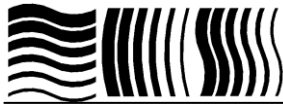


ANNUAL REPORT 2016

Objective

The Nederlandse Commissie voor Stralingsdosimetrie (NCS, Netherlands Commission on Radiation Dosimetry) was established on the 3rd of September 1982 with the main objective of promoting the appropriate use of radiation dosimetry, both for radiation research and for practical applications. The NCS is chaired by a board of scientists, installed in consultation with the supporting societies:

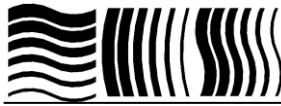
- Nederlandse Vereniging voor Radiotherapie en Oncologie (NVRO, Dutch Society for Radiotherapy and Oncology);
- Nederlandse Vereniging voor Nucleaire Geneeskunde (NVNG, Dutch Society for Nuclear Medicine);
- Nederlandse Vereniging voor Klinische Fysica (NVKF, Dutch Society for Medical Physics)
- Nederlandse Vereniging voor Radiobiologie (NVRB, Dutch Radiobiological Society);
- Nederlandse Vereniging voor Stralingshygiëne (NVS, Society for Radiological Protection of the Netherlands);
- Nederlandse Vereniging Medische Beeldvorming en Radiotherapie (NVMBR, Dutch Society for Medical Imaging and Radiotherapy);
- Nederlandse Vereniging voor Radiologie (NVvR, Radiological Society of the Netherlands);
- Société Belge des Physiciens des Hôpitaux/Belgische Vereniging voor Ziekenhuisfysici (SBPH/BVZF, Belgian Hospital Physicists Association);
- Nederlandse Vereniging van Klinisch Fysisch Medewerkers (NVKFM, Dutch society of Medical Physics Engineers)



To pursue its aims, the NCS has the following tasks:

- Participation in dosimetry standardization and promotion of dosimetry inter-comparisons;
- Drafting of dosimetry protocols;
- Collection and evaluation of physical data related to radiation dosimetry;
- Maintain or establish links with national and international organizations concerned with ionizing radiation;
- Promulgate information on new developments in the field of radiation dosimetry.

Website: <http://www.radiationdosimetry.org>



Board

On December 31, 2016 the members of the board of the NCS were:

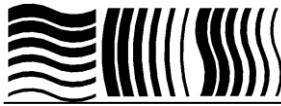
Dr. J.B. van de Kamer	chairman	(NVRO)
T.W.M. Grimbergen	vice chairman	(NVS)
Dr. J.A. de Pooter	secretary	(VSL)
Dr. A. Rijnders		(SBPH/BVZF)
J.M.J. Hermans	treasurer	(NVKFM)
Dr. J. R. de Jong		(NVNG)
Dr. P. Sminia / Dr. K. Franken		(NVRB)
Dr. Ir. F.W. Wittkämper		(NVKF)
M.K. Zeeman		(NVMBR)

The board of the NCS met four times in 2016, on 13 January, 10 May, 17 September and 14 December. The main subjects raised at the board meetings were:

- Monitoring the progress of activities by the subcommittees and the platform;
- Initiate the publication of NCS-reports;
- Development of new activities.

In 2016 NCS report Human Exposure to Ionising Radiation for Clinical and Research Purposes was published.

Three new subcommittees have been installed; Guidelines for Radiation Protection and Dosimetry of the Eye Lens, Dosimetry for Scanned Pencil Beam Proton Therapy and Code of Practice and Recommendations for Stereotactic Body Radiotherapy. As of September 2016 Aart Spilt has resigned from the NCS board. Aart Spilt has been a member of the NCS board for 7 years. The NCS board appreciates the valuable contribution of Aart Spilt and wants to thank him for his commitment. The representation of the NVvR in the NCS board was taken over by Nanko de Graaf in January 2017. The end of 2016, preparation for the 7th NCS lustrum symposium was started by the NCS board. The topic is 'proton therapy'. For citation purposes in scientific literature a system exists for identification of papers, standards, etc: the so-called DOI. Since NCS reports are frequently cited in the scientific literature it was decided to register DOI's for each NCS reports to harmonize the way NCS reports are cited in the literature.



Subcommittees

1. *Subcommittee on Guidelines for Quality Assurance of Helical Tomotherapy*

Helical Tomotherapy is a modality for radiation therapy treatment with integrated systems for treatment planning, imaging, image registration and dose delivery. It has several differences compared to conventional linear accelerators, which imply that general Quality Assurance guidelines are not always applicable or adequate. For example, current dosimetric protocols, based on the absorbed dose (NCS 18, AAPM TG-51), require calibration measurements under reference conditions. These reference conditions can not be met. New methodologies are proposed in literature and are currently under discussion. Other specific QA issues concern the acceptance testing and commissioning of the integrated system, verification of dose planning and delivery, mechanical QA and patient safety.

Since the publication of TG148 on Tomotherapy Quality Assurance (Langen et al, Med.Phys. 2010) new functionality has been added to the system, like the dose control system, a new type of linac and target, the VoLO optimization and dose calculation using GPU architecture, calibration of the MVCT HU units to density, TomoDirect (treatment with fixed gantry angles), TomoEdge (treatment with dynamic collimation in cranio caudal direction) and TQA (integrated and automated tool for QA using the build in detector array). The goal of this report is to provide an updated guideline for QA and dosimetric calibration of the Helical Tomotherapy system.

The report is in the process of review by external stakeholders and will be published in 2017. The report will cover the following topics:

- Treatment delivery – mechanics - TQA
- Dosimetry
- Treatment planning
- Imaging and set up verification
- Miscellaneous (adaptive, patient transfer and DQA)

Members of this NCS subcommittee:

Vincent Althof (Radiotherapiegroep, Deventer, chairman)

Bie De Ost (UZA/ZNA, Antwerpen, secretary)

Nick Reynaert (Centre Oscar Lambret, Lille)

Kay Schubert (DKFZ, Heidelberg)

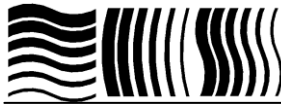
Edmond Sterpin (UCL, Brussel)

Jeroen van de Kamer –(NKI/AvL, Amsterdam, representative from the NCS-board)

2. *Subcommittee on quality assurance of cone-beam CT*

Cone-beam CT scanners integrated with linear accelerators have become increasingly important tools for image guidance of radiotherapy treatments. The application of cone-beam CT based image guidance is very diverse, ranging from bony anatomy based offline correction protocols to online stereotactic tumor based correction strategies. Although most institutions have presently implemented QA procedures for CBCT, the frequency and methods vary widely.

The aim of the subcommittee is to develop uniform guidelines for the commissioning and quality assurance of cone beam x-ray based image guidance systems on conventional linacs, i.e. cone-beam CT (XVI, OBI), and portal imagers. The guidelines will be based on current literature as well as clinical experience from the participating members of this subcommittee.



Only one meeting of the committee has been held in December 2016 in Amsterdam (NKI), due to other commitments of most subcommittee members. The meeting was focused on finalizing the draft versions of all chapters. By March 2017, a complete version will be ready for external review. Willy de Kruijf resigned the committee due to other obligations. His place was taken by Greet d'Olieslager. Kirsten Deurloo has taken over the role of Secretary of the committee. For the coming year the goal is to finalize the report.

Members of the subcommittee

Peter Remeijer (NKI/AVL, Amsterdam, Chairman)
Kirsten Deurloo (MCA, Alkmaar, Secretary)
Heleen van Herpt (UMCG, Groningen)
Martijn Hol (LUMC, Leiden)
Martijn Kusters (UMC St Radboud, Nijmegen)
Greet d'Olieslager (BVI, Tilburg)
Marianna Sijtsema (UMCG, Groningen)
Niek van Wieringen (AMC, Amsterdam)
Koos Geleijns (LUMC, Leiden, advisor CT dosimetry)
Joep Hermans (MAASTRO, Maastricht, representative of the NCS board)
Martijn Eenink (LUMC, Leiden, past-member)
Willy de Kruijf (BVI, Tilburg, past-member)

3. Subcommittee on "IMRT & VMAT Audit"

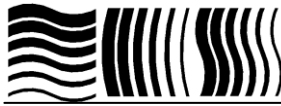
The subcommittee conducts a voluntary audit of IMRT and VMAT/RapidArc delivery modalities in the radiotherapy institutes in the Netherlands. The goal of the audit is to independently validate patient-specific quality assurance (QA) methods, clinically used in the Netherlands, for IMRT and VMAT plans using the same set of treatment plans for all institutes.

For a limited set of RT plans, defined by the committee, the dose distribution computed by an institution's treatment planning system is compared with the dose measurements performed by the audit team at the institution's linear accelerators. This is done independently from the treatment planning optimization process. Each plan is measured by an ionization chamber (pinpoint), Gafchromic film and a 2D ionization chamber array (Octavius, PTW). Additionally, the results are compared to the QA measurements done by each institute according to their local protocol.

In 2016 the subcommittee met 5 times. The data were analysed and the final report is being finalized. Leo van Battum (VUmc) was added to the subcommittee. An oral presentation at the 35th ESTRO forum, Torino, Italy, was given.

Members of the subcommittee are:

Enrica Seravalli (UMCU, Utrecht, Chair)
Anette Houweling (AMC, Amsterdam / UMCU, Utrecht, Secretary)
Marion van Gellekom (ARTI, Arnhem)
Leo van Battum (VUmc, Amsterdam)
Jochem Kaas (NKI-AVL, Amsterdam)
Erik Loeff (Erasmus MC, Rotterdam)
Thom Raaben (MST, Enschede)
Marc Kuik (MCA, Alkmaar)
Wilfred de Vries (UMCU, Utrecht)
Jacco de Pooter (VSL, Delft, Representative from the NCS board)



4. *Subcommittee on QA of brachytherapy with Ir-192 afterloaders*

The subcommittee has been set up in 2014. Goal of the subcommittee is to prepare a code of practice for Quality Assurance of Ir-192 afterloaders for HDR and PDR brachytherapy, as used in The Netherlands and Belgium. In 2016 the subcommittee had 8 meetings in which we wrote the several chapters of the report. Chapters are dedicated to QA of afterloader and source; QA of applicators and transfer tubes; safety and security; organizational aspects. Discussions were very fruitful.

We anticipate finishing the report in fall 2017.

Members of the subcommittee are:

- Jacco Steenhuisen (Catharina-ziekenhuis, Eindhoven, Chairman)
- Marja Harbers (MST, Enschede)
- Aswin Hoffmann (University Hospital Carl Gustav Carus, Technische Universität Dresden)
- Astrid de Leeuw (Universitair Medisch Centrum Utrecht)
- Rita Reymen (GZA-Sint Augustinus Wilrijk/Antwerpen)
- Mirko Unipan (Maastricht Clinic, Maastricht)
- Alex Rijnders (Europa Ziekenhuizen, Brussel, representative from the NCS board)

5. *Subcommittee on Code of Practice and recommendations for Total Body Irradiation and Total Skin Irradiation*

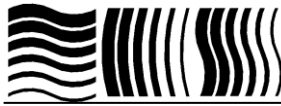
The goals of this NCS subcommittee is to investigate the status of treatment protocols and quality control for total body and total skin irradiation in the Netherlands and Belgium. Most centres use AAPM reports 17 and 23 as a starting point, but deviate from this after a few decades. Recent technological evolution allows new treatment and treatment planning techniques, creating a need for a guidance report for individual centres in order to compare their current way of practice to the state of the art practice. The workgroup did not meet this year. The questionnaire was returned and analysis is still in progress. The working group was divided in subgroups and each subgroup was asked to make a overview of the topics on their chapter. All the chapters were submitted to the dropbox. On January 20th 2017 a meeting was scheduled to start the drafting of the report.

Members of the subcommittee are:

- Geert Pittomvils (UZ Gent, Gent, Chairman)
- Wim Jansen (LUMC, Leiden, Secretary)
- Maxime Coevoet (Saint Luc UCL, Brussels)
- Nicolas Hermand (UZ Leuven, Leuven)
- Phil Koken (VUMC, Amsterdam)
- Heleen van Herpt replacing Heidi Lotz (UMCG, Groningen)
- Daan Martens (NKI-AvL, Amsterdam)
- Lars Murrer (Maastricht Clinic, Maastricht)
- Peter Van der Hulst (UMCG, Groningen)
- Ruud Van Leeuwen (RadboudUMC, Nijmegen)
- Francoise Vanneste (Saint Luc UCL, Brussels)
- Jeroen Van de Kamer (NKI-AvL, Amsterdam, representative of the NCS Board)

6. *Subcommittee on Radiation Dose & Risk Estimation of Medical Diagnostic and Research Procedures*

The aims of this NCS subcommittee were (1) to define threshold radiation doses regard-



ing the risk of deterministic effects and to estimate stochastic effects in humans exposed to ionizing radiation, (2) to provide guidelines for diagnostic and interventional procedures in patients and healthy volunteers participating in scientific medical research, and (3) to define additional measures for those cases where the threshold values are exceeded. Threshold radiation doses (mSv/mGy) have been derived from the literature, mainly the ICRP reports. Based on these threshold values and taking into account several variables like radiation dose, age at exposure, gender and life expectancy, risk estimations were presented. The subcommittee also proposed guidelines for interventional procedures that inevitably exceed the threshold values, both for clinical practice and for healthy subjects or patients participating in medical research. A follow-up working group will define those interventions for which additional measures, e.g. specific training or protocols, are required.

Communication of the subcommittee was via e-mail, phone and writing sessions. On April 20, a next version of the report was presented and discussed in a meeting of the Centrale Commissie Mensgebonden Onderzoek (CCMO) for the chairs of all Medical Ethical Committees in the Netherlands. The CCMO supported publication of the final version.

The report was finalized and published on the website of the NCS in May 2016 (Human Exposure to Ionising Radiation for Clinical and Research Purposes: Radiation Dose & Risk Estimates. NCS Report 26). Following publication, the task of the subcommittee was completed and the committee was discontinued.

In order to inform experts in the field, a Dutch summary of the report was published in the Tijdschrift voor Nucleaire Geneeskunde (Is het middel erger dan de kwaal? Toepassing van straling in de medische praktijk. J. van de Kamer, A.A. Lammertsma en P. Sminia. TvNG 38(3):1585-1587) and is in press in the Nederlands Tijdschrift voor Stralingsbescherming of the Nederlandse Vereniging voor Stralingshygiëne (NVS).

Members of this NCS subcommittee:

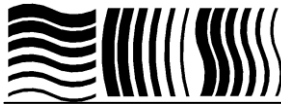
- Peter Sminia (VUmc, Amsterdam, Chairman, representative of the NCS board)
- Marloes de Fluiter-Zeeman (NVMBR, Utrecht, representative of the NCS board)
- Klaas Franken (AMC, Amsterdam, representative of the NCS board)
- Marcel Greuter (UMCG, Groningen)
- Frank de Lange (Radboudumc, Nijmegen)
- Alie Vegter (NVMBR, Utrecht, representative of NCS Platform)
- Adriaan Lammertsma (VUmc, Amsterdam, representative of NVNG)
- Aart Spilt (Spaarne Gasthuis, Haarlem, representative of the NCS board)
- Marcel Wiegman (Radboudumc, Nijmegen)
- Jeroen van de Kamer (NKI/AvL, Amsterdam, Chairman NCS)

7. Annual report NCS subcommittee on Audit of high-energy Electron beams

Based on the results of a survey about the use of electron beams in the Radiotherapy departments in The Netherlands and the wish of a number of Radiotherapy departments for an electron dosimetry audit, the NCS board established in 2015 the NCS subcommittee on Electron Audits.

The subcommittee decided to establish an audit method for electron beams and apply this audit method at the 4 participating institutes. Thereafter the VSL will adopt the audit method and will make it available to all Radiotherapy centers.

In the first half of 2016 the results of the audit were finalized and the report has been written in concept. During the first quarter of 2017 the report will be finalized and published as NCS report. June 2016 Wenzel van Klink has accepted another position and resigned from the subcommittee.



Members of this NCS subcommittee:

- Frits Wittkamper (NKI/AvL, Amsterdam, Chairman and representative of the NCS board)
- Thijs Perik (NKI/AvL, Amsterdam)
- Stan Heukelom (VUmc, Amsterdam)
- Wenze van Klink (VUmc, Amsterdam, past-member)
- Wim Jansen (LUMC, Leiden)
- Elfried Kok (RdGG, Delft)
- Leon de Prez, (VSL, Delft, secretary)
- Bartel Jansen (VSL, Delft)
- Jacco de Pooter, (VSL, Delft, advisor)

8. Subcommittee on Radiation Protection and Dosimetry of the Eye Lens

Evaluation of the eye lens dose is of increasing importance due to the growing insight in the sensitivity of the organ. The European BSS directive of 2013 has implemented the recommendations of the ICRP and limited the annual eye lens dose to 20 mSv. This directive will be implemented in the national legislation in 2018.

The goals of the subcommittee are:

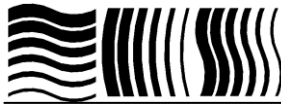
- 1) Provide guidance for reducing the exposure of the eye lens
- 2) Provide guidance for determination of the eye lens dose
- 3) Provide decision rules when to use eye lens dosimetry

The kickoff meeting of the subcommittee took place at July 14th. The committee gathered 3 times in 2016 (July, October, December).

During the kickoff, the scope of the committee work was discussed, as reflected in the goals above. During the second and third meetings the committee members were assigned to different subgroups. Literature was investigated and content of the report chapters was discussed. Topics include:

- Results from eye lens dosimetry studies and relation between eye lens dose and dose measurements at other wearing positions
- Overview of protection measures
- Analysis of exposed worker groups with potential high eye lens dose using Hp(0.07) and Hp(10) data

The majority of the involved exposed workers can be found in interventional radiology applications. Small groups are found in e.g. veterinary practices, non-destructive testing and cyclotron maintenance activities. A concept report which can be discussed with different user groups is planned to be complete in June 2017, resulting in a final report at the end of 2017. A presentation was given at the NVMBR symposium on 18 November 2016; "Ik zie, ik zie wat jij niet ziet... Ooglensdosis en de verlaging van de limiet," Martine Lagerweij.



Members of the subcommittee are:

Robert P. Kollaard (NRG, Arnhem, Chairman)
Bertine de Bes (Flevoziekenhuis, Almere)
Mariska Damen (LUMC, Leiden)
Bart Goessens (UMC Radboud, Nijmegen)
Tom Grimbergen (NRG, Arnhem, representative from the NCS board)
Kirsten Henken (Antonius Ziekenhuis, Nieuwegein)
Kitty Hoornstra (UMCU, Utrecht)
Pierre Kicken (Astra Consultancy, Eindhoven)
Martine C.M. Lagerweij (Isala klinieken, Zwolle)
Alexander H. Maass (UMCG, Groningen)
Leo Schultze Kool (UMC Radboud, Nijmegen)
Lara Struelens (SCK, Geel)
Doreth Valk (RIVM, Bilthoven, Secretary)
Ischa R. de Waard (RIVM, Bilthoven)

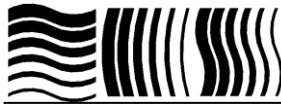
9. Subcommittee on "Dosimetry for Scanned Pencil Beam Proton Therapy"

International codes of practice for reference dosimetry and recommendations for measurement of beam characteristics in proton therapy (TRS-398, ICRU 78) are mainly focused on passive scattering delivery technology. These reports do not address specific issues of pencil beam scanning. The aim of the subcommittee on "Dosimetry for Scanned Pencil Beam Proton Therapy" is therefore to develop uniform guidelines for the absolute and relative dosimetry of the pencil beam scanning modality with continuous and pulsed proton beams. The subcommittee focuses on the new proton therapy facilities that are currently being developed in the Netherlands and Belgium. The goal is to deliver a report that can be used as a code of practice in proton therapy not only in the Netherlands, but internationally as well. The report will be based on the current literature as well as clinical experience of the participating members of this subcommittee. Moreover, members of the subcommittee are in close contact with international committees working on the similar reports to be sure that NCS report will be in agreement with future international recommendations.

The first meeting of this NCS committee was on the 5th September 2016. In this meeting, the scope of the committee has been defined. This meeting was followed up by a second meeting on the 17th October 2016 where possible topics and detailed content of each topic was thoroughly discussed.

The subcommittee has defined a scope of the future NCS report. The report will address the following topics: reference dosimetry, single pencil beam specific characteristics, time and space dependent dosimetry, neutron contamination and dosimetry equipment.

The subcommittee has agreed upon a content of each subchapter / topic. The first drafts of each subchapter are in progress.



Members of the committee are:

Petra Trnkova (HPTC/ErasmusMC, chairman),
Arturs Meijers (UMCG, secretary),
Marco Schippers (PSI/UMCG, advisor),
Jacco de Pooter (VSL, representative from the NCS board),
Marc-Jan van Goethem (UMCG),
Frank Verhaegen (MAASTRO),
Enrica Seravalli (UMCU),
Steven Habraken (ErasmusMC),
Carles Gomà (UZ Leuven),
Severine Rossomme (UCLouvain),
Paul van Beers (HPTC)

Advisory platforms

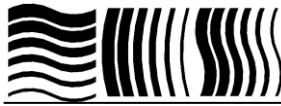
The Netherlands Commission on Radiation Dosimetry covers a wide range of expertise through the participating scientific societies. In 1999 NCS platforms were established on dosimetry for radiology and nuclear medicine and dosimetry for radiotherapy. The tasks of these platforms are to give advice on specific research projects initiated by the Government. In case of future needs the NCS can be approached for consultation through its secretary under the condition of modest coverage of NCS experts in terms of attendance fee and travel costs for meetings.

1. Advisory platform on Radiation Protection in Hospitals

The Netherlands Commission on Radiation Dosimetry covers a wide range of expertise through its participating scientific societies. In 2010 the NCS platforms was reinitiated with the aim to provide practical advice regarding legal aspects concerning the use of radiation in the clinical environment. For this, the platform is represented by the participating societies, expanded with the Dutch Society on Pharmacy in Hospitals. To achieve this goal, the platform has frequent contact with the Dutch Government.

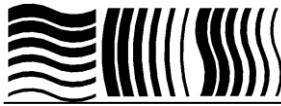
The platform had two meetings in 2016 and frequent discussions through email. The topics discussed concerned the 'Toezichthoudend deskundige Medische Technologie', the implementation of the dose correction factor due to the use of radiation protective clothing and the required educational level of physicians, other than radiologists, nuclear medicine physician and radiation oncologists, to facilitate safe application radiation in the clinical environment. In addition, a new version of the radiation safety spreadsheet for radiology is being developed. Furthermore, we devised a coherent comment on the ICRP draft report on Diagnostic Reference Levels in Medical Imaging.

Herman Pieterman, Peter Brands (chair) en Kitty Hoornstra (secretary) have joined the platform, whereas Christiaan van Swol and Paul Jonkergouw left.



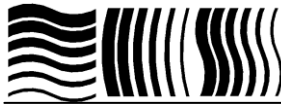
Members of the platform in 2016 are:

Dr. Christiaan van Swol (Chair)
Dr. Jeroen van de Kamer (ad interim chair)
Peter Brands (Chair)
Paul Jonkergouw (Secretary)
Kitty Hoornstra (Secretary)
Marja Harbers
Niels Veltman
Alie Vegter
Jan Habraken
Dr. Bradley Pieters
Dr. Kirsten Schimmel



NCS FINANCIAL OVERVIEW 2016

	Income (€)	Costs (€)
Current-account on Januari 1, 2016	7001.66	
Project-account on Januari 1, 2016	18421.18	
Contribution Netherlands Society for Radiology (NVvR)	600.00	
Contribution Netherlands Society for Medical Physics (NVKF)	400.00	
Contribution Netherlands Society for Radiotherapy and Oncology (NVRO)	800.00	
Contribution Netherlands Society for Nuclear Medicine (NVNG)	200.00	
Contribution Netherlands Society for Radiological Protection (NVS)	0.00	
Contribution Netherlands Radiobiological Society (NVRB)	100.00	
Contribution Dutch society of Medical Physics Engineers (NVKFM)	100.00	
Contribution Netherlands Society for Medical Imaging (NVMBR)	300.00	
Contribution Belgian Hospital Physicists Association (BHPA)	0.00	
Banking costs project account		66.00
Interest savings-account	238.28	
Banking costs current account		16.8
Costs web site		834.90
Costs meetings NCS board		452.88
Costs NCS subcommittees		458.90
Savings-account on December 31, 2016		38038.36
Current-account on December 31, 2016		7738.18
Project account on December 31, 2016		18355.18
Total	65691.20	65691.20



NCS BUDGET 2017

	<i>Income (€)</i>	<i>Costs (€)</i>
Contributions scientific societies	3100.00	
Interest savings-account	200.00	
Banking costs		150.00
Costs of board and subcommittees meetings		1500.00
Website maintenance etc		850.00
NCS Lustrum		3000.00
Total	3300.00	5500.00