Expert systems for managing asbestos in premises

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Abstract **– In this paper is presented an Expert System for Managing Asbestos in Premises. Asbestsois one of the most dangerous materials on human health that causes cancer. The Expert System is created on the basis of production rules (IF…Then) and quantified facts about asbestos harmful presence. The process of creating the expert system as well as its application are also explained in the paper.**

Keywords **– Expert system, asbestos, managing.**

I. INTRODUCTION

Expert systems are used to advise, diagnose, or troubleshoot problems that were once only performed by humans. A knowledge automation expert system contains practical knowledge culled from a human expert. Expert systems bring specialized knowledge directly to the fingertips of a novice. This enables people with little or no training to perform far more complex tasks than were previously possible.

Knowledge automation expert systems are expanding the scope of information systems. They allow conceptually new types of applications to be created and existing applications to be expanded and leveraged. The goal of expert systems is to deliver answers and knowledge, not merely to provide information for a person to think about.

Such systems have great importance and huge application in environmental and health protection. A diagnostic expert system is given identifiable information through the user's observation or experience. Nuilt into the system's knowledge base is a list of all identifiable symptoms of specific casual factors.

For a medical diagnostic system, the goal is to identify the patient's illness. It starts by assuming that the patient has a particular illness. It proceeds by reviewing the rules and their actions an asks the patient for additional information about unique symptoms in order to create a description of the illness. If it cannot prove an illness exists on the basis of the symptoms, the system takes up another possible illness as the assumed illness and proceeds in the same fashion. All previous responses by the patient are retained in working memory so that repetitive questioning of the patient is avoided.

An efficient environmental management system has to include software tools for air, water and soil pollution diagnosis.

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This group includes systems that we will consider in this paper, expert systems for managing asbestos. This expert system performs diagnostic and interpretive chores in a time-sensitive environment such as old buildings. If the findings differ from the standard, the system alerts the human technician and suggests an action. Final decisions are left to the human in charge.

II. ABOUT ASBESTOS

Asbestos is a group of fibrous silicate minerals that naturally produced in the environment. Asbestos in Europe was very used in industry, manufacturing and construction between 1940 and 1990, but there are examples and for his later use. More than 3000 products are used in production due to their durability, resistance to fire and excellent insulating properties. There are three main types of asbestos:

[1] Chrysotile (white asbestos)
[2] Crocidolite (blue asbestos)
[3] Amosite (brown asbestos)

Other rare forms of asbestos include actinolite, anthophyllite and tremolite.

Legally, asbestos is defined as a material or object, whether natural or manufactured, which contains one or more mineral silicates listed above.

When asbestos is affected by heat or chemicals or combined with other substances, its color and texture may be changed. There is no simple test to identify the presence of asbestos-accredited laboratory analysis is the only reliable method.

All types of asbestos can be harmful to health. Generally, the presence of asbestos is not a health risk, unless due to damage, poor condition or inquiry during operations, produce dust containing asbestos fibers.

Inhaling asbestos fibers pose a serious health risk and can lead to diseases such as mesothelioma, lung cancer and asbestosis.

Expert system has been developed which helps when dealing with asbestos containing materials. The System uses a two-part numerical algorithm. The first algorithm is to estimate the material, and the second algorithm is to assess the priorities for action. The end result of dealing with the material is a combination of these two algorithms.

III. CREATING EXPERT SYSTEMS FOR MANAGING ASBESTOS IN PREMISES

The system of risk assessment, which has been adopted here, is based on the current guidance and recommendations

as set out by the HSE. The System uses a two-part numerical algorithm.

The algorithm sets out the factors, which are most relevant in assessment of the potential release of fibers from a suspect material. These factors have been assigned quantifiable numerical values. The algorithm produces a single numerical value for each asbestos item, which may then be used as a priority rating for remedial work.

Both the material and priority assessments have been undertaken with regard to the parameters as set out in the following Tables I and II:

TABLE I
MATERIAL ASSESSMENT ALGORITHM

Sample Variable	Score	Examples
Product type (or debris from product)	1	Asbestos reinforced composites
	2	Asbestos insulating board, mill board
	3	Thermal insulating, sprayed asbestos…
Extent of damage/deterioration	0	Good conditions
	1	Low damage
	2	Medium damage
	3	High damage
Surface treatment	0	Composite materials containing asbestos
	1	Enclosed sprays and lagging
	2	Unsealed AIB
	3	Unsealed lagging and sprays
Asbestos type	1	Chrysotile
	2	Amphibole asbestos excluding crocidolite
	3	Crocidolite
TOTAL	2 - 12	

TABLE II
RISK ASSESSMENT ALGORITHM

Assessment parameter	Score	Example
Normal occupant activity:		
Main type of activity in area	0	Rare disturbance activity
	1	Low disturbance activities
	2	Periodic disturbance
	3	High levels of disturbance
Likelihood of disturbance:		
Location	0	Outdoors
	1	Large rooms or well-ventilated areas
	2	Rooms up to 100 m^2
	3	Confined spaces
Accessibility	0	Usually inaccessible or unlikely to be disturbed
	1	Occasionally likely to be disturbed
	2	Easily disturbed
	3	Routinely disturbed
Extent/amount	0	Small amounts or items
	1	>10 m^2 or 10 m pipe run
	2	>10 < 50 m^2 or >10 < 50 m pipe run
	3	>50 m^2 or >50 m pipe run
Human exposure potential:		
Number of occupants	0	None
	1	1 - 3
	2	4 - 10
	3	> 10
Frequency of use of area	0	Infrequent
	1	Monthly
	2	Weekly
	3	Daily
Average time area is in use	0	<1 hour
	1	>1 - < 3 hours
	2	>3 - < 6 hours
	3	>6 hours
Maintenance activity:		
Type of maintenance activity	0	Minor disturbance
	1	Low disturbance
	2	Medium disturbance
	3	High levels of disturbance
Frequency of maintenance activity	0	ACM unlikely to be disturbed for maintenance
	1	≤1 per year
	2	>1 per year
	3	>1 per month

The algorithm value has been considered in providing a basis in determining a recommendation for management and/or remedial works. It must always be remembered that asbestos is only harmful if fibers are released into an area where they can be inhaled. The potential for fiber release can be determined by four factors:

[1] The type of material and its properties e.g. friability

[2] The type of asbestos used

[3] The condition of the material and any sealant or enclosure

[4] The location of the material

The first three factors listed fall within the category of 'Material Assessment' whilst the fourth can be used to decide a priority and is covered in the Risk Assessment. For the material assessment a score for each part of the algorithm is assigned and they are totaled to give a final score between 2 and 12. (Presumed or strongly presumed ACMs are always scored as crocidolite (blue asbestos) unless there is strong evidence to the contrary).

This material assessment identifies the high hazard materials, that is those that will most likely release air bone fibers if disturbed (Fig. 1). It does not automatically follow that those materials assigned the highest score in the material

assessment will be the materials that should be given the priority for the remedial action.

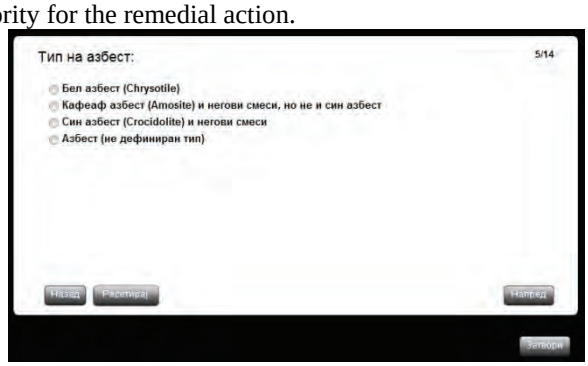

Fig. 1 Part of the expert system for selecting the type of asbestos (Material Assessment)

This information can then be used to form part of a risk assessment. Materials with assessment scores of 10 or more are regarded as having a high potential to release fibres, if disturbed. Scores of between 7 to 9 are regarded as having a medium potential and between 5 to 6 a low potential. Scores of 4 or less have a very low potential to release fibres.

The material assessment gives a figure relating to the likelihood of an ACM to release fibres. As mentioned earlier, a high figure does not necessarily mean that that ACM has to be deal first. The figure gives an estimate of likely bold. In order to determinate the bold other factors have to be considered. The guidance to be produced by HSE suggests the following:

[1] Occupant activity – compare a little used storage room to a frequently used fire door made from AIB.

[2] Likelihood of disturbance – 3 parameters are considered here; location of ACM, accessibility and the amount or extent of the ACM.

[3] Human exposure potential – again 3 different parameters are noted; number of occupants, frequency of use of the area and average time or use of the area.

[4] Maintenance activity – is scored for type and also frequency.

Algorithm is used as follows:

Each of the factors listed above should be scored using the attached table. The score for each factor is the sum of the scores for the parameters divided by the number of parameters; e.g. Factor = maintenance activity. If the score is a 2 for type and a 1 for frequency then the score would be 3 (sum of scores) divided by 2 (number of parameters) = 1.5. Figures should be rounded up but as this is not a precise science, some practical consideration of the area will be needed.

The resultant figures are then summed together and added to the material assessment figure.

If this process is repeated for a number of ACMs, a comparative list for action may be drawn up.

Algorithm is a tool. Further discussion/ interpretation may be required. The recommended actions stated in this report represent our considered opinion as to the appropriate course of action for each material.

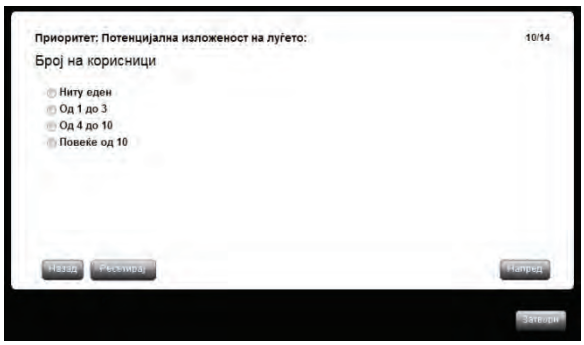

Fig. 2 Part of the expert system for selecting number of occupants, parameter of Human exposure potential

The risk assessment (Fig. 2) should produce a ranking of materials which reflects the risk they present to people working on or near them. This will also form part of the final management plan and can be used to prioritise nay work needed. It is important to understand that if the use of the space changes, in which the asbestos containing materials are present, this may alter the risk associated with that material. The condition of the material will also deteriorate over time and therefore risk assessments should be carried out on a regular basis.

For each sample/inspection a priority risk assessment is compiled using an algorithm. A point score (weighting) is allocated on the basis of the examination of a number of parameters. The value assigned to each of these parameters is added together to give a total score, the higher scores indicating high priority risk. These scores are added to the material assessment scores to give an overall score, from this final score an accurate management plan can be put in place, and depending on the score depends on the recommendation shown on Fig. 3.

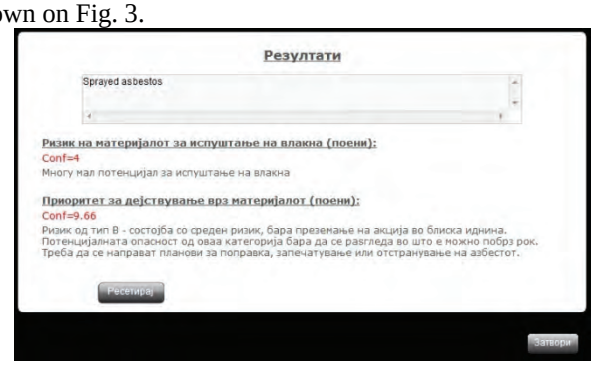

Fig. 3 Results of the expert system by selecting arbitrary parameters

The following describes the different risk bands and associated appropriate actions. These are only guidelines and should still be reviewed for suitability in each circumstance.

[1] Risk Band A (15 Points or more) – High risk situation requiring immediate action. The potential hazard arising from this category warrants urgent attention. Immediate plans should be made for the room/area to be isolated and signage positioned highlighting the immediate danger. Immediate plans should be made for the removal or permanent enclosure of the ACM.

[2] Risk Band B (10 – 14 Points) – Medium risk situation requiring near term action. The potential hazard arising from this category warrants near term attention. Immediate plans

should be made for the repair/encapsulation/enclosure or removal of the ACM.

[3] Risk Band C (7 – 9 Points) – Low risk situation requiring minor remedial works. The potential hazard arising from this category warrants minor remedial works. Immediate plans should be made for the repair/encapsulation/enclosure of the ACM.

[4] Risk Band D (6 Points or less) – Minor risk situation requiring annual inspection. The potential hazard arising from this category warrants an annual visual inspection in order to ascertain any change to the ACM and priority risk.

[5] Risk Band E (0 Points) – No asbestos detected in sample. No action necessary.

Expert systems are developed, for individual materials such as: sprayed asbestos, lagging (pipes, boilers), asbestos insulating boards, asbestos cement, etc. In addition, on Fig. 4 we presented scheme under which manages expert system for asbestos cement.

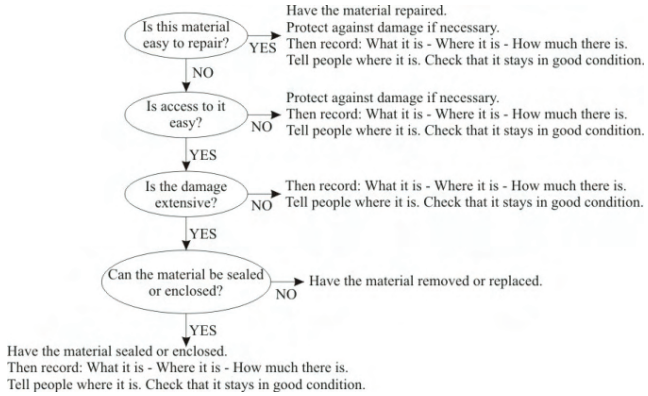

Fig. 4 Scheme for expert system for asbestos cement

The following on Figs. 5 and 6 are shown pictures of the expert system for asbestos cement.

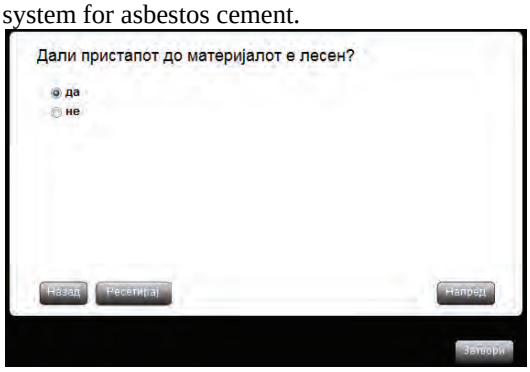

Fig. 5 Part of expert system for asbestos cement (Question: Is access to it easy?)

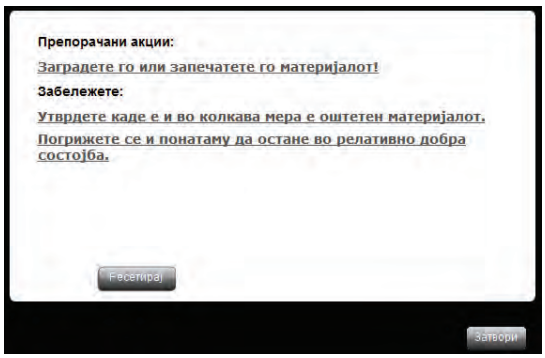

Fig. 6 Results from expert system for asbestos cement with arbitrary parameters

Similar expert systems are made and for other materials, that help us to deal with these materials.

IV. Conclusion

Asbestos is the one of the most dangerous materials on human health that causes cancer. Expert systems are a great tool to make an assessment of the material and the risk of release of asbestos fibres. Once you are done assessing the presence and type of the asbestos containing material, the expert system offers recommendations on how to proceed with such material.

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