Bringing Health to Business

ORGANISATIONAL HEALTH

How to integrate Occupational Health Data – Back to Basics

Exposure Monitoring (OREP), Biological Monitoring, Medical Surveillance, Data Analysis and Reporting

The case of Chromium (VI)

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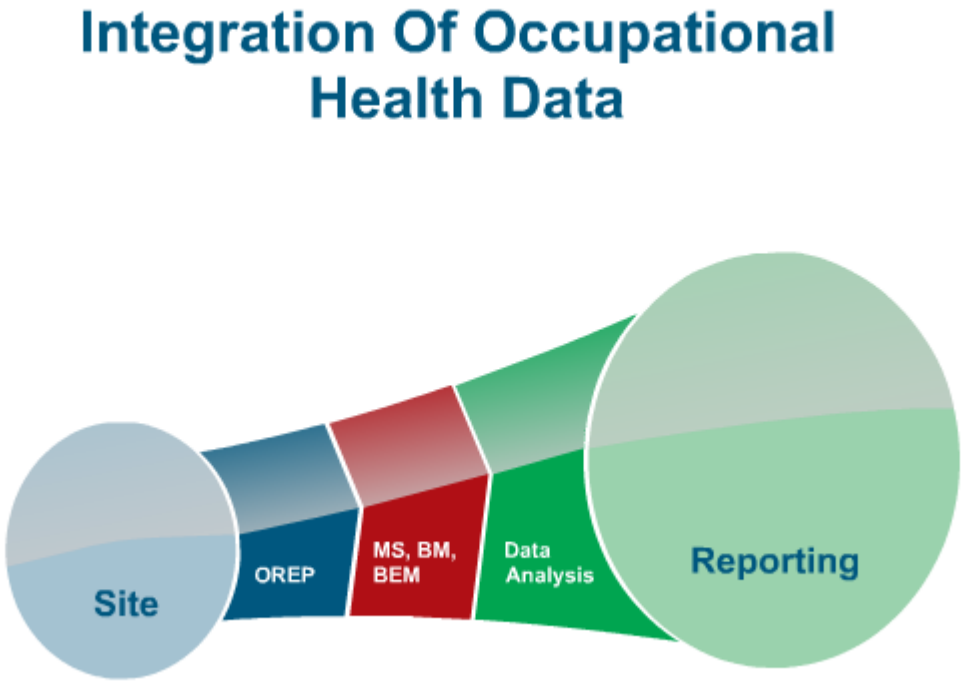
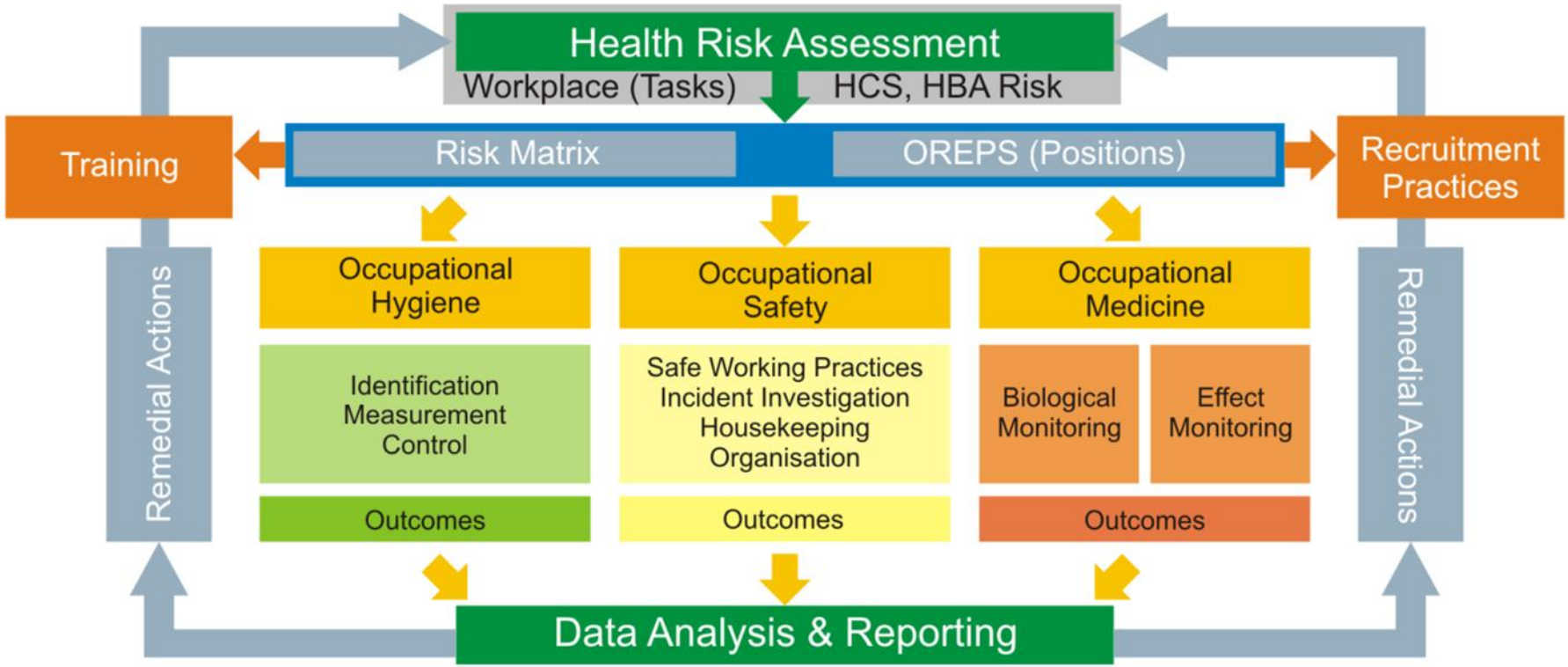
AN EOH COMPANY

Presentation map



OH Electronic System

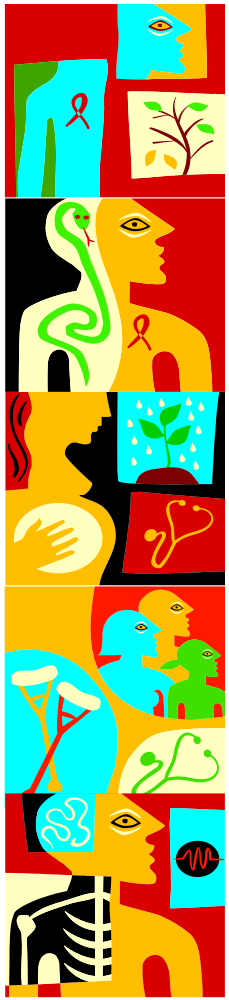


Risk Assessment Matrix – MSDS/Research/Science

HAZARD CONSEQUENCE CRITERIA						PROBABILITY CRITERIA				
INCREASING SEVERITY SCORE ⇨	TYPES OF IMPACT					INCREASING PROBABILITY SCORE ⇨				
	Score	Human Health & Safety (Generic)	Environment	Financial	Public Perception	1	2	3	4	5
	0	None (No toxic, harmful, corrosive, irritant or asphyxiant effects) (Chemicals: ACGIH A5 carcinogens, Those with no OELs)				VL (0)	VL (0)	VL (0)	VL (0)	VL (0)
	1	Minor injuries (No lost time) Or reversible health effects (e.g. awkward posture) **Chemicals:** CONTROL BAND 1 - ACOH A4 & IARC S. - Irritants, defatting agents, mild skin sensitisers	Local off-site effects, Reversible (<6 months)	Loss < R100 000	Local	VL (1)	VL (2)	L (3)	L (4)	M (5)
	2	Moderate inures (lost time) Or reversible significant health effects (e.g. repetitive tasks) **Chemicals:** CONTROL BAND 2 - ACGH A3 & IARC 28 - Severe dermatitis - OEL6-60 PPM: OEL 0.1mg/m3 (dust)	Locally significant Long term effect (Reversible in > 6 months) Or Regionally significant effect (reversible <6 months)	Loss R100 000 – R 1m	City	VL (2)	L (4)	M (6)	M (8)	M (10)
	3	Single major injury (hosp) Or multiple disabling injuries Or irreversible significant health effects (e.g. noise, poor manual handling) **Chemicals:** CONTROL BAND 3 - ACGH A2 & IARC 2A - OEL 0.6-4.9 PPM, OEL <0.01 mg/m3 (dust)	Regionally significant Long term effect (Reversible in >6 months>	Loss R 1m – R 10m	Region	L (3)	M (6)	M (9)	M (12)	H (15)
	4	Multiple major injuries/disabilities Or life threatening health effects (e.g. ionising radiation, avian flu) **Chemicals:** CONTROL BAND 4 - ACGH A1 & IARC 1 - Potent resp sensitisers - OEL <3.6PPM, OEL <0.01mg/m3	National significant Reversible effect (>1 year)	Loss R 10m – R 100m	National	L (4)	M (8)	H (12)	H (16)	VH (20)
	5	Multiple fatalities or Extreme health hazard **Chemicals:** CONTROL BAND 5 - ACGH A1 & IARC 1 - Mutagen, teratogen, potent resp sensitisers - OEL <3.5OOM, OEL <0.01 mg/m3 (dust)	Internationally significant effect (irreversible)	Loss > R 100m	International	M (5)	H (10)	H (15)	VH (20)	VH (20)

LIKELIHOOD	Unlikely ever	1 incident / 10yra	1 incident / year	1 incident / month	1 incident / week
EXPOSURE FREQUENCY	Once / year	Quarterly	Monthly	Weekly	Daily
EXPOSURE DURATION	< 1 hr / week (<10%)	1-5 hr / week (10%)	5-19 hr / week (10-50%)	20-40 hr / week (50-100%)	>40 hr / week (>100%)
EXPOSURE INTENSITY	Enclosed sealed process	Manual work with local exhaust	Semi-enclosed process	Manual application, protected (PPE)	Manual application, unprotected
MEASURED TWA EXPOSURE (where known)	As per table or <50% of prescribed limits	As per table or 50-70% of prescribed limits	As per table or 75-100% of prescribed limits	As per table or 101-200% of prescribed limits	As per table or >200% of prescribed limits

Notes: RISK = CONSEQUENCES X PROBABILITY (or EXPOSURE) (OUT OF 25)
Use LIKELIHOOD in Phase One of HRA (Hazard Identification)
Use EXPOSURE SCORE (Freq x Duration x Intensity)/3 in Phase Two of HRA (Detailed HRA)
Use MEASURED TWA instead of Exposure Score if the value has been measured



SA Medical & Environmental Surveillance Guidelines

2nd Edition

Dr Murray Coombs

Chairman: SASOM Scientific Committee on Biological Monitoring

Health Risk Assessment: The OREP

The Occupational Risk Exposure Profile:

- Single Occupational Group
- Inherent Requirements
- Hazard Exposures

Uses:

- Cornerstone of future risk reduction strategies, including Medical Surveillance design.

What is an OREP?

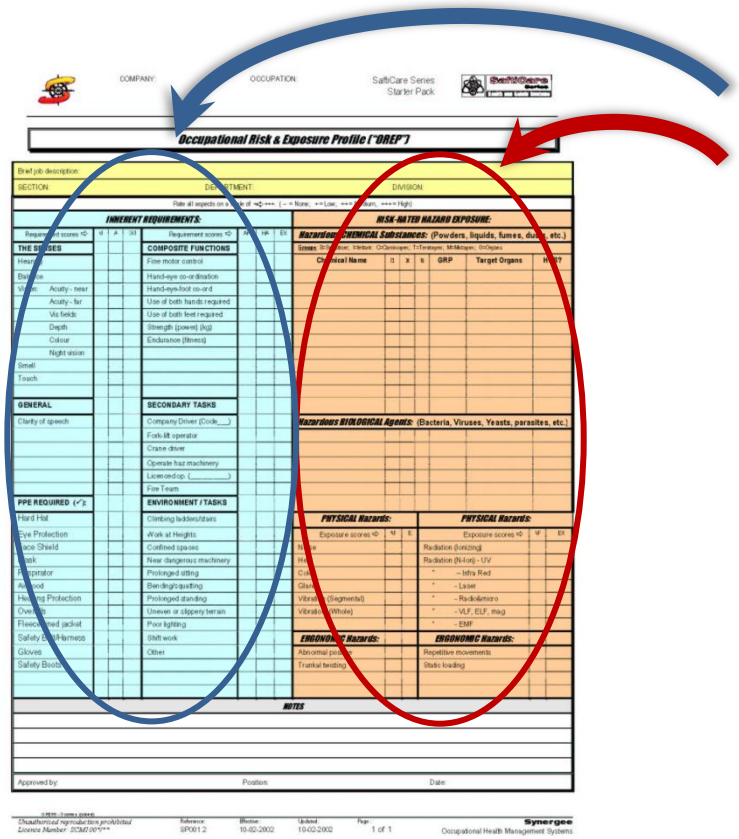
A summary of:

- The key Inherent Requirements of a job
- The key hazards (risks) to which the job (employees) are exposed

Key legal imperatives include:

- **Inherent Requirements:** Employment Equity Act and Labour Relations Act & Codes of Practice, as well as many statutes specific to occupations (Aviation, Drivers, Divers, construction workers, etc.)
- **Hazards/Risks:** Occupational Health & Safety Act & Regulations, Including Hazardous Chemical Substance Regs

Diagrammatic representation of an OREP



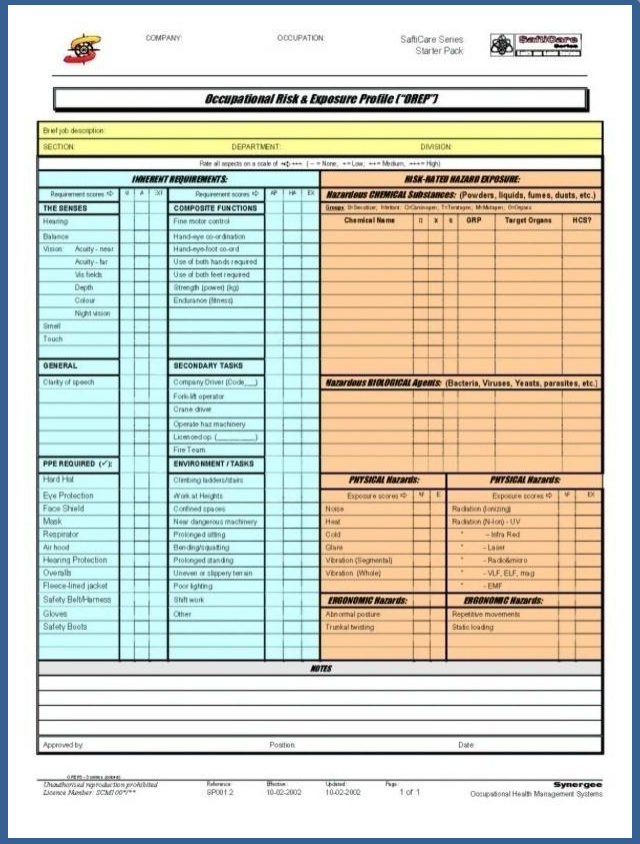
The information in the OREP is as follows:

- General information about the job (yellow)
- A checklist of the **Inherent Requirements** of the Job (blue)
- A checklist of the **hazards** to which the job is exposed (red)

The information directs the components of the Occupational Health Programme by:

- Ensuring that hazard exposure information is available to all parties (“Risk Assessment beneficiaries”)
- Establishing minimum health requirements in advance.
- The information directs any training needs, as prescribed by the Hazardous Chemicals Substances regulations.
- The information determines placement requirements for the various occupations, improving the effectiveness of the Human Resources personnel. This provides protection from the Labour Relations and Employee Equity Acts, which require rational and defendable approaches to employment/placement strategies AND incapacity management.
- Presenting the required data for all the beneficiaries of the Risk assessment in a manner that enables rapid implementation.

OREP's & Risk Assessment



Occupational Risk & Exposure Profile ("OREP")

COMPANY: OCCUPATION: SafriCare Series Starter Pack

Brief job description:

SECTION: DEPARTMENT: DIVISION:

Rate all aspects on a scale of ++0+++ (- = None; ++Low; +++ Medium; ++++ High)

INHERENT REQUIREMENTS:

Requirement scores +0	W	P	SH
THE SENSES			
Hearing			
Balance			
Vision: Acuity - near			
Acuity - far			
Vis fields			
Depth			
Colour			
Night vision			
Smell			
Touch			
GENERAL			
Clarity of speech			
PPE REQUIRED (✓):			
Hard Hat			
Eye Protection			
Face-Shield			
Mask			
Respirator			
Air hood			
Hearing Protection			
Overalls			
Fleece-lined jacket			
Safety Belt/Harness			
Gloves			
Safety Boots			

Requirement scores +0	AP	HA	EX
COMPOSITE FUNCTIONS			
Fine motor control			
Hand-eye co-ordination			
Hand-eye-foot co-ord			
Use of both hands required			
Use of both feet required			
Strength (power) (kg)			
Endurance (Illness)			
SECONDARY TASKS			
Company Driver (Code ___)			
Fork-lift operator			
Crane driver			
Operate haz machinery			
Licenced op. (_____)			
Fire Team			
ENVIRONMENT / TASKS			
Climbing ladders/stairs			
Work at Heights			
Confined spaces			
Near dangerous machinery			
Prolonged sitting			
Bending/squatting			
Prolonged standing			
Uneven or slippery terrain			
Poor lighting			
Shift work			
Other			

RISK-RATED HAZARD EXPOSURE:

Hazardous CHEMICAL Substances: (Powders, liquids, fumes, dusts, etc.)

Groups: St=Sensitiser; Irr=Irritant; Ca=Carcinogen; Te=Teratogen; Mu=Mutagen; Or=Organic

Chemical Name	R	X	N	GRP	Target Organs	HCS?

Hazardous BIOLOGICAL Agents: (Bacteria, Viruses, Yeasts, parasites, etc.)

PHYSICAL Hazards: Exposure scores +0	Y	E
Noise		
Heat		
Cold		
Glare		
Vibration (Segmental)		
Vibration (Whole)		
ERGONOMIC Hazards:		
Abnormal posture		
Trunkal twisting		

PHYSICAL Hazards: Exposure scores +0	W	EX
Radiation (ionizing)		
Radiation (N-ion) - UV		
" - Infra Red		
" - Laser		
" - Radiofreq'o		
" - VLF, ELF, mag		
" - EMF		
ERGONOMIC Hazards:		
Repetitive movements		
Static loading		

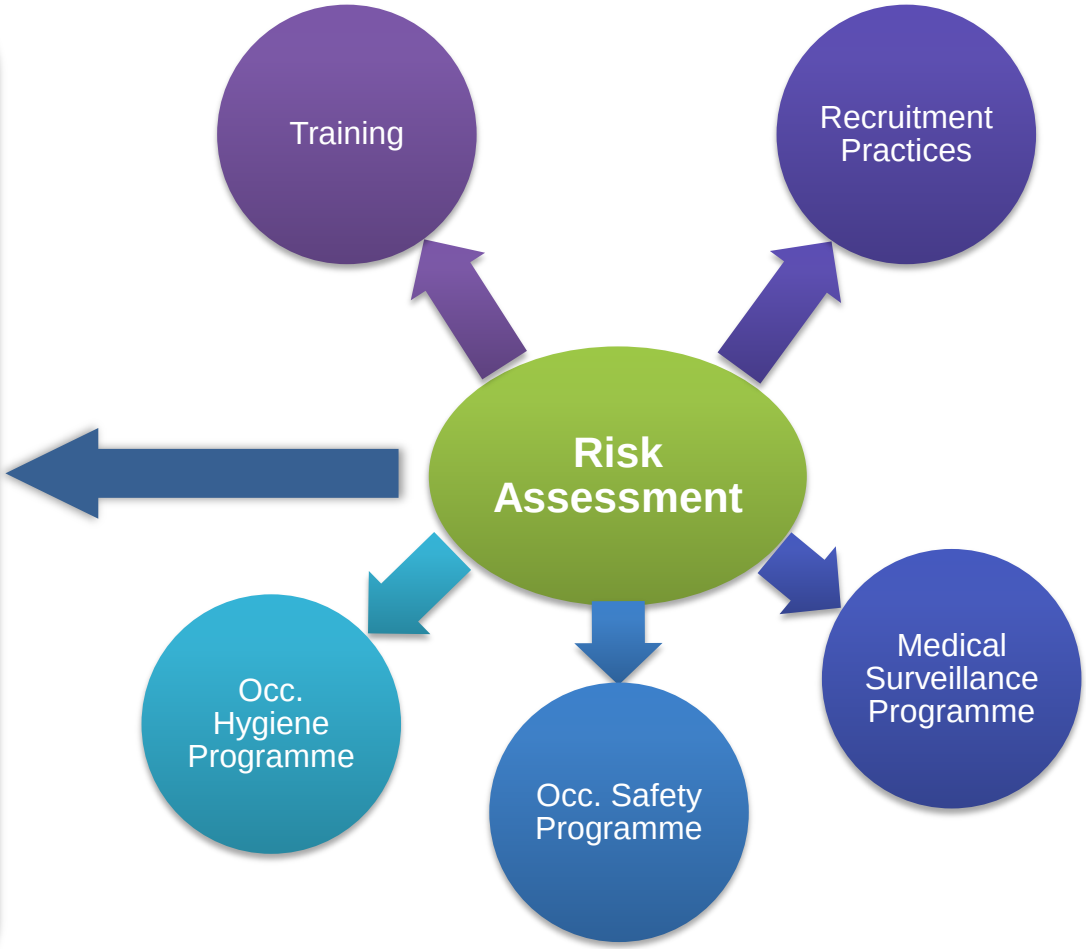
NOTES

Approved by: Position: Date:

Reference: SP001.2 Effective: 10-02-2002 Updated: 10-02-2002 Page: 1 of 1

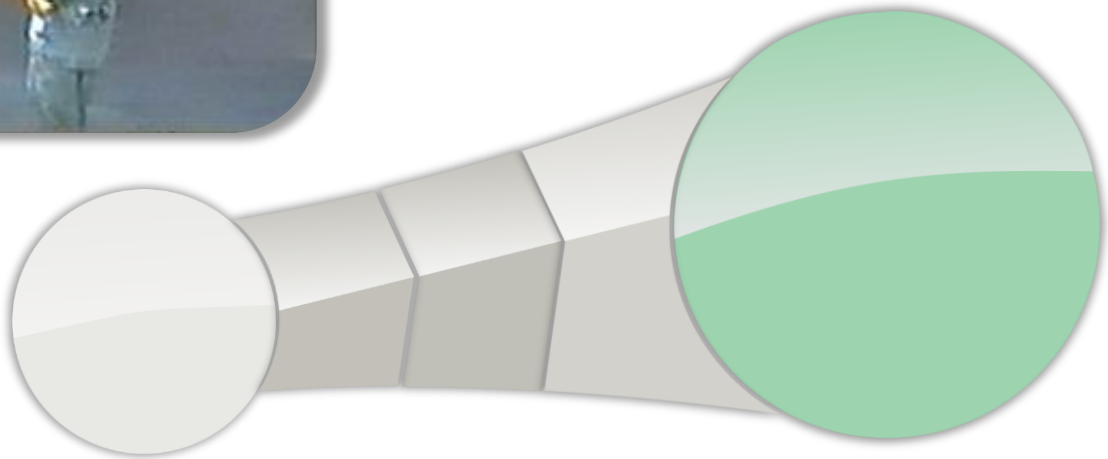
Synergee Occupational Health Management Systems

THE OREP



COMPREHENSIVE DRILL DOWN

Spot the hazard/risk



Chromium (VI)

- Chromium is a hard metal with a melting point of 1900^0C and a boiling point of 2672^0C. Chromium (VI) is one of the most common valence types found in the workplace; the other is chromium (III).
- The solubility of Cr(VI) varies from very water-soluble to insoluble, depending on the chemical form. Water-soluble hexavalent chromium compounds include chromic acid, chromium trioxide, and the monochromates and dichromates of sodium, potassium, ammonium, lithium, cesium, and rubidium (alkali chromates).

Cr (VI) OEL/TLV-TWA

- The TLV-TWA for water-soluble Cr(VI) compounds is 0.05mg Cr/m^3[34]. Soluble chromates are assigned an A1, confirmed human carcinogen, notation, based on the IARC classification for all chromates as human carcinogens (Group 1).

- The basis of the TLV-TWA is “to minimise the potential for respiratory tract irritation and cancer, dermatitis, and possible kidney damage.”

Designing and implementing a programme of medical surveillance

4.4.1 The following steps should be included in any program:

(a) Risk assessment to determine the potential exposure to and routes of absorption of an HCS, as required by regulation 5.

(b) Identification of target-organ toxicity, so as to direct medical screening.

(c) Selection of appropriate tests and testing schedule. Tests should have the desirable operating characteristics of high sensitivity, specificity, reliability and predictive value. The frequency of testing is laid down in general terms by regulation 7(2) , but should in any case be based on an understanding of the nature of the hazard and the natural history of any adverse effects.

(d) Development of action criteria. These are provided for some HCSs in the form of BEIs in Table 3 of Annexure 1. Criteria for interpreting lung function testing have also been published in the medical literature. However, in many cases, the occupational health practitioners will have to develop pragmatic criteria in the context of the specific workplace.

(e) Standardisation of test process. Quality control needs to be exercised both in the testing site and in the laboratory contracted to carry out analyses. Consistency over time should be sought so as to make longitudinal measurements comparable.

(HCS Regs)

Designing and implementing a programme of medical surveillance (cont.)

(f) Ethical considerations. Information and training of employees as required by regulation 3(1) should include the rationale for doing medical surveillance, and the consequence of abnormal findings. An employee must be notified of the results and interpretation of his/her tests and any recommendations made. The confidentiality of personal medical records is laid down by regulation 9.

(g) Determination of employees fitness to remain in that job. [Regulation 7(3)]. Results may be compared against the action criteria (BEI if relevant), and preferably also the employees previous results to determine whether individual action needs to be taken. Action may include repeating the test, further medical examination, removal of the employee from further exposure, and notification of the employer. Co-operation of employees can be best secured by a policy of protection of conditions of service in case of medical removal from a particular job.

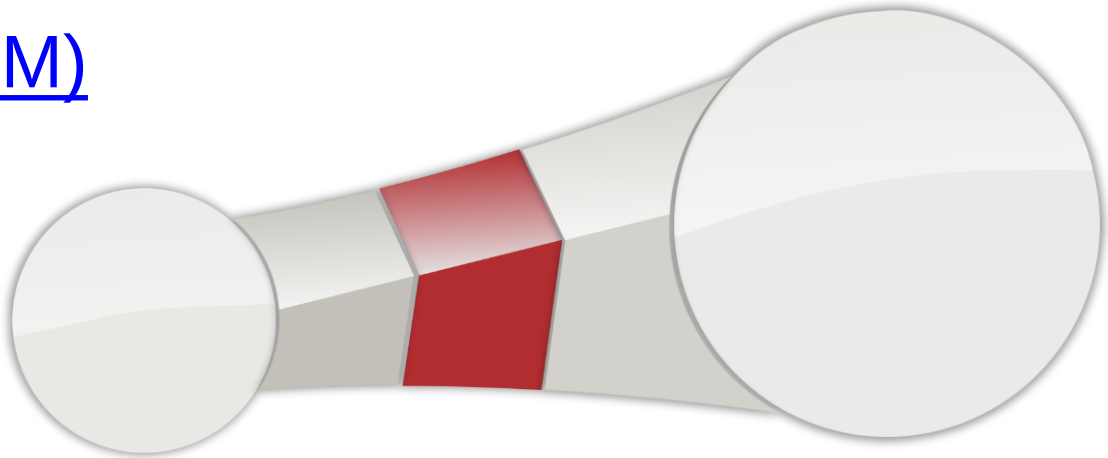
(h) Evaluation of control. An abnormal finding in an employee, or a pattern of findings in a group of employees, may point to inadequate primary control of exposure. In such cases the employer needs to be notified of such details of the medical findings as are necessary to evaluate the workplace problem and take remedial action.

(i) Record keeping. This includes both medical records and exposure information for every employee. While the employer is responsible for record keeping in terms of regulation 9, the contents of personal medical records may be accessible to the occupational medicine practitioner, the employee, and any person nominated by the employee in writing.

DATA COLLECTION

BIOLOGICAL MONITORING (BM), BIOLOGICAL EFFECT MONITORING (BEM), MEDICAL SURVEILLANCE (MS)

- Biological Monitoring
- BEI Sample data (Chromium (VI))
- BEI Process
- MS Process (SASOM)



Biological Monitoring

Biological monitoring is the measurement and assessment of workplace agents or their metabolites either in tissues, secreta, excreta, expired air or any combination of these to evaluate exposure and health risk compared to an appropriate reference *(HCS Act).*

BEI's

- BEIs are reference values intended as guidelines to be used in the evaluation of potential health hazards in the practice of occupational hygiene.

- BEIs do not indicate a sharp distinction between hazardous and non hazardous exposures. For example, it is possible for an individual's determinant concentration to exceed the BEI without incurring an increased health risk.

BEI's

- If measurements in specimens obtained from a worker on different occasions persistently exceed the BEI, the cause of the excessive value should be investigated and action taken to reduce the exposure.

- BEIs apply to 8 hour exposures, 5 days per week. Although modified work schedules are sometimes used in various occupations. ACGIH does not recommend that any adjustment or correction factor be applied to the BEIs (i.e. the BEIs should be used as listed, regardless of the work schedule)

BEI's

- The BEIs should be applied by a knowledgeable occupational health professional. Toxicokinetic and toxicodynamic information is taken into account when establishing the BEI; thus, some knowledge of the metabolism, distribution, accumulation, excretion, and effect(s) is helpful in using the BEI effectively.

- The BEI is a guideline for the control of potential health hazards to the worker and should not be used for other purposes. The values are inappropriate to use for the general population or for non occupational exposures. The BEI values are neither rigid lines between safe and dangerous concentrations nor an index of toxicity.

BEI's

The main source of inconsistency in information on exposure intensity by air monitoring and biological monitoring is the variability of the following factors:

- Physiological and health status of the worker
- Occupational exposure sources
- Environmental sources
- Individual lifestyle sources
- Methodological sources

BEI's

- The significance of these effects must be accessed individually for each situation. Drugs, pollutants, or co-exposure to another chemical can alter the relationship between the intensity of occupational exposure and the level of the determinant in the specimen either by adding to the level of the determinant or by altering the metabolism or elimination of the studied chemical.

- The documentations provide specific information on the effects of these factors. The timing indicates when the samples should be collected with respect to the exposures. It must be carefully observed because distribution and elimination of a chemical or its metabolic products as well as biochemical changes induced by exposure to the chemical, are kinetics events.

BEI’s

- The BEI’s are applicable only if collection is conducted at the specified time. The quality control program of the laboratory performance is essential to reduce analytical errors and bias in the results

- It is essential to consult the specific documentation before designing biological monitoring and interpreting BEI’s.

- Action on unexpected values should not be based on a single isolated measurement but on measurements of multiple sampling.

Chromium (VI)

Possible Nonoccupational Expoosure

Chromium is a naturally occurring metal (occurring mainly in the trivalent state) and is a required trace metal for humans. Dietary intake and smoking are the most important sources of nonoccupational chromium exposure. The average amount of chromium ingested daily by adults is about 25 µg. Municipal water supplies and ambient air frequently contain traces of chromium.[5,8] Urinary concentrations in the general population are a median value of 0.4 µg/L (range, 0.24-1.8).[9,10]

Chromium (VI)

Absorption

The absorption of chromium is dependent on the **valence** and **solubility** of the particular chromium species. The degree of **absorption decreases with increasing particle size and increases with increased water solubility of the chromium compound**.[5,!!] Soluble forms of Cr(VI) in the form of fumes, vapors, or mists are readily absorbed by inhalation.[5,11]

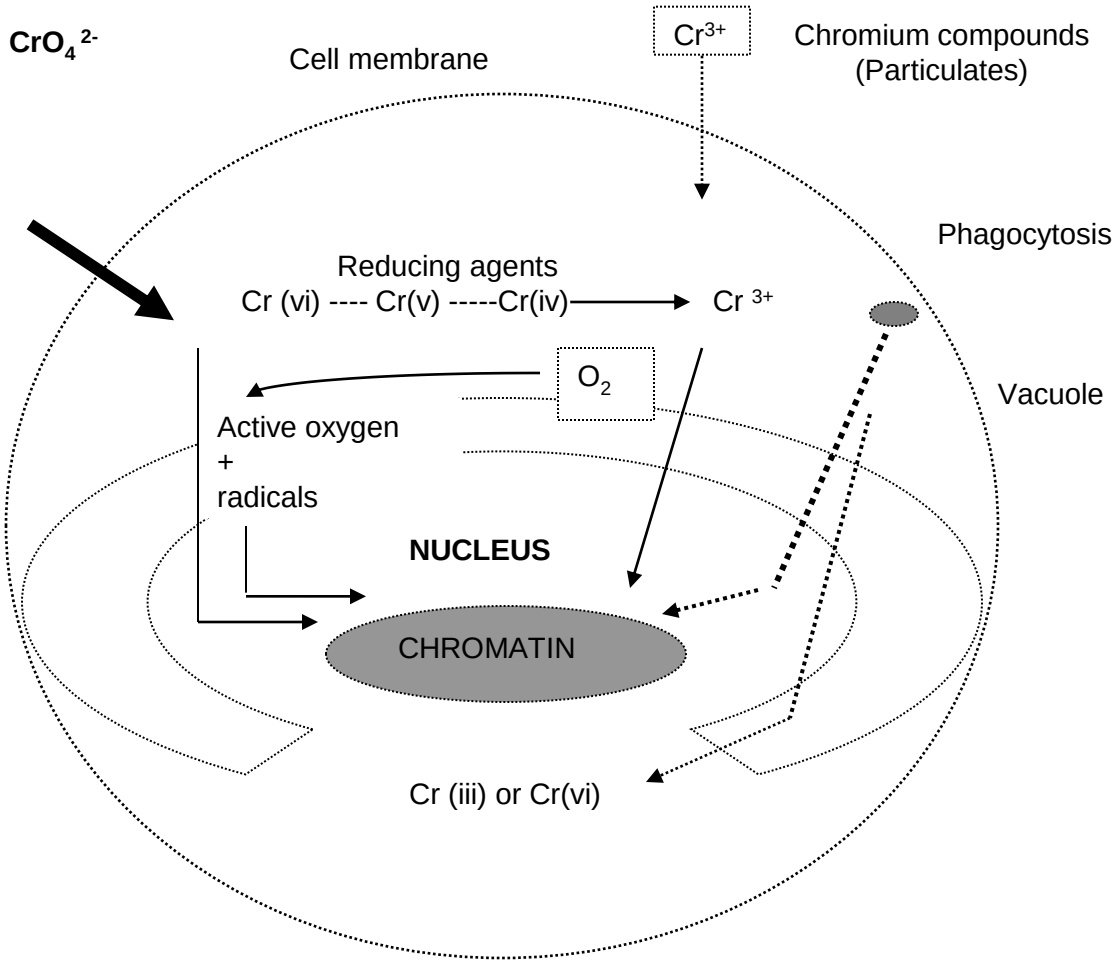
Hexavalent chromium entering the body by any route is reduced to trivalent chromium [Cr(III)].

Chromium (VI)

Metabolic Pathways and Biochemical Interactions

- Soluble Cr(VI) readily crosses cell membranes and is reduced enzymatically to Cr(III)

Theory / Mechanisms Cr (VI)



GSSG ⟷ 2 GSH

2 GSH + PROTEINE

GSSG

TRACE METAL + 2 GSH

GSH METAL COMPLEXATION

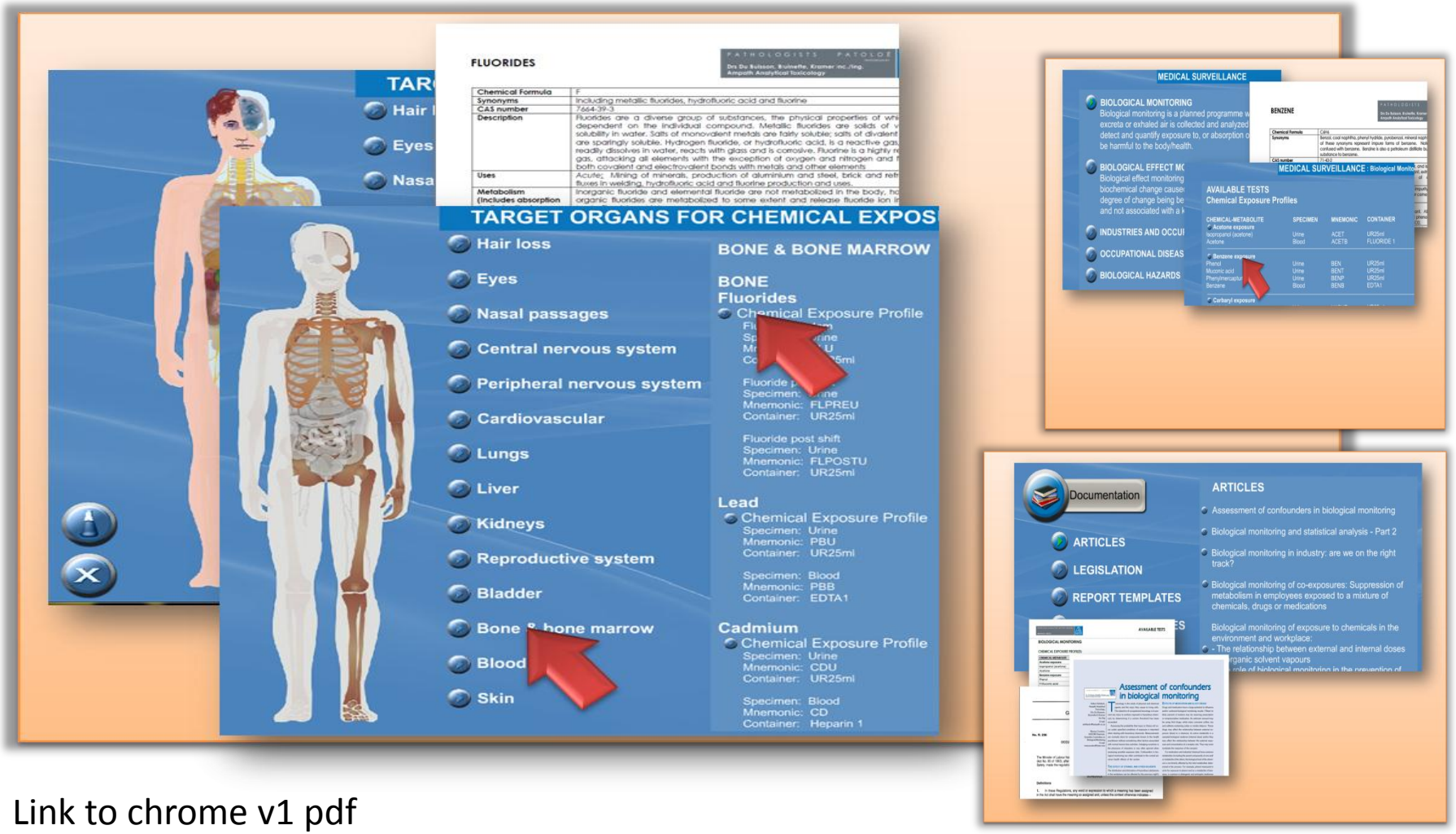
LOSS OF THIOL STATUS

IMPAIRED SH^- ENZYMES/PROTEINS

PROPHYRIA

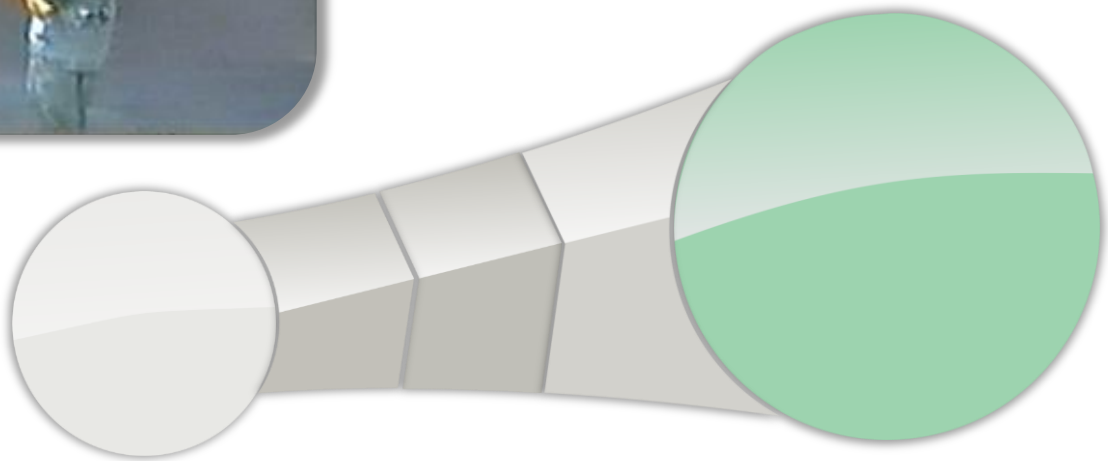
CELL INJURY

Target organs for chemical exposure



Link to chrome v1 pdf

COMPREHENSIVE DRILL DOWN



Summary of Toxicology

The toxicology of chromium and different chromium compounds has been extensively reviewed.[1,3,5,11,26-28] levels of Cr(VI) can cause irritation of the upper respiratory tract and, in extreme cases, ulcers in the nasal septum. Irritation has not, however, been shown to be associated with induction of cancer.[29] Local, topical exposure effects, e.g., to Cr mists are not necessarily associated with systemic effects in general. Chromium VI compounds may cause adverse effects to the skin, respiratory tract, and, perhaps, the kidney. Chromium III compounds are less toxic.

Summary of Toxicology

- Toxic effects vary widely with the solubility and physical form of the compound.
- Exposure to high ambient levels of Cr(VI) can cause irritation of the upper respiratory tract and, in extreme cases, ulcers in the nasal septum. Irritation has not, however, been shown to be associated with induction of cancer.
- Chromium VI compounds may cause adverse effects to the skin, respiratory tract, and, perhaps, the kidney. Chromium III compounds are less toxic.

Chromium (VI)

Kinetics

The elimination of chromium is triphasic, as observed in stainless steel welders, particularly those using MMA welding techniques.[16-20,24,42,43] The half-lives were about 7 hours, 15 to 30 days, and 3 to 5 years.[11]

A physiologically based pharmacokinetic model for the ingestion of Cr(III) and Cr(VI) in humans has been developed.[44] The model does not include a physiologic lung compartment.

Chromium (VI)

Elimination

The principal route of elimination of water-soluble Cr(VI) is the urine.[5,15] Soluble chromium compounds are slower elimination follows, as documented in workers with high chronic exposure who may maintain elevated concentrations of chromium in the urine for many years.[16] Intracellelar reduction and trapping of reduced chromium forms (e.g., erythrocytes and to some extent, bone and kidney) may be important determinants related to sequestration and subsequent delayed excretion of chromium. Chronic exposure to chromium increases renal clearance of chromium. Chromium (VI) is reduced in humans and eliminated in the urine as Cr(III).

Concentration of chromium in pre-shift samples reflects past exposure, whereas post-shift sample values reflect both past and current exposures.

BEI Examples: Chromium (VI) (US)

Determinant:	**Total chromium in urine**
Sampling Time:	Increase during shift
BEI:	10 μg/L
Notation:	B

Determinant :	**Total chromium in urine**
Sampling Time:	End of shift at end of workweek
BEI:	25 μg/L
Notation:	B

BEI Examples: Chromium (VI) (GER)

Determinant:	**Total chromium in urine**
Sampling Time:	Increase during shift
BEI:	10 µg/L
Notation:	B

Determinant :	**Total chromium in urine**
Sampling Time:	End of shift at end of workweek
BEI:	25 µg/L
Notation:	B

BEI Examples: Chromium (VI) (SA)

Determinant:	**Total chromium in urine**
Sampling Time:	Increase during shift
BEI:	10 μg/g creatinine
Notation:	B

Determinant :	**Total chromium in urine**
Sampling Time:	End of shift at end of workweek
BEI:	30 μg/g creatinine
Notation:	B

Sampling and Storage

Urine should be collected in acid-washed plastic bottles. To minimize sample contamination, specimens should be collected after the worker has showered and changed clothes. Timing of urine collection for pre-shift specimens is not critical. Urine specimens collected at the end of the shift should represent a collection period in the bladder of at least 2 hours to be representative of exposure during the entire shift. Urine specimens should be refrigerated or frozen until analysis. Preservatives used to stabilize the urine must be checked for chromium content before use.

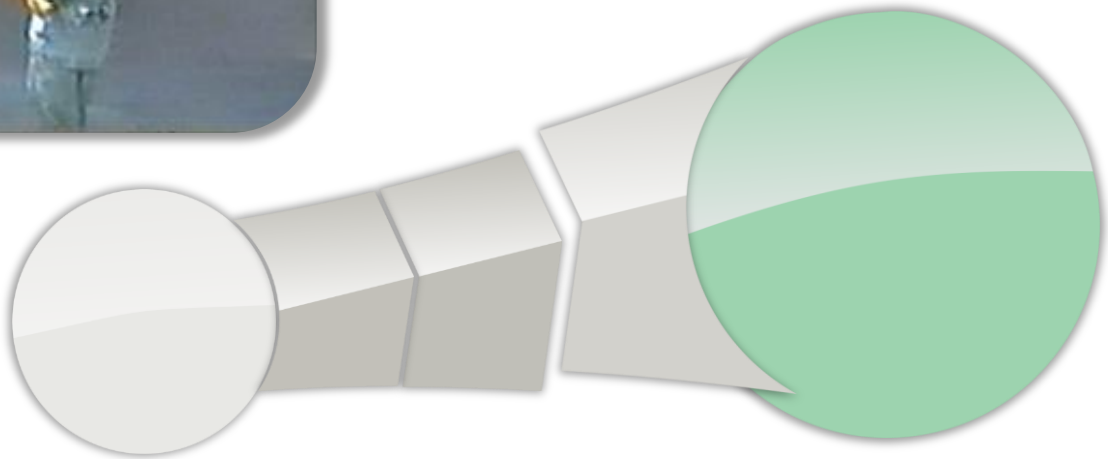
Red cell Cr -

- Chromium in whole-blood erythrocytes has been suggested as an indicator of exposure to water-soluble chromium. However, there is insufficient validated information to support its use in assessing uptake of chromium.[5,11] In addition, the low concentrations normally present make sample analysis difficult. No BEI is recommended for blood samples.

Lewalter et al - Germany

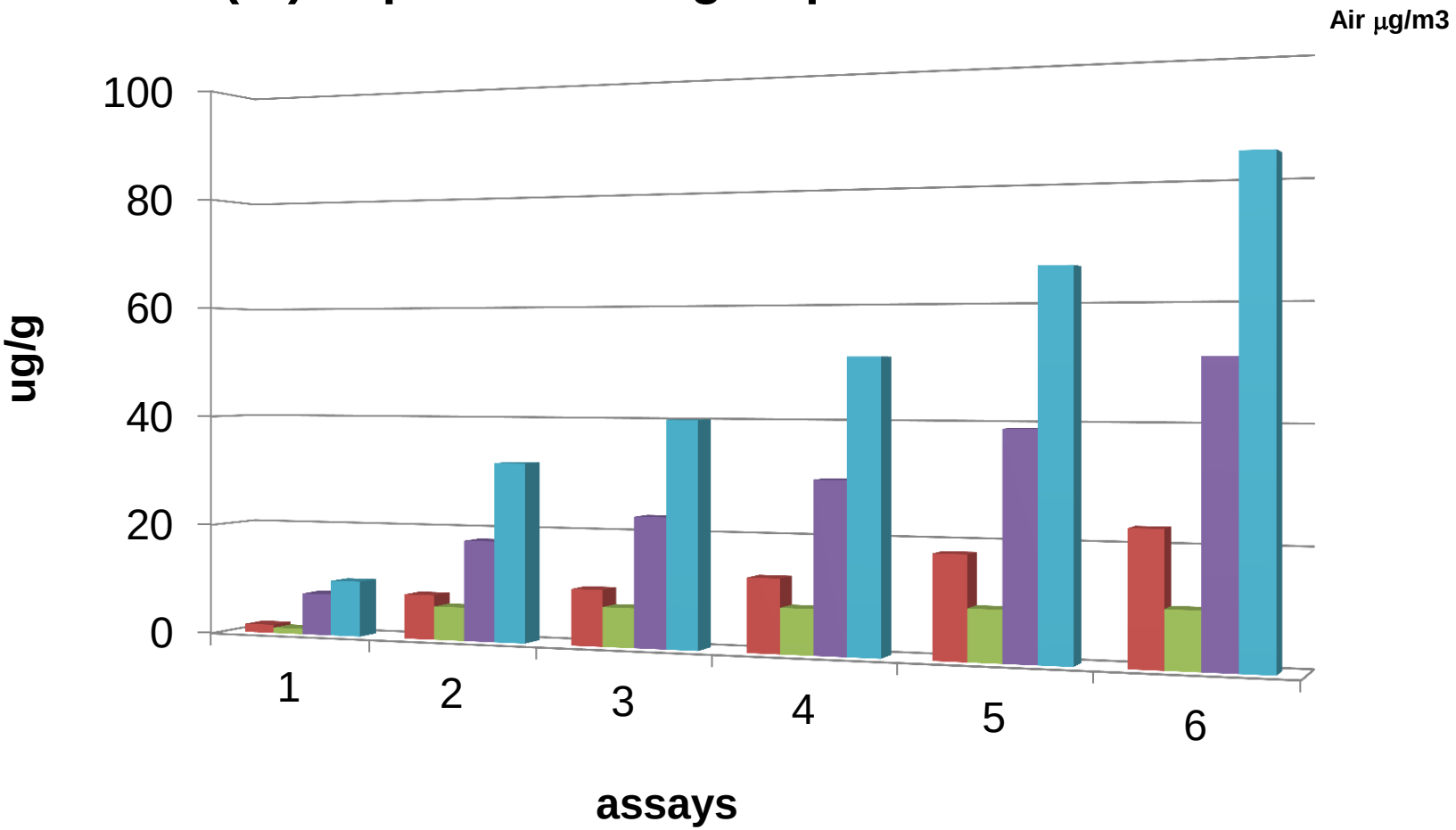
- Not industrial exposed: < 4.0 μg/100ml
- Action level: 17 μg/100ml
- Suggested BEI: 5 - 54 μg/100ml

COMPREHENSIVE DRILL DOWN

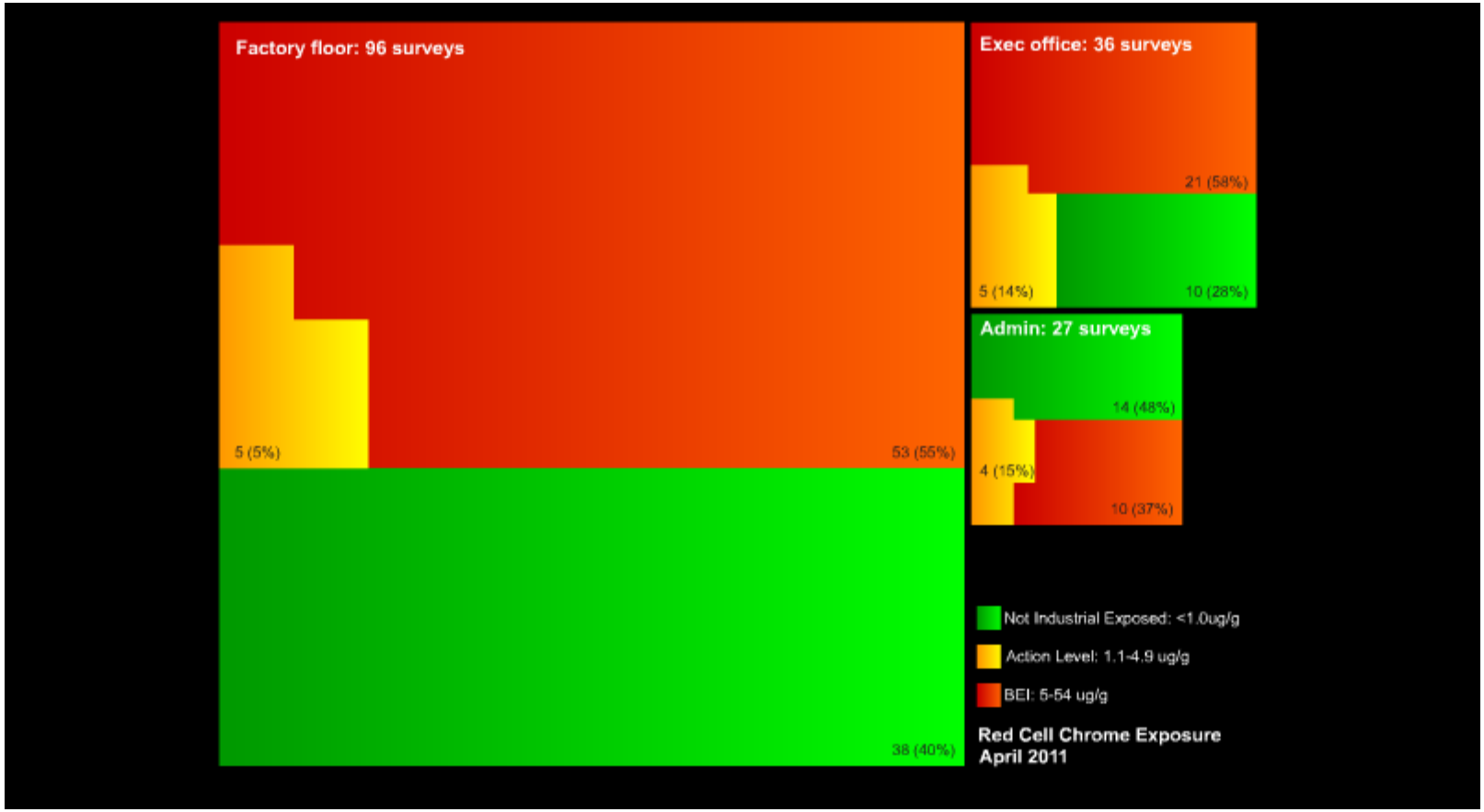


Sample data

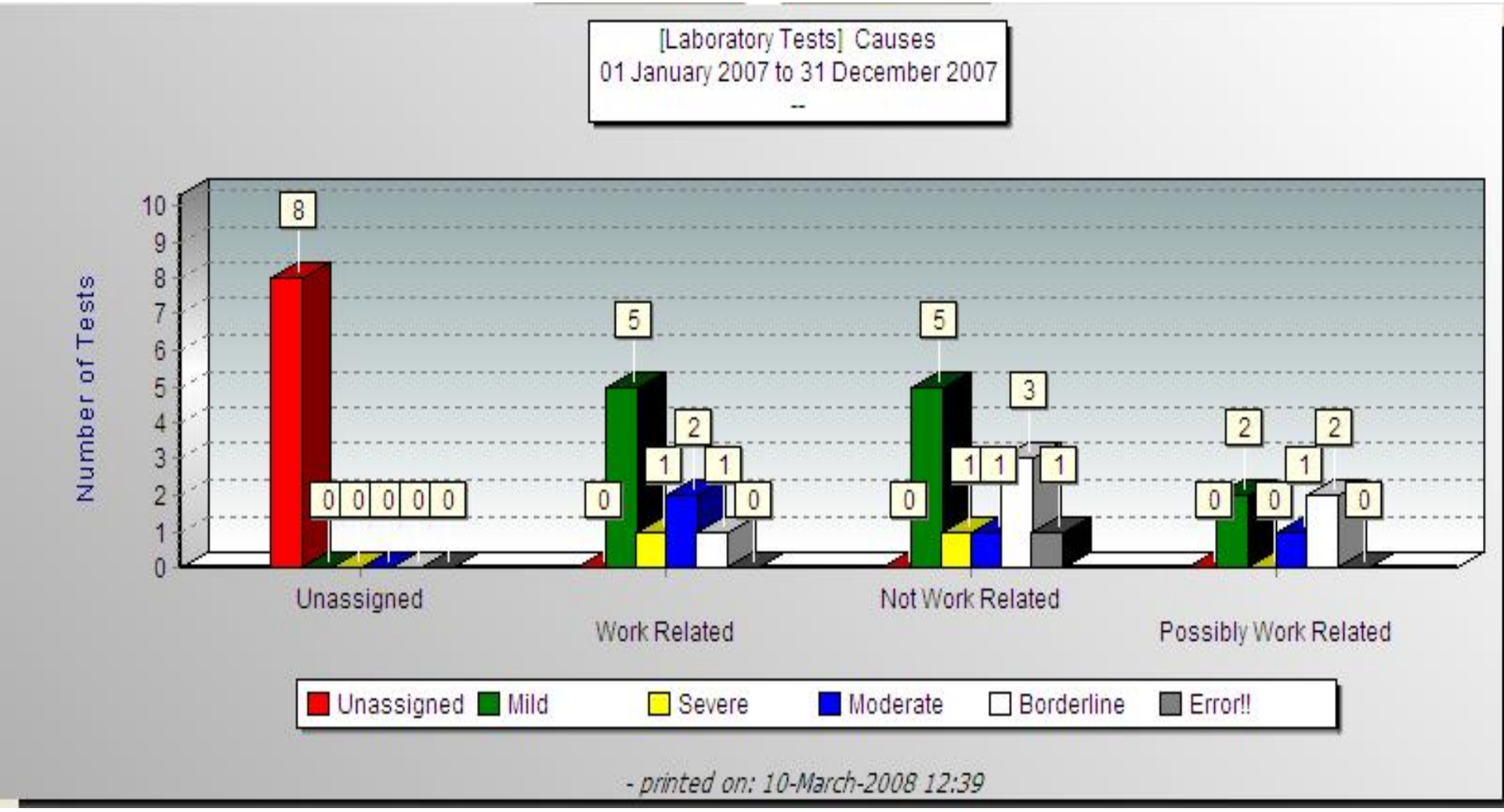
Chromium (VI) Exposure Risk group record



BEI Examples: Single Company Exposure – Plant breakdown

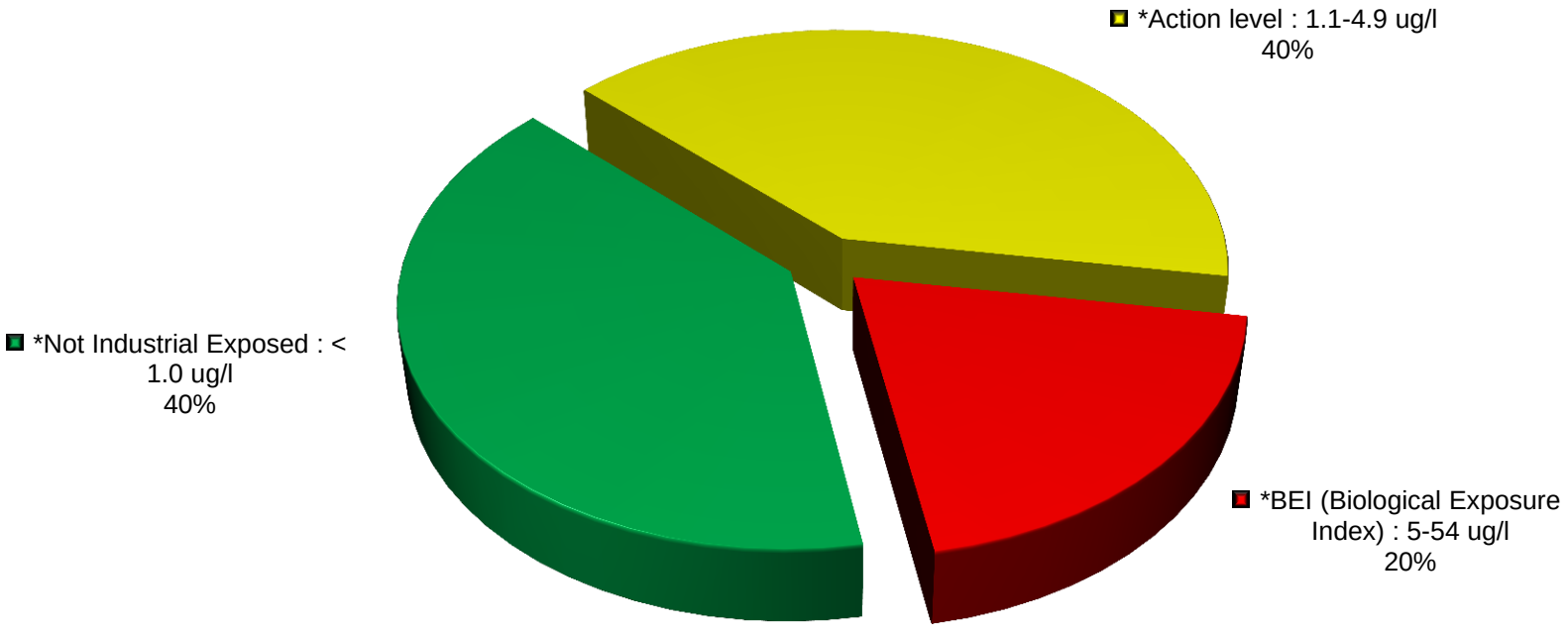


Data Analysis and Reporting: Report sample - Chromium



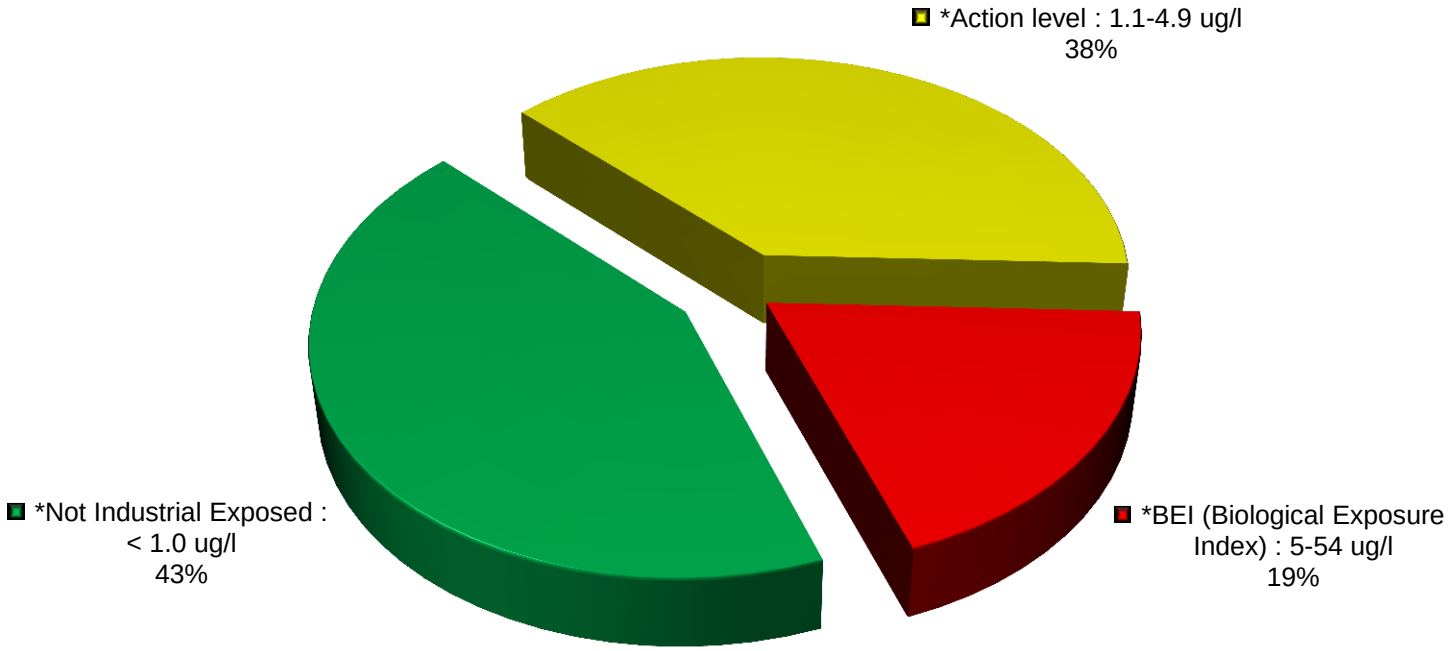
BEI Examples: Single Company Exposure

Company A - Exposure Aug 2008-April 2011 (Chromium (VI) Red cell)



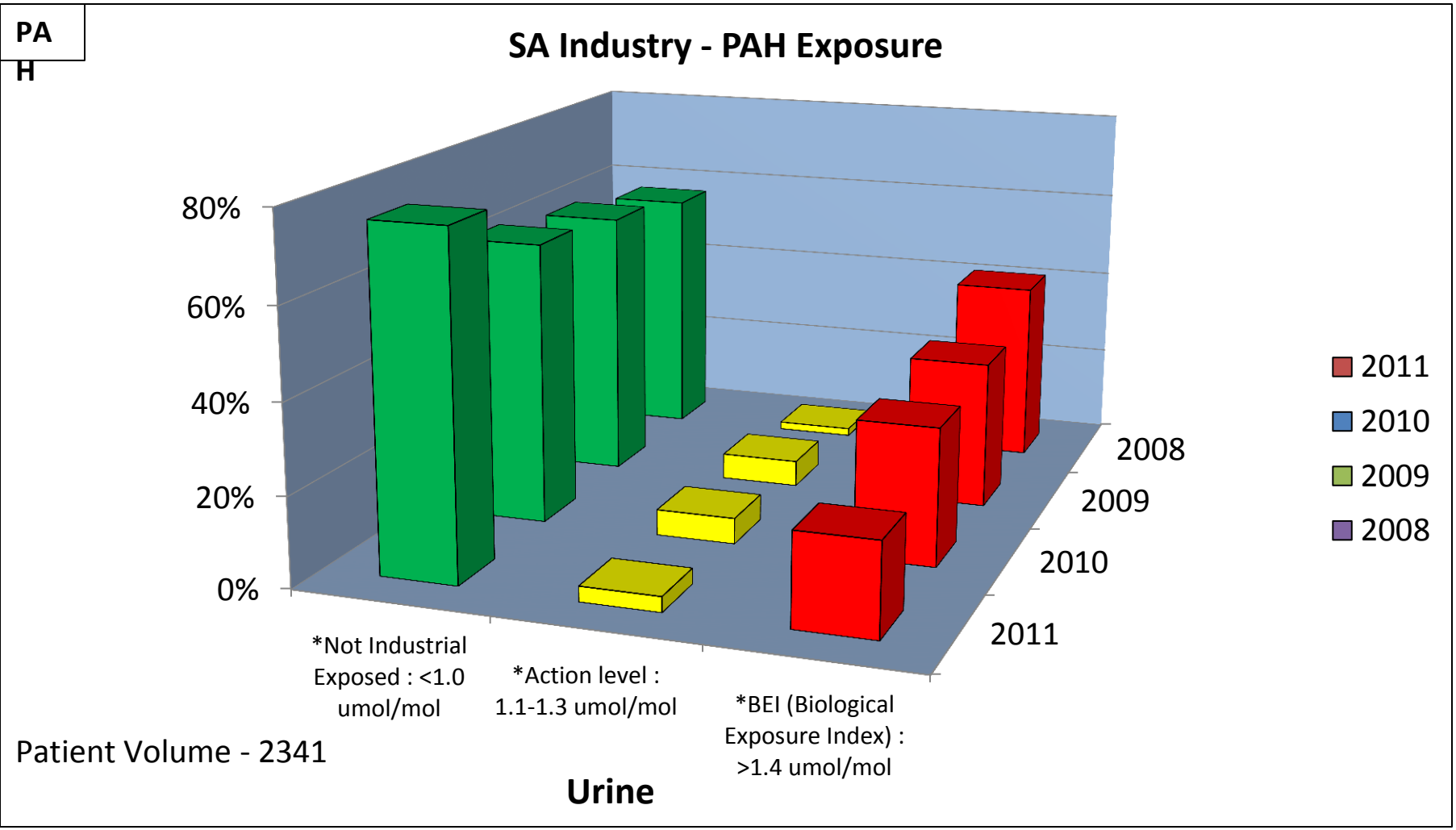
BEI Examples: SA Industry Exposure

SA Industry Exposure Aug 2008-April 2011 (Chromium (VI) Red cell)

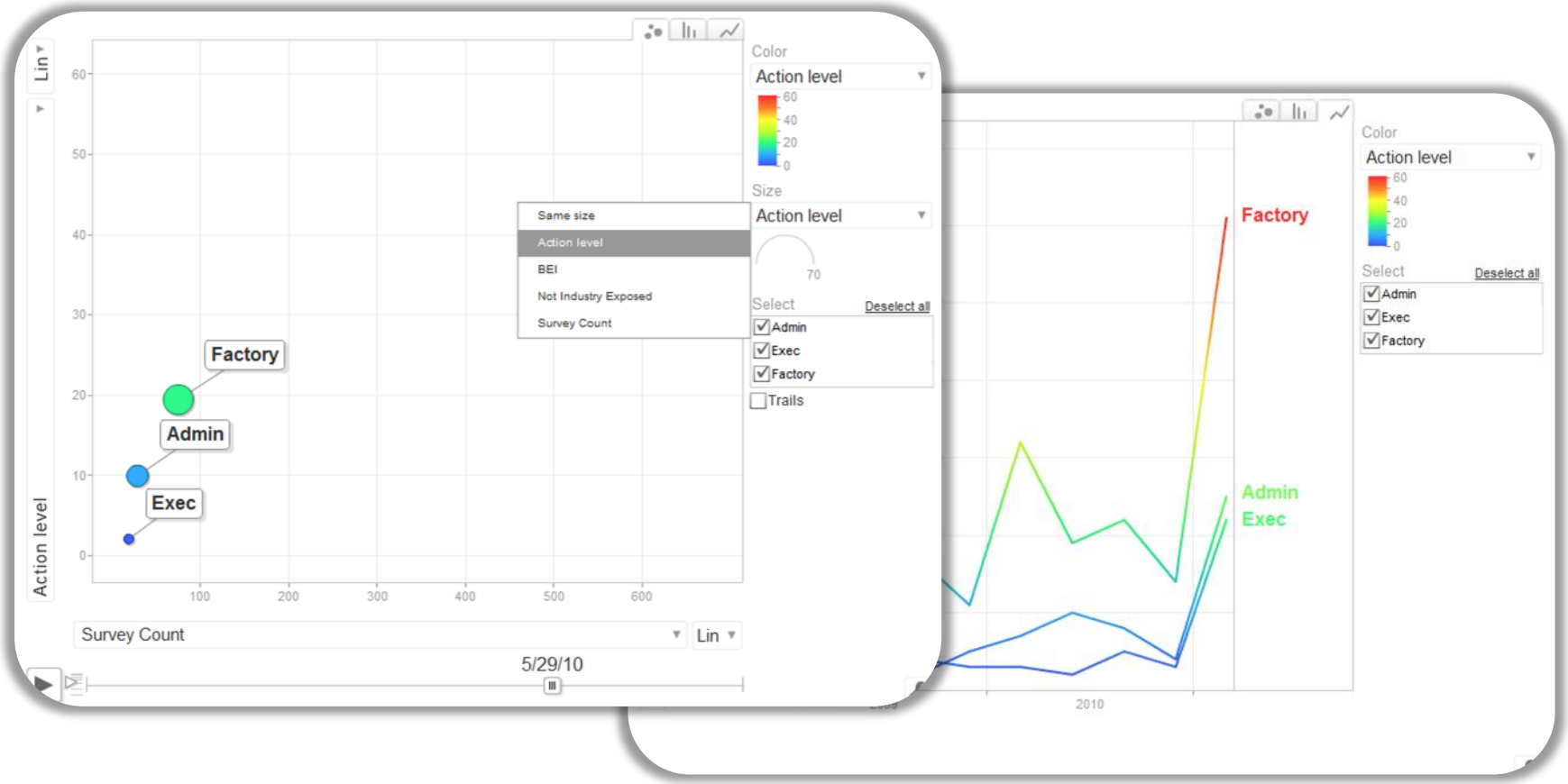


Data Analysis and Reporting: Report sample - PAH

PA
H

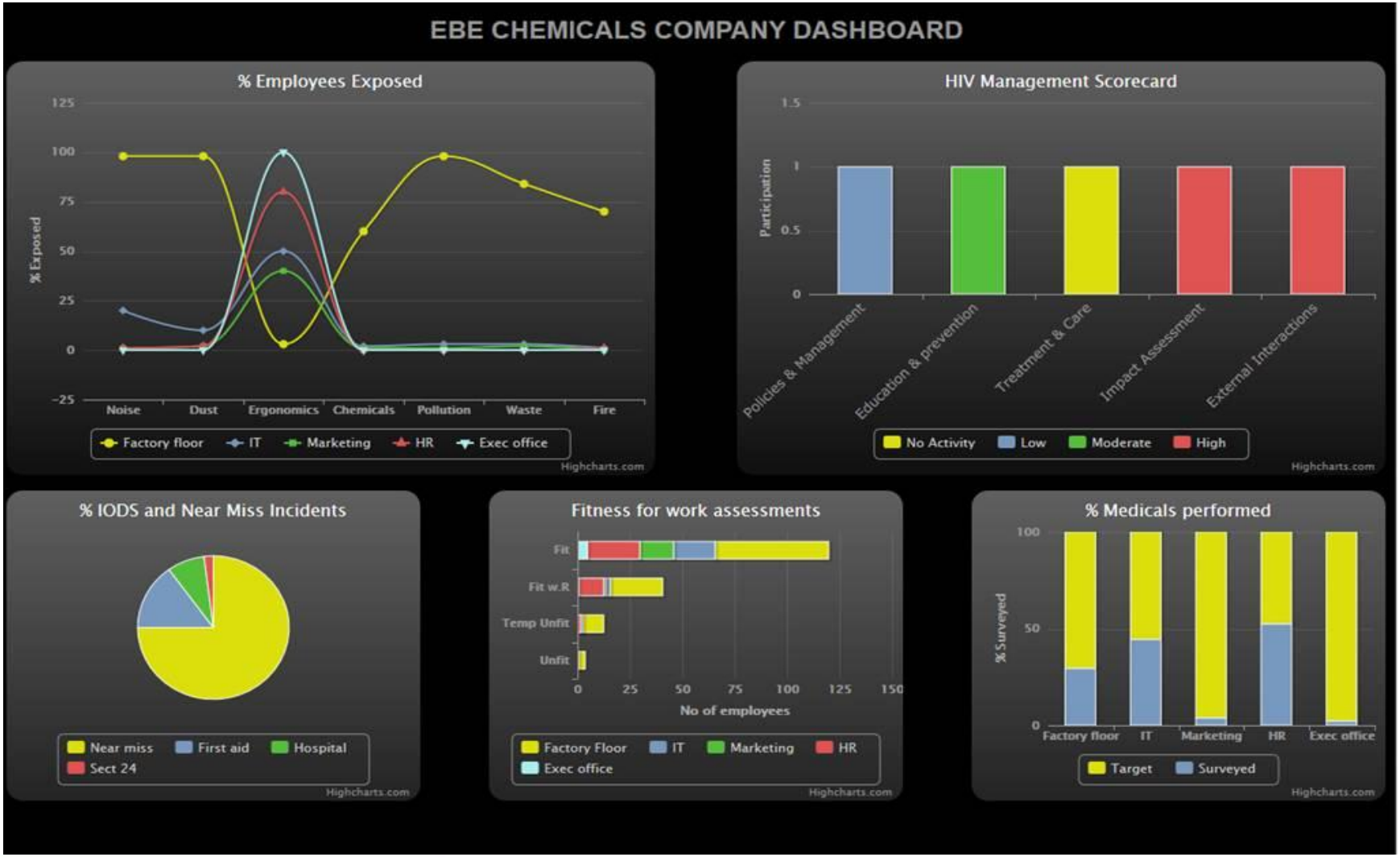


BEI Examples: Graphical representation (Chromium) – Timeline



View live demo (online)

Data Analysis and Reporting: Interactive Exposure Dashboard



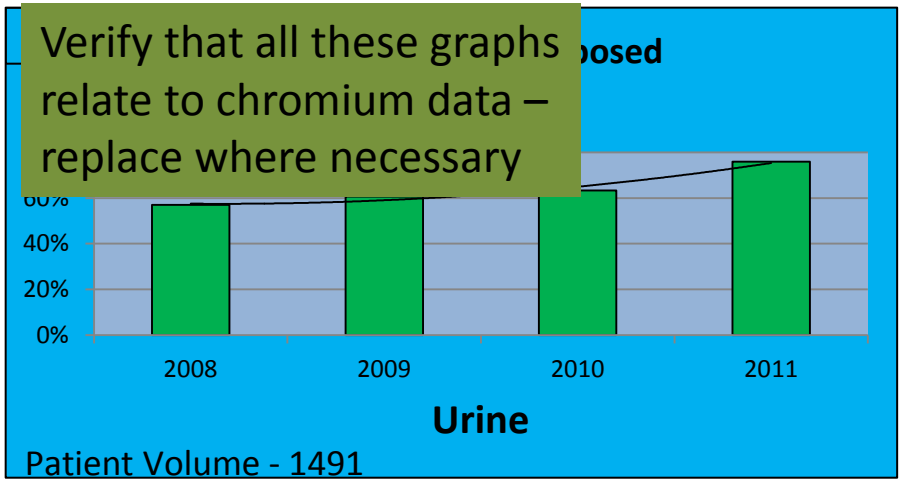
Back to Basics

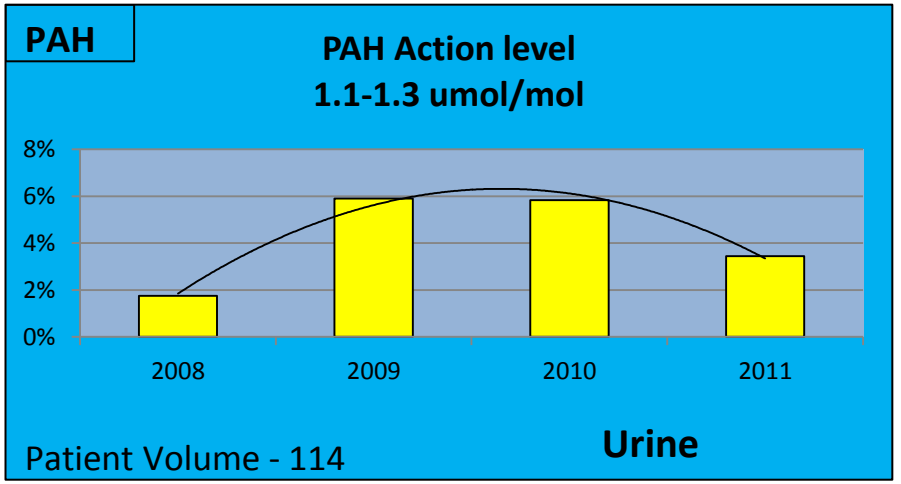
Thank you

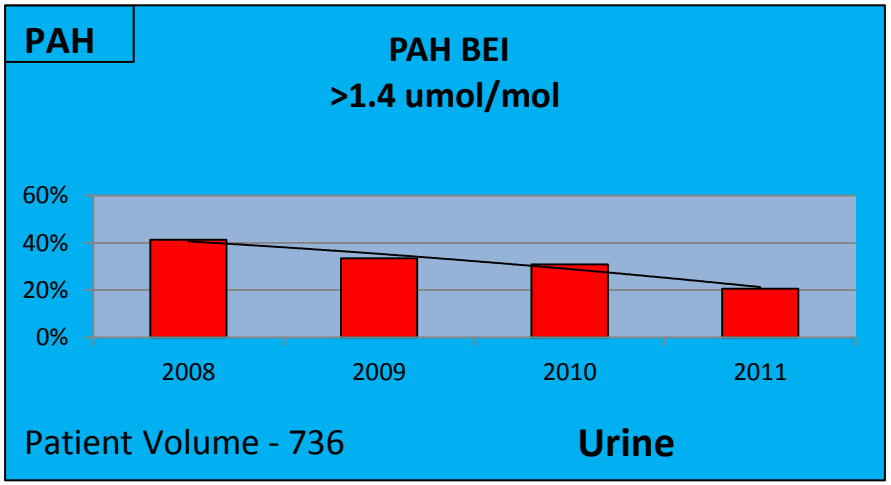
Background slides

Data Analysis and Reporting: Report sample - Chromium

Verify that all these graphs relate to chromium data – replace where necessary







Data Analysis and Reporting: Report sample - Chromium

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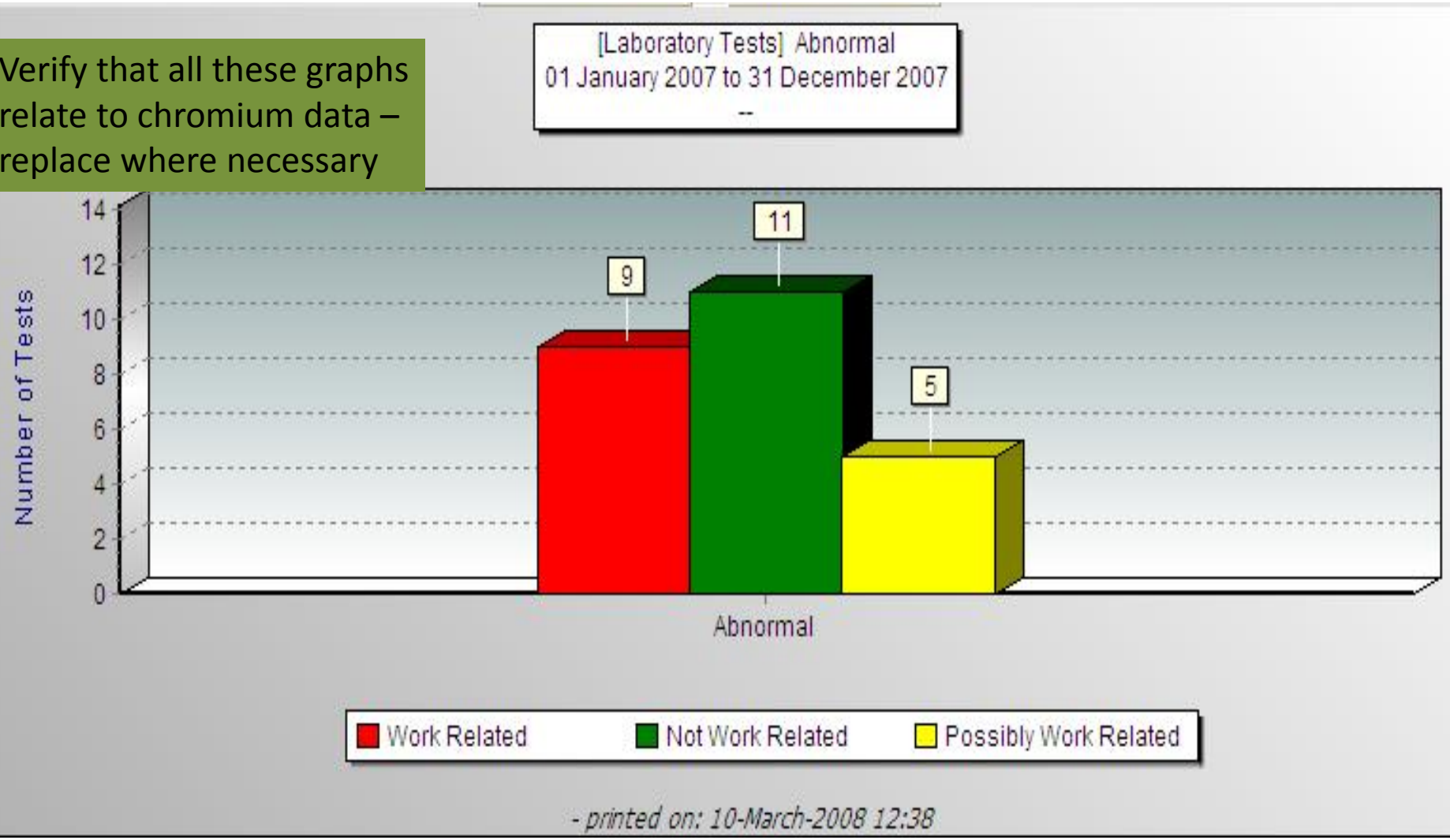

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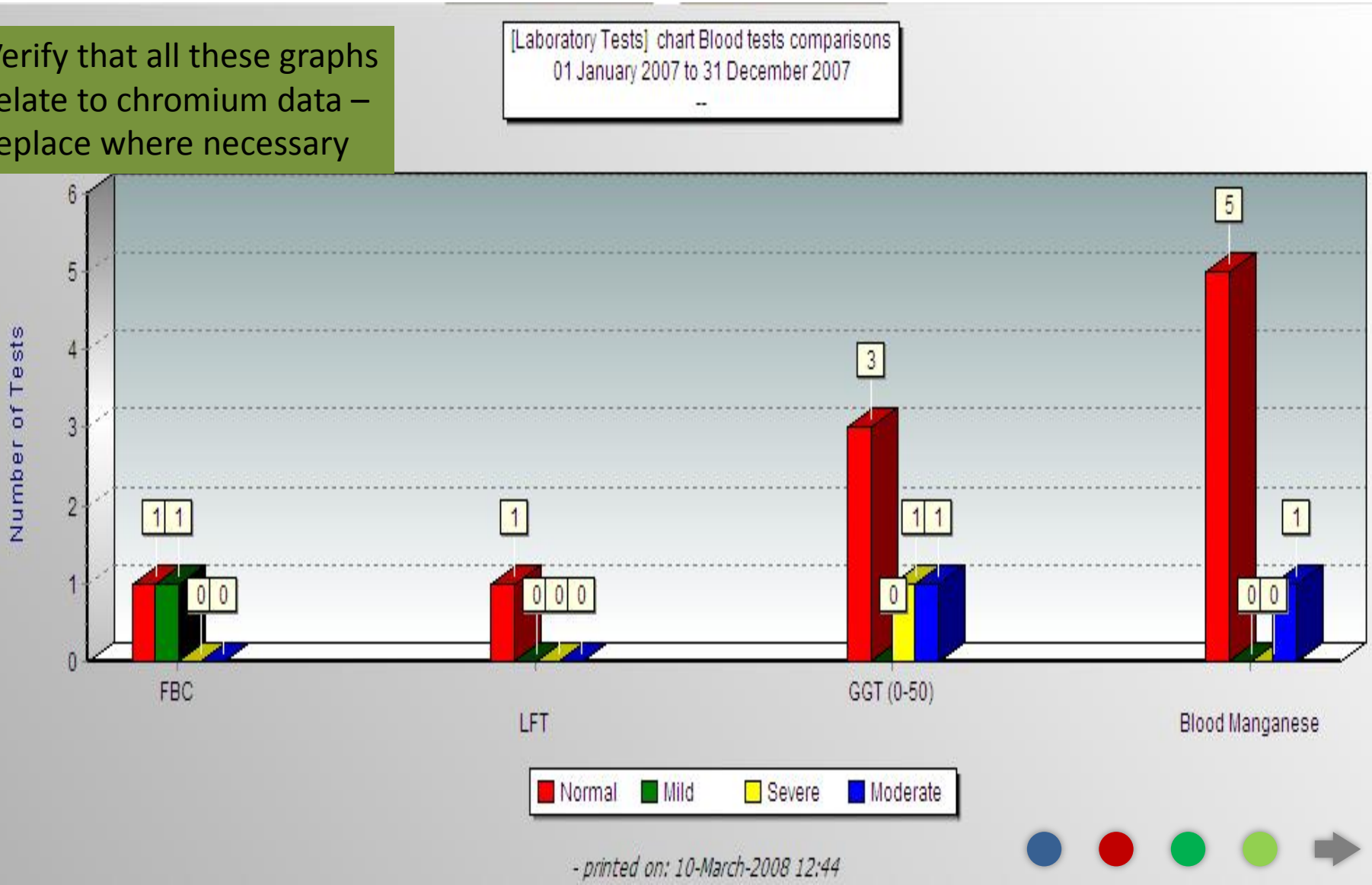
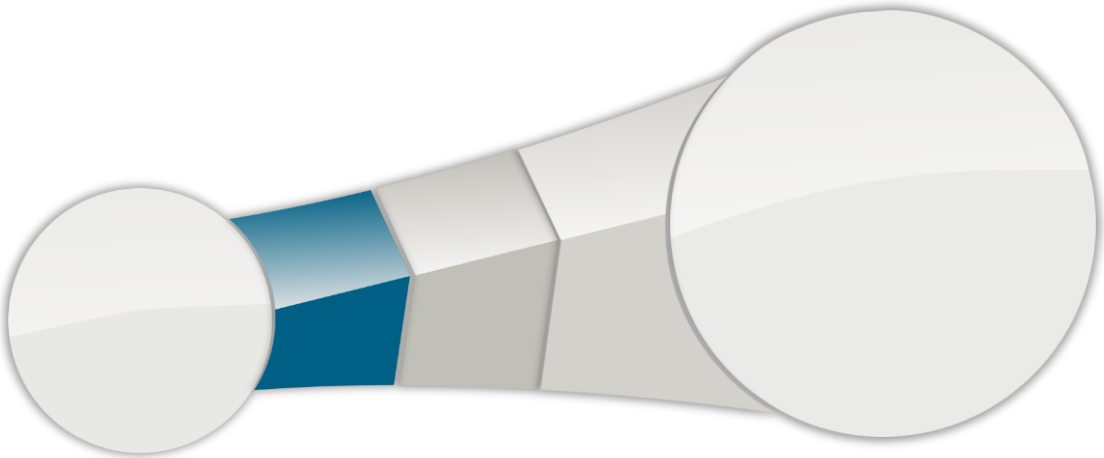


HEALTH RISK ASSESSMENTS

eliXir ORGANISATIONAL HEALTH

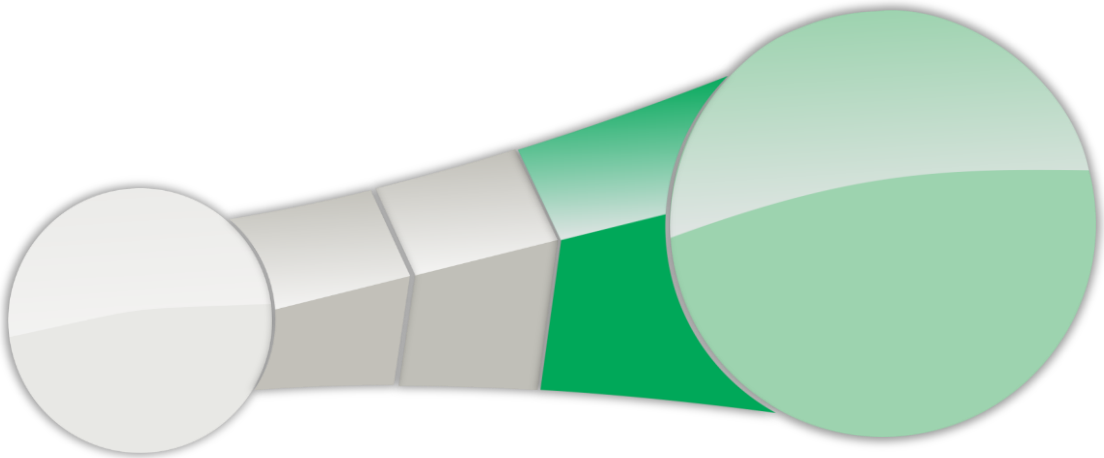
THE OREP

- Definition
- Risk Assessment Matrix & Sample

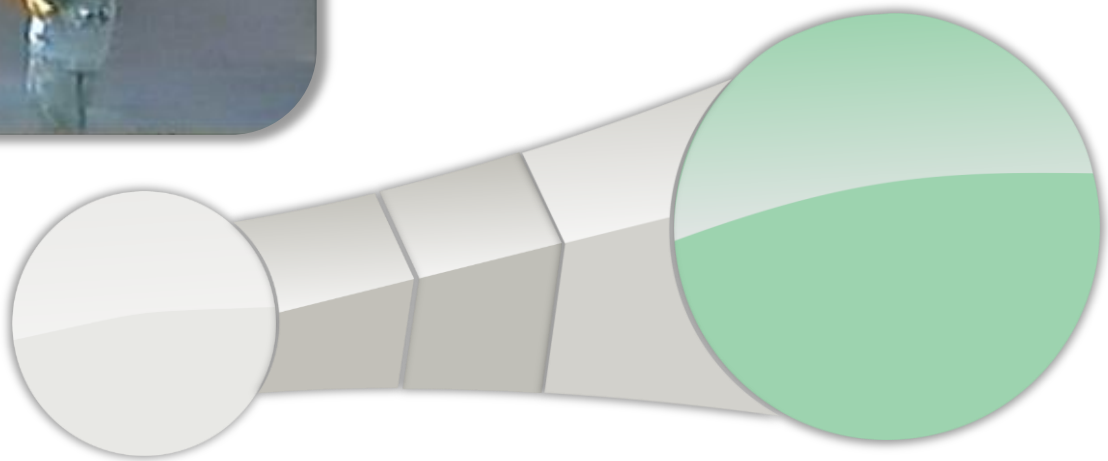


DATA ANALYSIS & REPORTING

- Report sampling



COMPREHENSIVE DRILL DOWN



BEI Notations

- “B” (background): the determinant may be present in biological specimens collected from subjects who have not been occupationally exposed, at a concentration which could affect interpretation of the result. Such background concentrations are incorporated in the BEI value.
- “Nq” (nonquantitative): Biological monitoring should be considered for this compound based on the review; however a specific BEI could not be determined due to sufficient data.
- “Ns” (nonspecific): The determinants are nonspecific, since it is also observed after exposure to other chemicals.
- “Sq” (semiquantitative): The biological determinant is an indicator of exposure to the chemical, but the quantitative interpretation of the measurement is ambiguous. These determinants should be used as screening tests if quantitative tests are not practical or as confirmatory tests if the quantitative test is not specific and the origin of the determinant is in question.

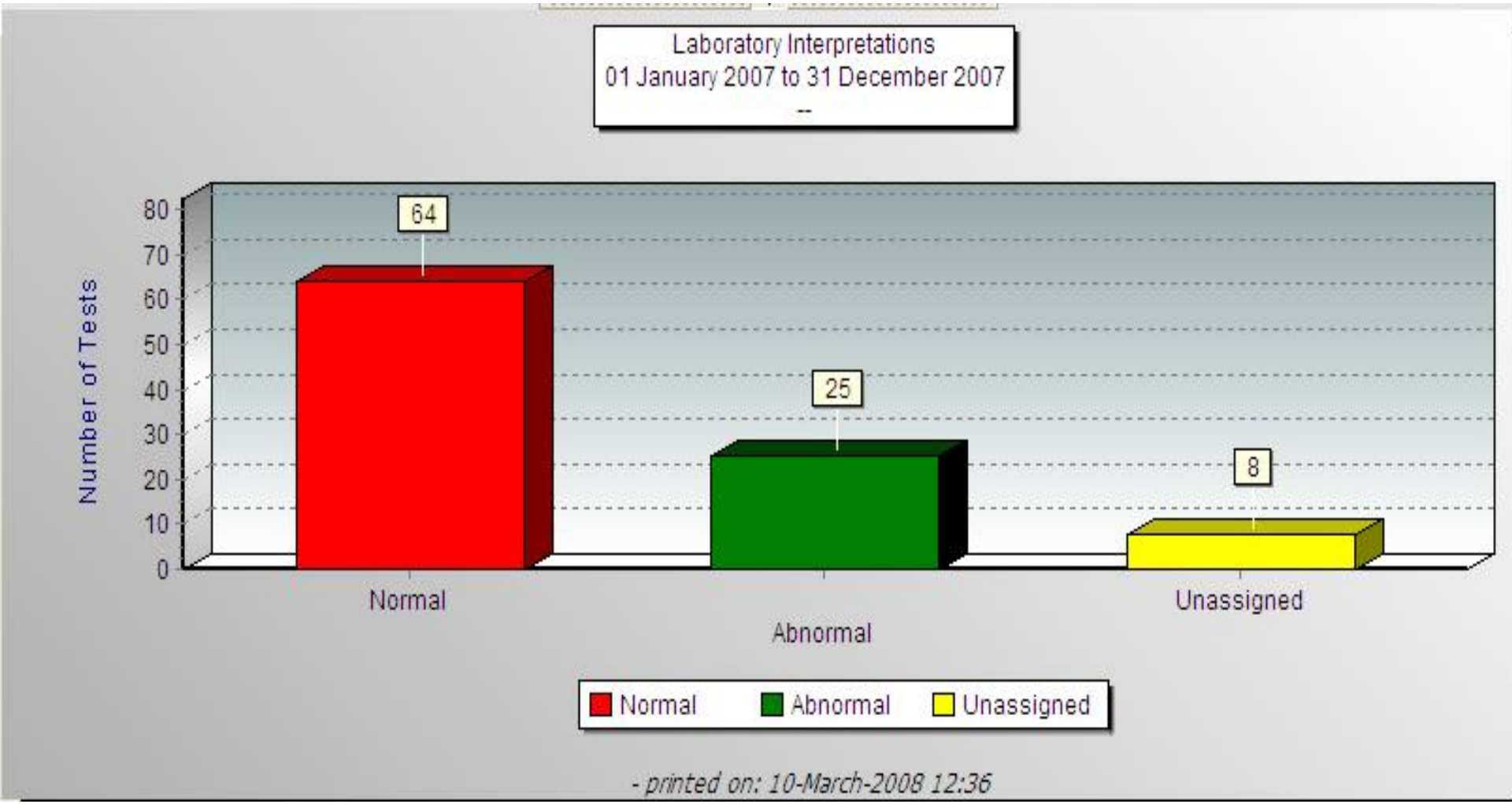
Note: It is essential to consult the specific BEI Documentation before designing biological monitoring protocols or interpreting BEIs

BEI's

- The BEIs should be applied by a knowledgeable occupational health professional. Toxicokinetic and toxicodynamic information is taken into account when establishing the BEI; thus, some knowledge of the metabolism, distribution, accumulation, excretion, and effect(s) is helpful in using the BEI effectively.

- The BEI is a guideline for the control of potential health hazards to the worker and should not be used for other purposes. The values are inappropriate to use for the general population or for non occupational exposures. The BEI values are neither rigid lines between safe and dangerous concentrations nor an index of toxicity.

Data Analysis and Reporting: Report sample - Chromium



- According to the International Agency for Research on Cancer (IARC),[3] there is sufficient evidence in humans for carcinogenicity of Cr(VI) compounds in chromate production, chromate pigment production, and chromium plating industries. Five cancer epidemiology studies in chromate production and plating and painting have been published since the IARC review.[29-33] Taken as a whole, there is evidence that past, relatively high exposures in the chromate production industry were associated with significantly increased risk for lung cancer. However, changes in manufacturing processes in the late 50s and early 60s, resulting in lower exposures, may have reduced lung cancer risk to background rates. IARC[3] found limited evidence for carcinogenicity of welding fumes and gases (Group 2B).

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- The recommended BEIs apply to water-soluble and sparingly soluble Cr(VI) compounds. Chromium in urine, collected at the end of the shift, represents the sum of long-term exposure, plus exposure during the workday. The net increase in urinary chromium excretion during the work-shift is a better indicator of daily exposure than a concentration measurement in urine collected at the end of the shift. For daily exposure estimates, both a pre-shift and a post-shift urine sample must be collected and analyzed.