

# **A Case Study of Illicit Transfer of Nuclear and Nuclear-Related Technology Drawn from Khan Network Court Records**

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## **ABSTRACT (515)**

Although controls on single use and dual-use technologies (technical data and technical assistance) are deeply embedded in export control regimes, it is notable that nuclear and nuclear-related technologies are underrepresented in the annexes to the Additional Protocol. Export control regimes recognize the central importance of technologies needed for the development, production, or use of nuclear and other weapons of mass destruction (WMD) because technology is critical to the use of controlled goods and the development of indigenous WMD-related production capabilities. A historical, public case study helps to understand the danger posed by trafficking in uranium enrichment gas centrifuge technologies. The specific case involves the extensive assistance, including technical centrifuge data and technical training, provided by a Swiss family to the secret Libyan gas centrifuge program, trafficking critical to Libya's nuclear weapons program and all but invisible to authorities for many years until Libya decided to abandon its nuclear weapons program under IAEA verification. This assistance in turn depended on extensive technical assistance provided to this family by the Khan network. The information was uncovered and released as part of the successful Swiss Federal prosecution of three members of this family. This case study shows the importance of more fully incorporating technologies into safeguards reporting and awareness. It can also inform proposed modifications to annexes of the Model Additional Protocol.

## **INTRODUCTION**

The provision of technical data and assistance for the manufacturing and use of gas centrifuges were critical to the A.Q. Khan network's covert sale of an enrichment plant to Libya, designed to make weapon-grade uranium (WGU) for nuclear weapons. In fact, without extensive technology transfers, Libya would not have been able to finish or operate the centrifuge plant. In that sense, the provision of the technology was as, or more, important than the provision of individual centrifuge components or systems. Fortunately, the enrichment plant was never built as Libya's abandonment of its nuclear weapons program in 2003 led to the cancellation of this plant and the exposure and dismantlement of the Khan network's activities. However, that abandonment did not occur before the Khan network had transferred significant amounts of sensitive technical data to Libya as well as to several manufacturers.

The Khan network's nuclear proliferation activities in the period from the 1980s until the early 2000s have been extensively studied, and its members' transfers have been cataloged by national governments, the International Atomic Energy Agency (IAEA), and experts. Most of the publicly available assessments have focused on the single use and dual-use materials, equipment, and components associated with providing and operating a turn-key gas centrifuge plant. However, there has been less public focus on the technical data and assistance provided by the Khan network under the Libyan contract.

This report reviews the extensive illegal transfers of centrifuge and centrifuge-related technical data and assistance provided by the Khan network's Swiss node, principally composed of three members of the Tinner family, known colloquially as "The Three Tinnners." Although by no means the network's only providers of sensitive centrifuge data, all three played essential roles in providing to Libya's secret nuclear weapons program the ability to build a gas centrifuge enrichment plant aimed at enriching uranium for nuclear weapons. Their activities, as detailed in Swiss court records, reveal the types of technical data and assistance they were involved in providing to Libya's undeclared gas centrifuge program. Nuclear weapons designs digitized by the Tinnners are also discussed briefly.

## **WHO WERE THE TINNERS?**

Friedrich Tinner and his sons Urs and Marco played a key role in the Khan network. Friedrich was important in outfitting Khan's uranium enrichment gas centrifuge program in Pakistan starting in about 1975, and later, with his sons, helped Khan sell Libya the wherewithal to make gas centrifuges for nuclear weapons.<sup>1</sup> Mohamed Matuq, a senior member of the Libyan government and head of its nuclear weapons program, was key in organizing the purchase of a centrifuge plant from Khan (see Sidebar). Khan's chief aide Buhary Seyed Abu Tahir stated in a South African court deposition that the Tinnners oversaw the production of gas centrifuge components under the Khan network's lucrative contract with Libya.<sup>2</sup> To this end, Friedrich used his important contacts among suppliers of proliferation-sensitive goods, making them available to his sons. He transferred his knowledge of the centrifuge feed and withdrawal system, vacuum and valve technology, welding, and the production of centrifuge components to his sons and then, along with his sons, to Libyan mechanics and technicians.

After the 2004 revelations about the Khan network's proliferation activities, Swiss federal prosecutors focused on the Tinnners' support for Libya's nuclear weapons program between 1997 and 2003, leading to the multiyear incarceration of Urs and Marco. The charges centered on their activities to supply P2 centrifuge parts, technical data, and training in Switzerland, the United Arab Emirates (UAE), Turkey, and Malaysia. The P2 was a Pakistani designation reflecting Khan's illicit procurement of the design of the German G2 centrifuge in the 1970s. Libya renamed it the L2 centrifuge. In addition, the Swiss charges also included the illegal supply of key equipment for uranium hexafluoride gas piping systems for the P2 and the earlier generation P1 centrifuges, and the transfer of centrifuge technology during training sessions.

In June 2003, according to Swiss court records, the Tinnners signed a cooperation contract with the Central Intelligence Agency (CIA) and played a key role in exposing the Khan network. Until that time, however, the Tinnners provided extensive assistance to the Libyan centrifuge program.

After a lengthy pre-trial investigation, in September, 2012, the Swiss Federal Criminal Court in Bellinzona accepted a plea bargain negotiated between the three Tinnners and the team of federal prosecutors led by Peter Lehmann. The three Tinnners pled guilty to violating Switzerland's War Matériel Act. For their admission, and mindful of the mitigating circumstances of the Tinnners' work for the CIA, the court accepted the federal prosecutor recommendation that the Tinnners should not serve any more time in jail and should pay court costs and relatively small fines.<sup>3</sup>

## **SIDEBAR. THE A. Q. KHAN NETWORK AND ITS SUPPLY TO LIBYA**

The transnational A. Q. Khan network arose from the creation and operation of Pakistan's centrifuge program to make nuclear weapons. It had originally formed in the late 1970 and early 1980s to organize procurements abroad, both legal and illegal, for this program; later, it morphed into supplying Libya and others' centrifuge programs. Buhary Seyed Abu (B.S.A) Tahir was Khan's right-hand man for the Libyan sale. He was based in Dubai, which became the network's major hub, where many network members typically shipped their wares, for final shipment to Libya.

The centerpiece of the contract with Libya was the provision of a gas centrifuge plant, containing about 6000 P2 centrifuges organized into cascades to produce weapon-grade uranium from natural uranium. Because centrifuges can break, the contract required the supply of 10,000 P2 centrifuges. It also included the provision of a workshop to make additional P2 centrifuges and a few hundred P1 centrifuges.

The network was organized so that its key members had little direct contact with each other, and Khan and his key associate Tahir took steps to keep it that way, for example by using cover names, where Friedrich was "Garfield". Network members created elaborate civilian covers, took steps to disguise their activities, and compartmentalized to avoid directly confronting the true purpose of their activities.

The centrifuges themselves were to be produced by the Tinnens and the German Gotthard Lerch. The Tinnens concentrated on making the non-rotating components of the centrifuge and conducting much of the training of the Libyans. Lerch tried to organize the production of the difficult-to-make rotors of the gas centrifuges in South Africa, but that effort failed. The task was then assigned to the Tinnens, but they also failed. In the end, the task was pushed onto Libya itself.

A centrifuge plant requires a vast piping system to transport uranium hexafluoride (UF<sub>6</sub>) feed, product, and tails. This piping system was manufactured in South Africa. Lerch recruited the South African Gerhard Wisser of Krisch Engineering to be responsible for the manufacture of this system, who in turn enlisted Johann Meyer as the principal manufacturer of the components. Meyer named Daniel Geiges as the chief engineer for the project. Friedrich Tinner organized the supply of specially constructed valves.

The centrifuge stators, a specialized part that forms the non-rotating part of the centrifuge motor, were produced in Turkey by Günes and Kürsad Cires. They merged the stators with the aluminum motor housing, which had been manufactured in Switzerland. The Turkish national Selim Alguadis was responsible for producing electronic equipment, including the power supplies or inverters that drive the stators by a frequency synchronous with the speed of the centrifuge rotors.

Peter Griffin was initially responsible for supplying equipment for Libya's gas centrifuge manufacturing workshop, a feature of many centrifuge plants that want to expand or replace broken centrifuges.

Libya's main technical contact to the Khan network via Tahir was Abdu-Alkareem Milad Belaeid Emeghigh (also known as Karim) who headed Libya's centrifuge program.

The Tinnings admitted that from the late 1990s to June 2003 they knowingly assisted Libya's production of nuclear weapons in violation of the Nuclear Non-Proliferation Treaty, and as part of the plea deal, did not dispute a long list of illegal activities involved in that assistance. This assistance is detailed in the *Summary Bill of Indictment* ("*Summary Indictment*").<sup>4</sup> In addition to containing admissions of the Tinnings' supply of many centrifuge and centrifuge-related goods, the *Summary Indictment* states that "the training of technicians was facilitated, who were able to apply the acquired knowledge in their country of origin for construction of uranium enrichment plants and thus to manufacture weapons-grade uranium, which is vital as a preliminary stage for the manufacture of nuclear weapons, and thus facilitated the manufacture of nuclear weapons."<sup>5</sup>

## **DRAWINGS AND DESIGN**

The foundation of the Khan network's provision of a centrifuge plant, known as a gas ultracentrifuge plant (GUC) in the *Summary Indictment*, rested on the centrifuge designs and associated instruction materials. Most were originally in the possession of Khan and his Pakistani centrifuge colleagues at A.Q. Khan Research Laboratories, since renamed. These designs, along with manufacturing and operating instructions, were transferred to the members of the Khan network.

One of Urs Tinner's first tasks for the Khan network involved creating additional drawings by measuring specific P1 centrifuge parts, which he had received from Tahir. He did this in Dubai, where he had moved in 1998 to work for Tahir, a position he obtained through the mediation of his father. Tahir made him the factory manager at the Desert Electrical Engineering Factory (DEEF).

Between 1998 and 2000, according to German court records, Marco supervised making modifications to the centrifuge drawings aimed at simplifying the manufacture of specific parts.<sup>6</sup> According to the *Summary Indictment*, Friedrich periodically corrected errors on centrifuge component drawings or otherwise changed them to prepare them for manufacturing. He also redrew technical drawings of the P2 centrifuges, "supplemented missing or false measurements," and "made changes in the originals for cost reasons." Changes in centrifuge drawings were checked with Khan.<sup>7</sup>

During the week from March 7-14, 2000 in Dubai, Friedrich and Urs "redrew the blueprints (original drawings) received from Khan/Tahir, whereby they renumbered the technical drawings, which served as the basis for the manufacture of the P2 GUC [gas ultracentrifuge] components with 200,000 and 9,000 numbers [series], translated the drawings' title blocks from English to German, completed the illegible or non-visible parts, designated the material to be used or supplemented them with all information required for manufacture of the GUC components, and then transferred the prepared drawings to Khan."<sup>8</sup> This redrawing removed all traces pointing to Pakistan and updated the drawings. Each relabeled component drawing had a new number, e.g. 9001, 9002, 9003, etc. The German-language title blocks would further point any manufacturers away from Pakistan while easing manufacturing in German-speaking countries like Switzerland.

Urs supplied his brother Marco with about 40 P2 centrifuge component drawings so that Marco could have them manufactured at the Swiss company Kirag AG. As Kirag finished

manufacturing the components, Marco delivered them to the Tekno Co. in Turkey, the SCOPE Co. in Malaysia, and Al Khadar Technologies Establishment in Dubai.

Using centrifuge drawings and know-how, Urs set up an industrial production shop in Malaysia in 2000, at SCOPE Co, to make a range of other non-rotating centrifuge components (see below). The Tinnars also were involved in setting up a manufacturing workshop in Turkey to make centrifuge parts, to which they supplied other drawings and know-how (see below).

Later, Urs scanned and redrew “blueprints” of both the P1 and P2 centrifuges and their piping system in Dubai. He also digitized the P2 centrifuge drawings and delivered them to Tahir and his brother Marco. Urs sent a complete set of digitized P1 gas centrifuge drawings as well as a schematic of the P1 centrifuge via Tahir to Libya.

**Sabotaging Components for the CIA?** Urs and to a lesser extent Marco have claimed, without any supporting evidence that they altered a few centrifuge components to make them unfit for operation. Based on their descriptions, the alterations involved modifying the assembly of some components out of their subcomponents, not the altering of design drawings. There is dispute about whether this sabotaging happened before the June 2003 contract with the CIA or was effective, at least for components destined for Libya. European centrifuge experts, including at least one of whom examined the alleged altered parts, discounted their claim.<sup>9</sup> The centrifuge experts concluded that the sabotaging was either non-existent upon visual examination or the purported changes would in fact not interfere significantly in the centrifuges’ operation. Even if the Tinnars’ claims were true, these actions do not diminish the vast amount of sensitive centrifuge data and assistance they illegally provided to Libya.

### **Uranium Hexafluoride Piping and Valves**

Under the Libyan arrangement, Friedrich provided construction drawings and schematics for the centrifuge plants and applied his decades of experience in the centrifuge feed and withdrawal systems. He also used his expertise to designate necessary workshop equipment for the training of mechanics and technicians in how to handle UF<sub>6</sub> enrichment technology.

### **Nuclear Weapons Drawings<sup>10</sup>**

In 2006, The Swiss authorities seized digital files from the Tinnars containing nuclear weapons design information. There was a digitized and more thoroughly documented version of nuclear weapon drawings and instruction manuals provided directly by Khan to Libya. Pakistan acquired the design from China in the early 1980s. In addition, the Tinnars also had drawings for the components of two smaller, more advanced Pakistani nuclear weapons, developed after receiving the Chinese design. One design dated to the 1990s and was tested in 1998. Missing in the set of the more advanced drawings were those for high explosive and uranium metal components. Marco and Urs appeared to be working on the electronic and metal parts. The Tinnars worked on the drawings on different computers in the United Arab Emirates, Malaysia, and Switzerland. They did not appear to have a set schedule for completing the work. The Tinnars were scanning these drawings onto hard discs in preparation for turning them into digital drawings, and also developing manufacturing instructions for each part. The original

Pakistani drawings, some quite large, were hard copies produced by draftsmen; some even had the draftsmen's initials on them. The process of producing digitized drawings was laborious and not likely to be done without a specific purpose in mind.

Why were the Tinnners digitizing these drawings? According to officials who examined these documents in Switzerland, the Tinnners' work on the drawings appeared to be aimed at selling finished drawings and accompanying manufacturing instruction manuals. As far as is known, they did not provide any to Libya. However, they did not archive the drawings in a centralized location and left them unencrypted, increasing the risk of further transfer and the difficulty of recovery by authorities.

## **TRAINING FACILITY IN DUBAI AT DEEF**

At the Desert Electrical Engineering Factory, starting in 1998, Urs built a precision workshop with machinery and equipment that the family procured. The DEEF workshop became a critical repository of a wide variety of sensitive centrifuge and centrifuge-related technical data and expertise, serving a critical function in transferring that data to Libyans seeking a wide spectrum of skills and technologies for their centrifuge program.

### **Building the Training Facility**

In 1998, Urs advised Tahir on how to set up DEEF "for training purposes, including the interior structure of the assembly room, the two offices, a conference room, and the sanitary facilities," according to the *Summary Indictment*. He recommended to Tahir which machines and related equipment and materials should be procured for training purposes, and his family acquired them from a variety of suppliers in different countries.

Friedrich played an important supervisory role at DEEF, advising on the operation of DEEF and modifications to it. For example, in April 1998, following an inspection of the DEEF factory floor, he initiated recommendations for the doors of the clean-room door systems.

**Centrifuge Test Cascades.** One of the key training tools at DEEF were small centrifuge test cascades, referred to as "units" or "modules" by the Tinnners. These units lacked centrifuges but contained control, cooling, measurement, vacuum, and the feed and withdrawal systems. They also included a leak detector and cylinders to hold uranium feed, product and tails.

Friedrich initially provided the test modules' construction drawings and schematics. Marco, supervised by his father, helped to prepare the drawings required for the construction of at least one of the test modules, and systematically numbered the drawings he provided.

The Tinnners manufactured the test modules 09 and 19, which would hold 9 and 19 P1 centrifuges, respectively, and delivered them to DEEF. Urs installed the 09 and 19 test modules in DEEF starting in November 1998, welding together the piping units delivered from Switzerland. Later, they designed a 64-machine unit.

In the fall of 1998, the Tinnens procured six turbomolecular vacuum pump stands, used for the evacuation of the centrifuges' feed and withdrawal system. Urs set up the pump stands at DEEF as a demonstration in training Libyan mechanics or technicians in how to produce a vacuum in the centrifuge test modules.

Following a November 1998 training session in Dubai, and a discussion with Karim, the head of Libya's centrifuge program, Friedrich ordered a range of goods for future DEEF training sessions. The goods included vacuum valves, leak detectors, helium pistols for leak testing, replacement parts for the modules and flow meters, welding equipment, a mass spectrometer, an ultrasonic cleaning system, and Pirani gauges (a vacuum gauge).

Later, DEEF's equipment with accessories was sold via Tahir to Libya. Friedrich then ordered tools for another workshop nearly identical to the first one with an assembly room, clean room, tables, and trolleys. In March 1999, Urs helped construct this nearly identical workshop at DEEF and used it for additional training.

**Centrifuge Test Stands.** At DEEF, Urs assembled the components delivered by Khan (without rotating parts, i.e. centrifuge rotor assemblies) for two P2 centrifuges. Without the rotor assemblies, these centrifuges could not enrich uranium but would be valuable for training.

### **Training Sessions at DEEF**

The Tinner family regularly used the DEEF workshop to train Libyan personnel in centrifuge and centrifuge-related technologies. They conveyed the critical skills needed to build and maintain a centrifuge plant, including expertise in basic mechanical activities, vacuum and valve technology, using a mass spectrometer, working with test modules, quality control, computerized machining techniques, and special electronic fields.

Friedrich carried out several training sessions at DEEF, including:

- Training mechanics and technicians in welding, vacuum, and valve technology and mass spectrometry from September 2 to 9, 1998;
- Training mechanics and technicians in welding of pipes to the centrifuge triffanges, in operating an enrichment plant, and in connecting the flanges and valves from November 6 to 14, 1998; and
- Giving individual centrifuge-related lessons to Karim.

During a training session from December 9 to 14, 1999, in Dubai, Marco explained the function of an inverter (power supply unit that drives the motor and the rotational speed of a centrifuge).

Urs fulfilled Tahir's assignments for training of Libyan mechanics and technicians. In seven training blocks, he instructed eight persons in the cutting, processing, and welding of pipes, and trained them in tool, connector, flange, and induction technology:

- From November 6 to 14, 1998, he trained technicians in the welding of bellows to end pieces (used in what are called bellow-sealed vacuum valves), welding of pipes to the

triflanges, operation of the test module, connection of flanges and valves to the test modules, and in welding techniques generally;

- In 1999, after the modules at the DEEF workshop were sent to Libya and replaced by new equipment, he trained three persons for a week in how to use a lathe, knowing that they had identical machines in Libya;
- In 1999, he instructed five persons in milling;
- In 1999, together with his father, he taught the basic principles of vacuum technology;
- In the period from 1999/2000, he taught technicians how to weld together the units of piping sent from Switzerland for the 9-machine, 19-machine, and 64-machine test cascade, in particular the TIG, plasma, and orbiter welding techniques needed for that;
- In late 1999, he trained technicians in the installation of the P1 centrifuge and showed them how the rotor is installed in the P1 centrifuge, the Fomblin oil (a PFPE lubricant) is introduced, and the centrifuge's outer casing is sealed with its cover; and
- He taught mechanical skills generally, and how to control centrifuge motors using the power supply units manufactured in Turkey at ETI (see below).

## **WORKSHOPS AND TRAINING IN TURKEY**

The Tinnens identified and procured machine tools for the manufacture of P2 centrifuge components in Istanbul, Turkey. They supported two fabrication companies, ETI Elektronik and its subsidiary Tekno Elektrik Sanayi Ve Ticaret Ltd. (Tekno) that were contracted to manufacture centrifuge motors, most importantly the stator, which is the critical non-rotating part of the motor designed for synchronous operation in a vacuum (the rotating part of the motor or armature is connected to the bottom end cap of the centrifuge).

Friedrich contracted on the procurement and delivery of machine tools to Tekno and a specialized vacuum oven, along with Araldite, a specialized adhesive that can withstand uranium hexafluoride, used for the sealing of the P2-centrifuge motors. Marco's company, TRACO Schweiz, manufactured and delivered the vacuum oven (consisting of a heating chamber and a pump) to Tekno.

Urs trained technicians at ETI to make the stators. In 2001/2002 he trained about 10 technicians from Libya including Karim in Araldite sealing of the stators at ETI. He demonstrated how the Araldite behaves in the oven. Urs also explained the functions of the magnetizer unit and the vertical and horizontal equilibration of the standard electromotor parts.

## **TRAINING MANUALS**

The Tinnens produced and disseminated many centrifuge and centrifuge-related operating instructions and manuals for training purposes at DEEF and elsewhere. In March 1998, they brought the training literature to Dubai. After their use in training at DEEF and Turkey, the Tinnens provided these items, via the Khan network, to Libya.

Urs scanned original documents received from Tahir and Khan and transferred them into data media. These documents described the manufacture of the P1 gas ultracentrifuge, including its assembly and testing; the construction, operation, and testing of a plant of 1000 gas centrifuges;

the operating and installation instructions for the “blackening” of centrifuge parts (specially oxidized to prevent corrosion); the uranium gas handling system; and the production process from uranium yellowcake to uranium hexafluoride.<sup>11</sup> Urs provided these operating and installation instructions to his father, who used his specialized knowledge in May 1999 to recommend to Khan improvements in the construction and test instructions for the P1 centrifuge.

Friedrich undertook a variety of other activities to produce or improve instruction manuals. During a training session at DEEF, Friedrich translated individual centrifuge-related subjects into English for participants. In February 2000, Friedrich translated parts of the instructions for the passivation of the P1 centrifuge (to reduce corrosion). In June 2000, he translated into German operating instructions for the startup of a cascade with 64 centrifuges and their subsequent operation. He also included instructions for sampling and the replacement of autoclaves. In January 2002, he wrote instructions for the construction and operation of ovens necessary for the heating of adhesives and for the sealing of the stators in the centrifuge motors.

## **CENTRIFUGE MANUFACTURING AT SCOPE**

Starting in early 2000, on behalf of Tahir, armed with centrifuge drawings and manufacturing expertise, Urs started researching opportunities to produce P2 centrifuge parts in Malaysia. He examined various company sites, developing a concept, and settling on the Scomi Group. The Scomi Group worked in the areas of oil, gas and transportation; Tahir knew the key person at SCOMI who happened to also be the son-in-law of Malaysia’s then prime minister.

Urs helped construct an industrial workshop to mass produce centrifuge components at the newly created Scomi subsidiary, Scomi Precision Engineering SDN. BHD (SCOPE) in Shah Alam, Malaysia. Toward that end, he traveled regularly between Dubai and Malaysia. Along with his father and brother, he identified and procured workshop and production equipment, including machine tools and lathes, for the production of centrifuge components.

From February 2001 to June 2003, Urs arranged for the SCOPE employees to manufacture centrifuge components for the Libyan centrifuge plant with redrawn and updated 9000-series drawings, including numbers 9004, 9005, 9006, 9008, 9009, 9011, 9026, 9035, 9037, 9048, 9056, 9059, 9064, 9071 and 9073. He then supervised their work and checked the parts’ quality.

## **CONCLUSION**

Despite the age of the case, the lessons learned are still relevant to several situations today involving Iran, North Korea, Russia, and transshipment countries, among others. More broadly, it stands as a precautionary tale for many other sensitive WMD and missile technologies.

For strategic trade controls, the Tinner case showcases the wide range of sensitive technologies critical for building centrifuge plants. This case also serves as a reminder of the importance of incorporating controls on sensitive technical data and assistance, including intangible technology transfers, into export control regimes and national systems. The Tinner’s activities highlight the need to maintain vigilance in industry, academia, and governments about the potential misuse of sensitive technical data. This case also shows that it is not just major supplier countries who face

this risk but also transshipment hubs and more broadly countries with less developed export controls and supply potential. There is an ongoing need for improving and expanding strategic trade control implementation and risk assessments of clients, external collaborators, sensitive technical data, and proliferation threats.

For IAEA safeguards, the Tinner case sheds light on how sensitive technology is transferred as part of acquiring undeclared nuclear facilities. It should be noted that this case also represents a success for the IAEA, involving cooperation with Swiss authorities in assessing the Tinner's actions and information<sup>12</sup> The case also highlights the troubling role third countries can play as important hosts to such a transfer, especially countries with no nuclear material, and thus little interaction with the IAEA, and with fewer means to detect the transfers. Some of these countries, including Malaysia, still do not have the Model Additional Protocol (AP) in force, increasing the risk of centrifuge component manufacturing passing under the radar. This case also shows the potential value of incorporating technical data more fully into safeguards reporting and awareness. There remains a need for an IAEA evaluation of how to better harmonize the inclusion of technical data and transfer in safeguards arrangements, including the AP, with national export control systems and the Nuclear Suppliers Group guidelines. For example, the Tinner's centrifuge data is not included in the AP's Annex II, so its export today would not require a state declaration to the IAEA by a state with the AP in force.

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<sup>1</sup> David Albright, *Peddling Peril* (New York: Free Press, 2010).; and Albright, Libya, A Major Sale at Last, Institute for Science and International Security Special Report, November 9, 2010.

<sup>2</sup> Extract from the Statement Sayed Abu Tahir Bin Bukhary, South Africa, June 7, 2006, Court Copy, [https://isis-online.org/uploads/conferences/documents/SouthAf\\_Tahir\\_affidavit.pdf](https://isis-online.org/uploads/conferences/documents/SouthAf_Tahir_affidavit.pdf)

<sup>3</sup> David Albright and Michael Rietz, Closing the Tinner's Swiss Criminal Case, *Institute for Science and International Security*, October 26, 2012, <https://isis-online.org/isis-reports/detail/closing-the-tinner-swiss-criminal-case/>.

<sup>4</sup> Anklageschrift im abgekürzten Verfahren, gemäss Art. 360 StPO an die Strafkammer des Bundesstrafgerichts in Bellinzona, in der Strafsache Beschuldigte, Friedrich Tinner-Göldi, Marco Walter Tinner, Urs Tinner. In English, *Summary Bill of Indictment*, pursuant to Art. 360 stop [Code of Criminal Procedures] to the Criminal Division of the Federal Criminal Court at Bellinzona in the Criminal matter, accused persons Friedrich Tinner-Göldi, Marco Walter Tinner, Urs Tinner. An official Court stamp for the document is August 17, 2021. In this report, this document is referred to as the "*Summary Indictment*." English translation of the *Summary Indictment* by Schreiber Translation in 2012 for the Institute for Science and International Security.

<sup>5</sup> Unless otherwise noted, the source of the technical data and assistance supplied by the Tinner is from the *Summary Indictment*."

<sup>6</sup> German Prosecutor, Preliminary Proceedings Against Anonymous on Suspicion of Treason by Delivering Gas Ultracentrifuge Technology to Libya, Interviews, Karlsruhe, July 2, 2004.

<sup>7</sup> *Peddling Peril*.

<sup>8</sup> *Summary Indictment*.

<sup>9</sup> See "CIA Recruitment of the Three Tinner: A Preliminary Assessment," by David Albright and Paul Brannan, *Institute for Science and International Security*, December 21, 2010, pp. 8-10, [https://isis-online.org/uploads/isis-reports/documents/three\\_tinner\\_recruitment\\_21Dec2010.pdf](https://isis-online.org/uploads/isis-reports/documents/three_tinner_recruitment_21Dec2010.pdf).

<sup>10</sup> This section is drawn from *Peddling Peril*.

<sup>11</sup> The Tinner possessed a range of sensitive nuclear data beyond centrifuge and nuclear weapon data.

<sup>12</sup> David Albright, "Procurement Data and Safeguards: Looking Historically and to the Future," presented at the IAEA Safeguards Symposium 2022, IAEA-CN-303-263.