2-2003

Programme - 1st REST Workshop

APOPO

Geneva International Centre for Humanitarian Demining (GICHD)

PROGRAMME – 1st REST workshop

**Sokoine University of Agriculture,
Morogoro, Tanzania**

08 – 11 February 2003

Saturday Evening: Dinner at Hotel Oasis (not organised)

Sunday 09 February 2003 – Equipment issues

TIME	EVENT	LOCATION
08.30 – 0900	**OPENING SESSION** o Introduction o Administration o Programme introduction	ICE conference hall APOPO/GICHD
09.00 – 09.30	**REST – BACKGROUND AND PROJECT PRESENTATION** o Historical background o Strengths and weaknesses o REST challenges o Status quo	ICE conference hall Håvard Bach/GICHD
09.30 – 10.30	**THE REST ANALYSIS PROCESS**	ICE conference hall Jim Phelan/Sandia
10.30 – 11.00	Coffee Break	
1100 – 11.30	**FILTER AND SAMPLING EQUIPMENT** o The FOI filter study - overview o Gas chromatograph compatibility o Demonstration of filter cartridge/sampling machine o Discussions	ICE conference hall Lena Sarholm/FOI
11.30 – 12.00	**FILTER AND SAMPLING EQUIPMENT** o Tests of filter options and pumps o Discussions	ICE conference hall Christophe Cox/APOPO
1200 - 1230	**ALTERNATIVE MECHANICAL SAMPLING METHODS**	Philip Askeland/IVEMA
12.30 – 13.30	Lunch	
13.30 – 15.00	**WORKING GROUPS – Group discussion** o Optimising sample collection o Optimising sample release o Sample stability – understanding handling and storage issues	ICE conference hall

15.00 – 15.30	Coffee Break	
15.30 – 16.15	**WORKING GROUPS – presentation by Groups** ○ 3 working groups – 15 minutes presentation by each	ICE conference hall Conny Åkerblom/GICHD
16.15 – 17.00	**SUMMARY AND CONCLUSIONS** ○ Status quo – filter and sampling equipment ○ Sampling and analysis – key issues ○ Future aspects to be addressed	ICE conference hall Håvard Bach/GICHD
19.00 – 22.00	Dinner	Location TBA

Monday 10 February 2003 – Training issues

TIME	EVENT	LOCATION
08.30 – 09.30	**TRAINING ASPECTS – NOKSH/NPA**	ICE conference hall Rune Fjellanger/NOKSH
09.30 - 1030	**TRAINING ASPECTS – MECHEM**	Kip Schultz/Mechem
10.30 – 11.00	Coffee break	
11.00 – 12.00	**TRAINING ASPECTS - RATS**	ICE conference hall APOPO
12.00 – 1230	**DISCUSSION – IDENTIFY TOPICS FOR WORKING GROUPS**	ICE conference hall Håvard Bach/GICHD
12.30 – 1330	Lunch	
13.30 – 15.00	**APOPO PRESENTATION – Different training set-ups** ○ Different training set-ups ○ Other key training issues/aids	APOPO camp Ron Verhagen/APOPO Christophe Cox/APOPO
15.00 – 15.15	Coffee break	
15.15 – 16.15	**WORKING GROUPS – training issues** ○ 3 working groups – topics to be identified	ICE conference hall

16.15 – 17.00	**WORKING GROUPS – Presentations** o 3 working groups – 15 minutes each	ICE conference hall Conny Åkerblom/GICHD
17.00 – 17.30	**SUMMARY AND CONCLUSIONS** o Recommendations o Research needs	ICE conference hall Håvard Bach/GICHD
19.00 – 22.00	Dinner	Location TBA

Tuesday 11 February 2003 – Operational Applications

TIME	EVENT	LOCATION
07.30 – 10.00	**APOPO DEMONSTRATIONS** o Field rats o REST training/test field	APOPO training area APOPO staff
10.00 – 10.30	Coffee break	
10.30 – 11.00	**OPERATIONAL APPLICATIONS - REST** o Road clearance – current application o Area reduction – A major REST potential o An analysis concept – global or local approach	ICE conference hall Håvard Bach/GICHD
11.00 – 11.30	**TESTING IN CROATIA**	ICE conference hall Kip Schultz/Mechem
11.30 - 1200	**TESTING IN BOSNIA and ANGOLA**	Rune Fjellanger/NOKSH, Ian McLean/GICHD
12.00 – 12.30	**DISCUSSION – IDENTIFY TOPICS FOR WORKING GROUPS**	ICE conference hall Håvard Bach/GICHD
12.30 – 13.30	Lunch	
13.30 – 15.00	**WORKING GROUPS – Operational issues** o 3 working groups – topics to be identified	ICE conference hall
15.00 – 15.15	Coffee break	
15.15 – 16.00	**WORKING GROUPS – Presentations** o 3 working groups – 15 minutes each	ICE conference hall Conny Åkerblom/GICHD
16.00 – 17.00	**DISCUSSION, SUMMARY AND CONCLUSIONS** o Recommendations o Research needs o The way ahead	ICE conference hall Håvard Bach/GICHD
19.00 – 22.00	Dinner	Location TBA

Attendance at First REST Workshop
Sokoine University of Agriculture, Morogoro, Tanzania
8-11 February, 2003

Name	Affiliation	Contact
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Meeting Notes: REST Workshop

Sokoine University of Agriculture, Morogoro, Tanzania
8-11 February, 2003

Local Hosts: APOPO
Supporting Agency: GICHD

0830	**B. Weetjens, H. Bach** Opening Comments: Welcome and Administration details. **Weetjens** Welcome from the local organisers, administration details in relation to local logistics. **APOPO: an introduction** • Started as small organization in Belgium 6 years ago began training rats for mine detection. • Promising results in beginning and by 1999 needed suitable partner to develop the concept. Needed stable environment where research centre could be established. • Long cooperation between Antwerp University and Sokoine Uni of Ag. already, and this formed the basis for establishing a new centre. Opened July 2000. • Still focused on research, although operational experiment has just begun. • Train both free running and REST rats. • Aims – search for technical solutions, sampling solutions, etc. • Welcome, and hope you all enjoy the workshop **Bach** • Many thanks to the local hosts, and the Sokoine University of Agriculture, and especially to APOPO for initiating the idea and pushing GICHD to make it happen. • Structure is 100% informal, and discussion and interruption is encouraged. • Not expecting to find a lot of solutions • Are expecting to identify a lot of problems and issues, and propose mechanisms for searching for solutions • **GICHD – a quick introduction.** • Created 1998, but 1999 really beginning activities • Created as response to dissatisfaction among some donors wrt management of mine action process • Grew quickly, and today is playing an important role in humanitarian mine action – research, international agreements, IMSA, mine risk education and mine awareness, develop and maintain IMAS. • Divided into different departments. Technical group divided into: operational methods; socioeconomic; standards and guidelines; EOD • On operational methods, the mine detection dog project is the biggest study.

	Began in 2000. Proposed by Bach, and eventually approved by GICHD. Multifaceted project. Not just about dogs, as includes many activities; current count is 18 components • Important current areas: training practices, analysis of operational systems. Still a lot to be done, especially in relation to successful concepts • On REST. A series of studies, but a long way to go • Literature; Environmental effects; practical methods needed to assess these effects; … • GICHD mostly works with partners – is not a research organization. Main partners are Sandia (USA), FOI (Sweden), NOKSH (Norway), NPA (Norway), Global Training Academy (USA), FFI (Norway), APOPO (Belgium/Tanzania), UWA (Australia) • REST. Status today. System that is still poorly described and not properly tested and proven. Many limitations. Currently still only used for road verification. Equipment poorly described and not optimized. Training methods – little documentation. Analysis poorly understood. Sampling techniques have no scientific documentation. • Today at the workshop, focusing on equipment. Mechem filter has been used by many people; other filters are now being tested. Suction unit has been standardized, but needs improvement. • Improving equipment: Testing – how to and who pays. How can we get this equipment into use • Sampling concepts – very relevant to area reduction • Training methodology (Monday). Alternatives need discussion • Operational applications – needs discussion • Area reduction as a concept – needs discussion • Purposes of the workshop: identify problems, propose how to address them, liaison and networking
0920	Vernon Joynt History and early applications of REST • About 1986, problems in SA with smuggling of drugs and explosives and mine detection. New concepts needed for border controls. • Once war ended, needed to turn swords into plowshares – hence humanitarian applications of the technology • Started applying the technology, but not sharing it • UN refused to award contracts because were keeping the technology secret • Bach helped to open the barriers • Policy changed in relation to humanitarian mine clearance • Started with a vacuum cleaner at the border posts, sucking cars • Early filter was activated carbon, but had problems with it • Found that at least 10% of cars had something in them, and then the problem became to have a mobile roadblock – so system became very mobile • Development for mines, but still using activated carbon • Found had to enhance the ability of the smell to release the odour • Postal services switched from canvas to nylon bags, and the police dogs could

	not detect explosives through the nylon • Further development of filters led to the mosquito wire filter • Checks of trains and trucks were very successful for guns and ammunition • 800 containers a day through Durban Harbour. REST allowed checks of a much higher proportion than any other concept • Did some multiple filter checks • Cahora Bassa the first big contract in Mozambique, which proved the MEDDS concept. Was going to cost US$45mill. Did 40 m wide under power lines • Put sampling equipment onto front of vehicles, and flew filters back to SA. • MEDDS resulted in significant reduction of area needing checking. Form 50 to 2.4 (sq km?). Total cost reduced to US$8mill • Roads, 30 km/team/day; Bush, 8 km/team/day
0945	**Jim Phelan** **Elements of the REST process, from mine to detector** • Three things, but each of those 3 include a lot of detail 1) Scent availability (source of the odour) 2) Sampling System (equipment) 3) Detection system (animals, or technology) • Scent availability. • Looking at mine leakage and availability of explosive molecules. Very little effect of time on leakage of PMN mine • Also found big differences in leakage from different mines • How much scent is available depends on how much leaks. • Leakage variation at surface of ground in relation to weather. Takes about 6 months for odour to accumulate to a steady state level at the surface in Afghanistan. Rain events wash out the molecules, and then they slowly accumulate again. Clearly different conditions affect vapour availability. • Scent availability – release to the atmosphere. Complex phenomenon influenced by wind and thermal processes. Optimal conditions differ for vapour vs dust signals. Need to understand micrometeorology issues • Sampling System. Sample collection; sample stability; sample release • Sample collection – vapour and dust interception, filter designs; tradeoff between collection sorption (wanted during collection) vs analysis desorption (release). These may not be compatible because one may dominate, and may want to identify procedures to adjust conditions for optimizing both • Sample stability – storage conditions and holding time limits (14 days currently assumed as limit in chemistry labs) • Sample release – transfer agents. Could use moisture, chemicals, electrical methods. May depend on time (and distance) taken to get sample to detector. May want to keep filter and detector close to each other • Detection system – detector preparation (training); QA (a lot of this done in lab, including strong positives followed by blanks); verification (frequent); naturally occurring interferents; in field can lose sample during transportation, so try and spike one in the field and have it travel with the other samples, is available as a

	control; field blanks (monitors for possibility of cross contamination) • Use confirmation detector – second detector • Detection limits – how low can they go, and what are the lower and upper bounds of a sensitized detection system • These are the general issues that should be considered over the next three days. Aim is to come up with a list of projects or questions that will point to future research **Discussion** Joynt: sorption vs desorption. Please comment on tradeoff. Phelan: activated carbon too good for sorption. Aim of the tradeoff process is to find the adjusted conditions between the two requirements that optimise both.
1015	Break
1045	Introductions of all attendees
1100	**Joynt** **Screenprint sampling vapour tube** • Engineered by CSIR out of Mechem experience with MEDDS filters • Designed so that outer and inner holder are integrated; cannot come open by accident • Fits standard pump setup • Is handled using a small pair of pliars so that no fingers involved • Inner core is a holey cage; any substance can be used as the filter contained in the cage • Flexible PVC has a plasticiser (an oily substance) in it making it flexible. Old filter used mosquito gauze containing a lot of that substance. • Cage is made from rigid PVC, which contains very little plasticizer. Small handle for handling using the pliars. • Gauze on the inside is the reservoir for holding the TNT for years. Also holds a large amount, and filter can be renewed by closing it up for a short time because it is the PVC container that presents molecules tohte detector. • When changed to polypropelene, didn't work, because PVC works better to get the second stage which ensures release of the TNT molecules. • Outer holder should be polypropelene or polyethelene, because these do not accumulate odours easily. • Price around US$0.80. **Discussion** Fisher: plasticizers have an effect on TNT. Any understanding Joynt: activated carbon tends to break it down. Plasticisers tend to be neutral products. Explosives, especially TNT are affected by a slightly alkaline environment. TNT is quite soluble in those plasticizers. Essential that component of cage tube be chosen for quick release. Outer holder must be impervious. Best if Aluminium – but expensive. Sikes: Any tested so far?

	Joynt. No – offer of some free tubes to anybody who wants them Fjellanger: I will test it. Bach: Preferable if a test filter can also be tested using a GC or MS. The plasticizers are a problem for these machines. Joynt: Could use cotton cloth of some sort in the filter. Can still use the filter tubings.
1125	**Lena Sarholm** **Filter and sampling equipment** • Talk about new filters, and analysis attempts on current filters • FOI was unable to analyse Mechem filter using lab equipment. Problem is the plasticizers, which clog up the machines • Had problem with petrol powered pump that was delivered • A pump powered with battery instead of combustion engine is recommended • Developed 3 kinds of new filter materials, all compatible with the battery pump • Are consistently detecting vapours from military grade TNT, but not animal detection systems attempted yet • Descriptions of filters given • On storage of filter material – is degradation in UV light, adhesion to storage material, storage consistency is temperature dependent, contamination from storage material, some time limit, and storage should be as cold as possible • Analysis of filters by dogs will begin soon, including a thermal device for desorbing the filters during testing • Chemical analysis – using gas chromatography equipped with thermionic detector • No breakthrough in the lab so far. • Have designed an explosive vapour generator. Allows putting a standardized vour flow into a filter. • Prototype portable vapour detector designed. Sampling with battery operated pump through to small GC. Goal is analysis in 3 mins. Can be carried by one person. **Discussion** Sarholm: Up to 25 l/min sampling rate possible Fisher: What masses of TNT going onto filter when making measurements Sarholm: don't have records here Cox: how can the filter be presented to animals Sarholm: Not decided yet. (Short discussion with Fjellanger) Fjellanger/Schultz: how is the filter sealed up for transfer to the dog Sarholm: havn't yet decided how to seal it up. Schultz: cost? Sarholm: Expensive for one. Strictly verification options and lab tool for research. But one of the other filters is commercially available (don't know cost). One filter has been rejected and will not be used. Williams: Nomadics had similar problems with Mechem filters Ongoing discussion about details of filters

	Schultz: are changing a lot to find something new. But any adjustment costs time and money to change the animal. So changes should be kept as simple as possible, and should mimic current procedures as much as possible. Joynt: agreed, that adjusting a dog is expensive. Phelan: detection limits apply to everything, but are higher for the dog. These new filters will only help if they can be shown to have field application reasonably similar to what dogs are able to achieve. Problem is that most of the time, the levels over mines do not have levels that are detectable by machines. Need better definition of what these new filters are for before go any further with research on design issues. Bach's and Schultz's questions are about utility Schultz: the current filter works, isn't that enough Phelan: but problem is that don't know how well it works – that needs better definition, and it is always possible that there is something that will work better. None of these filter designs solve the problem that the machines detect at higher concentrations than the animals. Bach: train Runes dogs on these filters and that will allow comparison with results at FOI? Phelan: important not to mix up the objectives. What are the concentrations that animals detect – this is the central question Fjellanger: a significant concern is that I am using the same dogs to do two separate things – test filters from Angola or Bosnia, and test FOI filters, but if there are different training requirements then I am faced with a significant problem. Cox: a lot of variability is found from the field, and this needs to be understood better before any of this can be properly investigated. Phelan: these filters from FOI are clearly better for the laboratory. Schultz: need an accreditation standard that gives credibility and reliability from the animals point of view. It is practical outcomes that should stand as the primary measure. Phelan: this points to what is needed, but there are other sorts of questions as well.
1215	**Christophe Cox** **Testing alternative filters** • Study from end October to end December • Realised that current filter could be improved, and also that costs might be brought down. Believed that cost was blocking continuation of some programs, eg. Due to recycling of samples • APOPO now makes new samples every day (250/day), and that makes the cost prohibitive to ongoing experimentation at US$1.00/sample • Would like to buy very large numbers for a smaller amount • Sought out various materials that were readily available • Tested 7 new materials in two testing setups. Rats worked equally well in the two setups • Design: always comparison of original Mechem filter as a standard and the new material. 80 samples collected, 5 positives and 75 negatives. Both types sampled at the same time (using double mouth of sample machine)

	• Steel wool. Good absorber of TNT and is readily available. Results poor. 11.8% lower than Mechem filter. Take off first day (getting used to filter) and difference is -4%. Cost price is lower, but handling was difficult and it is dirty material. Also rusted in wet conditions. • Cotton Balls. Results ok. All data 7% higher than standard. Without first day, 13.8% higher. Large surface area, very low cost, manipulation easy, production easy (Joynt – Australians found that had low retention of molecules, so perhaps is no reservoir). • RockWool. Lot of problems. Glass fibre material, but breaks up easily. Poor results • IVEMA filters. Open cell polyurethane material. 2% better than standard. Large surface area and available in different densities. Cost similar to Mechem filter, perhaps a little lower. (General discussion about filter issues. Identified issues are retention, cost, consistency of detection, finding marginal improvements, verification) (Noted that the design of this study may not have given any statistically different results) • Polypropelene dust filter. Overall score -7.5%. Also gave a very high false positive rate. Poor • Cigarette filters. Cellulose material. Result -13.5%. Part of cause of this result may have been due to the design of the filter, which was too small. Rats bit them and pulled them out. Some rats hit on them very well. Very clean material and very cheap. • Sorbarod capillary reservoirs. Market fillings for Stetnor marker pens. Polyester fibre. Very good result at +12.1%. Also have a new type that is being tested now. • Conclusion. Almost everything works. Several appeared to be worth doing further tests on as potentially better than Mechem filters. Aim to improve the research design and improve sample size. Test additional filter materials. Test for optimal densities in relation to airflow. Handling and packaging issues need to be addressed.
1400	**Philip Askeland** **Equipment improvements** • Suction is very focused, not widespread, so sampling is potentially missing some areas. • Can slow down the sampler, slow down the movement, or open the intake, or slow down the vacuum. Unclear what might be done, or how effective the coverage needs to be. It is possible that sucking in at a higher pressure might prevent molecules from sticking to the filter material. Is a need for experimental work on the sampling procedure and rate. **Discussion** Fisher: If want to get air samples from very close to the ground, need to go very close to the ground. Nomadics is involved in chemical detection technologies, and samples as everyone else does. However, this might not be optimal Fjellanger: tested sampling as done in Bosnia, and found variance of 13 sec $\pm$ 4 sec for 5x5 m squares.

	Fisher: is the 60 l/sec so that get particulates? Joynt: tests done in cardboard boxes, so can't answer that Weetjens: detects a conflict between recommendation to slow down the suction rate, and to ensure that dust gets in. Is dust really needed. Joynt: Is a need to touch the vegetation because there is a lot of dust on the vegetation.
1415	**Lena Sarholm** **Soil Analysis** • Overview of all steps in the analysis process. All need to be done properly • Analysing soil samples in order to map explosives migration in soil and air; verify detection systems; detect mines • Methods used: microwave assisted extraction to get the molecules. Filtration and soil phase extraction, then GC with verification by LC/MS • Some results shown.
1430	**Working Groups. Three groups with assigned topics** **Conny Aakerblom** • **Optimising sample collection** • **Optimising sample release** • **Sample stability and cross contamination – understanding handling and storage issues** • Collection – vapour vs soil/dust or combination; tradeoff sorption vs desorption • Stability – material; transport; storage • Release – material; how to increase; release purpose (animal vs chemical detection systems) • Issues to be identified in relation to - real life sampling - test sampling - lab analysis - animal analysis - combination for verification/comparison **Discussion detail** • Principles, methodology, equipment, procedures; identify important questions and research areas
1630	**Group 1. Williams** **Optimising sample collection** **Sampling Factors** • Vapours vs particles • Weather (now and recent) • Time of day • Soil texture/type • Vegetation - height

	- density - species - surface area - plant - odours • Mine type and burial history • Testing (? This appears to cross all of the other factors) • Sampling equipment - flow rate - speed - height - length of time/sample - orientation to wind - clogging - fuel/electric/passive - blow dust • Filters - vapours vs particles - testing objective - material - cost - end use (research vs operations ; animals vs instruments) - trapping efficiency /stripping/ease of release • Sampling procedures - handling - spikes and blanks (should be included in all blocks of samples) - QC - roads, off-road, vehicles • Decontamination - frequency - methods • Research resources • Reporting **Discussion was unable to resolve:** • Prioritising this list. All seemed to be important, and information was not available on any of them that was good enough to allow a definitive statement about it. • Identifying general questions independently of the topics
	Group 2. Joynt **Optimising sample release** • Adsorption vs absorption - need heat to improve adsorption - need humidity to improve adsorption

	- dog's nose potentially provides both • Induced desorption • Dog nose properties described • Large outer container to enhance desorption-fading-regeneration step Questions: • How important are particulates in sampling and other steps in the analysis process • Adsorption strengths - vs animal desorption strength - vs chemical desorption strength • Assemble more chemical data on ad- and absorption - for material collection - for desorption technique selection (develop procedures to assist the desorption process) •
	Group 3. Bach **Stability and cross contamination** • Material stability • Transport casing • X (missed) • Production - sterile production, important because if is contaminated when get it, can't use it - Procedures needed to QC the supplier of filters. • Deployment - small details can ruin the REST process; contamination awareness is key - Gloves. TNT breaks through quickly, some better than others. Uncertain about need to use gloves. Gloves may increase discipline. Is a safety issue as TNT is dangerous - Acetone. Q effectiveness of use. Must be removed. Steaming might be better - Cleaning sample head. Q usefulness. Discussion but no consensus. Not sure how to clean effectively. In principle, the releaser should not be in contact with the tube holder. If so cleaning may be required. Rubber sealing ring is carrier of undesired contamination and difficult to clean. • The pump. Higher rate of false positives with fuel pumps than electric pumps. Not known why but the exhaust may be a factor. FOI recommends electric pumps. Long exhaust pipe could be used. Exhaust may be a clue, but should be background for training. Potential for problems with battery for electric pumps. • Storage - Mechem filter stored in plastic tube which could allow x contamination. Mechem insists not a problem. Storage material may be more important for chemical analysis - Sunlight, heat could cause degradation

	- Cool storage might be important. Mechem has stored filters long-term apparently without problems - Recommendations: Store dark, cool, sufficient separation, coloured tubes, clean environment in field and during transportation • During Analysis - Gloves used during handling - Signature reduction as filters quickly provide small signatures in open air. Mechem filters can be reloaded. Mechem and APOPO had different experiences with sun. - Pre-heating and moistening (Group 2) - Clues: animal contact with filter cartridges may become a clue. Not a problem with high concs. A problem with low concs. Could cause false positives. Not sure. - Controlling the envt. May be important. Painting may be a problem. Ventilation important. Store in different temp than in the analysis environment. Needs explanation - Cleaning issues. Be contamination conscious always at all levels (macro and micro). Cleaning itself is a potential source of contamination (not experienced by Mechem)
	Summary of outputs of workshops, Day 1. In relation to equipment, filters, sampling procedures, molecule capture and molecule release • Broad array of issues identified as poorly understood • No issues identified as well-understood • Needs to be a high level of attention given to procedural details at all stages of the capture, transfer and testing process in order to avoid contamination, and avoid introducing any other clues or biases into the analysis process. • Most of the issues identified could receive further research attention, but the availability of detectors to do those experiments is extremely limited. • There is a need to improve the quality of reporting of the useful experiments being done within the REST framework.
1730	END FOR THE DAY
	Day 2, Monday
0830	Introduction. Summary of issues identified yesterday. Bach/McLean
0840	**Rune Fjellanger** **Training issues and the dog's nose** Dogs Nose • Anatomy well known, but operation not so well known • Brain has cables from olfactory centre to nasal passages • One third of dogs brain deals with information about odour • Human brain deals more with tongue, lips, language; odour processing small • Birds brain deals mostly with orientation and balance, as they live in three

	dimensional environment • Three channels through dogs nose. Low, middle and high • Lower works like a pump. When dog sniffing is using this channel as pump creating vacuum causing air to be dragged into middle channel • Upper part has a two way stream when breathing normally and not sniffing. When sniffing, flow of air is continuous through upper channel. • Mesaurements made of one sniff. Not the same as a breath into the dog. A sniff is a paired out and in movement of air. So air first forced out, then drawn back in. At max speed, the out in cycle can occur 5-7 times/second. This is the dog's turbo . The air that is blown out is pulled back into the upper chamber. • 225 million cells in receiving area of nasal lining. • The blowing out comes from a pump based in the front of the nose that pushes air forward. The sucking comes from the vacuum pump in the lower channel which provides a continuous inward pressure for the upper channel. • Dog can inhale and process particles, although may have to mechanically clear them through snorting action. • Is some interference in mechanical function between the cooling function of the dog's nose (and the requirement to pant) and the sniffing function. Best sniffing is achieved when the dog is not panting, but dog can still sniff when panting. Training Issues: topics to be addressed • Selection of dogs (Schultz) • Training odour discrimination using shaping • Sensitisation – lowering the threshold (Schultz) • Training the dog to be independent • • Discrimination: Need to start with teaching the dog about the click. Click does not only mean food – can mean other rewards. Reward used varies with dog. • From early stage, dog controls the learning process. Up to the dog to decide what to do in a training situation. Dog controls the trainer and its job is to search for the behaviour that produces the reward. • First step is training the dog to place its nose on the cups of a multiple hcoice apparatus • Second step is to introduce an odour to the cup, and link the click to the presence of that odour. Search for the moment when the dog realizes that the inconsistency in the clicking is linked to the odour. Once have that moment can yuickly increase the number of cups on the apparatus • Routinely train for spontaneous sit training, in many different situations. Dog gets into the "habit" of sitting whenever it stops activity. The sitting is produced spontaneously in every situation. Never told to sit, but sit is rewarded whenever it happens (not necessarily with the click – often with the ball). • Because the dog does spontaneous sit, then now it knows to find a cup with an odour, but it needs to learn to sit at that odour. Sitting is offered spontaneously because it has become the natural thing to do whenever activity stops, such as when the target odour is found. Already at this point, the handler is disappearing

	from the training room by going behind a screen. So the click comes form behind the screen and the handler provides no cues to the dog. • Sensitisation – Kip will cover. Important step. • Maintenance training: - reward system is unpredictable - number of filters searched increases between positives until is searching a large (but variable) number of filters between positives - finding a positive does not always predict a reward (introduced early in training) – its always a gamble • Assessment. - continuous through training - necessary as a part of maintenance training - provides quality assurance • Demonstration of operational procedure with video Discussion about operational handling of even a single indication by one of a group of dogs Joynt – even a single indication must be treated as suspect Bach – if dogs recheck the
0945	**Kip Schultz** **Training Issues for REST/MEDDS** • Selection issues. Basic drives and characteristics; good hunting drive; prey/possession and compulsive desire to possess; sniffing behaviour; threshold limitations. E.g. found a perfect poodle, but in the end not purchased because breed incompatible with operational location (Iraq) • Two separate parts of a dog. Prey drive – selection and compulsion. Possession means if I have it, he wants it. • Selection makes a big difference to Mechem success. 108 selected, 2 failed so far (one on fear, other on congenital eye problem) • Sikes – why is hunt drive so important. A: If doesn't have hunt drive, won't sniff. If prey (kong) is primary reinforcer, hunt drive must be very strong. Possession improves the ability to get threshold to a very low level. • After selection comes imprinting. • Today use clicker, and was introduced at a later stage in the dog's training because were already well through training when clicker introduced. Used to refine behaviours already have. • System involves training on a line of targets • Vapour level sensitization can be difficult to initiate, so use a few small tricks to encourage it. Blank runs are introduced from an early stage. Other odours used as well as neutrals for blanks • Handler is a very neutral component, and is only there to direct the dog. Anybody can handle the dog • Reduction of threshold. Source material – very carefully produced to ensure consistency.

	• After the reduction, begin extending searches. Positives and rewards appear unpredictably. Often run blank trails and these are normal for the animal. Dog's technique varies and this is monitored for consistency. Variation between dogs is acceptable. Variation within a dog is not acceptable and is used to watch for inconsistent search. • Decoy odours are made strong or weak. Dogs should hit strong and weak non-targets unpredictably. • Discipline. Contamination awareness is fundamental. Everyone works as a tight team in unison. Daily procedures are structured. There is a routine so that the process is uniform for the dog, whether its training or operational. Internal cross checks are occurring all the time. E.g. could have hit 8 break fluids, but one contains TNT and should hit that one. Accountability to the system is important. Always monitoring to ensure that the system being used for training is working. The entire system must be working smoothly. **Discussion** Cox: training begins with test filters? A: Yes. May need some introduction to the filters in order to get them targeting it. Weetjens: Evaluation rate is high – around 250/hr? A: Yes, with up to 4 dogs evaluating the filters. 2 dogs achieve 250 consistently Weetjens: how many people involved A: 5 people in the room. 2 moving stands, scribe, dogmaster (supervisor), 2 handlers
1030	Coffee
1100	**Ron Verhagen** **Analysis of REST data from the rat study in relation to environmental issues** • 18 Oct – 24 Dec 2002, 38 sampling days. Mechem filter. Made in 27 boxes (7 empty). Field constructed in March 2002. • Boxes are 40x40, subdivided into 5x5 subboxes. Mine buried in middle. 4 different mines. Half buried deep, half shallow. Mimics Lubango field. • Sampling from 0800-1100 • Samples evaluated by rats in the square cage. • Each day, 5 rats evaluated samples on the day of sampling. All rats same age, trained since Jan 2001. • Square cage has 34 holes; rats make 4 runs of each cage (=134 filter test events); 15 positives of 136 filters made each day; mean time for 1 rat was 11 min • Weather station recording data at 30 min intervals. Needed to sort through all the weather data to identify most important variables. • Temp quite stable through period, slight increase towards December • Soil humidity follows rainfall, and were periods of rainfall • False positives ranged from 4-6.5%. • Success for individual rats ranged from 60-74%

	• Considerable between day variation in both success and false positives. • Factors? Individual variation between rats; testing facility itself; quality of REST samples • Samples affected by: 6 identified factors. • Half samples were taken by fuel and electric pumps. Big difference in success (73 vs 61), with fuel pump giving higher success. Fuel also gave more false positives, perhaps due to contamination from exhaust. Fuel pump sucks at twice the pressure than the electric pump (130 l/sec vs 65 l/sec). Sucking is through two filters in both cases. • Time of sampling influenced success, with 79, 71, 78, 83 (%) at 0800, 1000, 1300, 1500. These differences not significantly different, but data from only one day. Replication involves gathering data form more days. Number of rats provides a standard source of variance. • Climatic factors. Few linear relations and a lot of correlated variables. • Winde speed against false positives. FP goes down as wind speed increases • Success score goes the opposite way. Increases as wind speed increases • Humidity. Increasing outside humidity causes increasing FP and decreasing success. • Multiple regression investigates the relationships between these variables. Humidity and temp are interacting in complex ways. Best results are achieved with sampling at intermediate levels of windspeed and humidity (remember that all samples made in the morning). • Cause of FP is a combination of low availability of odours causing frustration, and positives that are real for the rat but were not taken near a mine • Different mine types. Deep and shallow, AP-frag mine only difference, with deeper found at lower rate • AT found at highest rate and AP-frag at lowest rate. AP-blast and mortar at intermediate rates • Scoring by the 5 rats (success form 0 to 5). Fragmentation mine found by relatively small number of rats and AT found by relatively large number • Conclusions. - quality of samples varies - quality affected by many interacting factors, including filter type, sampler and way of sampling. - Good experimental design needed (results depend on climatic factors which must be recognized in the design) - Long term data series on climate essential as background to this sort of study
1145	**Christophe Cox** **TNT detection threshold test** • Purpose of test was to quantify detection limits of detection vapour by rats • Secondary objective of testing a new test cage. • First tests with soil samples, and rats appeared to detect at a level that exceeded the theoretical vapour availability (no molecules available). Suggested cause was evaluation procedures. Could have been problems with treatment of samples as

	well. • Started new tests with TNT water solutions. Combine refined TNT with de-ionized water and all preparation procedures were identical for all samples • 10 groups of samples presented to the rats • All bottles made up and held closed from several hours before the test, to ensure head space vapour reaches equilibrium. • Rat works in line cage, and was a known and unknown (blind) positive in each run. • Took about 10 tests for rats to stabilize. By sample 17 achieved 0.0013 ppt (10^{-15}) as the final acceptable outcome. Intensive training and calibration required to achieve these levels. Capacity for generalizing limited, as some experimental evidence that was an upper bound to their sensitivity as well as a lower bound.
1200	**Identification of workshop topics** Difficult to frame workshop topics. Broad topic groups were defined Group 1. Training issues – equipment, clues, timing and rewards, type of reward Group 2. Selection – socialization, stress, motivation Group 3. Methodology – internal training principles, imprinting, chaining, shaping, QA, recording, the environment, maintenance training
1700	END FOR THE DAY
	Day 3, Tuesday
0700	Field visit with APOPO (delayed until 0800 by rain)
1100	**Workshop Reporting Back** **Group 1, McLean** **Equipment issues** • Felt that this was not an issue requiring discussion by the group. **Clues/problems in training** • This is a procedural issue. Therefore need to emphasise: - Consistency - Completeness - Regular review of procedures - Occasional external review encouraged (formal or informal) - Suggest creating internal checks (perhaps as a game) - Make the checking and review process routine (part of daily activities) **Timing and Rewards** • Procedures are well recognized and established in animal learning theory - emphasise early implementation in the training process **Importance of Rewards** • No specific recommendations developed
	Group 2, Weetjens

	Selection of animals **Selection Criteria** • The earlier socialization and training starts, the better • Establish external factors that animal needs to deal with • Good exploration and search behaviour is desirable • Animals with toys in the cage tend to be better than animals in a sterile environment • Generation learning – after several generations of selection there will be learning improvements • Attachment to trainers should not be too strong • Calm character, basic stress level, needs balance. Task tension provides motivation, but should not be too nervous • High search drive desirable (even crazy is good); low sensibility to other factors • For dogs, weeks 6-12 are crucial; contact with people and other dogs encouraged; kennel environment better avoided **Early Tests** • In rats: special learning test, pulling on levers, working in different environments, external factors, predators, open field, exploration test, maze test • In dogs: determine stress levels in different situations; build confidence and trust **Suggestions and Conclusions** • Possibilities of using specific tests at early stage • Too attached animals may show lesser performance (APOPO should look at using rats in even more instrumental way) • Experiment with different reward systems; tune to the individual • Try and establish training methods excluding strong repulsive odours • Investigate methods to avoid food being found during fieldwork (rats) • Periodic review of training methods • Create a reference group for discussions (within or between programs)
	Group 3, Bach **Methodology** **Internal training principles for structuring a training programme** • Not addressed **Imprinting** • Varying practices. Some introduce TNT from beginning. Some use aid scents. • APOPO uses vinegar to encourage animals to smell, and then switch to TNT • Too much scent may destroy the ability to detect the target scent. Vinegar may be too strong • NPA/Mechem use carousel for imprinting of free running dogs. Mechem does not use carousel for imprinting REST dogs. Introduce dogs to all at once

	• Training on many concurrent elements vs prior imprinting. Mechem puts pressure on the dog fright from the beginning. They return dog to source if it does not achieve objectives in 10 days. • Other organizations first establish sniffing behavior, then imprint. • False alarm rate is not allowed during imprinting. This will prevent false alarm rates during later training/search. Consistent imprinting is key for ultimate success with the animal. **Questions** • Is aid scent needed during imprinting • What is the trade-off between all-in-one imprinting and staged imprinting • Is aid scent useful or not during imprinting **Monitoring the training** • QA of the training process - organizations need to have general principles and standard criteria for internal QA - trainers must be monitored who will assist with the process of deciding to move to the next training step - recording of training progress is important and will provide for better external monitoring. Problem for APOPO due to the high number of rats that the are training at one time. **Observation skills/ability to reflect** • Handler. Needs full understanding of the way animals learn and how the use clues in addition to target scent detection. Good self evaluation necessary, and cross evaluation encouraged proactively. • The environment. The trainer and handler must understand effects of environmental factors. Contamination problems must be well known, and repeatedly stressed • Environmental factors should be recorded systematically and continuously. **Questions** • How can environmental factors be best recorded • which environmental factors are the most important to daily decision making and recording.
	Summary of outputs of workshops, Day 2 • Internal QA, monitoring and review, essential. Never assume the system is working perfectly. Should be designed as part of daily/weekly routine. • External review: occasional is encouraged; can be formal or informal but should not be viewed as threatening • Early stages of training: use standard training principles from early stage; ensure socialization appropriate to end use; selection process may be influenced by training concept

	• End use: could drive some training decisions and how some procedures are implemented. Needs to be properly identified and understood • Understanding of relevant principles by all personnel strongly underlined. Applies to training issues and background factors such as environmental factors. • Careful record keeping with appropriate analysis.
1145	**Kip Schultz, Mark Fisher, John Sikes** **Mechem in Croatia doing REST (MEDDS/NOMADICS Fido)** • Comparison of techniques • Nomadics has a FIDO machine. An offset of the DARPA project – building an artificial dogs nose. • Meeting in July 2001, where project initiated. Need for a contamination free area, and MEDDS to be used to QA the area as contamination free. • Comparative tests set up between MEDDS and FIDO • Mechem would demonstrate the comparative values of the 2 systems (presence or absence of vapour) -> area reduction objective • Test whether MEDDS and FIDO could be enhanced by working together • Suggest other applications • Two sites prepared. Fenced and veg cleared. Area Reduction done as a double blind operation. • 28 4x4 m vertical blocks. 10-15 unknown mines planted at variable intervals and depths • Depths of 10, 15, 20 cm. No information on types of mines • Sampling. Two sites. First sampling 72 hrs after planting. • Second sampling 60 days after field set up. Very difficult weather conditions (rain, mud, snow). • Third at 6 months. Postponed from May to July when conditions almost ideal. • Area Reduction: filer change every 48 m one way, 56 m other way • No results as yet because of double blind design. Two more samplings required. • Proximity – sampling at 3, 7, 11 m intervals from mine. Mine is clearly marked. • Indications on proximity testing suggests useful results. Indications at 5-7 m with MEDDS giving a response up to 11 m, but not clear what the cause is of this. • Lessons learned. Sampling in bad weather not a good idea. Some filters had mould on them. Analysis of the filter is not easy – the plasticizers on the filter are a problem. Are attempting to improve the filter to make it better for analysis and field deployment. **Discussion** Joynt: shape of detection around the mine is not round, so perhaps sampling should not be round A: agreed that this issue must be kept in mind. But the shape of the plume was not the question being asked by that small study Schultz: a REST trained dog may always detect at the edge of the plume and difficult to impossible to turn it into a dog that finds mines/explosives directly.

	Believes this is due to sensory threshold that is established in MEDDS dog. Example of a spaniel Fisher: FIDO found 7 of 12 samples prior to vegetation being cut. After vegetation cut in the area, FIDO found nothing over the mines. If the vegetation was sampled after being removed, maintained the hit rate using MEDDS. Over the mines, MEDDS results not known. Bach: what is loss of detectable odour from samples Phelan: dry soils lasts for up to several years. Wet soils, lost quite quickly, due to degradation (biological, chemical processes) Bach: APOPO had poor results after flooding of the training field. How long did the results take to pick up? Weetjens: as soil dried out, the high rate of false indications dropped away. So recovery response was quite quick – the contamination spread by the water disappeared.
1400	**Mark Fisher** **Fido Sensor Overview** • Sensor development challenges identified. - chemical signatures from mines not understood - Concentration of TNT and other compounds entering the air is very low. If are gong to detect it, sensor must have low detection limits. Low ppt under ideal conditions, to lower (ppq). - Sensor must be low in cost - Person-portable and easy to operate - Works in real time • Works how? - polymer amplification mechanism. - Traditional system uses chromophores (light emitting molecules). TNT blocks the light emitting effect - Amplification involves chaining these together • Sites on the polymer are negative in charge and tend to bind with the TNT. Gives it some selectivity. • Reviewed results and outputs • Future potential applications **Discussion** Verhagen: what is false positive rate A: varies with conditions. Ideal conditions get none. Poorer conditions get some. Verhagen: may be detecting other compounds A: surprisingly few Cox: Is DNB being found A: very low Sikes: Temp probe can be adjusted in different ways and that will change detection response for each chemical. Aim to vary that responsiveness in the future.

1420	**Fjellanger/McLean** **Testing viability of REST for area reduction and for use in Bosnia** **Area reduction study (Angola)** • Review of Angola project designed to investigate shape of plume around a mine as detected by REST • 25 boxes, each 40x40 m. 64 5x5 m boxes sampled within the box. 1600 filters prepared per trial. 10 trials planned • 4 mine types, 2 depths. • Aim to study the shape of the plume as detected by REST around the mine. • Study has failed to date due to internal management problems. About to be revived **REST Study in Bosnia** • Use the REST trained dogs to evaluate use of REST in Bosnia. • Don't transfer dogs to Bosnia yet, or build a REST capacity. Use the test fields in existence to make filters to send to Norway. • Project began in late June. • Received 8 shipments of known and unknown filter boxes – unknown means positive filters not identified. • Results of analysis sent to Bosnia for confirmation of analysis • Analysis system is a small room with a carousel. • Dog works the carousel independently of the observers • 12 positions on carousel. Dog may make several circuits. • First samples in May. Very simple – dogs caught everything. • 4 dogs used for all testing • Shipment in August – different result. Struggling to hit the positive filters. These were from the same mines in the same fields. Only difference was change in the weather. Filters made at low humidity and high temperature. • Analysis is all blind. Lots of the known boxes were analysed as unknown. Doghandler knows nothing about the filters. Records observations of dogs and results, as does test leader independently. Test leader deals with the filters and the carousel. Also makes decision about whether there should be more than 2 runs (always 2 runs). • Test leader and dog handler change roles regularly • Unknown filter boxes – only one run • Temp and humidity in room recorded • First samples were not unknown, but dogs did not miss any at all. • Presented results only from blind tests for filters (requiring confirmation from Bosnia). • Later filters when dogs had more trouble, weather monitored and used to link to the results. These filters taken the day after heavy rains for a week. • September filters taken in Mostar. Later filters in Sarajevo very poor result. But samples from Mostar were a lot better.

	• NPA had similar experiences in Bosnia. Clay in Sarajevo makes it very difficult to detect mines, and the program moves to Mostar in late autumn. Have greater success there. • Humidity result – significant relationship between humidity and proportion correct, with low humidity giving higher proportion correct • Very little relationship with temperature, and relationship not significant. However, low temperature inhibits detection.. • Critical factors – humidity, temperature, soil moisture, air flow through filter (suggested in original REST report). • Concentration of TNT and DNT is 1 million times higher in dust than in air. • When low humidity – should be more dust collected by filter. Need to work on filter design to encourage it to collect dust. • Is a need to have better weather records, covering longer time period before the sampling Discussion • Extensive discussion of the data in this study, including critical comments on the experimental design.
1530	Coffee
1600	**Havard Bach** **The operational Applications of REST: looking into the future** • Operational use issues. Road and route verification, area reduction application, strategy for future use • General discussion of issues related to above topics • Important lesson learned from the workshop – no matter how the study was done, somebody thinks it could have been done better. • Area Reduction issues in relation to testing – Targets used, test field layout, field preparation, how to sample (size and shape), how to analyse. Sikes: Is there a liability issue? A: presumably there is, although no different to the same issue for any demining program. Joynt: problem never goes away, but is partially dealt with by a QA system. However, can never prevent the possibility of a mine being newly laid. Bach: accreditation and licensing also helps to deal with it. • Current analysis capacity – NOKSH; Mechem, NPA, APOPO. Mechem and NPA are the only organizations with operational experience. All have a relatively small capacity. • Centralised analysis. - will the industry develop the concept – not likely - which organisations should analyse - who will test/accredit the analysis organizations - how to QA the analysis process

	- how to QA the sampling process - a practical logistical system required - industry agreement on price and timing - standards and Guidelines required - how and who to train organization to sample correctly - Logistical burden in transporting filter cartridges overseas - Demining organisation has no/little control of the analysis process - No global analysis concept in place • Decentralised analysis - Full control of the analysis process - No dependency of other organisations - Less filter transport requirements - Requires high skills and a more complex demining process - Likely to result in limited use of REST worldwide - Higher initial costs - Time consuming process of developing capacity - No system for external QA in place Schultz. Suggest is first picked up on a technical survey. A. could apply Joynt: old level one surveys gave very poor information and are no longer acceptable to donors as a basis for decision making. Don't replace it, but is a need to augment it. Bach: if system works, then there is only imagination that limits its use. Wide ranging discussion on a variety of themes. Difficult to direct the discussion towards coherent recommendations, in part because of lack of time.
1700	**Summary of outputs of workshops, Day 1.** In relation to equipment, filters, sampling procedures, molecule capture and molecule release • Broad array of issues identified as poorly understood • No issues identified as well-understood • Needs to be a high level of attention given to procedural details at all stages of the capture, transfer and testing process in order to avoid contamination, and avoid introducing any other clues or biases into the analysis process. • Most of the issues identified could receive further research attention, but the availability of detectors to do those experiments is extremely limited. • There is a need to improve the quality of reporting of the useful experiments being done within the REST framework. **Summary of outputs of workshops, Day 2** • Internal QA, monitoring and review, essential. Never assume the system is

	working perfectly. Should be designed as part of daily/weekly routine. • External review: occasional is encouraged; can be formal or informal but should not be viewed as threatening • Early stages of training: use standard training principles from early stage; ensure socialization appropriate to end use; selection process may be influenced by training concept • End use: could drive some training decisions and how some procedures are implemented. Needs to be properly identified and understood • Understanding of relevant principles by all personnel strongly underlined. Applies to training issues and background factors such as environmental factors. • Careful record keeping with appropriate analysis. • With respect to planning, programme managers need to recognize that the three central components of a REST program do not have the same requirements (the second two represent end uses, and that is not always recognized) - training (including maintenance) - operational use - research use **Summary of outputs of Day 3**. • Presenting data generates discussion • Clearly stated questions generate valuable disagreements • Artificial noses are detecting mines • The communication between personnel involved in operational use and research is uneasy, and the players sometimes talk at cross purposes • The way forward is a wide and lumpy path and many issues remain unresolved
	Recommendations • The workshop did not have time to run a coherent discussion designed to produce recommendations. However, the outputs of the workshop are summarized in the comments above, which provide some clearly stated themes. • It was clear that there is still tension
1715	**Havard Bach** **End of workshop** **Thank you to local organizers and Sokoine University of Agriculture** **Quiz awarding prizes to APOPO local staff**