

Radner



Date 26 January 1977

INTEROFFICE
MEMORANDUM

Subject Process Hazards Review -
Piscataway High Pressure Lab.

To J. T. Wharton

Ind. Chem. Tech Dept.

(Location, Organization, or Department)

From H. Joseph Smith

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On 7-8 December 1976 a Process Hazards Review of the High Pressure Laboratory at the Piscataway Research Facility was performed. The review committee consisted of:

S. P. DiMartino, Industrial Chemicals Process Engineering
G. C. Gundel, Polymer Chemicals, Piscataway
H. J. Smith, Chemicals Manufacturing-Safety

The preliminary findings of the review were then discussed at a meeting on 19 January 1977 attended by D. H. Blakeslee, B. S. Horton, E. W. Schwirian and R. K. Warden in addition to the committee members. The purpose of this meeting was to review the findings of the committee for technical accuracy and to agree on corrective action to be taken.

The object of this Process Hazards Review was to identify deficiencies in the equipment and operation of the high pressure laboratory. While it is true that the high pressure lab has been operated without major accidents in the past, serious doubts about the overall safety of the lab have been raised in light of recent investigations into the hazards and recommended controls of high pressure reactions in research facilities. Existing operating and safety procedures are appended to this report and the report itself deals only with deficiencies found during the review. Each component of equipment and procedure was to be analyzed individually and also as it interacts with other components and the system as a whole. This analysis would then lead to a list of items which warrant corrective action.

To accomplish this we had intended to use both the "What If?" analysis technique and the "Failure Mode and Effect" technique. Unfortunately, several factors prevented us from adhering strictly to these techniques, not the least of which were the complexity of the operation and the short time available. More importantly, however, is the fact that the techniques used in formal Process Hazards Reviews rely heavily on some basic assumptions concerning the sophistication of existing safety programs. Such things as specific corporate and local standards, complete written operating procedures, accurate drawings and functioning programs for maintenance, training and safety review are

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essential to the success of a Process Hazards Review. We found these areas to be lacking and have presented them as "Areas of Concern" below.

Because we felt it impossible to adhere strictly to the "What If?" and "Failure Mode and Effect" techniques, we decided to examine portions of the operation (eg. vinyl chloride storage and handling, ethylene storage and handling, reactor controls, etc.) to determine what hazards might exist that could result in (1) explosive rupture of vessels, (2) explosion or fire due to flammable gases or liquids, or (3) employee exposure to toxic chemicals. This portion of the review was performed as a walk-through inspection even though runs were being made and our access to equipment was limited. We then took what drawings and written procedures were available to us and applied the "What If?" and "Failure Mode and Effect" techniques to identify specific problems which warrant corrective action. We purposely ignored items such as ladders, stairs, fire extinguishers and lighting so as not to divert our attention from our primary concerns.

Many specific deficiencies were found which could present hazards to employees and equipment and a list of recommendations dealing with these deficiencies appears at the end of this report. Of greater significance, however, was the identification of the previously mentioned "Areas of Concern" which have a bearing more on safety management than on equipment safety. They deal with the programs, policies, and procedures which are designed to minimize human error. It is in these areas that priority effort should be concentrated.

Once the problems in these areas have been resolved, we strongly recommend that another Process Hazards Review be performed utilizing the updated drawings and written operating procedures. This will allow the use of the "What If?" and "Failure Mode and Effect" analysis techniques to their fullest advantage.

One question which confronted the review committee was that of direct responsibility for the high pressure lab. This question was resolved at the meeting on 19 Jan 1977 when we were informed that R. K. Warden is directly responsible for day to day operation of the high pressure lab, maintenance of equipment and training and supervision of technicians. As such, he will be largely responsible for implementation of recommendations contained in this report. In addition, G. C. Gundel is responsible for some of the administrative aspects and is specifically assigned to revise drawings and written operating procedures for the high pressure lab.

Below are the major findings of the committee including the "Areas of Concern" followed by specific action items.

AREAS OF CONCERN:

A. Drawings of the high pressure lab equipment, instrumentation, and layout are out of date and do not include recent modifications.

RECOMMENDATION #1: Prepare current drawings of the equipment, instrumentation and layout of the high pressure laboratory, including recent modifications. (This is currently being done by G. C. Gundel with the assistance of the Industrial Chemicals Technical Department) Develop a system whereby drawings will be reviewed quarterly to incorporate minor modifications. Major modifications will be incorporated immediately.

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B. Written operating procedures are incomplete and out of date. In general the procedures are quite good, but they have not been revised and updated to reflect equipment modifications and process changes. Written operating procedures are being reviewed, evaluated, and revised as necessary to reflect current operations and equipment set-ups.

RECOMMENDATION #2: Portions of the procedures dealing with hazardous operations should receive thorough safety review and specific safety precautions should be listed in the text of the procedures. As an alternative, a split page format could be used where operating procedures are written on the left half of a page and safety precautions are listed on the right half of the page directly across from the related procedures. Any changes in operating procedures should receive the same thorough safety review.

C. Existing operating procedures are not routinely being followed in the high pressure lab. In some instances, technicians are not aware of the procedures. In other instances the procedures have been changed either by supervision or by the technicians themselves. Some modifications have been made which are not compatible with standard operating procedures.

RECOMMENDATION #3: Management must stress adherence to operating procedures and provide close supervision to ensure that procedures are followed. It may also be beneficial to post portions of the operating procedures which are critical to safety (eg. VCM handling, short stop, etc.) near the equipment to which it pertains. This would allow quick and easy reference for the technicians while they are working. Temporary changes in procedure should be attached in writing to the associated run sheet. Permanent changes should, of course, be incorporated into the standard operating procedures. All changes should be reviewed for safety and technicians should not be asked to deviate from written procedures.

D. Formal training of technicians appears to be seriously lacking. Aside from training in the use of respiratory protective devices and the hazards of vinyl chloride there seems to be no formal training. In general, technicians are expected to learn on-the-job from "experienced" technicians who may never have been properly trained themselves.

RECOMMENDATION #4: A formal training program should be set up to include initial basic training, programmed advanced training and periodic follow-up. This is a long term project which would require a good deal of time and effort and an additional study of training needs should be made before work on the program is begun. Sufficient time must be set aside to accomplish these training functions.

E. It appears that a formal review and evaluation is not always performed prior to making equipment modifications and procedural changes. The impact of modifications on system safety as a whole is not routinely considered.

RECOMMENDATION #5: Before equipment modifications and procedural changes are made, they should be formally reviewed for their impact on overall system safety. Representatives from engineering, safety, and operations should examine proposed changes to determine whether the changes themselves or any associated failure or malfunction would have an effect on other components of the system.

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F. Preventive maintenance and inspection schedules are not defined or practiced. Safety devices are not routinely checked for proper functioning. In general, maintenance is directed primarily to simply "keep it running".

RECOMMENDATION #6: A preventive maintenance program should be instituted for the high pressure lab equipment. This is especially important for safety devices such as safety relief valves, instruments and controls. In addition, time should be set aside on a regular basis, for required maintenance which may suffer if time is not set aside specifically for this purpose. Additional personnel may be required to accomplish this.

SPECIFIC ACTION ITEMS: Many of the items below, duplicate items already identified by Piscataway personnel. Other items have been omitted because they were previously identified and corrected by Piscataway personnel.

RECOMMENDATION #7: A 275 lb. drum of 35% hydrogen peroxide was located inside the high pressure laboratory. The contents are being dispensed from the vent bung and combustible materials were located very near the drum. This is very unsafe due to the quantity and location of storage and the method of dispensing. This hydrogen peroxide should be purchased in much smaller containers (plastic gallons) and stored away from combustible materials and reducing agents. Personal protective equipment should also be available while handling 35% hydrogen peroxide. As an alternative, a more dilute solution (possibly 10%) could be purchased.

RECOMMENDATION #8: All process equipment, valves, tanks, instruments, etc. should be labelled with the appropriate identification number listed in the operating procedures. A short worded identification should also be included on major valves and equipment.

RECOMMENDATION #9: Ethylene supply valves 0304, 0305, 0306 should be capped when not connected to ethylene cylinder cradles.

RECOMMENDATION #10: Ethylene valve 0305 is labelled as an emergency shutoff valve even though a cylinder cradle is not connected. This label should be removed to avoid dangerous confusion.

RECOMMENDATION #11: When cylinders in a cradle fail to pass periodic testing they are simply taken out of line. They should be marked and/or modified to prohibit their re-use.

RECOMMENDATION #12: Ethylene supply lines should be equipped with excess flow check valves to limit the escape of ethylene in the event of a leak.

RECOMMENDATION #13: The discharge from ethylene vent valve 0316 is positioned beside the rear door to the lab and directed downward. The discharge should be relocated to avoid exposure of employees.

RECOMMENDATION #14: The rupture discs on the ethylene surge cylinders are directed toward the aisle beside the reactor 1001 cell, presenting a hazard to employees. The hazard will be eliminated by removing the cylinders since they are not needed.

RECOMMENDATION #15: Every effort should be made to reduce the number of ethylene cylinders in the high pressure lab. This also holds for nitrogen cylinders.

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RECOMMENDATION #16: A check valve should be installed in the ethylene surface feed line to the "T" kettle. R. K. Warden has assured us that this line does have a check valve although drawings do not show it.

RECOMMENDATION #17: Check valves in the sub-surface fill line reactor 1001 for ethylene and content of tank 1203 should be repositioned. One check valve should be placed in the line from tank 1203 upstream from the junction with the ethylene line. Likewise, the ethylene line should have a check valve upstream from the same junction.

RECOMMENDATION #18: A routine leak test of the ethylene system should be instituted.

RECOMMENDATION #19: A heat activated emergency shut-off valve should be installed where the ethylene feed line enters the building.

RECOMMENDATION #20: The vinyl acetate supply line to tanks 1201 and 1202 is a flexible tubing line at present. The line should be hard piped to each tank and include a line run over to the ventilated lab hood.

RECOMMENDATION #21: Tanks 1201 and 1202 should be exhausted during vinyl acetate filling to reduce the amount of vinyl acetate vapors entering the workplace. This would also apply to other tanks being filled with vinyl acetate.

RECOMMENDATION #22: Additional shutoff capability should be provided for the supply line from the vinyl acetate storage tank. At present, if a leak developed, a technician would have to go outside and up to the tank on the second floor to shut off the supply.

RECOMMENDATION #23: The present liquid level indicator for the vinyl acetate storage tank is very misleading and the tank often overflows during filling. The indicator and/or filling procedure should be improved to avoid this problem and/or a high level alarm or automatic shut off should be installed.

RECOMMENDATION #24: Valve 0343 should be replaced by an automatic reverse acting check valve (vacuum breaker).

RECOMMENDATION #25: The shortstop system for reactor 1001 should be revised, since the current system requires the technician to enter the cell to operate the shortstop and a delay of 5 to 10 minutes could occur before the shortstop could actually be injected into the reactor. The following revisions are suggested, as one possibility:

- a. The bomb should remain filled with the styrene solution. If polymerization is a problem then the solution should be changed periodically, or an alternative inhibiting solution found.
- b. Valve 1340 should be removed and bleed valve installed upstream of valve 1339.
- c. Valve 1339 should be replaced with an air operated valve controlled from the control panel.

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- d. Valve 1343 should be replaced by an electrically operated, fail open, valve also controlled at the control panel.
- e. A complete new operating procedure should be written covering the operation of the shortstop system.
- f. Similar modifications should be made to the shortstop system on the other reactors.

RECOMMENDATION #26: Because the control panels are occasionally left unattended, while technicians perform other duties, it is recommended that an alarm be placed on each kettle to warn of emergency conditions. It is suggested that this be a high pressure alarm.

RECOMMENDATION #27: An alarm should be placed on the chilled water line to warn technician if the temperature of the chilled water rises above 50°F.

RECOMMENDATION #28: Due to the many alarms associated with the high pressure lab, it is recommended that a unified alarm system be developed and installed. This would preferably include a panel mounted array of emergency lights which allow technicians to determine the nature and location of the emergency quickly by looking in one place only.

RECOMMENDATION #29: The vinyl chloride line which runs on the floor beside pump 1101 should either be relocated or protected to prevent damage from technician walking in this area.

RECOMMENDATION #30: Valve 1323 is also subject to abuse in the same area and accidentally opening this valve would cause vinyl chloride to back up into tank 1201. This valve should be relocated or protected.

RECOMMENDATION #31: The pressure rating of the vinyl chloride weigh tank should be determined and compared to operating conditions.

RECOMMENDATION #32: The static ground continuity on the VCM weigh tank should be checked.

RECOMMENDATION #33: Opening bleed valves 1309, 1310, 1311, and 1312 when they are under pressure creates a hazard and the discharges from these valves should be directed downward away from employees. This is also true of similar valves associated with the other reactors.

RECOMMENDATION #34: Sight glasses should have better protection against breakage.

RECOMMENDATION #35: The vent condenser on reactor 3001 is no longer used and should be removed along with associated valve 3349. An attempt should be made to identify other obsolete and superfluous equipment and have it removed.

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RECOMMENDATION #36: Emergency lights in the lab were not operating at the time of this review due to worn out batteries. These batteries should be replaced as soon as possible. (Already completed)

RECOMMENDATION #37: Storage shelves in the high pressure lab should be securely anchored to the wall to prevent them from tipping over.

RECOMMENDATION #38: The existing fire blanket cabinet mounted on the above shelves should be repaired or replaced because of the extreme force required to open it.

RECOMMENDATION #39: Every attempt should be made to eliminate the need for technicians to enter the reactor cells while the reactors are pressurized and running. This would include repositioning gauges, flowmeters, etc. so they can be read outside the cell and finding alternatives to manual charging of the reactors. The latter would also serve to reduce employee exposure to several toxic chemicals.

RECOMMENDATION #40: The use of non explosion proof extension cords and drop lights to check the reactors should be discontinued. Alternative methods utilizing explosion proof or intrinsically safe equipment should be found.



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