Swedish National Forensic Centre

The Swedish National Forensic Centre, NFC, is an independent expert organization within the police authority with an overall responsibility for forensics. Our mission is to integrate, consolidate and efficiate the national forensic services to meet society’s need.
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The First Years at Glance

In January 2015 the Swedish National Laboratory of Forensic Science (SKL) together with the major regional police laboratories in Stockholm, Gothenburg and Malmö became the National Forensic Centre (NFC) with responsibility for forensics and a mission to integrate, consolidate and efficiate the national services. Looking in the rearview it has been two years of challenges and accomplishments.

Forensic science is critical for law enforcement and prosecution. Our task is to perform forensic investigations and analyses in all forensic areas, except forensic medicine. We are also responsible for the forensic process within the Swedish Police; that includes approximately 1,100 employees and spans from a responsibility to monitor, evaluate, harmonize and assure the quality of all forensic methods throughout the forensic process, i.e. at the crime scene, in the laboratory and in digital forensics, to oversee and decide on materials and equipment.

The first two years has been a journey where we have grown from a small independent authority to a department in a very large police organization. This has included expanded responsibility and NFC has also grown with three laboratories in Sweden’s three major cities as well as continued growth in Linköping. The challenges have indeed been many. The number of cases coming into NFC is steadily increasing. This is our biggest challenge. Nevertheless, we completed 10 percent more cases 2016 than 2015.

In conclusion, the NFC’s strategic direction for the years to come is to maintain and strengthen our forensic capacity, quality and scientific excellence in an international context. The continuous need to increase our production capacity motivates flow-based case work. We strive for mandatory accreditation and certification of our forensic experts in the direction pointed out by European commission in the plan European Forensic Science Arena 2020 (EFSA2020), and we have implemented a programme to reach our goals within a five-year period. More efficient investigation methods release human and financial resources, which in turn benefit our R&D activities, in order to ensure continuous development.

It is with great pleasure I am looking forward to the years to come. It is an honor to lead an organization with so many dedicated and skilled employees - without whom we never would have been able to make this journey so successful in an organization in transition.

Lena Klasén, PhD
Director Swedish National Forensic Centre
Organization

The NFC comprises the national forensic laboratory in Linköping in addition with three regional forensic laboratories in Stockholm, Gothenburg and Malmö.

Swedish Crime Scene Investigators are employed at the forensic sections of the seven police regions. Limited laboratory activities – primarily the development of latent fingerprints – are performed at these sections. Digital forensics are undertaken at NFC, and also at the Department of National Operations, and at the forensic sections within the seven police regions.

155,000
The number of forensic investigations and analyzes in all forensic areas, except forensic medicine, that was completed during 2016.

463 employees.
(Dec. 2016)

30 million euro in total budget
(2016).
“Our mission is to be an impartial expert organization performing investigations in criminal cases to legal authorities. Our task is also to perform forensic research and development (R&D) as well as educate and inform on forensic issues. Our responsibility for the forensic process spans from a responsibility to monitor, evaluate, harmonize and assure the quality of all forensic methods throughout the forensic process within the Police Authority.”

More than 100 research and Development projects, activities and programs ran in 2016.

32 scientific publications were published during the years 2015 and 2016.

More than 40,000 hours were devoted to Research and Development, equivalent to 7.4% of the total working hours in a year.

12 days is the average processing time in 2016 (50% of the cases) which is a decrease of 3 days compared to the average for 2015.

Confiscated drugs 2015
The forensic process should not only be based on scientific results, efficiency and assured quality. It should also serve the customers’ needs, i.e. the end users of the results, both in the police investigation and in the judicial process. To achieve this very important goal various forums have been created where NFC interacts with customers both within and outside the Police.

The Forensic Council
The Forensic Council is composed of stakeholders at a strategic level from the judiciary system, senior police chiefs from both the Police regions and the National Operations Department, representatives from the Prosecutor’s Office, the National Board of Forensic Medicine, the Swedish Customs, the Swedish Coast Guard, the Swedish Economic Crimes Authority, the Ministry of Justice and the Swedish Bar Association. The forum provides guidance to NFC on the development of the forensic process. It assembles two to four times per year.

The Forensic Collaborative Forum
This forum comprises the managers of the forensic sections in the seven Police regions. The forum is a platform for operational level discussions. Problems are brought forward and specific solutions as well as general developments are presented and discussed. The group assembles four to six times per year.

The Forensic Scientific Council
A scientific council is being developed to ensure that the research and development carried out at NFC is directed to relevant areas and is performed according to recognized scientific standards.

Looking back at 2015 and 2016 the activities at NFC have contributed to:

- The formation of the new Police Authority
- A quality- and competence-assured forensic process
- A focus on customer’s needs, especially to further reduce case-turnaround times
- Improved and harmonized reporting, including development of evidence evaluation both at the crime scene and in the laboratory
- Accreditation of fingerprint development and identification throughout the Police
- The exchange of forensic DNA data within Europe (Prüm cooperation)
Besides performing forensic investigations and analyzes, NFC also has a national responsibility to monitor, evaluate, harmonize and assure the quality of all forensic methods used within the Police. In 2015 NFC initiated an extensive program to harmonize and assure the quality of all forensic activities within the Police relating to methods, skills, case management, reporting and performance measurement. The goal is to achieve an efficient, consistent and accredited handling of forensic cases on a national level. To achieve this, a special program was initiated, a framework that holds together the underlying projects and activities. The work began with a survey of all forensic activity within the Police. Harmonization of methods and competence in the various disciplines forms the basis of the accreditation, which should be completed by year-end 2019/2020.

**Improved Case-flow**

A flow-based approach for case work (LEAN) was introduced in drug analysis in 2015 to handle a pronounced increase in incoming cases and a need for shorter turnaround times. Flow-based organization of laboratory work has continuously undergone further development, resulting in an average turnaround time for uncomplicated drug cases of 4-5 days. The staff’s experiences and ideas for improvement are used to adapt the case-flow to the customers’ needs. Areas with high case load and a significant increase in incoming cases have been the driving force.

**Prüm DNA**

The Prüm cooperation (the European exchange of DNA profiles) gained momentum in 2015, and Sweden is currently exchanging DNA data with 16 EU countries (December 2016).

**International Collaborations**

NFC is an active member of European Network of Forensic Science Institutes – ENFSI. The purpose of ENFSI is to share knowledge, exchange experiences and come to mutual agreements in the field of forensic science. ENFSI is recognized as an expert group in the field of forensic sciences. One of ENFSI’s important tasks is to encourage all ENFSI laboratories to comply with best practice and international
Education

NFC organizes courses mainly for the Swedish Police, but also for other members of the judicial system. Some of the educational activities at NFC for the Swedish Police have consisted of:

- Education for Crime Scene Investigators
- Blood Stain Pattern Analysis
- Application of the Weapon’s Law
- Fingerprint Comparison

Courses Held for Other Judicial Agencies

The Swedish Prosecutors Authority and the Swedish National Court request courses at several different levels from NFC. In order to be a prosecutor or judge one has to pass these courses. The topics of these courses are forensic investigations, how to interpret forensic results and how to use them as evidence in court.
Performance of Forensic Investigations and Analyzes

There has been a continuous increase in requests for forensic investigations and analyzes since 1965, as shown in the diagram below.

Requests for Forensic Investigations 1964 – 2020 *)

*Reference samples concerning DNA registry and cases from Swedish Migration Agency concerning dactylogram are not included. From 2015 NFC Stockholm, NFC Syd and NFC Väst are included in the material.
## Case Development at NFC

### Incoming, closed and open cases, from the judicial authorities

<table>
<thead>
<tr>
<th>Performance indicators</th>
<th>2015</th>
<th>2016</th>
<th>Difference</th>
<th>Difference %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incoming cases</td>
<td>78,100</td>
<td>82,800</td>
<td>4,700</td>
<td>6.0</td>
</tr>
<tr>
<td>Closed cases</td>
<td>74,600</td>
<td>81,900</td>
<td>7,300</td>
<td>9.8</td>
</tr>
<tr>
<td>Open cases</td>
<td>9,900</td>
<td>10,700</td>
<td>800</td>
<td>8.1</td>
</tr>
</tbody>
</table>

### Cases from other principals

<table>
<thead>
<tr>
<th>Reference samples DNA</th>
<th>2015</th>
<th>2016</th>
<th>Difference</th>
<th>Difference %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference samples fingerprint</td>
<td>10,600</td>
<td>11,700</td>
<td>1,100</td>
<td>10.4</td>
</tr>
<tr>
<td>Swedish Migration Agency</td>
<td>111,000</td>
<td>23,000</td>
<td>-88,000</td>
<td>-79.3</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>10,200</td>
<td>10,200</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
We have developed a unified scale of conclusions based on likelihood ratios that are applied to all caseworks in Linköping that involve evaluative statements. The unified scale is now being introduced nationwide as part of the harmonization process. We are continuously developing methods for increasing the precision of estimated likelihood ratios for particular evidence types. This work involves co-operation with forensic and academic institutions across Europe.

We have also developed a framework for the interpretation of findings at the crime scene, with the purpose of enhancing CSI reporting. This framework has already been implemented at several forensic units and there is also an international interest. Moreover, we have research collaboration with faculties of law.
A large increase in the number of cases involving explosives was experienced during 2015. Instead of the “normal” 90-100 cases per year more than 140 requests for examination were received.

The creation of a national node at the NFC for R&D in digital forensics is underway in collaboration with the Police Cybercrime Centre, universities, government bodies and industry partners spanning. Applications for funding joint research projects have been submitted to Horizon 2020, amongst others. The Horizon 2020 project ‘ASGARD’ has been recently approved. The NFC also participates in national initiatives, e.g. the creation of a regional, large-scale and long-term national and international collaborative environment for data analysis and visualization (Visual Sweden).

The NFC participates in several activities aiming to improve the Swedish and European preparedness, operational capacity and competence with regard to CBRNE. We contribute with forensic expertise in several national and international projects and activities. One example is the Horizon 2020 project ‘GIFT’, where we participate in the development of methods for the safe handling and decontamination of hazardous forensic materials.
Biology Section

Case-load: 16,200 DNA cases per year, approximately 7,000 of these concerns serious crimes.

28,982 Reference samples DNA
Employees: 97 (December 2016)

The mission of the Biology Section is human biological trace search, identification, recovery and subsequent DNA analyzes, interpretation and reporting, also including DNA data basing.

The Swedish DNA Database

The Swedish DNA database expands and contains DNA profiles from 150,000 convicted offenders and suspects, and 30,000 profiles from crime scene samples in unsolved crimes. During 2015, 4,700 matches were reported from the national DNA database. The process of handling reference saliva samples and database matches is highly automated. From the day a reference sample arrives at NFC it takes about four days until the DNA-profile is included in the DNA database and any match is reported.
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Chemistry and Technology Section

Case-load: 6,700 cases per year, approximately 3,000 of these concerns fingerprint.
Employees: 96 (Dec. 2016)

Areas with High Caseloads

Fingerprint
During 2015, the influx of fingerprint cases increased by about 30% compared with the year before. To be able to handle this situation the fingerprint group has put great effort into organizing the case flow into functions manned according to a staffing plan. This has shown to be very successful and the throughput of cases has increased significantly.

Explosives
A large increase in the number of cases involving explosives was experienced during 2015. Instead of the “normal” 90-100 cases per year more than 140 requests for examination were received. A particular difference from previous years was the increasing use of hand grenades in Sweden, especially in the southern part of the country. The majority of the hand grenades had been manufactured in former Yugoslavia. NFC performed examinations in more than 40 of the investigations. A notable development in these cases is the success of finding DNA on the grenade.

The danger of hand grenades was especially obvious on one incident when a grenade was thrown at a Police bus and metal spheres/splitter from the grenade penetrated the bus.

Other cases included the identification and analysis of explosives, detonators, fuses, chemicals which can be used for making explosives and analysis of post blast samples. Dynamite is still the most common commercial explosive used by criminals in Sweden. Military explosive based on PETN is also used. Like in many other countries the misuse of pyrotechnics in Sweden is also prevalent.

Fire Investigation
During 2015 NFC performed more than 20 fire investigations both on behalf of the Police and different insurance companies. Most attention has been paid to the investigation of the fire in a mosque in Eskilstuna and several fires in different asylum accommodations.
Drug Analysis Section

Case-load: 40,800 cases (2016)
Employees: 72 (December 2016)

The principal role of the Drug Analysis Section is the analysis, both qualitatively and quantitatively, of material suspected to contain restricted substances in four categories; narcotics, goods dangerous to health, doping substances and medicines.

Cannabis and cannabis-related products (ex. hashish) account for around 45% of the cases which pass through this section, followed by medicinal/doping substances with 20%. The section also carries out profiling analyzes of amphetamine, hashish, heroin and cocaine (in collaboration with Denmark) in order to determine sample origin and, if possible, distribution patterns both nationally and internationally. Within the section approximately 100 cases of poisoning are addressed, often through the analysis of food and drink products, especially in cases involving an unknown cause of death. The section also analyzes illegally produced alcohol.

Analysis of New Drugs
Designer drugs are substances which have a structure similar to narcotic compounds but have been modified to circumvent existing drug laws. At the NFC structure determination of these new synthetic drugs is performed with nuclear magnetic resonance (NMR) techniques. NMR is a powerful analytical technique that provides important structural information about a molecule. In structural elucidations, this information is used in combination with other analytical techniques, which makes it possible to determine the structure of an unknown substance. Throughout 2014 we performed 72 structural investigations and around 50 in 2015. This, and the fact that the NFC is one of the laboratories that reports the largest number of new substances to the EMCDDA, the European Centre for the collection of data and statistics on drugs, makes us one of the leading laboratories in Europe in this field.
INFORMATION TECHNOLOGY SECTION

Case-load: 2,300 cases 2016
Employees: 57 (December 2016)

IT-forensics: Some Samples of Our Work

**Computer Forensics**
In the field of computer forensics NFC carries out acquisition of information that will be used in complex analysis, or where the storage media is corrupted and therefore needs to be repaired in order for data to be accessible. Data analysis includes complex investigations where the questions are complex and/or the data volume is very large. This places high demands on the equipment in the form of servers for processing data and storage space.

**Mobile Phone Forensics**
The activities in the field of mobile phone forensics are mainly focused on acquisition and interpreting data from heavily damaged or locked mobile phones. These types of cases have increased greatly during 2015. The work requires expertise on various phone models and how they can be investigated. Almost all mobile phone models must be handled in their own way. Acquisition is often done through so-called chip-off, i.e. directly from a desoldered memory chip. It is necessary to have a variety of tools to perform these investigations.

**Multimedia Forensics**
The forensic work regarding audio, video and images comprises a wide range of topics, and the group manages over two hundred cases each year. The most frequent case work includes image comparisons, height measurement in images, camera identification based on PRNU, recovery of image and video files, authenticity, audio enhancement and voice comparisons (via a subcontractor). Crime scene documentation is a field in which NFC is currently increasing its efforts as part of its new role within the Police organization. The team is working with and evaluating the usefulness of 3D scanners and the visualization of the results, the use of hyperspectral cameras to identify and age-estimate blood and different apps that could be of use for the crime scene investigator.
Regional Laboratories

NFC comprises three regional laboratories situated in Stockholm, Malmö and Gothenburg. The principal operations carried out at these sites incorporate analyzing traces secured and collected by CSI’s and other police officers at crime scenes within their respective region. This may for example imply development and identification of fingerprints, analyses of mechanical traces (trace evidence), questioned documents and shoe prints, investigation of fire arms as well as photographing of traces and video documentation.

**NFC Stockholm**

- Case-load: 5,400 (2016)
- Employees: 45 (Dec. 2016)

In addition to their regular cases, NFC Stockholm also carried out 23,000 cases from the Swedish Migration Board regarding search of asylum seekers during 2016. NFC Stockholm consists of three groups, two Fingerprint Groups and a Marks and Documentation Group.

**NFC Syd**

- Case-load: 6,500 (2016)
- Employees: 31 (Dec. 2016)

NFC Syd consists of two groups, a Fingerprint Group and a Marks and Documentation Group.

**NFC Väst**

- Case-load: 5,600 (2016)
- Employees: 22 (Dec. 2016)

NFC Väst consists of two groups, a Fingerprint Group and a Marks and Documentation Group.
Research and Development

Major R&D activities are focused within the following areas: evidence evaluation, DNA analysis, “designer drugs” and CBRNE. A special R&D effort is initiated in digital forensics on imaging and image analysis, to support investment in the Police’s Cybercrime Centre.

In 2016 R&D activities at NFC comprised in approximately 100 projects, activities, and programs, corresponding to 7.4% of the total annual hours. 15% of the activities consisted of research and 85% of development. Fields of research is for example evidence evaluation, big data, DNA Analysis (pre-PCR-processing), analysis of new drugs, CBRNE, digital forensics. A project office was founded in 2016 by the NFC to support the growth of forensic research and development.

DNA Analysis

An ongoing research collaboration between the NFC and Lund University (LU) aims to strengthen the existing forensic DNA analysis and aid the implementation of new technologies such as digital polymerase chain reaction (PCR) analysis and large-scale DNA sequencing. The research group is jointly financed by the NFC and external funding agencies.

One project uses the pre-PCR processing concept to develop new efficient and robust methods for detecting small amounts of DNA in chemically challenging environments such as soil, clothing and food. Validation and implementation of the new methods are included. In a PhD project with the National Institute of Standards and Technology (NIST) in the USA, digital PCR is used to study chemical inhibitors of DNA analysis, e.g. in soil and blood. Absolute DNA quantification with digital PCR is also employed to develop standard reference materials.
Scientific Productions

Reports

DNA-analysen inom brottsbekämpningen. Ur rapporten; Skurk, sjuk eller släkt - vem ska ha ditt DNA?

What Happens When the Designer Gets it Wrong – The Consequences and Causes from A Forensic Point of View”
Helene Andersson, Michael Johansson, Newsletter of the International Banknote Designers Association Issue 12, November 2016

Conference Contributions

DNAActivity: International cooperation in activity level interpretation of forensic DNA evidence

DTT quenches the passive reference signal in real-time PCR

A panel of PCR-inhibitory reference materials for quality evaluation of multiplex STR analysis kits

Reference material for comparison of different adhesive tapes for forensic DNA sampling

Crime scene DNA sampling by wet-vacuum applying M-VAC

Journal Papers

2015

Humic substances cause fluorescence inhibition in real-time PCR

Enhanced low-template DNA analysis conditions and investigation of allele dropout patterns

Chemometrics comes to court: evidence evaluation of chem-bio threat agent attacks

The optimal number of offspring per gamete donor

A panel of PCR-inhibitory reference materials for quality evaluation of multiplex STR analysis kits
Reference material for comparison of different adhesive tapes for forensic DNA sampling

Crime scene DNA sampling by wet-vacuum applying M-VAC

DTT quenches the passive reference signal in real-time PCR

Den nya svenska elimineringsdatabasen för DNA - ett effektivt verktyg för att hitta kontaminerade spår

2016

Comment on “Dismissal of the illusion of uncertainty on the assessment of a likelihood ratio by F. Taroni et.al. “
A. Nordgaard. Law, Probability and Risk, 15, 17 (2016)

Swedish legislation of forensic DNA elimination databases

Forensic characterization of mid range petroleum distillates using light biomarkers
J. Malmborg and A. Nordgaard, Environmental Forensics 17: 244 (2016).

High-throughput DNA extraction of forensic adhesive tapes
C. Forsberg, L. Jansson, R. Ansell, and J. Hedman, Forensic Science International: Genetics, 24,158 (2016)

Quantification of synthetic cannabinoids in herbal smoking blends using NMR
S. Dunne and J. Rosengren-Holmberg, Drug Testing and Analysis, 9, 734 (2016)

Comment on: C.M. Cale et al. “Could secondary DNA transfer falsely place someone at the scene of a crime?”
B. Kokshoorn, B. Aarts, R. Ansell, L. McKenna, Ed. Connolly, W. Drotz, and A.D. Kloosterman,
Journal of Forensic Sciences 61, 1401 (2016)

Results of an inter and intra laboratory exercise on the assessment of complex autosomal DNA profiles

Book Chapters

Bookchapter: Human factors in forensic examination

Bookchapter: Face recognition systems in police practice - a forensic perspective.
D. Dessimoz, E. Leitet. In: Biometrics in forensic science. Editors Tistarelli, M., Champod, C. Springer

Handbook of Biometrics for Forensic Science:Advances in Computer Vision and Pattern Recognition 2016
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