FILE NAME: Caterpillar (CAT)

DATE: 1959

DOC#: CAT039

DOCUMENT DESCRIPTION: Article from National Safety Congress Transactions - Hazardous Materials Control

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650036002 PRINTED IN U.S.A. 022.29—F

National Safety Congress Transactions

VOL. 9 1959

CONSTRUCTION INDUSTRY and PUBLIC EMPLOYEE

NATIONAL SAFETY COUNCIL
425 NO. MICHIGAN AVENUE · CHICAGO 11, ILLINOIS

CONTENTS

CONSTRUCTION SESSIONS

EVALUATION OF EQUIPMENT

By EARL W. WHEELER
Safety Engineer, Bureau of Yards & Docks, U. S. Navy, Washington, D. C.

It is time for safety engineers to begin practicing safety engineering by foresight—not hindsight. For too long we have been telling people what they should have done to prevent accidents—after the accidents have happened.

Every time a new piece of equipment comes out, we sit back and wait to see what happens. When an accident occurs, we run out and look for the accident cause and then we devise a way of preventing the same accident from happening again. We wait for another one to happen and we repeat the performance. This is hindsight safety engineering.

I know it isn't always that way. Sometimes we do foresee what kind of accidents will happen with a new process or a new item of equipment and we devise the means of prevention beforehand. I suppose all of us in the profession have some of this foresighted safety engineering effort to our credit.

In some industries this kind of safety engineering is done quite extensively. Regrettably, this isn't true in the construction industry.

Last October, when I reported for my reserve training duty at the Army Engineer Research and Development Laboratory at *Fort Belvoir*, Mr. Rutherford requested that I be assigned to the Engineer Proving Ground and he said very much the same thing to me then that he has just said to you. In the ensuing discussion, I suggested a procedure for analyzing the hazards in the operation of construction equipment. He felt that this procedure had definite possibilities so we tried it. The time available did not permit a thorough trial, but we learned enough to be convinced that it was practical and promising.

Accordingly, I returned to the Proving Ground in July 1959 and we began a complete study of a newly developed item of construction equipment in the prototype stage. The safety division, Office of the Chief of Engineers, assigned a safety engineer, Mr. Carlyle Bunn, to participate in this study. The new equipment, a "rough terrain crane-20 ton" was made available to us for two weeks, together with an operator and a photographer.

The basic procedure used in this study is the same as the Job Hazard Analysis procedure used extensively in the study of manufacturing processes. The application of the procedure to the study of construction equipment differs only in the techniques used—and these are very simple.

The Job Hazard Analysis procedure consists of four steps:

1. Job breakdown
2. Analysis of each operation in detail
3. Devising new job method
4. Testing new job method

This basic procedure was applied in the study of the rough terrain crane-20 ton as follows:

1. *Job Breakdown.* All of the operations or series of actions performed by the operator were listed. This was done by consulting with the operator, the test engineer, and the manufacturer's representative, and by observing the operator. Some of the operations originally listed were either combined or broken down further as appeared expedient.

The list so prepared contains 51 separate items. No list was made of operations of maintenance personnel. However, the list did include first echelon maintenance tasks performed by the crane operator, the carrier operator, or an oiler. During the next phase, the observation and analysis phase, some of the operations originally listed were combined or broken down in further detail.

2. *Analysis of Each Operation in Detail.* In the original trial of this procedure, it

dried. We corresponded with practically every state highway department in the union, looking for ideas in regard to this matter. At that time, our experience had not been good from this operation. We obtained some very good ideas from some of this correspondence.

Finally, one of our district shops developed a machine which is now in use in each of the twenty-five districts of 10 or 11 counties each. We have found that this machine does a reasonably good job under most traffic conditions. Since we have started picking up markers in this manner, no injuries have occurred to the men on this operation.

We use unusually high red flag markers, as well as flashing lights on all equipment operating on the traveled surface, since we believe that the so-called second or third car can easily get in trouble behind a large truck when approaching this operation, either meeting or passing the equipment. This flag arrangement is so constructed that it will fold down when the machine is being transported from one location to another.

A supply pickup truck follows the paint striping machine closely in order to offer additional protection to the men on the rear of this machine by discouraging traffic from cutting in behind it.

The markers are dropped down a pipe which allows the men to be in a less hazardous position than if they placed them directly by hand. These small pyramids are approximately 5½" in height and are used almost entirely in our state for protecting the fresh paint stripe. Sometimes, one or two 18" cones are used at the beginning of section of stripe to be protected.

In summary, I would like to say that we of the Texas Highway Department agree with what seems to be the general opinion that this is a hazardous operation requiring serious study, both from the standpoint of protection of employees and traveling public. We also agree that regardless of the type of markers used, a machine pick-up method of some kind should be used that will eliminate the hazard of retrieving these markers from bucket seats or similar practices.

Mr. Van Mechelen: (A motion picture was shown illustrating the Washington Department of Highways' system of retrieving traffic cones used to protect new highway striping. Mr. Van Mechelen then described some of the fire and explosion hazards of carrying striping materials.)

In addition to reducing hazard to employees by using mechanical methods to retrieve stripe markers the following safety measures should be observed.

All flammables whether liquid or solid not in actual use to be removed from deck of striper.

To reduce static spark hazard make certain all sources are either corrected or grounded. All components of the unit must be electrically bonded to each other. Chain grounds either for ground to ground or to ground components are not permissable as paint, rust etc., acts as insulation between links. Only continuous strip or cable bonds are permissable. Two grounds to ground should be used.

Solvent tanks should be pressurized only by use of a manually controlled valve which automatically cuts out when released. The pressurized vapor residual in the tank after each use should be bled off through a check valve and tubed directly into the compressor engine intake manifold to be burned as fuel.

All compressors should be of rotary type with apical pressure potential of 125 P.S.I. and equipped with not less than two blow-off valves. Both the compressor and truck engine stacks should be equipped with spark arrestors.

No smoking should be permitted near stripers whether operating or standing. This includes the cab. Extinguishers should be removed from brackets and kept ready near the machine during charging, cleanup etc. All tanks should meet A.S.M.E. requirements.

Battleship cleanliness and tidyness should be observed at all times. No material movement should be permitted while machine is moving. Service trucks which supply unit should be metallically bonded to unit prior to and during transfer of materials to unit.

HAZARDOUS MATERIALS CONTROL

By WILLIAM RETZER
Industrial Hygienist, Caterpillar Tractor Co.,
East Peoria, Ill.

Hazardous materials control is a vital part of our supervisory job. Whether it's in a large industrial plant like Caterpillar, in hospitals, in highway construction—no matter what the operation—large or small—our understanding of the materials we handle is extremely important to the safety of our employees.

In this discussion I will understandably dwell on our practices at Caterpillar because those are the ones I know about. I'm sure you'll agree, however, that similar practices can and should be observed—no matter where you work with hazardous materials.

Our first admonition to our supervisors is "know what you're using and how to handle it. If you don't know what the material is—don't handle it—leave it alone."

A few years ago we in the medical and safety divisions were awakened by the fact that the handling of hazardous materials in the plant was being taken much too lightly. Hazardous materials and chemicals were being used and stored indiscriminately. For instance, cyanide and acids were being stored next to each other, a situation which presented lethal possibilities. Wash tank operators were charging their tanks with caustic by the shovelful.

In the chemistry section of our Met lab we had an explosion in a perchloric acid hood, caused as the result of inadequate flushing of the hood. You know what happens when perchloric acid comes in contact with organic material. The explosion caused extensive damage to property in the laboratory, but luckily there was slight injury to personnel.

There was the case of the carbon tetrachloride; the stuff that has the 25 ppm maximum allowable concentration. A great deal of this solvent was being used throughout the plant with nearly as much abandon as if it were water. The word quickly got around that it could be obtained at the oil cribs and was very good for dry cleaning clothing.

There was supposedly good control over disbursement of carbon tet, yet when our safety manager sent our inspectors and investigators to the oil cribs to ask for a bottle of the solvent, they had little or no trouble obtaining it.

As a result of the foregoing, plus other evidences of loose practices in handling hazardous materials, the hazardous materials control committee was established. We refer to it as *hazmacco*. But here I'll call it the committee. It consists of the manager of the safety division, the plant industrial hygienist and the chief of plant protection; all of whom are naturally concerned with the safety and well-being, not only of plant personnel, but company property as well.

The committee operates primarily under part "J" of the Health and Safety Act of Illinois. This act contains the rules and regulations relating to labeling in the use, handling and storage of substances harmful to the health and safety of employees. Since it is the state law, it is basic to all operations involving the use and handling of hazardous materials. Secondly, the committee operates according to Caterpillar procedure (P-14) for handling hazardous materials. This company procedure more or less follows the state law *but applies it specifically* to Caterpillar operations.

It deals with:

1. selection of new materials, 2. labeling of containers, 3. storage of hazardous materials in disbursing cribs, 4. inspection of hazardous material containers, and 5. disbursing the hazardous material to the end user.

A hazardous materials safety manual is prepared by the committee as a guide for key personnel in the handling of these materials and in the conduct of hazardous operations.

Each manual is numbered and a register kept of the people who have copies. When new materials are introduced for use in the plant or procedures are established for hazardous operations, the information is sent immediately to the holders of the manual to be included in their copies. Thus the manual is kept current.

I would like to emphasize that distribution of the manual is done on a selective basis. Division heads indicate who of their personnel should receive the book and their recommendations are carefully scrutinized before releasing a copy. This is done simply to avoid promiscuous distribution of the manual to plant personnel who either have no use for it or would not know how to use it. Generally, the distribution is to the superintendent *level and over.*

Selection of new materials is an important and pretty basic function of the committee. When a new material is being considered for use in the plant, one of three things can happen. First, the buyer in the purchasing division obtains a sample of the material and forwards it to the committee. It is then sent to our Met lab where it is tested for its flash point, toxicity and corrosiveness. If the material is found to be extremely hazardous, permission for its use will no doubt be denied and recommendations made that a less dangerous substitute be found.

Upon examination in the laboratory, the material may be found to be hazardous but not to the extent that it can't be used safely under certain conditions. In these cases, permission is given for the material to be used, but at the same time specific instructions are given as to what protective measures must be taken. These may include protective clothing, ventilation, warning signs, etc. Then there is the third possibility that the material has been found to be relatively harmless. If this is the case, permission for use is granted, usually without restrictions.

Occasionally, after a material has been tested in our Met lab, it is considered wise to test its use under controlled conditions before releasing it for production use. In this case the Met lab will set up a pilot project so the material can be observed under actual production conditions.

In all our considerations of the degree of hazard present in the use of any material, it must be kept in mind that our primary objective, at Caterpillar, is to produce in quantity, the best quality of our product, which is tractors. Therefore, if a material proves to be extremely hazardous, but is the only one which can be used to produce top quality work, permission is granted for its use. Very rigid protective measures are imposed and strict adherence to these measures is the rule.

Don't feel apologetic about placing warning labels on hazardous materials and chemicals. Take a forward looking attitude; think of labels as visual evidence of an obligation recognized and fulfilled. Adopting such a policy is like taking out insurance on the future of your products, personnel and property.

At first we considered it satisfactory to let the vendors who sell us our hazardous materials, take care of placing warning labels on the containers. It didn't take too long to discover that this plan was at best, uncertain. We found that in many cases the labels simply weren't there—perhaps they had come off in transit.

Many vendor's warning labels are so small that they represent no warning at all. They don't attract attention. In still other cases, the vendor places the warning label on the lid of the container. When the lid is removed, so is the label.

So many deficiencies were found in this method that it was decided that we would design our own warning labels and that they would be affixed to the containers by the receiving division when the material arrived at the plant.

Radioactive materials are being used in increasing numbers as time goes on. We've found that there is no need for concern about labeling of these products. The labels are placed on the containers by the supplier according to strict rulings of the atomic energy commission. They are adequate in size, shape and color, and are always placed so that there is no doubt of the nature and danger of the contents.

When considering control of hazardous materials, it is almost impossible to avoid getting into the field of controlling processes and procedures which involve these materials. For instance, in our manual we have included the committee's recommendations for: 1. use of respirators, 2. acid handling, 3. carbon dioxide welding, 4. welding on coated or painted surfaces, 5. manifolding of cylinders, 6. storage and handling of compressed gases, 7. cleaning paint booths, stacks, pits and tanks, 8. spraying of flammables, and 9. radiation safety and operating procedures.

This list will grow as the number of hazardous processes and procedures increase.

The committee is never arbitrary in its recommendations. When a hazardous situation arises which we feel needs safeguards, considerable research is done on the subject before commitments are made. But once the committee has made its recommendations, no deviation from them is permitted. That procedure stands as written.

Here is an illustration of what the committee recommends where hazardous conditions are involved in cleaning pits and tanks (underground and above ground). When a tank is to be cleaned, the safety division, industrial hygienist and plant protection are all immediately notified. The industrial hygienist and plant protection men test the atmosphere within the tank for flammability and toxic concentrations as well as oxygen deficiency.

Sanitation division personnel (who clean the tank) obtain two airline respirators from the safety division, one for use and one for stand-by. The safety division also provides a safety harness and line which is always worn by the person entering the tank. A member of the safety division is in attendance at all times in case of emergency.

The man cleaning the tank uses non-sparking tools (shovel, bucket). The light used in the tank is provided with explosion proof protection. The man usually comes out into the fresh air at least once every half hour, even though the tank atmosphere is non-toxic. The employee also wears rubber boots, goggles, gloves, etc., for protection while in the tank.

In all of our recommended procedures, careful consideration is given to the hazards peculiar to that particular operation. For instance, in our recommendations for carbon dioxide welding, the following factors had to be considered: 1. gamma or beta radiation, 2. ultraviolet light, 3. ozone, 4. carbon monoxide, 5. phosgene, and 6. oxides of nitrogen.

There are other items which come under the jurisdiction of the committee: 1. empty containers (dangerous), and 2. pressurized containers (not allowed).

This control program is being carried out effectively in our plant. It could not succeed without the confidence and backing of top management plus the dynamic attitude of the committee itself. The whole control idea came about because we assumed that our employees knew what they were doing with hazardous materials.