prof. P. J. Werkhoven.

The Supervisory Board also welcomed two new members, namely Mr P. G. de Vries (Chairman) and Ms L. Verheij van Wijk.

Knowledge position

Having a high-quality knowledge position is of crucial importance to TNO. The quality of the knowledge process and the results of each knowledge position audit are discussed by the Supervisory Board's Quality Committee. Over the last year, discussions covered things such as the knowledge position audits in the Buildings, Infrastructure & Maritime unit and the Strategic Analysis & Policy units and the mid-term review of the QuTech joint venture.

A new approach to performance appraisal and remuneration

The intended overhaul of TNO's performance management system was discussed with (members of) the Supervisory Board on several occasions. In late 2019, the Supervisory Board signed off on this intended decision.

New brand strategy

In 2019, TNO launched a new brand strategy. The Supervisory Board welcomes this new brand strategy and the associated communications campaign as a good step in raising TNO's profile.

Evaluation of the unit-based organisation

Following the change to TNO's organisational structure in early 2018, 2019 was the time to assess whether the objectives of this organisational change were actually accomplished. People across the organisation see the new organisational structure as a significant improvement.

Compliance

The Supervisory Board regularly meets up with the Executive Board to discuss TNO's compliance with various laws and regulations. In 2019, the focus of these meetings was specifically on the development of an Internal Control Framework (ICF) and on cybersecurity.

Finances

On 27 March 2019, the Supervisory Board approved the 2018 financial statements, while the budget for 2020 was approved on 18 December 2019. EY has audited TNO's financial statements since 2018.

Performance of the Supervisory Board and evaluation of the Executive Board

The Supervisory Board has devoted an entire session to appraising the performance of the Supervisory Board and its members. Furthermore, the supervision approach at TNO was established based on what are known as balance rules.

To evaluate the Executive Board and its individual members, the Supervisory Board conducted the annual round of performance reviews with the chairman and members of the Executive Board.

COMPOSITION OF THE SUPERVISORY BOARD AND ITS COMMITTEES

On 1 July 2019, Dr C. A. Linse was, under Article 11(1) of the TNO Act, given an honourable discharge as Chairman of the Supervisory Board as he reached the age of seventy. He was succeeded by Mr P. G. de Vries, who was appointed chairman of the Supervisory Board as of 1 July 2019.

Ms I. G. C. Faber also left the Supervisory Board in 2019. She received an honourable discharge on 1 October 2019 upon completion of her second term on the board. She was succeeded by Ms L. Verheij van Wijk.

Aside from that, Ms J. D. Lamse-Minderhoud was reappointed to a second term starting on 1 November 2019.



The Supervisory Board, from left to right:

Peter van Laarhoven, Louise Verheij van Wijk, Peter-Paul Verbeek, Jolanda Lamse-Minderhoud, Gijs de Vries, Hester Bijl, Ingrid Vanden Berghe.

The Supervisory Board's three committees were made up of the following members in 2019:

Audit Committee

Ms J. D. Lamse-Minderhoud (Chairwoman)
 Ms I. H. J. Vanden Berghe
 Ms I. G. C. Faber (until 1 October 2019)
 Ms L. Verheij van Wijk (from 1 October 2019)

Quality Committee

Prof. P. P. C. C. Verbeek (Chairman)
 Prof. H. Bijl
 Dr C. A. Linse (until 1 July 2019)

Selection and Remuneration Committee

Dr P. J. M. van Laarhoven (Chairman)
 Mr P. G. de Vries (from 1 July 2019)
 Dr C. A. Linse (until 1 July 2019)
 Ms L. Verheij van Wijk (from 30 October 2019)

INDEPENDENCE

In the opinion of the Supervisory Board, the requirements relating to independence of action, as specified in provisions 2.1.7 to 2.1.9 inclusive of the Dutch Corporate Governance Code, have been satisfied.

MEETINGS

The Supervisory Board had five meetings in 2019. The Audit Committee and the Selection and Remuneration Committee each met three times, while the Quality Committee was convened for two meetings in 2019.

Where necessary, committee members liaised with each other outside of meetings. Representatives from the Supervisory Board attended two Works Council meetings. There were also regular consultations with the Dutch Ministry of Economic Affairs and Climate Policy.

ATTENDANCE

The attendance record of the individual members of the Supervisory Board for Supervisory Board meetings and committee meetings in 2019 was as follows:

	Supervisory Board meetings and sessions	Committee meetings
Mr Linse (until 1/7)	2 (of 2)	2 (of 2)
Mr De Vries (from 1/7)	3 (of 3)	1 (of 1)
Mr Van Laarhoven	4 (of 5)	2 (of 3)
Ms Vanden Berghe	5 (of 5)	3 (of 3)
Ms Bijl	4 (of 5)	2 (of 2)
Ms Faber (until 1/10)	4 (of 5)	2 (of 2)
Ms Lamse-Minderhoud	4 (of 5)	3 (of 3)
Mr Verbeek	5 (of 5)	2 (of 2)
Ms Verheij van Wijk (from 1/10)	2 (of 2)	1 (of 1)

GAME CHANGER OF 2019

THE RISKS OF EXTREME HEAT AND COLD

Heat and cold have an effect wherever you are: at home, at work and also out on the front line if you're a soldier. Climate change is a multifaceted issue that affects humans in a variety of ways. Air pollution is one facet of climate change, as is drought. What are the risks of heat or cold while engaging in physical exercise?

This is what Boris Kingma's research is all about. Kingma and his colleagues design models for the safe boundaries of physical activity in certain weather conditions and while wearing certain clothing or gear. His research earned him international acclaim and the accolade of 2019 Young Excellent Researcher of the year at TNO.

[Read more.](#)



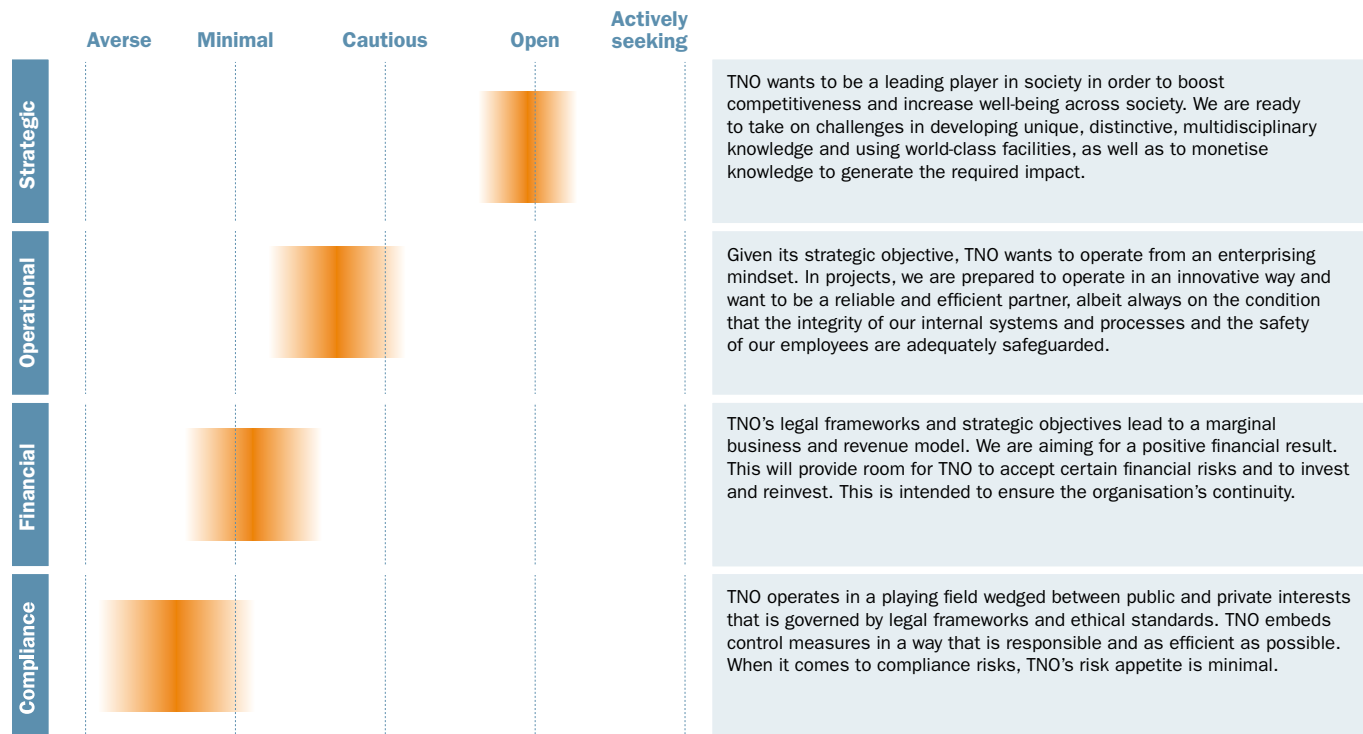
RISK MANAGEMENT AND CONTROL SYSTEM

RESPONSIBILITY

The Executive Board is responsible for developing, implementing and monitoring TNO's risk management and control system, which is intended to secure the achievement of operational, quality and financial objectives by, among other things, controlling the risks involved in pursuing these targets.

RISK APPETITE

Risk appetite is closely related to TNO's objectives and the unique nature of TNO as a research and technology organisation (RTO). Risk appetite is not so much about avoiding risk but rather about creating the right assessment framework in deciding which risks to take. TNO is, for example, prepared to expose itself to risk when it comes to innovating its scientific research - which is TNO's core business, after all - but has far lower risk acceptance in the areas of finance and compliance. TNO's overall risk appetite can be shown as follows:



NATURE AND SCOPE

Embedded in TNO's organisational, management and governance model, and therefore an integrated part of this model, the risk management and control system is made up of a number of sub-systems that are each intended to reduce the main risks involved in pursuing strategic objectives and seizing opportunities to an acceptable level. This concerns not only strategic risks but also (operational) risks and compliance with laws and regulations.

TNO uses the lines of defence model as a guiding principle in the set-up of the risk management and control system:

- First line: controlled execution of the primary process by all TNO employees within the (internally and externally) defined frameworks in order to achieve the objectives.
- Second line: support in and monitoring of the correct execution of these TNO activities.
- Third line: internal audits of (primary and secondary) processes at TNO focusing on quality, health & safety, the environment, compliance, internal control (financial management) and efficiency.
- Fourth line: audits by third parties, focusing on financial aspects (by an external auditor) but also on non-financial aspects. This includes quality audits of ISO certificate requirements, knowledge position audits and inspections of compliance with permits (such as HSE).

RISK MANAGEMENT AND CONTROL SYSTEM SET-UP

The following are the main elements of the risk management and control system:

- Culture and conduct
- Duties, responsibilities and authorisations
- Planning and control cycle
- Risk management
- Audits

These elements are detailed in the [appendix](#).

CONCLUSION

Based on the measures outlined in the appendix and on the audit outcomes, the Executive Board concludes that internal control mechanisms and risk management in the financial domain have been set up adequately and proven to be effective throughout 2019. There were no indications to the contrary. As far as the other elements of the operations are concerned, no evidence has emerged that these do not comply with current requirements. It should, however, be noted that risks may also occur that cannot be anticipated and that not all inaccuracies, losses, fraud and non-compliance with laws and legislation can be ruled out.



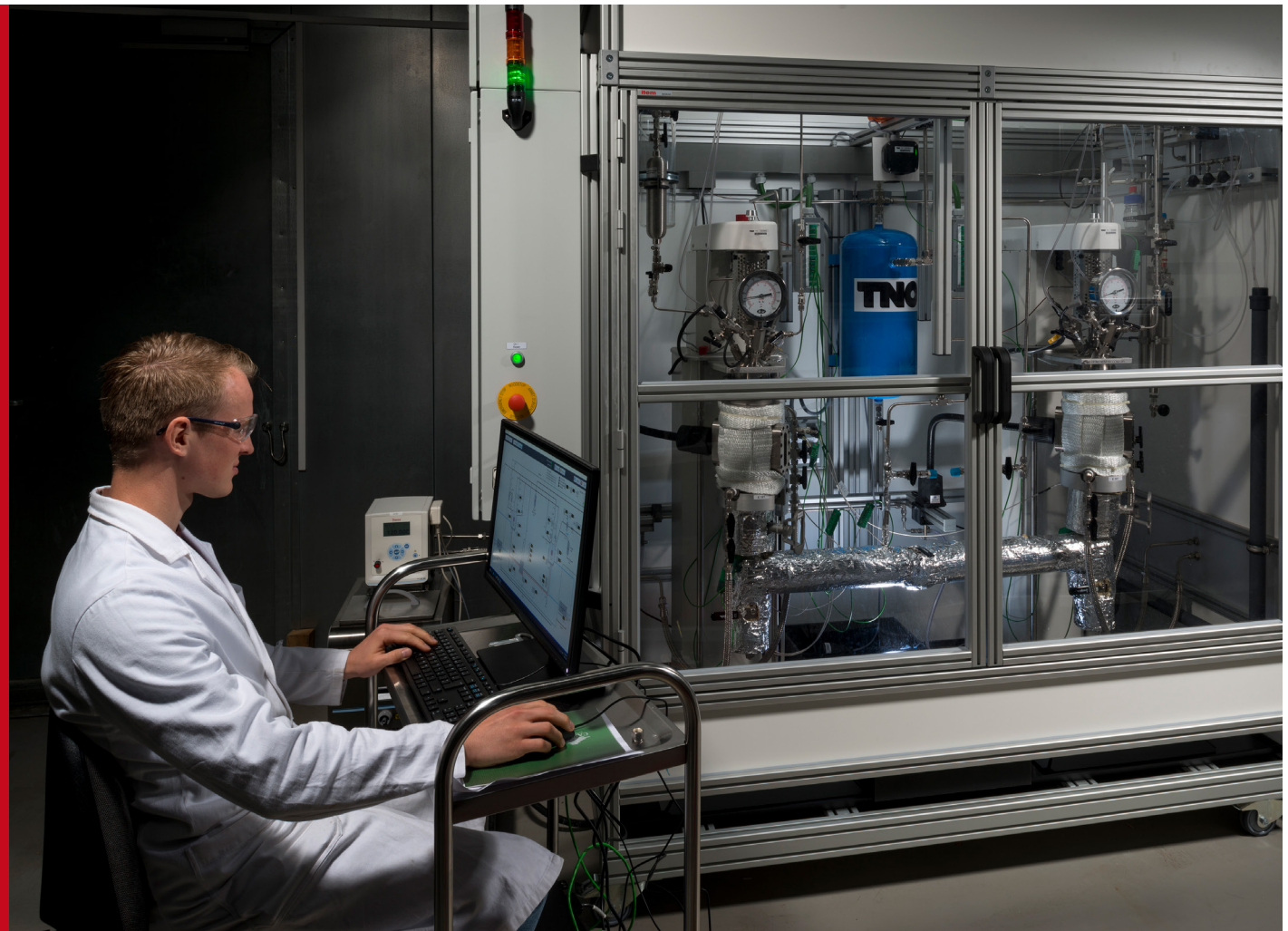
GAME CHANGER OF 2019

PLASTIC UPCYCLING

CIRCULAR ECONOMY & THE ENVIRONMENT

Recycled plastic is generally poorer quality than the original product, which means a loss of economic value (downcycling). TNO has developed a selective dissolution process to recycle or, better yet, upcycle polymers and additives in a resource-efficient and eco-friendly way. This process dissolves plastic waste and subsequently reassembles the original polymers as brand-new pieces of a jigsaw puzzle. One particular challenge in this process is the filtering out of additives such as plasticisers and flame retardants. By teaming up with industry, this technology will be developed to full maturity within several years.

[Read more.](#)



CIRCULAR ECONOMY & THE ENVIRONMENT



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RESPONSIBLE INNOVATION

Both in its operations and in the content of its research programmes, TNO works in the most sustainable and responsible way possible, always in close consultation with its stakeholders. TNO takes part in the EU's Responsible Research & Innovation (RRI) programme that seeks to strike a long-term balance between research organisations and stakeholders in society. The RRI programme covers focus areas such as 'sustainability, ethics and integrity' and 'public engagement.'

SUSTAINABLE DEVELOPMENT GOALS (SDGS)

TNO signed the Sustainable Development Goals Charter in 2017 and takes part in the Dutch Ministry of Foreign Affairs' SDG network of knowledge institutions. In 2019, all nine TNO units assessed their impact on the SDGs. The figure below shows how many TNO units are working to achieve the various SDGs.



With a view to raising awareness of TNO's impact among the general public, the 'Zie het voor je' (Visualise it) campaign was set up to capture the impact in text and visuals. For TNO employees, an impact mapping tool was developed to help them determine the contribution of their project or programme to the SDGs. This tool was rolled out across the organisation in 2019. Furthermore, TNO took the first steps in articulating an implementation strategy to embed the SDGs in TNO's operations.

SUSTAINABILITY

In 2019, work also went into updating the Corporate Social Responsibility (CSR) Statement of Policy, which is expected to be adopted in 2020.

Accommodation

Besides the numerous research activities centred on creating sustainability, TNO has also geared its internal organisation towards this subject. An internal programme to implement TNO innovations at TNO's own sites on a pilot or showcase basis has meanwhile been launched. TNO has, for example, set out to incorporate its own solar cells into the outer walls of its buildings, and has also teamed up with an external partner to work on smart sensors for effective ventilation and heating regulation in its buildings.

The new development at TNO's Ypenburg site is connected to a ground-coupled heat exchanger and uses concrete core activation to meet the building's heating needs. Over the past year, several applications were submitted for grants for the installation of solar panels on the roofs of TNO's proprietary buildings.

In 2019, energy efficiency measures taken in previous years were implemented and various renovations were completed. Aside from that, there was also a focus on the lengthy List of Recognised Energy-Efficiency Measures that TNO will be taking over the coming years.

Sustainable employability

TNO's Human Capital Strategy was behind several activities in 2019. The basic principle of the policy is for TNO to add value to employees' development and for employees to add value in the realisation of TNO's ambitions. TNO wants excellent employability for its employees so as to enable them to stay in control of their careers at all times.

In 2019, this saw TNO set up a referral programme and create additional options to help employees work on their sustainable employability. An active recruitment approach has led to many talented new employees joining TNO. Although TNO is considered to be an attractive employer in the job market, TNO faces

competition, especially for scarce talent. Things such as an inspiring learning environment and a multitude of engaging projects work in TNO's favour in this respect.

In 2019, the Fit For Your Future programme was launched to boost employees' health and fitness, as well as that of the organisation. This programme was set up by drawing on the wealth of health expertise at TNO's Healthy Living unit.

Diversity

In 2019, work continued on increasing diversity at TNO, especially by improving the gender balance, internationalising the workforce and including a focus on leadership. Aside from that, an extra diversity dimension was added in 2019 in order to incorporate a larger number of employees with poor job prospects.

The Industry unit organised implicit bias training on several occasions in 2019. Implicit bias training helps employees to be more objective in how they view people's opportunities and performance. The Defence, Safety & Security unit ran a study to identify how management and staff can help increase diversity and inclusiveness. Following on from this study, several similar information sessions were held at various sites at employees' request.

For TNO's female employees, two female leadership training programmes were organised this year. There was also a follow-up day for all participants who have taken part in this programme through the years.

And finally, Human Resources put together a digital dashboard to track progress on TNO's diversity targets, both at each unit individually and for the whole organisation.

Diversity also featured prominently in the annual employee engagement survey.

In 2019, the gender ratio at TNO was 69.6% male to 30.4% female. At the highest level of the organisation (Supervisory Board, Executive Board, first echelon), it was 52.2% male to 47.8% female. The share of TNO employees who are not Dutch nationals was 10.5%.

New performance appraisal and remuneration proposal

In 2019, a new system for performance appraisal and remuneration was designed. While the current performance management system does have some good elements, it is also largely viewed as overly complex and time consuming. The idea behind 'The New Approach to Performance Appraisal and Remuneration' is to simplify the current system and make it more incentivising.

In December 2019, the Executive Board and the Supervisory Board gave their approval to the proposal for 'The New Approach to Performance Appraisal and Remuneration'. In early 2020, the Works Council confirmed, by conducting a poll among employees, that the changes proposed can count on broad support in the workforce. The final decision to implement this new system was made by the Executive Board on 17 February 2020.

COMPLIANCE AND INTEGRITY

Scientific integrity

On 15 May 2019, the Dutch Code of Conduct for Scientific Integrity (*Nederlandse Gedragscode Wetenschappelijke Integriteit*, NGWI) came into effect for TNO. A dedicated NGWI task force set up by TNO took stock of the measures that were required to ensure compliance with this new code of conduct and to subsequently implement these measures. These measures included several changes to the management system. Regulations with respect to complaints handling, suspicions of abuses and the TNO code were also amended.

Additionally, a programme that will run in 2019 and 2020 was set up to raise awareness of the new scientific integrity code of conduct among all employees and managers. In 2019, awareness was raised by prominently featuring this topic on the intranet, in e-learning modules and on banners at all TNO sites. There were also several sessions for managers where they were presented with ethical dilemmas through gamified learning. In the first quarter of 2020, a similar toolkit will be made available to all employees.

Data protection

TNO ensures the protection of personal data in its operations. While TNO's focus in 2018 was on implementing the General Data Protection Regulation at the organisation, it shifted to further ensuring compliance in 2019. TNO's data protection policy guarantees that personal data is handled with due care, confidentially and transparently, and that people's right to privacy is respected at all times. TNO pursues this policy through, among other things, a dedicated data protection team that supports the business, internal controls to guarantee that TNO research is GDPR compliant and ongoing information sessions and training for employees. TNO detected eleven data leaks in 2019, one of

which was reported to the Dutch Data Protection Authority. With respect to data subject rights, a total of six requests were registered and completed in 2019.

Human subject research and animal testing

TNO's research scope also includes research involving human subjects and research for which personal data is collected. Part of such research is subject to the Dutch Medical Research and Human Subjects Act (*Wet Medisch-wetenschappelijk Onderzoek met mensen*, WMO). For all research that is not subject to this legislation, TNO has set up a method that ensures careful handling of human subjects and personal data. An internal committee that operates across all TNO units checks all human subject research that is not governed by the Dutch Medical Research and Human Subjects Act, examining over one hundred proposals in 2019.

TNO conducts biomedical research with a view to improving human health. Animal testing is still an inevitable part of that. TNO uses animal testing in a meaningful way, minimising both the number of animals and the harm done. The internal Animal Welfare Body, which TNO is required by law to have, supervises the correct implementation of the Dutch Experiments on Animals Act (*Wet op de Dierproeven*). Following the demerger of TNO and Triskelion in late 2018, the internal Animal Welfare Body was partly reorganised. TNO also has an internal working group that assesses the need for animal testing, looks for alternatives and takes part in national networks.

TNO's international AAALAC accreditation (Association for Assessment and Accreditation of Laboratory Animal Care International) was renewed in 2019. The association was full of praise for TNO's culture of care and the level of commitment across all levels.

Export control

In 2019, TNO introduced an Export Control Compliance programme to run (partly automated) checks with respect to international sanctions and export control legislation. After the launch at a number of TNO units in 2019, the programme will be rolled out further at TNO's other units in 2020.

Government Information (Public Access) Act

TNO responds promptly to all requests for information under the Government Information (Public Access) Act (*Wet openbaarheid van bestuur*, WOB), thus ensuring that the interests of those requesting access to information are served to the maximum degree possible while also protecting the interests of stakeholders, clients and employees' privacy. For transparency on the copying fees charged in relation to requests for information, TNO has set up a scheme regulating fees charged in relation to requests for information under the Government Information (Public Access) Act in 2019 and has posted it on the TNO website.

In 2019, 25 new requests for access to information were received under the Government Information (Public Access) Act, six of which were submitted to TNO directly. Of these requests, 19 related to the response of another administrative body in respect to a request for information under the Government Information (Public Access) Act submitted to that administrative body.

On three occasions in 2019, an objection was raised against a primary decision by TNO in response to a request for information under the Government Information (Public Access) Act submitted to TNO directly.

Reports and complaints

In 2019, the External Complaints Procedure was revised to incorporate amendments to regulations and changes to

practices. Three complaints were submitted based on the External Complaints Procedure in 2019. These were dealt with. The complaints came from third parties (not clients) and were settled. One complaint was lodged under the Individual Complaints Procedure (internal procedure).

Over the past year, no formal reports of suspected abuses at TNO were submitted using the scheme that TNO has set up for this purpose. The Integrity Officer has, however, briefed managers and employees on how to handle all kinds of integrity issues. A procedure with the Dutch Whistleblowers Authority (reported to TNO in 2018) following a report submitted in 2016 is still ongoing.

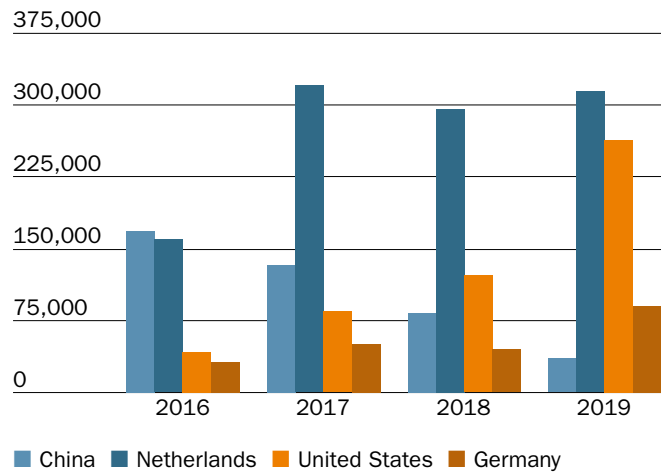
OPEN ACCESS AND OPEN SCIENCE

When it comes to Open Access*, TNO goes by the principle of 'open where possible, closed where necessary.' A carefully designed policy ensures that publicly funded research is protected by intellectual property rights where necessary. To facilitate the principle of openness, there are various platforms available on which scientific TNO publications are published.

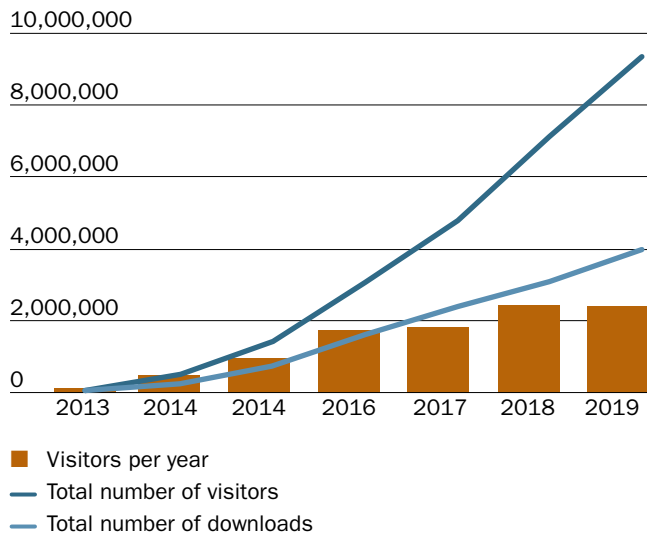
After going live in 2013, the TNO Repository meanwhile contains over 45,000 publications. In 2020, this (free) database will exceed 10 million consultations. Since we started logging visitors' countries of origin in 2016, visitors from over 200 countries have used the repository. As shown in the chart on page 29, most articles are downloaded from the Netherlands, the United States, Germany and China. Over three-quarters of all downloads every year go to these countries.

* Publishing as per the Open Access principle means that scientific information is made available free of charge, generally online. This means that the author (and any rightholders, such as the publisher) consents to distribution of the work, but also that there is a suitable platform to support such distribution.

Number of downloads per country



Visitor totals



COMPOSITION OF THE EXECUTIVE BOARD

EXECUTIVE BOARD MEMBER DETAILS (2019)

Mr P. de Krom, Chairman/CEO (born 1963)
Since 1/3/2015

Executive and supervisory positions

- Executive Board member, *Federatie van Samenwerkende Organisaties in het Toegepast Onderzoek (TO2)* (Federation of Organisations in Applied Research)
- Chairman of the Supervisory Board, HTM Beheer B.V.
- Supervisory Board member, *HTM Personenvervoer* (public transport provider in the City of The Hague)
- Director, *Koninklijke Hollandse Maatschappij der Wetenschappen* (Royal Netherlands Society for the Sciences)
- Vice-Chairman of the Supervisory Board, HU University of Applied Sciences Utrecht
- Chairman, Thorbecke Table, Sociëteit de Witte
- Member, Zuid-Holland Economic Board
- Chairman, Holland International Distribution Council
- Supervisory Board member, PhotonDelta

Mr M. G. L. H. Tossings, COO, Rear Admiral (born 1962)
Since 15/3/2019

Executive and supervisory positions

- Board member, The Netherlands Industries for Defence & Security (NIDV)
- Executive Committee member, Netherlands Maritime Cluster (NMC)
- Board member, *Stichting Maritiem Kenniscentrum (MKC)* (Centre for Maritime Expertise)
- Supervisory Board member, First Dutch Innovations B.V. (FDI)
- Chairman, Digital Task Force, Zuid-Holland Economic Board

Ms F. Marring, CFO (born 1963)
Since 1/2/2014

Executive and supervisory positions

- Board member, *Stichting Pensioenfonds TNO* (Pension Fund)
- Supervisory Board member, Novec B.V.
- Board member, *Nederlandse Vereniging van Financial Executives* (Netherlands Society of Financial Executives)
- Supervisory Board member, *Stichting Sint Antonius Ziekenhuis* (Hospital)
- Supervisory Board member, *Stichting de Noordzee* (The North Sea Foundation)

Prof. P. J. (Peter) Werkhoven, CSO (born 1959)
Since 1/5/2019

Executive and supervisory positions

- Professor, Utrecht University
- Board member, Top Consortium for Knowledge and Innovation, High Tech Systems and Materials
- Member, Technology and Innovation Committee, VNO-NCW employers' organisation

Dr W. C. A. Maas, Secretary (born 1967)
Since 1/1/2018

GAME CHANGER OF 2019

ACCELERATING CLINICAL DEVELOPMENT

When it comes to drug development, things such as the absorption, distribution, metabolism and excretion (ADME) of the medicine are generally not researched until late on in the development process. This means that if metabolites are detected at such a late stage, it will at least result in substantial delays for biotech companies in getting their medicine approved.

TNO is Europe's only organisation with a biomedical Accelerator Mass Spectrometer (AMS). Microtracer studies using this device make it possible to detect metabolites at an early stage in the development process. This not only enables companies to take a medicine to market quicker but also reduces the need for animal testing. The microtracer study with the AMS delivers cost savings in the drug development process.

[Read more.](#)



HEALTHY LIVING



COMPOSITION OF THE SUPERVISORY BOARD

Mr P. G. de Vries, Chairman as of 1 July (born 1958)
Since 1/7/2019, first term through to 1/7/2024.

Professional (outside) activities

- Chairman of the Supervisory Board, Erasmus University Medical Centre
- Chairman of the Supervisory Board, *Arbo Unie* (Occupational health service)
- Chairman of the Supervisory Board, Netherlands Comprehensive Cancer Organisation (IKNL)
- Chairman of the Board, *Stichting Achmea Slachtoffer en Samenleving* (Achmea victim and society association)
- Executive Coach, New Generation Leaders

Dr C. A. Linse, Chairman until 1 July (born 1949)
Since 1/3/2011, second term through to 1/7/2019.

Professional (outside) activities

- Supervisory Board member, AKZO Nobel Nederland B.V.
- Supervisory Board member, MRC Global Inc. Houston
- Chairman, Netherlands Commission for Environmental Assessment
- Chairman of the Supervisory Board, Leiden University Medical Centre

Dr C. A. Linse was granted an honourable discharge on 1/7/2019, stepping down as Chairman of the Supervisory Board on account of reaching the age of seventy.

Dr P. J. M. van Laarhoven, Vice-Chairman (born 1959)
Since 1/10/2016, first term through to 1/10/2021.

Professional (outside) activities

- Member, Strategic Platform for Logistics (Government-appointed team for collaboration between business, science and the public sector in the logistics domain)
- Chairman of the Supervisory Board, CQM
- Chairman of the Supervisory Board, Port of Moerdijk
- Supervisory Board member, CB Logistics
- Advisory Board member, H&S Group
- Advisory Board member, UTURN
- Member of the Netherlands' National UNESCO Commission

Ms I. H. J. Vanden Berghe (born 1962)
Since 1/2/2011, second term through to 1/2/2021.

Professional (outside) activities

- Administrator General, National Geographic Institute
- President, Eurogeographics (until 10/10/2018)
- Member, Council of Administrators General of State-Owned Organisations
- Chairwoman, the Belgian federal government's G-Cloud Strategic Board
- Visiting Professor, Catholic University of Leuven
- Chairwoman of the Executive Board, VITO (Flemish organisation for technology research)
- Management Committee member, Royal Museum for Central Africa

Prof. H. Bijl (born 1970)

Since 1/9/2018, first term through to 1/9/2023.

Professional (outside) activities

- Chairman of the Advisory Board, Airbus Defence and Space, Netherlands
- Vice-Rector Magnificus and Executive Board member, Leiden University
- Professor of Numerical Mathematics, Mathematical Institute, Leiden University
- Executive Board member, Leiden BiosciencePark Foundation

Ms I. G. C. Faber (born 1968)

Since 1/10/2009, second term through to 1/10/2019.

Professional (outside) activities

- Chief Executive Officer, Pooling Partners/
Faber Halbertsma Groep
- Supervisory Board member, Probos
- Supervisory Board member, PACOMBI GROUP

Ms I. G. C. Faber received an honourable discharge from her role as member of the Supervisory Board on 1/10/2019 upon expiry of her second term of appointment.

Ms J. D. Lamse-Minderhoud (born 1969)

Since 1/11/2014, second term through to 1/11/2024.

Professional (outside) activities

- Executive Board member, PricewaterhouseCoopers Netherlands (PwC)
- Executive Team member, PwC Europe

Prof. P. P. C. Verbeek (born 1970)

Since 1/5/2012, second term through to 1/5/2022.

Professional (outside) activities:

- Professor of Philosophy of Technology, University of Twente
- Co-Director, DesignLab, University of Twente
- Honorary Professor, Aalborg University
- Chairman, UNESCO World Commission on the Ethics of Science and Technology (COMEST)
- Executive Board member, Rathenau Institute
- Member, Social Sciences and Humanities Sector Plans
- Member, Netherlands Organisation for Scientific Research's Corporate Social Responsible programme council
- Member, Humanities Council, Royal Netherlands Academy of Arts and Sciences
- Member, the Netherlands' National UNESCO Commission
- Member, Royal Netherlands Academy of Arts and Sciences

Ms L. Verheij van Wijk (born 1964)

Since 1/10/2019, first term through to 1/10/2024.

Professional (outside) activities

- Vice-President of Commercial and Clinical Innovation, Philips (until 1 July)
- Member, IT & Innovation think-tank of Netherlands Comprehensive Cancer Organisation

Dr W. C. A. Maas, Secretary (born 1967)

Since 1/1/2018

Ms Vanden Berghe is a Belgian national.
The other members are Dutch nationals.

ARTIFICIAL INTELLIGENCE

THE KEY TECHNOLOGY THAT WILL MAKE A BIG DIFFERENCE IN THE 2020S

Artificial intelligence (AI) is able to detect patterns in large volumes of data, thus enabling the optimisation and personalisation of processes and services. Over the past ten years, AI has grown from a field that was the preserve of experts into a key technology that is applied in virtually all industries. And this trend is expected to continue throughout the 2020s. Governments, too, are turning to AI for public services.

In 2019, TNO continued to operate in the national AI domain. As a member of the Dutch AI coalition (NL AIC), TNO - together with partners from industry, the public sector and the research domain - is a driving force behind and organiser of activities in the AI field. Only through collaboration and a strong knowledge base will the Netherlands be able to maintain its strong competitive position on an international scale and grow its prosperity and well-being. TNO has also entered into strategic partnerships with Statistics Netherlands and the University of Amsterdam to ensure that AI algorithms operate within ethical and legal frameworks.

Internally, TNO grouped all its AI activities together in the Appl.AI programme in 2019. These activities include the development of applications for the healthcare sector (personalised health behaviour interventions to combat lifestyle-related conditions), agriculture industry (smart dairy farming), mobility (emission reduction and self-driving vehicles), technology industry (quantum computers to accelerate AI), law enforcement (tracking down convicted persons and protection against cyberattacks) and geology (classification of soil borings).

[Read more.](#)



COMPOSITION OF THE COUNCIL FOR DEFENCE RESEARCH

Mr M. G. L. H. Tossings, Chairman from 15 March 2019

Mr M. Gazenbeek, Vice-Chairman

Outside activities

- Advisory Board member, InterCoach
- Member of the Board of Directors, International Society for Military Law
- Chairman, *Militaire Rechterlijke Vereniging* (Military Law Society)
- Advisory Board member, Netherlands War Graves Foundation

Mr H. G. Geveke, until 1 October 2019

Dr H. A. H. C. van Veen, member on an interim basis from 1 October 2019

Mr Major General A. Steur, from 8 April 2019

Mr A. P. Venema

Dr M. P. I. Manders, Secretary until 1 May 2019

Mr H. F. Bousché, Secretary as of 1 May 2019

Other positions

- Chairman, Prof. Johan Kooy Fund, Royal Institute of Engineers (ending 31 December 2019)

GAME CHANGER OF 2019

ORCHESTRATING INNOVATION

TNO takes on major societal issues. Whether it be mobility, circularity, healthcare or digitalisation, rising to these challenges requires innovation and successful collaboration between many different parties. Through the Orchestrating Innovation approach, TNO helps governments, companies and other organisations to deliver sustainable innovations together. One example is the SMITZH innovation programme in the Netherlands' Zuid-Holland province.

SMITZH stands for 'Smart Manufacturing: Industriële Toepassing in Zuid-Holland' (Industrial application in South Holland province) and sets out to help companies bolster their competitive position by improving their production process. Field labs are a crucial part of that, allowing companies to run practice-based experiments to figure out what works and what does not work in the area of process digitalisation, the use of robots, 3D printing, people-centred technology and data sharing. This way, innovations drive regional economic development.

[Read more.](#)

 STRATEGIC ANALYSIS & POLICY



COMPOSITION OF THE STRATEGIC ADVISORY COUNCILS

Each TNO unit has a Strategic Advisory Council made up of representatives from business and industry, the public sector and knowledge institutions. These councils support their respective units with advice on spearheads and draw attention to new developments, fulfilling a key role in TNO's innovation strategy. Strategic Advisory Council members are appointed for a period that runs in sync with the Strategic Planning period.

DEFENCE, SAFETY & SECURITY UNIT

Mr Major General (ret.) A.C.J. Besselink
 Mr Brigadier General R.J. Jeulink, Dutch Ministry of Defence
 Ms P.M. Zorko MPA, Dutch Ministry of Justice and Security
 Ms E.G.M. Huyzer, National Police
 Mr J.C. Dicke, Dutch Ministry of Economic Affairs and Climate Policy
 Mr R. Nulkes, Netherlands Industries for Defence & Security (NIDV)
 Mr R. Berkvens, Damen Shipyards
 Mr L. Roffel, Thales Nederland
 Mr C. Haarmeijer, Re-LiON
 Prof. P.H.A.J.M. van Gelder, Delft University of Technology
 Prof. P.J. Oonincx, Dutch Defence Academy
 Mr H.J.J. Lenferink, Mayor of Leiden
 Mr G. van Klaveren, Limburg-Zuid Fire Department

INDUSTRY UNIT

Prof. E.M. Meijer, Figurehead for the Dutch chemical industry
 Dr P.M.T.M. van Attekum, ASML
 Prof. F.P.T. Baaijens, Eindhoven University of Technology (TU/e)
 Prof. S.C.M. Bentvelsen, Nikhef
 Mr J. ter Harmsel, Zeton BV
 Dr H. van Houten, Royal Philips
 Prof. P.F. Levelt, Royal Netherlands Meteorological Institute (KNMI)
 Dr P.J. Nieuwenhuizen
 Mr D. Pappie MBA, Dutch Ministry of Economic Affairs and Climate Policy
 Mr H. Tappel, Bronkhorst High-Tech B.V.
 Dr M. Wubbolts, Corbion

ECN PART OF TNO UNIT

Mr G.J. Lankhorst, VEMW
 Mr J. Atema, NAM
 Mr H. Fennema, Gasunie
 Mr A.F. Gaastra, Dutch Ministry of Economic Affairs and Climate Policy
 Mr M.E. Galjee, Nouryon
 Prof. M.P. Hekkert, Utrecht University
 Prof. P.M. Herder, Delft University of Technology
 Prof. M.W. Hofkes, VU University Amsterdam
 Mr J.W. van Hoogstraten, EBN
 Prof. N.J. Lopes Cardozo, Eindhoven University of Technology / Netherlands Organisation for Scientific Research, Exact and Natural Sciences
 Mr R. Miesen, NWE Generation SE
 Ms M. Minnesma, Urgenda
 Prof. A. Polman, Amolf / University of Amsterdam
 Mr Y. Sebregts, Shell Global Solutions International B.V.

CIRCULAR ECONOMY & ENVIRONMENT UNIT

Mr T. Wagenaar
 Prof. L.M.C. Buydens, Radboud University Nijmegen
 Prof. S.R.A. Kersten, University of Twente
 Mr M. Waas, Nouryon
 Mr B. Rüter, Rabobank
 Ms J.C.M. Sap
 Mr R.P. Lapperre, Dutch Ministry of Infrastructure
 and Water Management
 Ms M. Rietbergen, Design Innovation Group

TRAFFIC & TRANSPORT UNIT

Mr R. van Gijzel
 Ms S.M. Dekker, Minister of State
 Mr R. Paul, Havenbedrijf Rotterdam NV
 Mr M.B. Unck, *RET NV* (Public transport operator in Rotterdam)
 Mr B. Schultze, Schultze Interim Management
 Mr A. Toet, Sequel Work
 Mr G. Veenstra, Keolis Nederland
 Mr F. van Bruggen, Royal Dutch Touring Club (ANWB)

BUILDINGS, INFRASTRUCTURE & MARITIME UNIT

Mr J.H. Dronkers, Dutch Ministry of Infrastructure
 and Water Management
 Ms M.H.W. van Buren, Rochdale
 Mr C.F. Eggink
 Ms T. Muusse MSc
 Ms C. Reiner, Uneto-VNI
 Dr L. Volker, University of Twente
 Mr R.P. van Wingerden MBA, Koninklijke BAM Groep NV

HEALTHY LIVING UNIT

Prof. H.A.P. Pols
 Ms G.M. Fijneman, Zilveren Kruis
 Ms A.W.M. de Groot, Dutch Trade Union Confederation (FNV)
 Ms L.T. Bouwmeester
 Mr H. Smid, ZonMW
 Prof. A.J. van Gool, Radboud University Medical Centre
 Mr T.A.J. Oostrom, *Nierstichting* (Dutch Kidney Society)

INFORMATION & COMMUNICATION TECHNOLOGY UNIT

Dr R. Penning de Vries
 Mr S.B. Luitjens
 Mr T.D. Poelhekkens, Koninklijke KPN B.V.
 Prof. M.R. van Steen, University of Twente
 Ms S.S. Heukelom-Verhage, Pels Rijcken

STRATEGIC ANALYSIS & POLICY UNIT

Dr K.M. Becking, Tilburg University
 Prof. N.M.P. Brocken, IIIIEE, Lund University
 Ms M. Demmers MBA, *Natuur & Milieu* (Environmental
 organisation)
 Prof. J.F.T.M. van Dijck, Utrecht University
 Mr P.A.J. Geluk, The Boston Consulting Group
 Prof. M.L.P. Groenleer, Tilburg University
 Mr R. de Jong MScBA, Royal Philips N.V.
 Mr R. Zonneveld, InnovationQuarter

GAME CHANGER OF 2019

PARTICLE COUNTING FOR VEHICLE EMISSIONS CERTIFICATION

Since the early 2000s, diesel vehicles have come fitted with a diesel particulate filter (DPF) to reduce emissions to an extremely low level. That said, a large number of cars and vans on the road today in the Netherlands have a poorly functioning DPF or it has been removed altogether. The problem is that current vehicle testing methods are unable to detect this.

TNO was the first to develop a particle counter for diesel-powered vehicles that can detect a defective or removed DPF. Within a time span of between 10 and 30 seconds, the particle concentration is measured to detect whether the DPF works properly. This test is expected to become the new standard worldwide in the near future. With this innovation, TNO not only helps reduce air pollution but also presents a global first.

[Read more.](#)

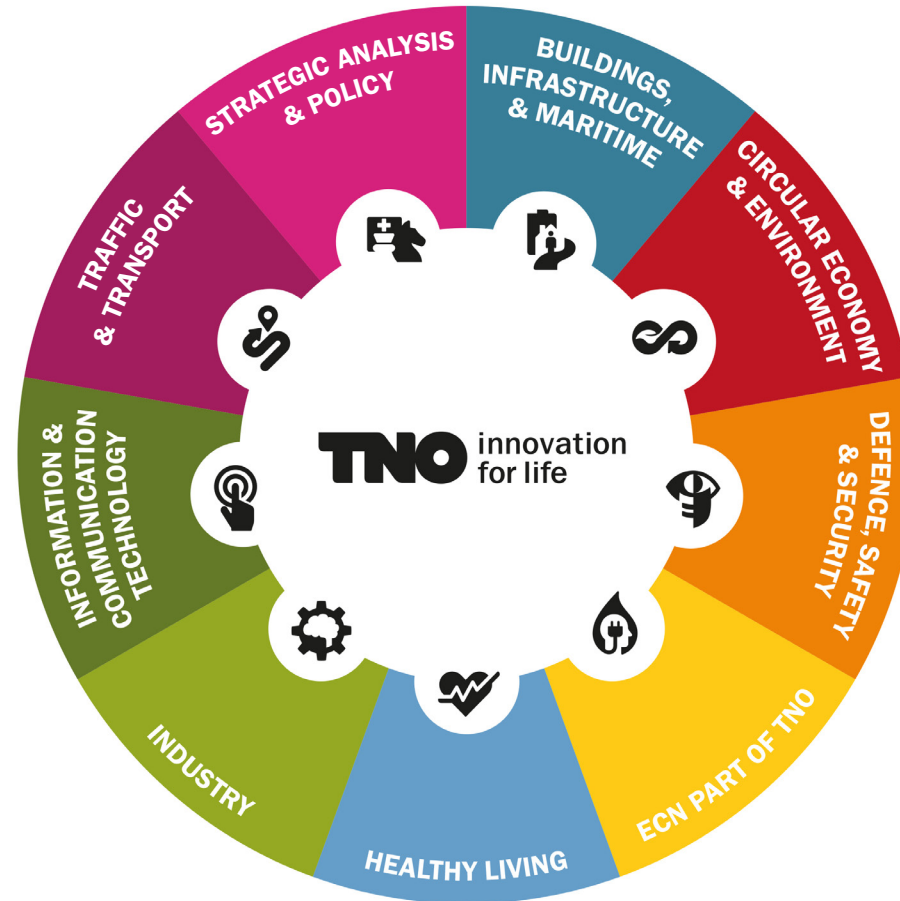


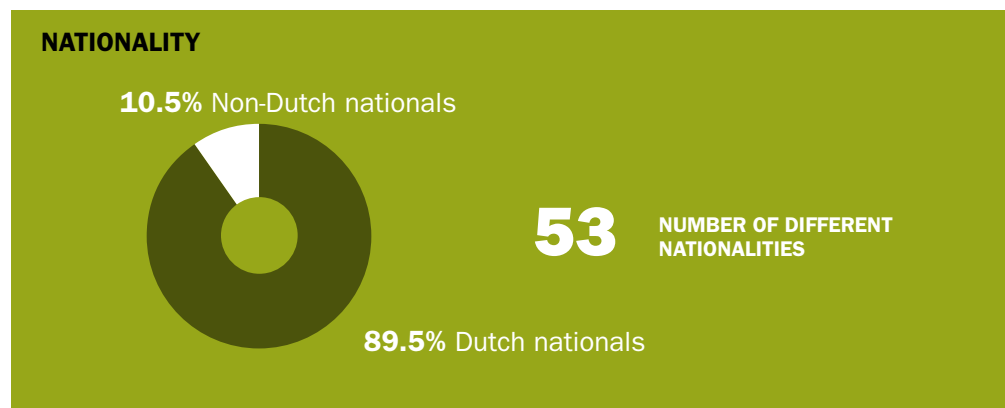
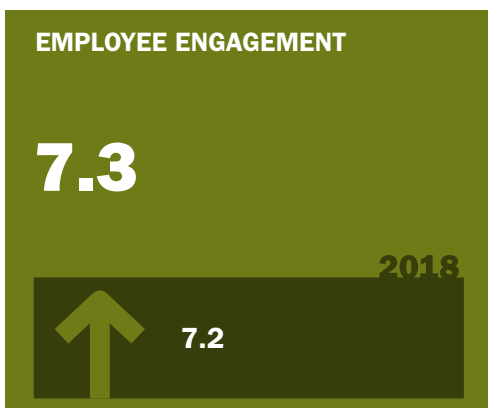
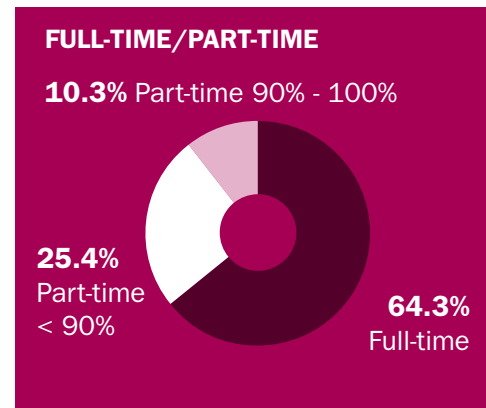
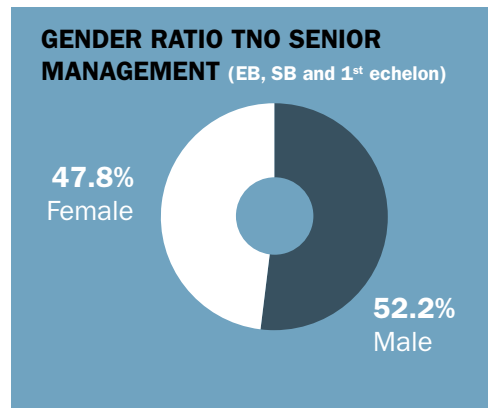
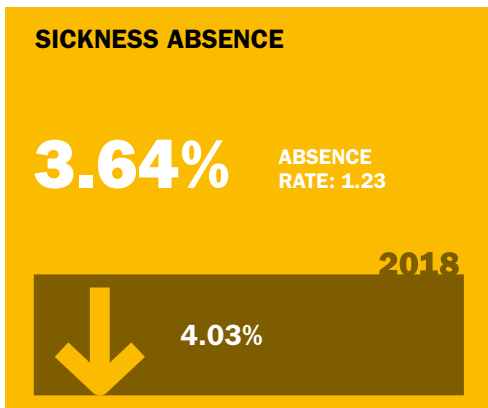
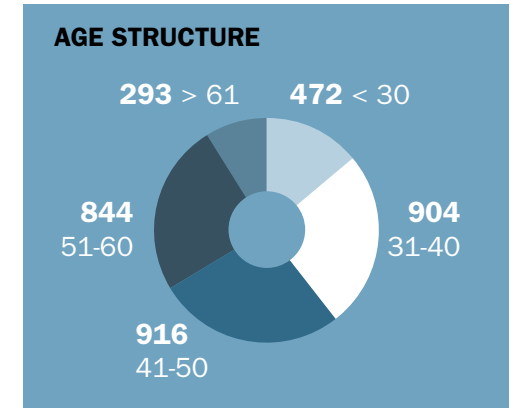
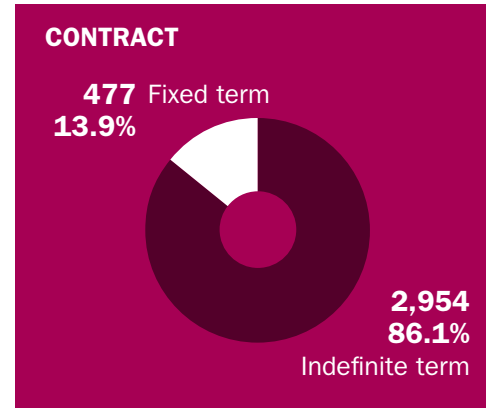
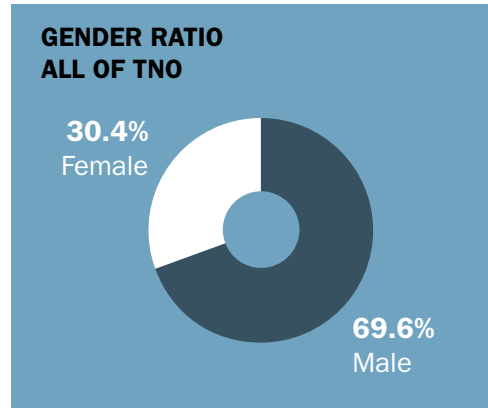
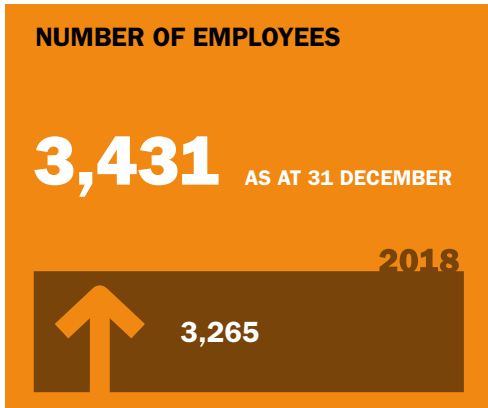
TNO ORGANISATION

The core of TNO is made up of nine units, as shown in the chart.

The Managing Directors of these units report to the Executive Board. The Executive Board and the units are supported by the Services Organisation. The Executive Board reports to the Supervisory Board.

The Council for Defence Research has specific statutory competencies with respect to the Defence, Safety & Security unit.





GAME CHANGER OF 2019

LEARNING FROM SENSITIVE DATA WITHOUT SHARING IT

As it becomes increasingly important for organisations to share information, data protection and sensitivity often throw up obstacles that are hard to circumvent. How do you learn from data from different organisations without sharing the underlying data? TNO is working on developing secure data analysis capabilities using Multi-Party Computation (MPC). One of the research projects in this context is BigMedilytics.

Based on sensitive data on heart failure patients, TNO's computer model learns all sorts of connections from the combined data of the Zilveren Kruis health insurance company and Erasmus University Medical Centre. The pilot is limited to experiments with synthetic data.

MPC uses encryption to interconnect and analyse data securely, which produces an ability to predict which heart failure patients run a heightened risk. These patients can subsequently be given the treatment they need.

[Read more.](#)



INFORMATION & COMMUNICATION TECHNOLOGY



REPORT OF THE EXECUTIVE BOARD

STRATEGY

REPORT OF THE COUNCIL FOR DEFENCE RESEARCH

REPORT OF THE SUPERVISORY BOARD

RISK MANAGEMENT AND CONTROL SYSTEM

RESPONSIBLE INNOVATION

FINANCES

APPENDICES

FINANCIAL INDICATORS FOR 2019

<i>(in millions of EUR)</i>	2019	2018	2017
TNO consolidated result			
Operating income	553.9	504.9	477.4
of which revenue	534.7	483.0	461.4
of which other operating income	19.2	21.9	16.0
Revenue breakdown			
Market sales	292.1	266.7	284.9
Government grant	242.6	216.3	176.5
Costs			
Operating expenses	537.7	497.9	480.6
of which personnel costs	340.2	313.2	301.1
of which impairment	1.7	-	-
Net profit	15.4	1.0	58.6
of which result of participating interests	3.6	-3.9	60.8
Cash flow for the financial year	5.8	55.6	40.2
Capital			
Invested operating capital	297.9	284.7	281.4
Equity	263.3	247.9	247.5
Solvency ratio	53%	51%	58%
Assets			
Tangible fixed assets	192.5	181.2	177.4
Investments in tangible fixed assets	42.3	37.5	56.2

	2019	2018	2017
Employees			
Number of TNO employees (average FTEs)	3,079	2,860	2,627
Number of TNO employees (average FTEs)	3,173	2,900	2,670
Number of group company employees (average effective)	2	5	372
Number of group company employees (effective as at year-end)	2	5	0
Number of FTEs (at year-end)	3,175	2,905	2,670
Average number of FTEs	3,081	2,865	2,999

FINANCES AT A GLANCE

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

Result

In 2019, TNO achieved a positive result of EUR 15.4 million. In the previous year, 2018, the result after the accounting policy change* came in at a surplus of EUR 1 million.

The positive result for 2019 was pushed up substantially by non-recurring income, growth relating to the increase in the government grant and significantly better results from participating interests. The non-recurring income includes a book profit on the sale of a site (EUR 3.3 million) and the impact of the aforementioned change in accounting policies on the results (EUR 3.1 million). The growth combined with the increased government grant produced an estimated EUR 9 million hike in the results. The significantly improved result from participating interests totalled EUR 3.6 million, compared to a loss of EUR 3.9 million in 2018. On the other hand, there are negative VAT effects that add up to a net amount of EUR 3.7 million.

Capital

The result for 2019 will be used to increase the buffer capital and, among other things, finance the new building for the chemical ballistic lab (reserves earmarked for projects for the Ministry of Defence). TNO's equity totals EUR 263.3 million, EUR 125.6 million of which relates to TNO's defence activities.

* In 2019, TNO's accounting policies with respect to service anniversary bonuses and recognition of major maintenance in the financial statements were changed.

The corresponding figures for 2018 now also include a provision for service anniversary bonuses. The method used for the major maintenance provision that involves saving up money for major maintenance has been changed to what is known as a component approach, whereby major maintenance is entered as an asset and subsequently amortised.

The corresponding figures on the balance sheet and in the income statement have been amended accordingly. (The result for 2018 before the accounting policy change was a surplus of EUR 39 thousand).

[Click here for the 2019 financial statements.](#)

UNEQUAL FINANCIAL PLAYING FIELD

When it comes to investments in R&D, financing options and tax treatment, there is great inequality in the financial playing field between universities, knowledge institutions, the public sector and business and industry, both in the Netherlands and internationally. While the Netherlands currently invests roughly 2% of its GDP in R&D, Germany already invests 3% and has increased the target percentage to 3.5%. TNO's financing model also requires TNO to charge its client the full cost price for its work, while universities have their overheads and accommodation costs paid up in the first funds flow. Aside from that, TNO became liable to pay corporation tax in 2016 at a rate of 25% of the result. Although most of TNO's peer organisations in Europe are also liable for tax, they benefit from national schemes that exempt them from corporation tax. As a result of these disadvantages, TNO's position is under pressure.

NOTES TO THE SEPARATE FINANCIAL STATEMENTS

Revenue

Revenue rose from EUR 482.2 million in 2018 to EUR 534.6 million in 2019. This rise came largely on the back of an increase in the government grant and integration of ECN. In 2019, revenue relating to the integration of ECN was included in the figures for the full year, while it was only included from 1 April in 2018, i.e. for nine months.

The ratio of public funding to market sales in 2019 was EUR 1 to EUR 1.19 (2018: EUR 1 to EUR 1.23). The change in this ratio is due primarily to uncovered VAT payables in the market sales and an increase in knowledge investment funded from the government grant (which did not immediately generate more market revenue).

Work in progress

The total value of work in progress at year-end 2019 stood at EUR 436 million. As a result of market conditions, two units were partly reorganised in 2019.

Other operating income

In 2019, other operating income was down EUR 3.2 million on 2018. Income from licensing and patents rose from EUR 4.5 million in 2018 to EUR 5.9 million in 2019, partly as a result of the sale of various patents to a minority interest. On the other hand, rental income was down, the result from the sale of tangible fixed assets was lower than expected and the balance of other income was up, which adds up to a drop of EUR 4.6 million.

Operating expenses

The integration of ECN had a significant impact on the trend in operating expenses and also on revenue. In 2019, operating expenses relating to the integration of ECN were included in the figures for the full year, while they were only included from 1 April in 2018, i.e. for nine months. This resulted in a difference of approximately EUR 13 million.

Personnel costs showed an increase of EUR 27 million compared to 2018. Of this amount, EUR 20.5 million relates to higher wages and salaries, including pension and social insurance contributions, as well as to changes in staff facilities. This is due to an increase in average staffing levels and the associated higher pension costs and social insurance contributions, as well as the integration of ECN and the autonomous 1.5% salary increase as of 1 January 2019. On balance, other personnel costs were up EUR 6.5 million as the costs of insourced staff rose EUR 3.4 million and rising average staffing levels pushed costs up a further EUR 3.1 million.

Other operating expenses rose EUR 7 million compared to 2018. Accommodation and energy costs, technical assets, general management costs, outsourced work, movements in provisions and other expenses were up EUR 9.8 million, largely on the back of TNO growing in size and the integration of ECN. On the other hand, the costs of materials, contributions issued and other expenses were down EUR 2.8 million.

Direct project costs rose EUR 2 million, from EUR 78.2 million in 2018 to EUR 80.2 million in 2019, which is in line with the general trend.

In 2019, depreciation charges were up compared to 2018, rising by EUR 4.6 million from EUR 19.2 million to EUR 23.8 million. Investments in 2019 topped EUR 42 million, exceeding depreciation charges in 2019 by approximately EUR 18 million. New developments at TNO sites in Petten, Ypenburg and Waalsdorperweg particularly drove up the investments.

The depreciation charges include an impairment of EUR 1.7 million, EUR 1.2 million of which is accounted for by a write-down on assets at one of the cash-generating units following impairment testing.

Taxation

As of the 2016 financial year, TNO is liable to pay corporation tax on the full result. The corporation tax return for 2016 was filed and is being reviewed by the Dutch Tax and Customs Administration. TNO and the Dutch Tax and Customs Administration are in talks on the adoption of the opening balance sheet as at 1 January 2016, discussing two points in particular: the release of the equalisation account and the measurement of the patents. The tax item in the income statement amounts to EUR 3.9 million, relating primarily to the acute tax liability for the year 2019. There was only a minor change in deferred tax assets in 2019.

Equity

The reserve earmarked for projects for the Ministry of Defence increased by EUR 0.4 million from EUR 17.6 million at year-end 2018 to EUR 18 million at year-end 2019. This movement concerns the balance of defence-related investments (EUR 4.7 million) and the allocation to the earmarked reserve (EUR 5.1 million). The general reserve has decreased as a result.

The statutory reserve was up EUR 2.9 million in 2019, coming in at EUR 15.4 million at year-end 2019 and containing non-distributable profits on participating interests in group companies.

Combined, the above movements and the positive result of EUR 15.4 million have led to a EUR 12.1 million increase in the general reserve.

Liquid assets

At year-end 2019, the balance of liquid assets stood at EUR 168.1 million (year-end 2018: EUR 161.2 million). The EUR 6.9 million increase in liquid assets generated in 2019 compared to year-end 2018 is made up of the balance of various items, which are detailed below.

Tangible fixed assets were up EUR 11.7 million, EUR 11.4 million of which relates to an investment in the new development at the TNO site in Petten and other investments totalling EUR 6.8 million over and above the regular depreciations. On the other hand, there are disinvestments totalling EUR 4.8 million, with EUR 4.5 million of this figure relating to the sale of a site. Combined, the positive result for 2019 of EUR 15.4 million and other balance sheet movements totalling EUR 3.2 million drove up the liquid assets item by EUR 18.6 million.

Of the total balance of liquid assets, EUR 18 million was set aside for future investments in defence-related property. Liquid assets at year-end 2019 also include an amount of EUR 67.8 million in: (1) accrued liabilities and deferred income yet to be settled totalling EUR 29.1 million, of which EUR 23.4 million relates to liquid assets still to be transferred for secretaryships, and (2) unspent public funds amounting to EUR 38.7 million, of which an amount of EUR 21.8 million represents unspent investment resources.

Released investment budgets for 2020 top EUR 60 million. Factoring in the aforementioned unspent investment resources totalling EUR 21.8 million, this is expected to lead to an additional outgoing cash flow of over EUR 38 million in 2020.

Solvency ratio

The solvency ratio was, as expected, up on the previous year, rising from 51% in 2018 to 53% in 2019.

Number of employees

The average number of FTEs in 2019 (3,079 FTEs) was 219 higher than in 2018 (2,860 FTEs).

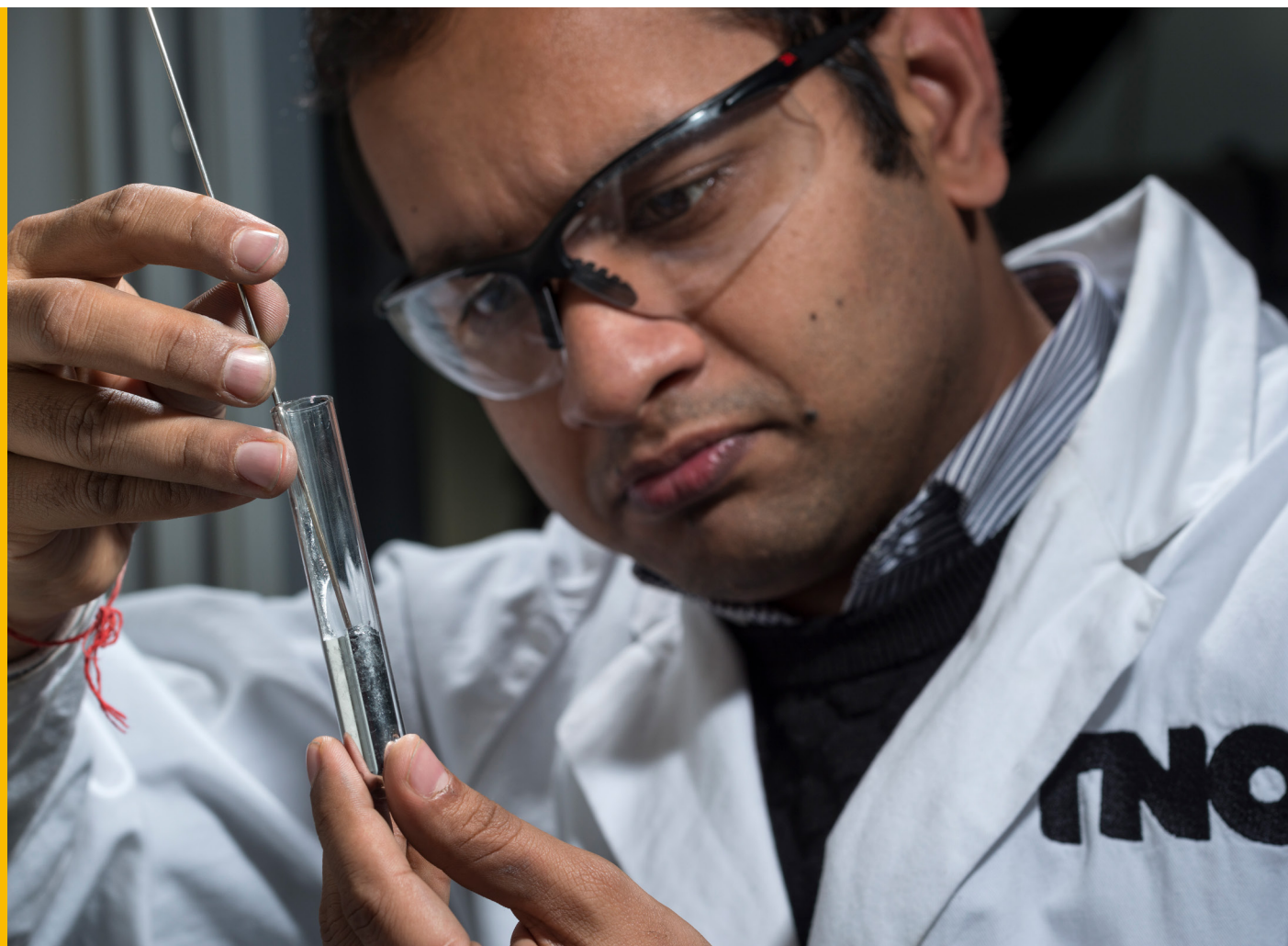
GAME CHANGER OF 2019

HYDROGEN WITHOUT CARBON EMISSIONS

Hydrogen is clean, safe and found in nearly all matter in the universe. This makes it a promising alternative to fuels from non-renewable sources. One way to produce hydrogen is through electrolysis. The downside, however, is that electrolysis produces CO₂ emissions.

TNO has now developed hydrogen production technology that does not involve carbon emissions: methane pyrolysis. This process not only delivers a clean energy source but also produces solid carbon, which is a valuable by-product that can be used as an additive for steel or as a soil conditioner.

[Read more.](#)



 ECN PART OF TNO



REPORT OF THE EXECUTIVE BOARD

STRATEGY

REPORT OF THE COUNCIL FOR DEFENCE RESEARCH

REPORT OF THE SUPERVISORY BOARD

RISK MANAGEMENT AND CONTROL SYSTEM

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CORPORATE GOVERNANCE APPENDIX

GOVERNANCE AND SUPERVISION STANDARDS

TNO was established by law as an independent organisation that connects people and knowledge. Operating from a position of objectivity, TNO delivers practicable innovations that serve the public interest, society and industry.

Corporate governance is a set of rules, standards and institutions for the administrative set-up of the organisation, intended to ensure adequately supervised ethical, responsible and transparent operations.

The corporate governance set-up is based on the specific legislation governing TNO, i.e. the TNO Act. Furthermore, TNO is governed by the Code of Conduct for Applied Research Organisations (*Gedragregels voor TO2-organisaties*), as included in the Dutch government's 'Vision for applied research' (*Visie op toegepast onderzoek*) by the Joint system of standards for financial management (*Gemeenschappelijk normenkader voor financieel beheer*) and by the supervisory authority for semi-public institutions (*Toezicht semipublieke instellingen*).

TNO is a public, societal organisation. TNO is committed to adhering to the governance code for companies (2016 Corporate Governance Code) and governance code for public sector organisations (2015 Governance Code for Public Service Providers (*2015 Code Goed Bestuur Publieke Dienstverleners*)), even if TNO is not legally required to adhere to these codes.

TNO also has a code of conduct (TNO Code) of its own, as well as an internal and external complaints handling scheme and a scheme that allows people to raise concerns regarding abuses at or perpetrated by TNO. The code of conduct and the various schemes are based on the governance code specified above, the Netherlands Code of Scientific Practice and relevant legislation.

The rules of procedure for TNO, the Executive Board, the Supervisory Board, the Council for Defence Research, the Strategic Advisory Councils and the Works Council make up TNO's organisational regulations along with the mandate regulations. The organisational regulations specify mutual responsibilities, competencies and duties. The competencies and authorisations assigned to members of the organisation are shown accurately in the Mandate Regulations and Competencies Matrix. Adequate checks and balances are ensured as part of careful decision preparation by a system of internal approval and advice mechanisms.

The Executive Board is supported by four multidisciplinary advisory bodies that cover the organisation as a whole:

- Governance, Risk & Compliance Advisory Board
- Human Capital Advisory Board
- Integrity Advisory Board
- Strategy & Markets Advisory Board

These advisory councils are organised based on specific areas of expertise and help ensure effective and balanced governance, the careful preparation of policy changes and broad support for the implementation of these changes.

THE EXECUTIVE BOARD

The chairman and members of the Executive Board are appointed by the Crown. They are remunerated in compliance with the Senior Executives in the Public and Semi-Public Sector (Standards for Remuneration) Act (*Wet normering bezoldiging topfunctionarissen publieke en semipublieke sector* (WNT)).

The Executive Board is in charge of governing TNO and is responsible for defining objectives, policy and strategy, as well as for implementing these and for the ensuing results. As required under the TNO Act, the Executive Board is a collegial board,

meaning that apart from the chairman, each board member operates from a specific strategic, scientific, operational and financial profile.

THE SUPERVISORY BOARD

The chairman and members of the Supervisory Board are appointed by the Crown for a term of five years. Members can be reappointed for one further term. They are remunerated in line with the Senior Executives in the Public and Semi-Public Sector (Standards for Remuneration) Act (*Wet normering bezoldiging topfunctionarissen publieke en semipublieke sector (WNT)*).

The Supervisory Board is tasked with overseeing the Executive Board's policy and the implementation thereof, as well as with fulfilling an advisory role to the Executive Board. Its supervisory role primarily covers risk management and compliance, extending to the monitoring of performance on objectives and Key Performance Indicators, the strategy, the annual plan including a plan for investments, financial reporting and compliance with laws and regulations. The TNO Act specifies for which decisions the Executive Board needs the Supervisory Board's approval or consent.

The Supervisory Board evaluates its own performance and that of individual members and committees on an annual basis. The Supervisory Board has annual individual performance reviews with the chairman and each member of the Executive Board. There are three committees within the Supervisory Board: the Selection and Remuneration Committee, the Audit Committee and the Quality Committee.

The financial statements are accompanied by an opinion on the truth and fairness of the financial statements issued by an auditor engaged by the Supervisory Board. The current auditor, EY, has been auditing the financial statements since 2018.

The auditor also conducts a separate audit of the rightful collection and spending of the government grant received, using an audit protocol agreed between TNO and the Dutch Ministry of Economic Affairs and Climate Policy.

COUNCIL FOR DEFENCE RESEARCH

The policy pursued with respect to TNO's research for the Dutch Ministry of Defence is, under the TNO Act, the responsibility of the Council for Defence Research. The chairman of the Council for Defence Research is appointed by the Crown at the nomination of the Minister of Defence and is also a member of the Executive Board.

To be effective, the Dutch armed forces need to continuously innovate their military capabilities to stay ahead of (potential) adversaries, for which they need scientific support in a large number of knowledge and technology domains. Part of the knowledge required is so specific to defence matters that the Ministry of Defence has to develop it itself, which is where their strategic partnership with TNO comes in. Since as far back as 1947, TNO has been handling the majority of all applied scientific defence research in the Netherlands, working in close collaboration with the Ministry of Defence, companies and other knowledge institutions. Defence and a safe and secure society make up a closely interconnected ecosystem in this respect. The fact that TNO also works for other clients in the defence, safety and security domain broadens and deepens the defence knowledge base and keeps it affordable for the Ministry of Defence.

EMPLOYEE PARTICIPATION

Employee participation at TNO is organised in the form of the Works Council and Unit Committees. Works Council members are elected by the employees of TNO. The Works Council debates all matters relevant to employees in general and TNO as an

organisation, issuing solicited and unsolicited advice to the Executive Board.

There are also Unit Committees for each unit separately. The unit's Managing Director has regular meetings with the Unit Committee for his or her unit to discuss matters relating to the unit. There is also a Unit Committee for the Services Organisation.

STRATEGIC ADVISORY COUNCILS

A Strategic Advisory Council is made up of leading individuals from across business and industry, the public sector and knowledge organisations. These members are appointed by the Executive Board for a term that runs in sync with that of the Strategic Plan.

The Strategic Advisory Councils have an advisory duty with respect to the setting of priorities and selection of research spearheads and programmes in the field of the unit in question. The Strategic Advisory Council identifies external developments in the unit's environment and shares these with the board of the unit.

A Strategic Advisory Council meets at least twice a year and their meetings are attended by a member of the Executive Board. The joint chairs of the Strategic Advisory Council are invited to a strategy meeting convened by the Executive Board at least once a year.

DIRECT TNO SUBSIDIARIES

TNO has transferred its participating interests to three holding companies: TNO Tech Transfer Holding B.V., TNO Affiliates Holding B.V. and TNO International Holding B.V.

TNO Tech Transfer Holding B.V. is a venture capital company that administers shares, mostly minority stakes, in spin-off companies. This includes the participating interests of First Dutch Innovations B.V. Creating a spin-off is a business transaction whereby TNO pursues equality and transparency. TNO is not involved in the day-to-day operations of each of the participations transferred to TNO Tech Transfer Holding B.V. Aside from that, TNO enters into agreements with these spin-offs on market terms, such as when leasing TNO facilities or providing a licence to intellectual property rights owned by TNO (such as patents and know-how).

TNO Affiliates Holding B.V. holds shares in other Dutch entities that are not TNO spin-offs. For reasons relating to transparency, tax treatment or collaboration with third-parties, these entities are placed at arm's length from TNO. TNO is generally more actively involved in these entities than in participations held by TNO Tech Transfer Holding B.V.

TNO International Holding B.V. holds shares and similar stakes in TNO's branch offices outside the Netherlands. These branch offices were set up for transparency, fiscal and risk management reasons.



RISK MANAGEMENT AND CONTROL SYSTEM APPENDIX

CULTURE AND CONDUCT

In TNO's Strategic Plan, the organisational culture and conduct hinge on four core values: integrity, independence, professionalism and social commitment. Various tools are used to actively encourage the target behaviour, including the TNO Code, the scheme to raise concerns about possible abuses at or perpetrated by TNO, the integrity policy and the integrity officer, the central compliance function, the complaints handling scheme, the outside activities policy, the Netherlands Code of Conduct for Scientific Integrity, the data protection policy and the agency policy.

The TNO Code operationalises a number of important core values for ethical behaviour. Every single TNO employee confirms compliance with the TNO Code every year.

DUTIES, RESPONSIBILITIES AND AUTHORISATIONS

The Executive Board's management practice consists of defining strategic, policy and organisational frameworks and decision-making (Strategy & Policy), which includes financial frameworks and budget allocation, formulating and implementing the annual plan and budget, policy-making and framework definition, the TNO strategy and TNO-wide knowledge development.

The units' Managing Directors are - together with their respective teams, on which market, implementation and knowledge are brought together - responsible for implementing the TNO strategy and the execution of their respective units' annual plan and budget. The units have operational responsibility for knowledge development and management, market development, order intake, commercialisation of intellectual property and operational efficiency.

The Managing Directors of the Services Organisation are responsible for the functioning of TNO-wide processes and systems. The Services Organisation supports the Executive Board and the management of the various units.

PLANNING AND CONTROL CYCLE

Every year, TNO makes an annual plan and sets a budget for the year, in keeping with the Strategic Plan. Progress is partly monitored based on Key Performance Indicators (KPIs). Each unit's results are discussed on a monthly basis by the unit's Managing Director and the Controller and by the Chief Operating Officer and Chief Financial Officer. A business review is conducted three times per year, which sees a unit's management team meet with the Executive Board to discuss milestones and KPIs to evaluate progress and, if necessary, make changes. Such a business review includes a progress report that covers primary risks and measures, linked to the (strategic) objectives of the units and the Services Organisation.

RISK MANAGEMENT

TNO's risk management policy concerns both the identification of the main financial and non-financial risks regarding the achievement of TNO's objectives and the controlled execution of operations across all layers of the TNO organisation.

IMPROVEMENTS IN 2019: INTERNAL CONTROL FRAMEWORK

In 2019, work started on the introduction of the Internal Control Framework (ICF), which is intended to provide *comprehensive* insights into the main risks and associated controls, as well as to document them. In this context, 'comprehensive' means that all kinds of key risks (strategic, operational, compliance and financial risks) are assessed in their interrelationship across the entire TNO organisation. This also brings any 'white spots' into focus. The ICF also established, for the first time, a link between the assessed risks and the risk appetite articulated by the

Executive Board in 2019. Finally, the ICF is intended as a verifiable substantiation for risk control efforts so as to be able to issue an in-control statement. The emphasis of the first step in setting up this framework was on financial risks and control measures.

The compliance programme is an integrated part of the Internal Control Framework. In 2019, an action plan was adopted for this programme, which also provides an accurate overall view of compliance-related (non-financial) risks affecting the licence to operate. The action plan assigns duties and responsibilities in

the second line of defence while also anchoring compliance with laws and regulations and ethical standards by setting up a centralised compliance function. The latter function is intended to identify and raise compliance concerns, suggest compliance frameworks and monitor the progress of policy implementation in this area.

Finances

Target	Key risks	Key controls
Reliable and healthy finances	Unreliable control information	<ol style="list-style-type: none"> 1. Planning and control cycle: framework letter, bottom-up budget process, adoption of budget, adoption of annual plan, monthly reporting, monthly review and forecasting 2. Financial model details, definition of target values, translation of target values to the various units, follow-ups on improvement plans and embedding in the budget
	Inadequate financial accountability	Process-based and data-driven checks to guarantee the accuracy, timeliness and completeness of financial data reported
	Inappropriate use of public funds	<ol style="list-style-type: none"> 1. Predefined process in the Knowledge Procedure 2. Formulating Knowledge Plans for projects funded from government grant for the full 100% 3. Use of government grant in Mixed Funding audited by internal audit committee (<i>Interne Beoordelingscommissie</i> (IBC)) 4. Project monitoring based on schedule, content and budget, under the responsibility of the Market Director 5. End-of-year review by Corporate Control of use of government grant funds in Mixed Funding
	Non-compliance with tax legislation	Tax Control Framework
	Insufficiently insured	Risks are identified and insured in consultation with the insurer
	Non-compliance with European tendering rules	<ol style="list-style-type: none"> 1. Capacity planning for the procurement department 2. Spend analysis 3. Tender reporting

With respect to compliance with sanctions and control legislation and regulations governing exports, the implementation of an automated tool for the screening of external parties and the classification of products and services started in 2019. This will enable well-founded and verifiable decisions when it comes to applying for the required permits.

In the area of IT, risks are differentiated in terms of system and data availability, reliability and integrity. Control measures deemed necessary are detailed in various security guidelines. These measures include data and document classification and compartmentalisation, the separation of functions with layered roles and rights and the monitoring of compliance with agreed procedures. TNO has organised its data and system security in line with the principles of ISO 27001. Security measures include data processing agreements with providers of externally procured IT solutions. These agreements are audited by an external party (including an ISAE 3402 audit). Aside from that, TNO's external auditor audits information security on relevant systems as part of the greater audit of the financial statements. This includes general application controls, such as the automated separation of functions and system access.

EMPHASIS FOR 2020

The emphasis for 2020 is on strengthening TNO's Internal Control Framework and the ensuing risk management policy by, among other things, implementing the concept of risk appetite on a larger scale within the organisation. In 2020, the focus will

be more on elements of the ICF that have received less attention so far, such as the other elements of operations and topics in the primary process which are pertinent from an operational perspective.

The TNO-wide risk analysis, as it was until 2019, will be integrated into the Internal Control Framework in 2020. The implementation of the compliance organisation, as described in the above action plan, will largely materialise in 2020. And 2020 will also be the year in which the ISMS (Information Security Management System) will be implemented. This system is used to monitor the IT risks and gain insight into the effectiveness of control measures.

AUDITS

The Operational Excellence & Auditing department conducts (internal) operational and financial audits. The Supervisory Board has signed off on a three-year cycle for the implementation of the auditing plan, which is based on the risk analysis and process descriptions across TNO in the TNO management system. Audit reports are discussed with the Executive Board and fed back to the Supervisory Board's Audit Committee. The outcomes and recommendations are used as input for improvement processes.

Within the expertise groups, there are also periodic knowledge position audits in each of TNO's areas of expertise, which are conducted by committees made up of certified experts so as to assess the quality and societal relevance of TNO's knowledge base.

TNO is audited by various external bodies every year, with the main ones being the following:

- TNO's management system, ISO 9001, is audited by Det Norkse Veritas GL
- The financial statements and approximately 150 subsidy projects are audited by an external auditor
- Compliance with security legislation and regulations is audited by the Dutch Military Intelligence Service (MIDV) and the Dutch General Intelligence and Security Service (AIVD)
- Compliance with working conditions and environmental legislation and regulations is audited by Dutch Customs and the competent authority at permit-issuing bodies
- Quality audits at labs for Good Laboratory Practice and ISO standards

The outcomes of these external audits do not concern material findings. Any recommendations made based on audit outcomes are implemented.

CORONAVIRUS

As the risk of a pandemic was not considered to be one of the main risks for TNO, it was not included in the risk analysis in recent years. With the virus now manifesting itself, various measures are being taken to reduce its impact, starting with measures needed to stem the spread. TNO is adhering to the advice issued by the Dutch government and the Dutch National Institute for Public Health and the Environment (RIVM). We have set up a crisis team that comes under the direct management of the Executive Board and has been tasked with implementing the government-imposed measures. The excellent home-working facilities that TNO has been offering employees for several years now have been scaled up over the past few weeks. For those jobs that cannot be done from home, physical measures have been taken at various TNO sites in accordance with the national guidelines.

› PUBLICATION DETAILS

› If you want to find out more about TNO or have any questions or ideas you would like to share after reading this report, send us an email at info@tno.nl.

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