1. *BACKGROUND

Chemical hazard communication, through the provision of labels and safety data sheets, is a key strategy for the prevention of illness and disability due to unsafe use of, or from exposure to potentially hazardous chemicals. Increasing international concern for chemical safety has seen the development of a Globally Harmonized System for Classification and Labelling of Chemicals (GHS) for hazard classification and labelling of chemicals in light of the need to strengthen national capacities for management of chemicals in line with Chapter 19 of Agenda 21. The GHS has been developed under the auspices of the Inter-Organisation Programme for the Safe Management of Chemicals (IOMC) and aims to enhance the protection of the people and the environment by providing an internationally comprehensive system for hazard communication; reduce the need for duplicative testing and evaluation of chemicals to determine their hazardous effect; facilitate international trade in chemicals whose hazards have been properly assessed and identified on an international basis; provide a recognised framework for those countries without an existing system; and, provide an informational framework upon which countries can base programmes for the sound management of chemicals. Timely implementation of the GHS has been a priority of international bodies, particularly the Intergovernmental Forum on Chemical Safety (IFCS).

Critical to the success of the GHS is the question of comprehensibility of hazard communication strategies. Systems developed at international agency levels have to be tested at national and sub-national levels to ensure their meaningful effectiveness on the ground, and optimise their value for countries, consumers and working populations exposed to potentially hazardous chemicals.

The Occupational and Environmental Health Research Unit (OEHRU) located in the School of Public Health and Primary Health Care at the University of Cape Town successfully tendered in mid-2002 for the contract to conduct hazard communication comprehensibility testing (CT). The Unit had previously developed a CT tool for the Co-ordinating Group of the Inter-Organisational Programme for the Sound Management of Chemicals (IOMC), under the secretarial co-ordination of the International Labour Office (ILO). This instrument has been adopted in ILO documentation as a method available for supporting the adoption of the GHS for countries around the world.

The original UCT CT tool is a detailed and comprehensive instrument comprised of 11 modules with many testing components and possibilities. The tool was piloted in Zambia in June 2002 with a view to shortening and adapting the tool. These adaptations were used as the basis for further modifications for the South African study. The adapted tool and manual are available as Report #2 in this series (Study into the Implications of Implementing the Globally Harmonised System of Classification and Labelling of Chemicals and Development of an Implementation Strategy for South Africa: Chemical Hazard Communication Comprehensibility Testing - Tool and Toolkit, FRIDGE/UNITAR, Johannesburg, April 2003).

The OEHRU project team is outlined in Annexure 2. Ms Shirley Miller assisted the team in the preliminary stages in developing the research. Co-ordination with the consortium put together by Wiechers Consulting for the broader investigation of feasibility was affected through regular contact by phone, and email. Regular reports were provided to the CPG on a monthly basis.

2. *THE HAZARD COMMUNICATION COMPREHENSIBILITY TESTING (CT) TOOL

The tool consists of a set of questionnaires administered in relation to labels and safety data sheets presented to respondents. The questionnaires are divided into sections called modules, for which specific pre-designed labels and data sheets are developed. Each module deals in detail with a specific element of hazard communication – for example, symbols, signal words, colour, hazard statements and advisory pictograms. A general module also tests recall and sequence of reading of elements on the label. Impact on behaviour is determined through reported intention to practice safety behaviours. (Although a module allowing for an observed simulation exercise exists in the original ILO tool, this was not included in the South African study for reasons of practicability.) The opening module collects demographic information and visual performance related to reading hazard communication

(colour blindness and visual acuity). The final module includes a detailed work history, and a small set of repeat questions to test the effectiveness of a limited training opportunity (a 5-minute explanation provided by the interviewer) on comprehension. This module also affords the opportunity for a number of open-ended feedback comments.

Along with the modules are specific labels and safety data sheets specifically designed for the testing scenario. Although based on real chemicals (e.g. acetone, cholorpyrifos, etc), the labels and data sheets carried hypothetical brand details (such as trade names, manufacturer, address, contact details, etc). This was done to avoid situations where workers familiar with a particular chemical perform better than others simply because of familiarity, rather than because of their real comprehension. Labels are laminated to enable repeated use in testing. SDSs chosen were those derived from US sources, because of the high variability and occasional poor quality of the majority of South African SDSs sourced in preparing for the study. The particular SDSs selected for this study were sourced through a reputable international search engine for chemical information (CCINFO).

Table 2.1 - Tool Outline: Modules included

Module Number	Contents in original ILO tool	Inclusion for SA study
1	Focus groups to test veracity of modules	No. Previous piloting in Zambia and SA indicated reasonable face validity
2	Demographic data, visual acuity, colour blindness	Yes
3	Labels: Familiarity, recall, sequence of reading, comprehension of symbols, signal words, hazard statements, hazard ranking; and ability to identify hazard information on a SDS	Yes
4	Labels: Colour ranking, symbol comprehension	Yes
5	Labels: Identification of hazard class from symbols	Yes
6	Size, Placement, Background Colour and Border of Symbols / Pictograms	No. No longer part of GHS
7	Comprehension of Pictograms	Yes. Additional GIFAP advisory pictograms for agricultural chemicals included for farm workers and consumers
8	Safety Data Sheets: Ability to identify safety information from a SDS, comprehensibility of information; what is read and in what order; identify information that is used, useful, appropriate and understandable; impact on intention to behave safely	Yes
9	Simulation exercise	No. Not practically feasible.
10	Post-interview questionnaire: Work history, exposure to chemicals at work and home, safety training, chemical information needs	Yes
11	Group exercise: Identify differences present in group learning, chemical information needs	Limited inclusion

The South African transport sector makes use of Tremcards in line with provisions of the Road Traffic Act (Act 93/1996) and the SABS Standard 232.1. Tremcards provide information on the chemical and are seen as the equivalent to Safety Data Sheets used in industry. However, they represent a method of hazard communication that occupies a place somewhat between an SDS and a label, with respect to the kind and depth of information provided. As such, the GHS does not address standardisation of

hazard communication in terms of methods other than SDSs or labels. Moreover, there are plans to replace the Tremcards with a Driver Emergency Information Document. For these reasons, hazard communication was not conducted using Tremcards in the transport sector, but labels and SDSs consistent with those used in agriculture, consumers and industry. In any event, the hazard elements contained in labels and SDSs are largely the same as those found on the Tremcards, and these were the object of comprehensibility testing in the questionnaires.

Table 2.1 summarises the modules available for inclusion from the original ILO tool, and the final set of modules included in the South African study.

3. IMPLEMENTATION

The project initiation, scheduled for October 2002, was delayed due to negotiations required to clarify contractual issues between UCT and the IDC, as holder of the funds for project. As a result, the contract was only concluded in December 2002 and the project had to catch up planned milestones in the first three months. A revised project schedule was agreed with Wiechers Environmental and the CPG to accommodate the late start. Nonetheless, by February, the project had more or less recovered to its original schedule.

The project was essentially conducted in phases.

3.1 *Phase I: Preparatory Development

In the first 3 months of the project, the team concentrated on Tool Refinement and adaptation. The purpose of this phase was to consolidate previous work on the CT tool, and to adapt it for local use, as well as identifying human resources needed as well as the sample population. This involved the following:

3.1.1 Questionnaire/Module Refinement

The team reviewed each module from the original set of 11 modules (ILO) as well as the abbreviated CT set used in Zambia in light of the FRIDGE study terms of reference. From this review, a draft set of 7 questionnaires was developed appropriate for each of the 4 sectors to be tested. The modules were piloted on 8 respondents from industry, domestic and farm workers and consumers in the Western Cape to assess ease of administration, face validity and length. Based on initial piloting, the modules were further shortened, questions changed and reorganised. Consumer questionnaires had a short occupational history added to capture past workplace experience relevant to their knowledge and awareness of chemicals. A manual to accompany the modules was compiled as guide for administration. The full CT material therefore includes modules (questionnaires), toolkits (labels and safety data sheets) and a guidance manual for administration.

In January 2003, the CPG suggested including companies that were surveyed by the consortium under Wiechers Environmental. It was agreed that only companies in the Gauteng and Western Cape would be included. A set of additional questions suited to the broader feasibility study were also piggy backed onto the CT modules, after the questions were clarified.

In this period, a request from the CPG to test Tremcards as part of the GHS was also investigated. Because the composition of the elements included in a Tremcard did not match what the GHS specifies for either a GHS label or a SDS, testing Tremcards would not have met the objectives of the study adequately. Moreover, given the likelihood of changes to the Tremcard, and the fact that hazard communication elements on the Tremcard would be individually testing in the modules, it was decided to retain the testing tools in as consistent a format as possible across sectors.

3.1.2 Recruitment of Staff

During this period, staff were recruited to undertake design and field piloting of the tool (2 staff) as well as for main field testing (9 staff). Collaboration with the National Centre for Occupational Health was secured to provide a base for Gauteng-based field-testing. Students from both the Peninsula and Vaal Technicons were recruited to assist. Piloting was used for training of staff in questionnaire administration.

3.1.3 Information Feedback

Plans were developed in this stage as to the material to be provided to workers as direct benefit for participation. A certificate confirming participation as well as a handy (laminated) pocket card explaining all the GHS symbols was developed in this stage for distribution as part of the field work in phase II.

3.1.4 Sampling

During this phase, a preliminary sampling frame (see Tables 3.1 and 3.2 in Part 2 of the series of reports in this study[1]) was constructed to provide a basis for sampling of companies for field sampling, drawing on expertise of other members of the OEHRU experiences in occupational health research. The preliminary sample was presented to the CPG for feedback and adapted as fieldwork identified shortcomings in the database.

3.2 Phase II: Comprehensibility Testing

This took place over the final 4 months of the project, commencing March 2003 and ending June 2003. The purpose of this phase was to conduct field-testing in order to:

- provide data on comprehensibility of labels and SDSs presently in use;
- provide data comprehensibility on proposed GHS symbols to be used in SA;
- identify areas of low comprehension where training will be required; and
- identify areas needing to be addressed during GHS implementation.

3.2.1 Interviewers

A team of 5 interviewers based in Cape Town and 6 interviewers based in Johannesburg undertook field interviews. Interviewers were trained in administration of the questionnaire in a standardised method. Two interviewers travelled to Johannesburg to supplement the Johannesburg team so as to complete Gauteng-based sampling.

3.2.2 Procedures

Companies sampled were contacted to secure their participation in the study. An explanatory letter from UCT along with a NEDLAC letter confirming the importance of the GSH project was the first communication made with selected companies in almost all cases. This was followed up by telephonic communication to clarify details and timetable the visit. Co-operation was obtained in over 80% of employers. Where selected companies declined participation, or were uncontactable, the next company on the sampling list was selected. Replacement was required in 5 of the chemical companies (42%), 9 of the non-chemical companies (45%) and 3 of the transport companies (23%).

In two cases, companies requested the signing of a confidentiality agreement before participating. However, after explanation that the project involved no access to any proprietary information, and after being supplied with the testing instrument, one company was quite happy to participate without a contract. The second company was not followed up because it was already nearing the end of the data collection stage and their participation was not needed by that point.

Appointments at participating companies were scheduled on a running basis, approximately one to two weeks ahead of the field visit, at dates and times convenient to employees and employers. Companies were requested to facilitate interviews with appropriate categories of employees. The outline of the sampling frame is described in more detail in Part 2 of the series of reports in this study[2].

[1] Part 2: Study into the Implications of Implementing the Globally Harmonised System of Classification and Labelling of Chemicals and Development of an Implementation Strategy for South Africa: Chemical Hazard Communication Comprehensibility Testing - Tool and Toolkit, FRIDGE/UNITAR, Johannesburg, April 2003).

[2] Part 2: Study into the Implications of Implementing the Globally Harmonised System of Classification and Labelling of Chemicals and Development of an Implementation Strategy for South Africa: Chemical Hazard Communication Comprehensibility Testing - Tool and Toolkit, FRIDGE/UNITAR, Johannesburg, April 2003).

Interviews were conducted in the language of interviewee, although the testing instruments were only produced in English for reasons of logistics and cost. Interviewers were conversant with the languages dominants in the two study regions and administered the questionnaires in the language of the respondents.

Questionnaire administration took between 45 to 90 minutes per person. Companies provided appropriate venues to interview workers, while consumers were interviewed in malls, or in venues provided by supermarkets and shops. Domestic workers were interviewed in private homes, as were employers of domestic workers.

Group interviews were conducted with two worker groups (one farm worker group and one chemical company) in order to assess how group understanding of hazard communication differs from that of individuals, and to afford opportunities for insights from employee collectives. Where such group data support or indicated important differences to data emerging from individual questionnaires, these are cited in the text of the results section.

3.2.3 Ethics

All participants were given information on what the study was about and asked for their consent before inclusion. Participants were assured of complete confidentiality and study data obtained were kept secure. No companies were given individualised data so as to protect individual participants' identity. Consumers who participated were reimbursed for their time (R50).

4. METHODOLOGY

4.1 Population

The study is intended to provide a snapshot view of comprehensibility to support the implementation of the GHS in South Africa. For that reason, it should be, as far as possible, generalisable to those sectors most affected by future GHS implementation. As previously defined in international documentation on the GHS, these have focused on 4 sectors: Industry, Transport, Agriculture and Consumers. The study population is therefore taken to reflect employees involved in production activities with potential exposure to chemicals as well as consumers similarly experiencing potential exposure to chemicals. Only the Western Cape and Gauteng were included as per the project proposal.

4.2 Stratification

In order to achieve some measure of generalisability of the study population, the sample needed to be drawn in a way that is representative of the population. The most effective way to undertake sampling that is representative is by random sampling of an established sampling frame.

Where there is significant variability within a population attributable to a particular variable, stratification by that variable will help to reduce random variation in the population estimate. Thus, for example, chemical companies may be sampled as a stratum within the industrial sector, and within the stratum of chemical, a sub-stratification may seek to include companies according to their size. At such levels of sub-sub-stratification, the intention is to ensure that the final distribution of (for example) company size across the whole sample is more or less representative of the distribution in the population, even though within a particular sub-stratum the distribution may not conform.

However, random sampling may not always be possible, due to logistic reasons, non-participation of the majority of the population or inadequate data to construct a sampling frame. Under such circumstances, sampling of participants who are typical of the target population is a reasonable second best. By identifying the typical sub-strata found in a sector, and applying opportunistic sampling to ensure a sufficient number of respondents with those characteristics, a reasonable approximation of the population characteristics may be obtained, provided there is no substantial bias introduced by the opportunism of the sampling process.

4.2.1 Sampling Undertaken

Four main categories (sectors) were identified for sampling:

- Industrial (to include workers, managers, factory laboratory scientists, supervisors)
- Transport (including road, rail, air and sea transport)
- Agricultural (to include farm workers, managers and other related agricultural categories)
- Consumer

It was originally intended to include 100 in each category, 50 each from the Western Province and Gauteng. However, following discussion amongst members of the Team and with the Unit's senior staff, it was realized that it would not be feasible to seek all strata in both provinces, since some strata may not exist or may be over-represented in some Provinces (e.g. no mining in W Cape and less farming in Gauteng). Hence, sampling was planned to be flexible in where the strata samples would be drawn, but would still aim to keep total numbers at 200 subjects in each province.

Because the chemical industry is an important user and generator of chemicals, it was over-sampled as an industry category. Other categories included in the non-chemical industry sector were a combination of randomly selected Standard Industrial Classification categories (mining, paper, textiles, electricity, gas and water, construction, and wholesale and retail trade) and purposively selected categories thought to represent vulnerable populations in industries with significant chemical exposure (health care, domestic works, and cleaning industries). Sampling within categories included size criteria for all industry and transport companies: Small = < 20 employees; Medium = 20 to 199 employees; Large = >200 employees. The transport sector was also stratified by companies exclusively involved in transport versus companies in the manufacturing or other sectors who maintained substantial transport fleets (e.g. petroleum).

Sampling within industrial and transport sector was based on random sampling from an established sampling frame assembled from a multitude of sources: Chamber of Commerce lists, Websites, Telephone directories and membership of industry associations. If a company declined to participate, or did not respond, one substitution was allowed from the company next on the list. The full outline of the sampling strategy used is contained in Report 2 of this series[3].

For agriculture, the size of the operation is less important than the character of the agricultural operation. As a result, strata in agriculture distinguished large commercial farming (including agribusiness) from small commercial, emergent farmer and state-run farms. In addition, a stratum for pesticide retailers was used. Because of limitations in access, farms were selected by opportunistic sampling.

Consumers were sampled by opportunistic sampling from supermarkets, laundromats, hairdressers and hardware shops, stratified by urban and rural consumers.

In addition to the random sample of industry and transport selected, companies in Gauteng and Western Cape that had been previously interviewed by the consortium under Wiechers Consulting were included in the list. A small number of these companies (n=3) declined participation in the Hazard Communication study even though they had been interviewed for the broader GHS feasibility study.

Within each stratum, a specially designed protocol sought to select workers and consumers as indicated in the Part 2 report. In general, every workplace sample aimed to include a range of production workers, shop stewards/safety representatives, managers/supervisors and technical (e.g. laboratory) staff. Details are included in Annexure 1.

[3] Part 2: Study into the Implications of Implementing the Globally Harmonised System of Classification and Labelling of Chemicals and Development of an Implementation Strategy for South Africa: Chemical Hazard Communication Comprehensibility Testing - Tool and Toolkit, FRIDGE/UNITAR, Johannesburg, April 2003).

4.2.2 Sample Realisation

Due to a number of practical constraints, sampling did not achieve the final sample as planned:

- Certain companies did not respond, did not exist or declined to participate, and even after an allowed substitution (the company next on the list), the substituted company did not participate. The non-participation differed across sectors and sub-sectors, resulting in different sample sizes. Under-included strata were particularly evident for photo laboratories and dry cleaners; sea and air transport; emergent farmers and retailers in the agricultural sector.
- Some of the reason for the inability to include certain categories was attributable to the exceeding difficulty in reaching these sectors (e.g. emergent farmers) or to the fact that were not present in sufficient numbers to make the sampling strategy feasible.
- The textile industry was the only industrial sub-sector where significant numbers of working women could be recruited to the study, which resulted in over-sampling this sector. This may be of significance for the results if the workforce is systematically different in hazard experience and perception of chemical risks. However, this did not appear to have been the case when reviewing results by sub-sector (see results).
- Communication in Gauteng proved more difficult than in the Western Cape, despite attempts to improve participation by soliciting the support of the Chair of the CPG and the assistance of Wiechers Consulting. For most of the Gauteng companies, researchers had to visit the company first before access was agreed. This included some of the companies whom were included in the initial list on the basis of their participation in the larger feasibility study by Wiechers consulting. This requirement significantly reduced the numbers that were feasible for inclusion. It was noticeable that, when it was mentioned that the survey would provide a limited form of training, participation rates increased significantly. In retrospect, had the project been in a position to link comprehensibility testing to training, access would have been much easier.
- Access to the Working for Water Programme of the Department of Water Affairs and Forestry could not be effected in time for the study due to the decentralised nature of the programme and the fact that the majority of workers are sub-contracted to the programme, and therefore difficult to organise or access. Waterworks and sewage operations were substituted for this sub-sector.

Table 4.1 Final Sample Realised in the CT study

	Western Cape	Gauteng	TOTAL
Chemical Industry	62	24	86
Industry other than chemical	63	27	90
Transport	44	28	72
Agriculture	55	12	67
Consumer	67	20	87
TOTAL	291	111	402

As a result, the final sample included 402 respondents, including 21% from the chemical industry, 22% from non-chemical industries, 18% from transport, 17% from agriculture, and 22% from the consumer sector (Table 4.1). The implications of this sampling are explored under Analyses (Section 5.2) and in the Discussion (Section 7) of this report.

5. CODING AND ANALYSES

5.1 Coding

Comprehension of hazard communication items is not a dichotomous variable. For example, a worker may grasp part of the concept behind a hazard symbol without fully understanding the exact intention of the icon. This was coded as a category 'partly correct.' Alternatively, the worker may understand the symbol in a way that is worse than simply incorrect if his or her understanding will lead to an action

that increases risk. For example, if a respondent interprets the symbol for environmental hazard to mean that you can apply the chemical to trees, this is a mistake that is worse than simply getting the symbol wrong – your understanding leads you to increase environmental contamination. This was coded as the category 'critical confusion.' Moreover, where respondents gave wrong answers for particular symbols, qualitative analysis of the nature of the wrong answers was captured to give a sense of what stereotypes and misjudgements are typical in this area.

Note that for a number of variables, respondents could provide more than one answer. For example, if he or she was asked why they used a label, their responses could be coded into up to 4 variables. Such data would therefore not add up to 100% when considering the distribution of possible reasons for use of a label. Where respondents could provide more than one answer to a question, this is indicated in the analyses, usually at the foot of the relevant table.

5.2 Analyses

The majority of data are categorical; hence univariate (descriptive) results are presented as frequencies or percentages. Descriptive data are presented for the whole sample, and for each of the 4 sectors separately. Where percentages by sector differed, these were cited specifically and statistical testing conducted using χ^2 testing at a significance level of $\alpha = 0.05$. No multivariate analyses are presented in this report.

Where percentages were similar across sectors, the overall percentage for the whole sample could be easily interpreted. Weighted analyses would be particularly useful to achieve high levels of precision in a specific outcome variable where there is high variability across sectors. However, given the nature of this study to support the implementation of the GHS in South Africa, and its focus on only two provinces, such high levels of precision did not appear warranted. Based on a reasonably representative sample, and citing data by sector where appropriate, unweighted statistics are presented as adequate for the purposes of the study.

Numerous bivariate analyses (exploring associations between two factors) were conducted, comparing comprehensibility outcomes to demographic, work history, and other independent variables. The project dataset is very large, containing over 470 variables, which implies that the permutations for bivariate comparisons (i.e. comparisons of different groups) are essentially endless. The description of analyses run for this project, the glossary of variables, and the data runs (bivariate analyses results), which informed the comments in this report are available on request from the CPG. What is included in this report is only those comparisons directly relevant to the study objectives and requested by the CPG. Analysis presented in this report includes all 402 respondents.