Kazatomprom
Ulba Metallurgical Plant
Contact: K. Grabelnikov, grabkon@sigma.kz
Tel: 007 3232 298106

Joint Research Centre Ispra
Non-Proliferation and Nuclear Safeguards
Institute for Protection and Security of the Citizen, Via Fermi, 1, I-21020 Ispra, Italy
D. Landat, M. Caviglia, L. Silva-Pestana, L. Dechamp, G. Janssens-Maenhout, B. Hunt
Contact: brian.hunt@jrc.it, tel:++39 0332 78 9683, fax:++39 0332 78 9216

TACIS Project: K5.01/97

Establishment of Facilities for Mass/Volume, Containment/Surveillance and Training at the ULBA Fuel Fabrication Plant in the Republic of Kazakhstan.

Funded by the European Community

Objective

Improvement of the nuclear material accountancy and control system (NMAC) at the ULBA Uranium conversion and fuel fabrication plant at Ust-Kamenogorsk

ULBA Plant

- **includes** **facilities for** **lines for**

UF_6 / UNH —conversion→ U solution (different U^{235} enrichment) —transformation→ UO_2 powder —preparation→ pellets for RMBK NPP, VVER NPP

a large number of tanks with solutions containing Uranium

- **areas identified where significant improvement of NMAC could be accomplished**

Organisation

The project has been divided into three sub-projects, namely:

1. Implementation of Mass/Volume Measurement Techniques:
   - Calibration of tanks
   - Solution monitoring of large number of tanks
   - Data evaluation
   - Training at JRC Ispra and at Ulba

2. Implementation of Containment/Surveillance Techniques:
   - Telecamera surveillance in storage areas
   - Data analysis tools
   - Seal identification tags
   - Training at JRC Ispra

3. Technical coordination, monitoring and procurement of equipment through a call for tender:
   - Technical Specifications
   - Call for tender procedure

Supported by: JRC Ispra; KAEC; Joint Stock Co. (Ulba) subcontractor; SKI Sweden

1993	1995	1996	14.04.2000	14.04.2004
NPT signed	Safeguards agreement in force	1st contact Project definition	Start with administrative contract	Project completed

M. Energy & mineral resources
Kazakhstan Atomic Energy Committee

D.G. External Rel. Tacis
EuropeAid Co-Operation Office

Kazatomprom
Ulba Metallurgical Plant
Contact: K. Grabelnikov, grabkon@sigma.kz
Tel: 007 3232 298106

Joint Research Centre Ispra
Non-Proliferation and Nuclear Safeguards
Institute for Protection and Security of the Citizen, Via Fermi, 1, I-21020 Ispra, Italy
D. Landat, M. Caviglia, L. Silva-Pestana, L. Dechamp, G. Janssens-Maenhout, B. Hunt
Contact: Dominique.Landat@jrc.it, tel:++39 0332 78 5076, fax:++39 0332 78 9216

Multi Tank Scanning System

The Multi Tank Scanning System or **MulTaS** device was developed at the TAME lab of Ispra to establish **solution monitoring** of multiple tanks at Ulba fuel fabrication plant

The major hardware components include:

- 3 Digital Pressure Modules (0.01% F.S. accuracy)
- 1 Digital temperature probe PT100
- Digital mass flow controller for air supply
- a pilot electrovalve system
- autonomous monitoring devices on a network
- U.P.S. to guarantee power supply
- non-volatile flash memory of 128Mb
- dedicated calibration port
- Automatic backup programme

Basic principle is the dip tube technique

- the traditional technique, which is commonly used for large tanks with radioactive solutions

The dip tube technique is selected for monitoring tank levels because of its accuracy and easy maintenance

Comparison with examples of other level measurement techniques, commonly used in control areas:

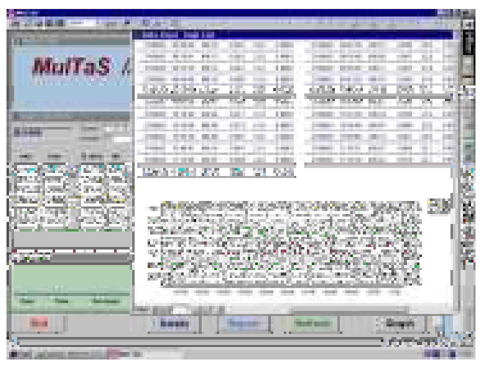
Technique	capacitance probe	radar probe	ultrasonic device	weighing technique	dip tube
accuracy	0.5%	0.1%	0.2%	0.5%	0.1%
maintenance effort	medium	high	high	low	low

Characteristics of the MulTaS device:

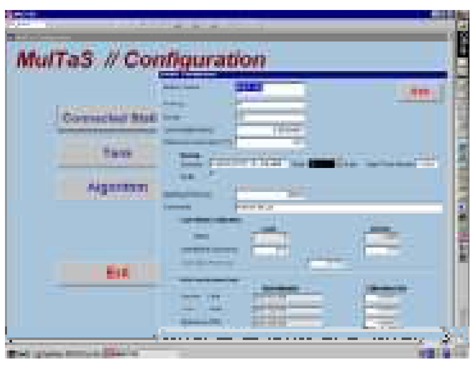
- performs data acquisition from 15 tanks recording pressure readings from 3 dip tubes inserted into each tank
- permits Near Real Time Accountancy by precisely monitoring solution level/density of inventory tanks

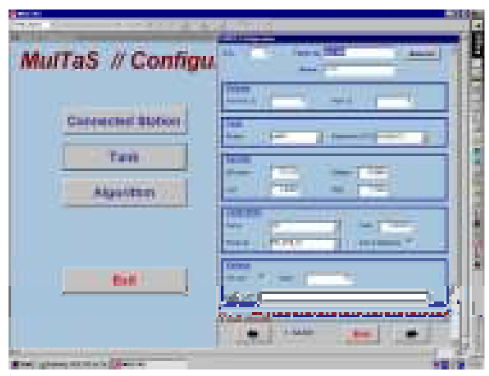
The appropriate application Software:

- visualises the history of one selected tank
- monitors the level/density online of all tanks



- enables the user to configure the measurement settings (off-set, measuring rate) appropriately
- enables to easily connect additional tanks





Kazatomprom
Ulba Metallurgical Plant
Contact: K. Grabelnikov, grabkon@sigma.kz
Tel: 007 3232 298106

Joint Research Centre Ispra
Non-Proliferation and Nuclear Safeguards
Institute for Protection and Security of the Citizen, Via Fermi, 1, I-21020 Ispra, Italy
D. Landat, M. Caviglia, L. Silva-Pestana, L. Dechamp, G. Janssens-Maenhout, B. Hunt
Contact: brian.hunt@jrc.it, tel:++39 0332 78 9683, fax:++39 0332 78 9216

Tank Calibration

VOLume CAlibration Measurement software: VOLCAM

Procedure

1. Offset measurements
2. Determine heel
3. Weight before transfer
4. Visualise the level by P_L-P_R
5. Acquisition of P_L, P_D, P_R
6. Weight after transfer
7. Temperature and
8. buoyancy correction
9. Calculation of increment
10. Evaluation of calibration data

start loop

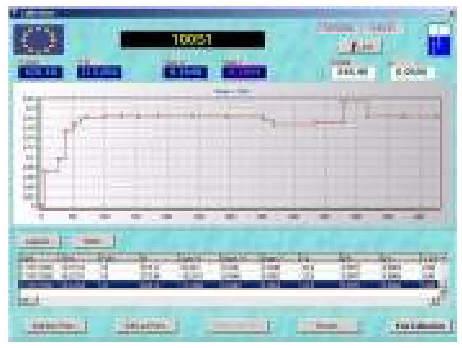
loop of increments from second till last

end of calibration

0. entry

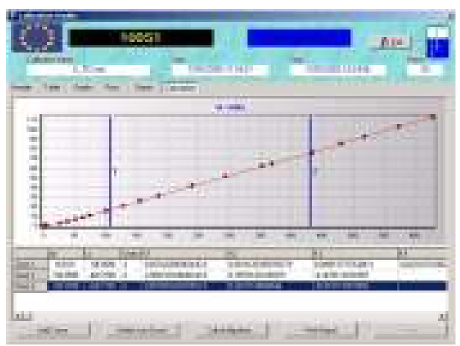
1. setup monitoring

2. run calibration



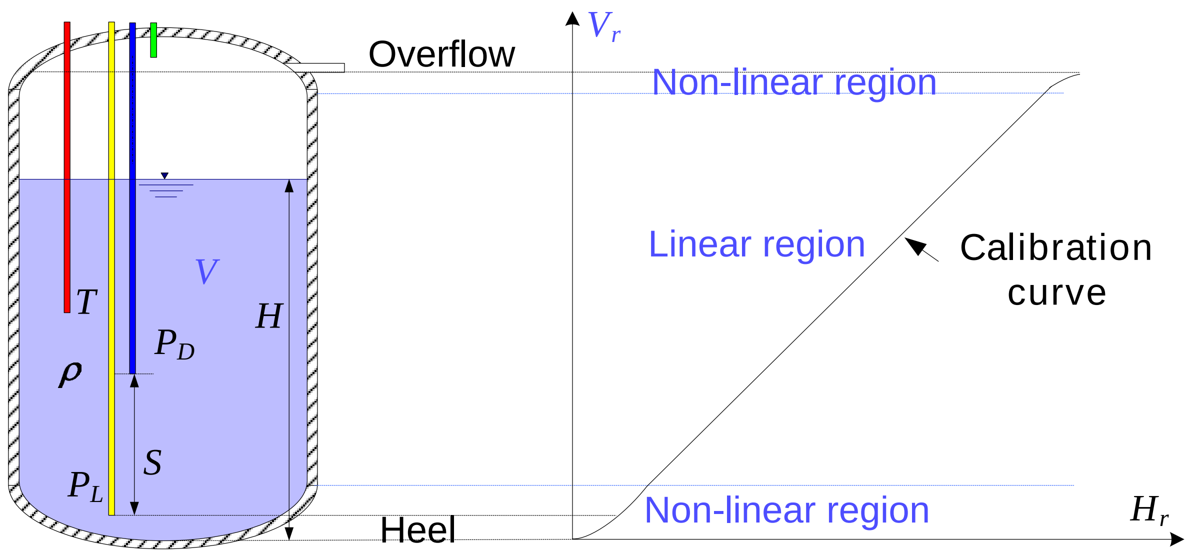
3. tabular results of calibration points

4. algorithm to evaluate the calibration curve



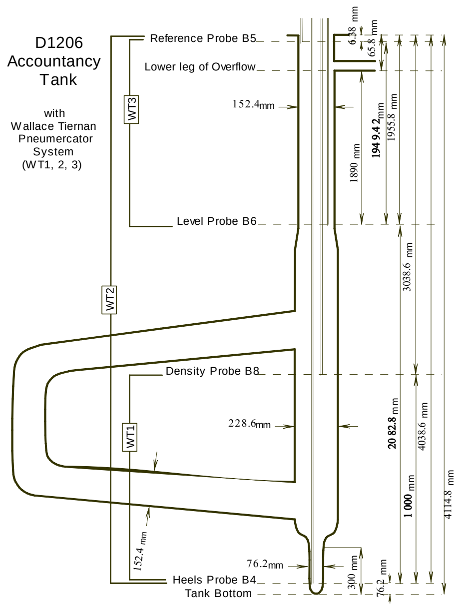
5. run monitoring in a calibrated tank

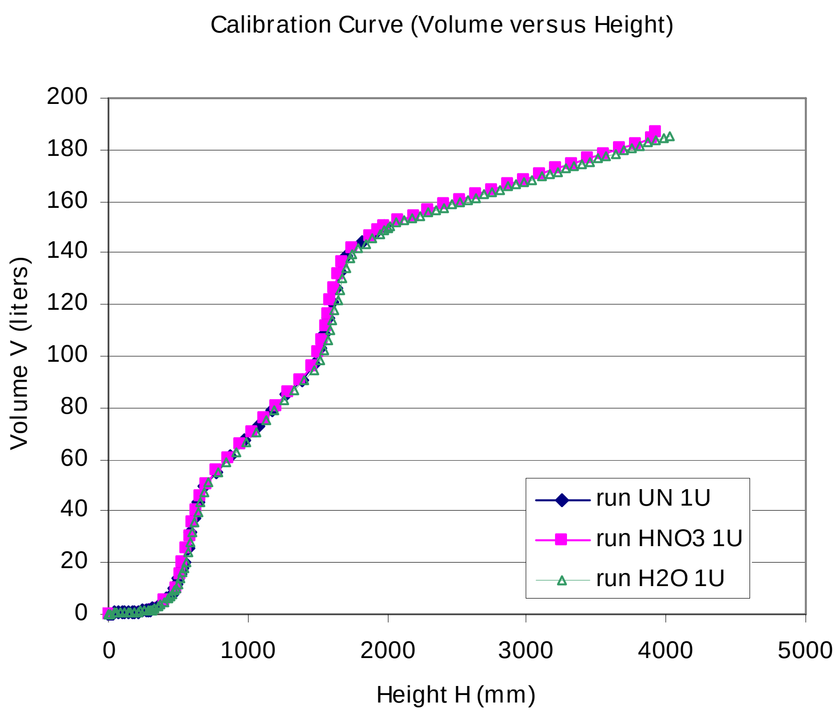
Calibration of an ideal cylindrical tank



For criticality reasons non-cylindrical tanks are commonly used in reprocessing plants, such as cone or harp process tanks, ... The tanks are characterised by strong non-linear calibration curves

Calibration of a D-tank with non-linear profile





M. Energy & mineral resources
Kazakhstan Atomic Energy Committee

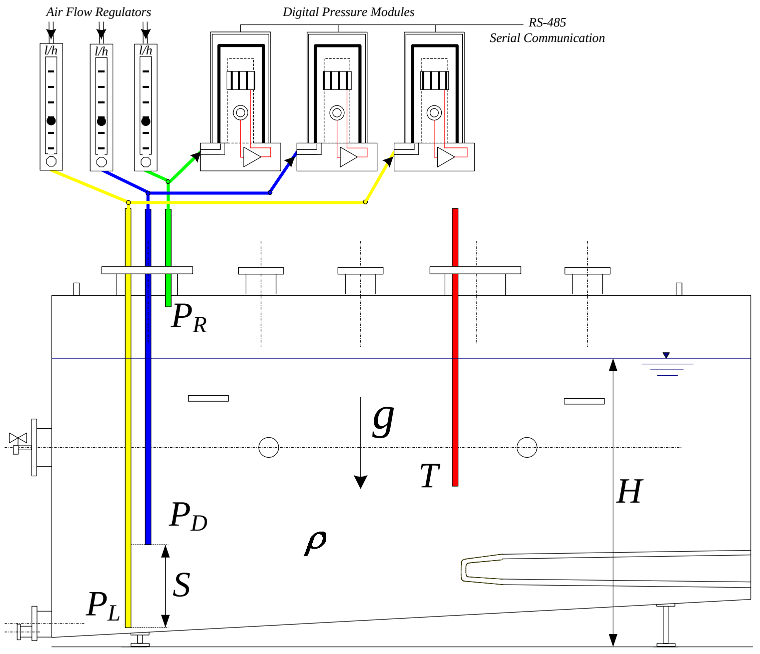
D.G. External Rel.
Tacis
EuropeAid Co-Operation Office

Kazatomprom
Ulba Metallurgical Plant
Contact: K. Grabelnikov, grabkon@sigma.kz
Tel: 007 3232 298106

Joint Research Centre Ispra
Non-Proliferation and Nuclear Safeguards
Institute for Protection and Security of the Citizen, Via Fermi, 1, I-21020 Ispra, Italy
D. Landat, M. Caviglia, L. Silva-Pestana, L. Dechamp, G. Janssens-Maenhout, B. Hunt
Contact: greet.maenhout@jrc.it, tel:++39 0332 78 5831, fax:++39 0332 78 9216

Training on Tank Volume Determination

Minimal configuration of dip tube technique



Principle of volume determination

1. Reference probe separation S_r
   temperature correction $S_m = S_r(1+\alpha(T_m - T_r))$
2. Measure $P_L - P_D$
3. Determine $\rho = (P_L - P_D)/gS_m$
4. Measure $P_L - P_R$
5. Measured level $H_m = (P_L - P_R)/\rho g$
   temperature correction $H_r = H_m(1+\alpha(T_m - T_r))$
6. Volume at reference V_r
   temperature correction $V_m = V_r(1+3\alpha(T_m - T_r))$
7. Mass at measurement $W_m = V_m\rho$

$$\Delta P = \rho g h$$

$$V_r = f(H_r)$$

Symbol: α=linear expansion of tank material; index m= measured; index r= reference

Assumptions:
- dip tubes are made of the same material as the tank and the tubes are fixed on the top of the tank
- the tank is non-hyperstatic (expands in all directions equally) and has a relatively small heel

Remarks:
- the corrections are based on experimental findings during relatively fast calibration runs

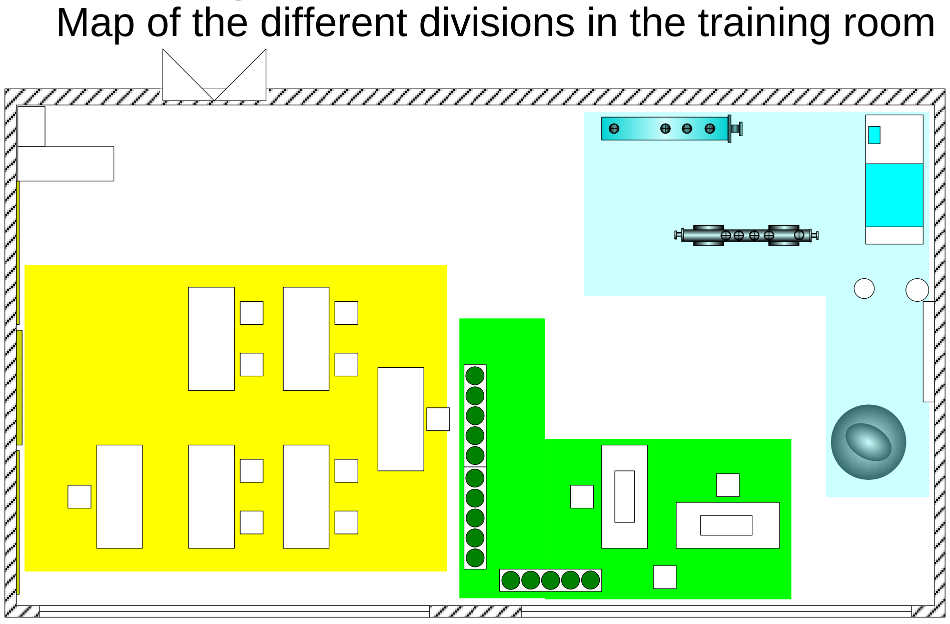
Practical correction:
- thermal expansion of liquid is compensated by measuring twice the pressure with the same device
- thermal expansion of the tank volume is to be corrected with the volumetric expansion coefficient
- flow losses in the relatively long pipes supplying the air flow is to be taken into account
- the position (level) of the measuring digital pressure module is to be considered

The volume determination is twofold:

TAnk MEasurement laboratory
- initial setup: Tank Calibration
- real time: Solution Monitoring

Training: on Mass/Volume Methodology at the TAME lab of IPSC in JRC Ispra, plus onsite at ULBA Plant

Map of the different divisions in the training room



Theory — MulTaS — Calibration
Prover — Slab Inventory tank — Harp process tank — Cone process tank

Training room with harp tank, slab tank and prover vessel

M. Energy & mineral resources
Kazakhstan Atomic Energy Committee

D.G. External Rel. Tacis
EuropeAid Co-Operation Office

Kazatomprom
Ulba Metallurgical Plant
Contact: K. Grabelnikov, grabkon@sigma.kz
Tel: 007 3232 298106

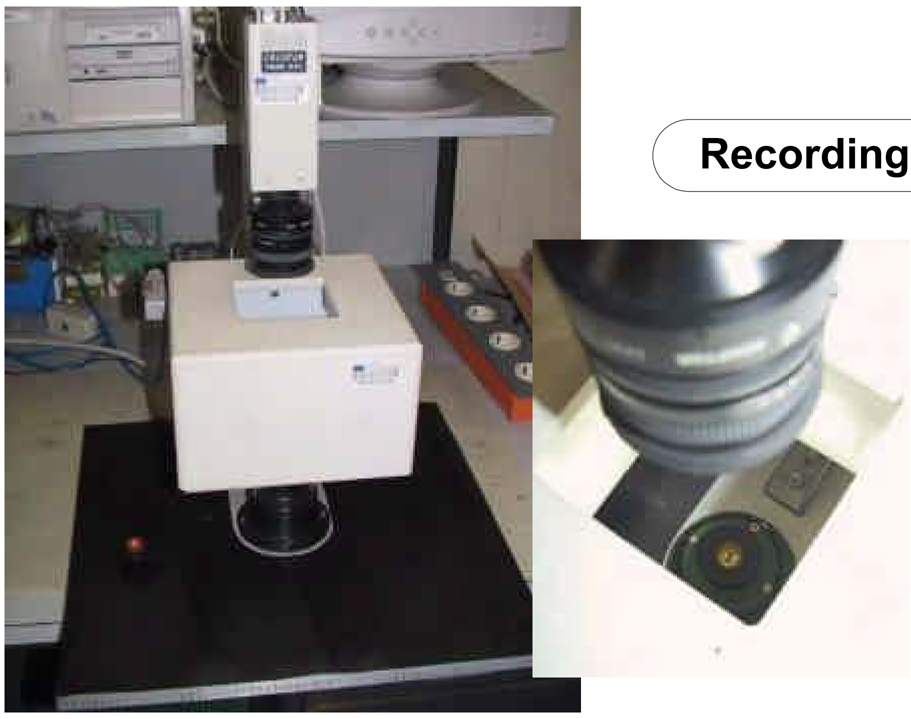
Joint Research Centre Ispra
Non-Proliferation and Nuclear Safeguards
Institute for Protection and Security of the Citizen, Via Fermi, 1, I-21020 Ispra, Italy
F. Sorel, D. Negro, D. Landat, G. Janssens-Maenhout, B. Hunt
Contact: brian.hunt@jrc.it, tel:++39 0332 78 9683, fax:++39 0332 78 9216

Sealing and Surveillance System

Typical containment seals for safeguards purposes

Copper Brass Seals (used by IAEA and Euratom)

- each piece weighs only 10 g and costs maximum 2.5 Euro
- the seal consists of a first cup in copper and a second in brass
- cups snap together to form closed box, which hides the wire loop knots
- the seal is unique because of the pattern in both cups and its number
- applicable to all types of containment, mainly used in storage positions
- verification of the used seals by comparing the original stored image with the corresponding part of the returned seal after special cutting
- not suitable for those cases where in-situ verifications are needed



Software CIVES

Recording of new seals → **Verification of used seals**

Cutter which allows seal verification after opening

- Before installation of the seal,reference images from bottom and cover part are taken and stored on DVD
- For the attachment of the seal the 2 parts are crimped together blocking a metal wire for a period of years.
- The verification after removal consists in (1) opening the seal by the cutting machine (shown right), (2) comparing the 2 parts with the previously stored reference images.

2 verification stations CIVES are shipped to Ulba (10/2001)

Containment/Surveillance Training

on verification of metal seals / **on installation/use of camera**

Surveillance camera system

The CODIS modular surveillance camera system

is provided to survey large storage areas on the site of the Ulba plant.

- comprises 15 video acquisition stations and 1 central review station
- all 16 are conected via Ethernet and powered by UPS
- the video systems have been modified to function under extreme ambient conditions (e.g. -50 to +50ºC temperature) at Ust-Kamenogorsk
- Each video station is packed in a protective box
- Software CODIS allows: (1) remote control, (2) analysis of the stored images with autenthication of the results.

a review station and 7 acquisition stations are ready for shipment
a training course with Ulba staff took place in June 2002

M. Energy & mineral resources
Kazakhstan Atomic Energy Committee

D.G. Enlargement Tacis
EuropeAid Co-Operation Office