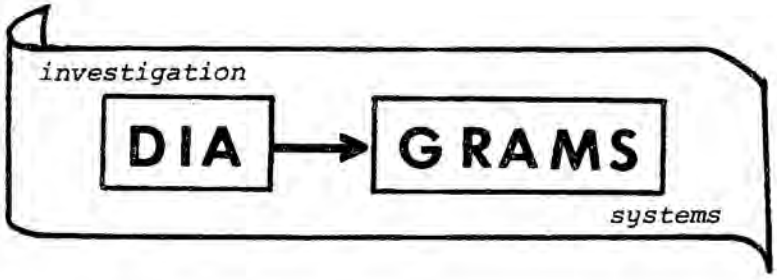
FOUR ACCIDENT INVESTIGATION GAMES

Simulations of the Accident Investigation Process

4 ACCIDENT INVESTIGATION GAMES

Simulations of the Accident Investigation Process

for use with the



By Ludwig Benner, Jr.

LUFRED INDUSTRIES, INC. OAKTON, VIRGINIA

TO THE INSTRUCTOR:

Every student should have a copy of this publication for personal use during the games. The instructor should also have one copy of the ACCIDENT INVESTIGATION GAMES: INSTRUCTOR'S MANUAL available. The instructor's manual contains specific suggestions for presenting and operating the games, as well as examples of some of the outputs from previous simulations. Copies can be obtained by writing the publisher.

PREFACE

Accidents are unhappy events. Games are usually viewed as fun and entertainment, and not as a part of the serious business of acquiring an education, or the conduct of an accident investigation. Teaching games, however, are designed to address all these considerations, by involving students in structured activities that simulate real processes.

The games in this book replicate the dynamics of several of the more important aspects of the accident investigation processes in the United States. These processes are diverse and complex, but common elements can be found in all of these processes. These common elements include identification and reaction to the interests of affected parties, acquisition of data from people and things involved in the accident, and the organization of the acquired data to serve the interests of the parties. An understanding of the dynamics of the investigative processes as they affect these elements can best be acquired by actually engaging in the processes. By engaging in simulated processes under controlled circumstances in a classroom, with support and suggestions from the instructor, students can acquire a working knowledge of these elements quickly and without penalty for experimentation or error.

There are no correct answers in these games. Each student is encouraged to identify indicators of problems, adapt to these problems within the framework of his needs by adopting tactics that he percieves most practical, and test the results by the criteria the cases help him develop. Valuable lessons can be drawn from the conflicts designed into the games. Freedom to select strategies or tactics increases the interest and the enthusiasm of the students.

The outcome of each game depends on the knowledge brought to the simulation by the students. The games are designed to be played by novices as well as seasoned investigators. Clearly, the more sophisticated the student, the more likely he will be to recognize the subleties the games expose.

The simulations are deliberately kept simple and flexible. The only materials required are 3 x 5 index cards; there are no requirements for specialized equipment or computers. The games may accomodate from twelve to thirty students. Games can be scheduled for any length class period from one to three hours, or they can be run sequentially during a weekend session. The games can be adapted to almost any physical facility,

with a clear wall or floor area of approximately seven by twenty feet. Simulations have been conducted in standard sized classrooms and adjacent open seminar rooms.

The games were developed with the patient support and cooperation of the students in a course INVESTIGATION OF ACCIDENTS offered by the University of Southern California, Eastern Region, at Washington DC. These students are, for the most part, active safety specialists and accident investigators, who brought much of the conventional wisdom in the accident investigation field to the games. The insights gained by these students during the conduct of these games prompted this publication. If the games can provide future students comparable improvements in their perceptions and vision in the accident investigation field, the effort will have been amply rewarded.

CONTENTS

INTRODUCTION

Rules of the Games

Teaching games can be opportunities for learning, or they can become a farce. If every person does their part, the games offer you an opportunity to acquire and practice the new materials and ideas that constitute the DIA→GRAMS investigation system. This system uses a "process" approach. That means there is order in what you will be doing. In a group, order requires that conduct be governed by some rules. As with other games, these Accident Investigation (AI) Games have to be played by certain rules which - if followed by all - will make the games enjoyable, interesting and informative.

The primary purpose of this group of games is to broaden your understanding about the accident investigation processes so you can make this understanding serve your needs. The games will show you some of the interpersonal interactions during this process, and the reasons they occur. This purpose can easily be obscured during the excitement of a game, by personality conflicts, or by the tendency to defend a "sacred cow" that has become irrelevant to an investigation. No doubt some of these kinds of distractions might also lead to illumination of ideas, but try to remain attentive to the purpose. Try to put yourself into the shoes of the person whose role you are playing, and ask yourself the questions that person would ask in real life. Keep looking for the special interests of that person. Look for general principles that can help you in your future activities. Watch for the subtle nuances that arise in the interactions among the players during the games. Your instructor and the appendices will help you, but you will learn in direct proportion to the effort you put into the games.

There are no scores to keep in the traditional sense of most games. The text provide a place for you to keep some notes about the observations you make. How you arrive at the outputs is more important to you than the specific outputs produced by the simulations, so keep notes on the process as well as the outputs. Read each game before you undertake it. Follow the instructor's directions faithfully. After the games, exchange views with your classmates. Pursue more references, Practice the principles in your work whenever you have a comparable problem.

Each Game begins with a statement of purpose and objectives. Keep these in mind throughout the game. The setting and matter being investigated will be explained, to help you get comfortable with the role you will be playing. Each game has slightly differing rules, so familiarize yourself with the rules before the game begins. Ask questions freely; don't let anything continue unless you understand what is happening and WHY it is happening. Don't hesitate to throw out tentative conclusions suggested by the process you are observing, for discussion with the instructor and your fellow participants.

Above all, relax and enjoy yourself as you would any other game.

CONFLICTING INTERESTS: PLAN FOR THEM

MEEKER'S LAW

Always expect all people to act in what they perceive to be their own best interests.

William G. Meeker, economic analyst, negotiator, safety specialist and friend. 1971.

GAME I

CONFLICTING INTERESTS: PLAN FOR THEM

This is a game about the interests different people have in accident investigations. Investigations are driven by many and diverse purposes. Understanding and adapting to these purposes may spell success or failure for the investigator.

PURPOSE OF THE GAME

The purpose of this game is to demonstrate the diversity of interests involved in an accident investigation, to show some of the conflicts and issues these interests generate, to show their impact on the investigative processes, and to discover possible ways to adapt each interest to the benefit of the investigator.

GAME OBJECTIVE

The objective of the game is to develop a rough outline of an investigative plan for the accident.

THE APPROACH

An accident case will be furnished. First, identify all the parties which have an interest in the investigation. Then try to identify their interests and their objectives for the investigation. After these have been identified, try to work out some way to conduct the investigation that will use the interests to the benefit of the investigator. Finally, prepare a work plan for the investigation.

THE ACCIDENT

The investigation is concerned with an accident that occurred on a clear, cold, calm dry day in a large coastal city. The driver of a propane truck for a major fuel supplier was planning to make a delivery of liquefied petroleum gas at a pier, into a storage tank that was used to hold fuel for the fork lift trucks, heating units, welding gas, and other purposes associated with the pier operation. As the truck driver was backing his truck up to the storage tank, the rear of his truck struck a rugged 4" diameter by 30" high steel post, installed by the pier builder to protect the storage tank piping from damage by backing trucks. The post tore open a section of the cargo tank piping, allowing the LPG to escape. Escaping LPG spread over the pier area, engulfing a temporary shack used by the longshoremen to keep warm on cold days. The LPG inside the shack ignited, and blew the shack apart. The ignited gas burned at the truck, impinging on the partially full storage tank, which exploded about thirty minutes after the initial fire started. The explosion ignited a nearby vessel and some cargo on the pier, and startedfires in several adjacent buildings on the pier. 3 longshoremen in the shack were fatally burned, the truckdriver and 24 other longshoremen

were seriously burned. The fire lasted for eight hours, and resulted in about $10 million damages. The incident was on live TV within an hour after the explosion. It occurred while safety legislation about liquefied energy gases was pending action.

THE PLAYERS

The players in the game are the individuals who have an interest in an investigation of the accident. Each player will be played by a student who is expected to represent and act according to what he believes is in the player's best interest. Each role should be played as realistically as possible, avoiding behavior that is not "reasonable" in the circumstances. Students should act civilly, and speak when recognized by the instructor, or respond when a question is directed to a player to clarify a point. Recognize that the game reflects negotiations among the participants, as the plan emerges from the discussions.

The players are, in the order they are introduced:

1. IM, the Inquiry manager for an agency with authority to conduct an accident investigation for a public body.

2. IS, the Investigative specialist and member of IM's staff who will be in charge of one phase of the inquiry.

3. TD, the truck driver who was driving the truck and was injured.

4. PL, a pier longshoreman who was on the pier, saw the accident, and was badly injured but can talk comfortably.

5. TO, the truck owner for whom the driver worked; also owner of a distributorship for a major LPG producer.

6. PO, the owner and operator of the pier facility involved.

7. UD, the union representative for the truck driver.

8. RT, a manager in the regulatory agency with safety regulations over the truck operations.

9. MC, the media cameraman's news director for the TV station that broadcast the fire news.

10. PE, the pier engineer who designed the pier facility.

11. VO, the vessel owner whose vessel was in the middle of picking up a load of electronic machinery and other cargo, much of which was burned in the fire, when the vessel caught fire.

12. PI, the executive of the firm which insured the pier.

13. RP, the regulations division manager for the agency which issued

vessel loading regulations.

14. TL, the truck owner's lawyer.

15. PB, the pier builder who erected the pier facility.

16. SE, the engineer who designed and supervised the erection of the storage tank which exploded.

17. CA, the Congressional aide for the Congressman whose bill is now being considered as a way of improving pier safety.

18. FC, the Fire Chief who was in charge of emergency operations at the pier, and who directed the extinguishing of the fires.

19. NC, the National Code Committee chairman which has an industry standard for pier safety.

20. IS, the investigative specialist and member of the IM's staff who will be in charge of witness interviews.

21. GP, the claims manager for the producer of the LP gas involved in the fire and explosion.

22. TI, the truck owner's insurance company representative.

23. PB, the pier boss who supervised the longshoremen from the hiring hall.

24. LL, the longshoreman's laywer who will be handling the litigation for the injured longshoreman.

25. EI, the engineering laboratory that often conducts tests for insurance companies' accident investigations.

26. RE, the representative form a government laboratory that provides frequent technical support for regulatory agencies.

27. UL, the longshoreman's union representative.

28. MR, the media reporter who took photographs of the tank just before the explosion, and wrote a long news article for the wire services.

29. TE, the engineer who designed and supervised installation of the cargo tank and piping on the truck.

30. CL, the county prosecutor who would bring charges for the deaths in the accident.

GAME I

THE GAME

The game consists of two phases. During the first phase, each player develops his perceptions of his best interests for the accident, under the guidance of the instructor. During the second phase, the Inquiry Manager solicits assistance in his investigation by asking for contributions to the investigation in terms of making people available, debris examination, etc., and translating replies into an investigative task plan.

For phase one, the instructor will poll each player for an expression of that player's perception of his best interests. This expression should cover both interests the player is attempting to advance, as well as interests the player is trying to protect. In other words, each player should try to state what he would like to see established by the investigation, as well as what he would like to keep murky or obscure, and why he perceives these actions to be in his best interests.

During this phase, each student should keep notes about the interests of each player. These notes should cover the points being made by the student playing the role, and should also include any additional points that may be recognized during subsequent players' commentaries.

At the conclusion of this phase, each student should have a record of the motivating interests for this class of party in an accident investigation, regardless of the nature of a particular accident. These notes can be used for evaluation of the investigation plan for the accident used in this game.

To assist the role playing by students, a brief biographical sketch of each player will be found in the Appendix.

The following pages provide room to record the interests of each of the players.

GAME I

THE PLAYERS' INTERESTS

1. IM, the Inquiry Manager.

2. IS, the Investigative Specialist.

3. TD, the truck driver.

GAME I

THE PLAYERS' INTERESTS

4. PL, the pier longshoreman.

5. TO, the truck owner.

6. PO, the pier owner.

GAME I

THE PLAYERS' INTERESTS

7. UD, the driver's union representative.

8. RT, the truck regulator.

9. MC, the TV cameraman's director.

GAME I

THE PLAYERS' INTERESTS

10. PE, the pier engineer.

11, VO, the vessel owner.

12. PI, the pier insurer.

GAME I

THE PLAYERS' INTERESTS

13. RP, the pier activity regulator.

14. TL, the truck owner's lawyer.

15. PB, the pier builder.

GAME I

THE PLAYERS' INTERESTS

16. SE, the storage tank engineer.

17. CA, the Congressional aide.

18. FC, the Fire Chief.

GAME I

THE PLAYERS' INTERESTS

19. NC, the national Code committee chairman.

20. IS, the investigative specialist for witness interviews.

21. GP, the gas producer.

GAME I

THE PLAYERS' INTERESTS

22. TI, the truck insurer.

23. PB, the pier boss.

24. LL, the longshoreman's lawyer.

GAME I

THE PLAYERS' INTERESTS

25. EI, the engineer investigators.

26. RE, the regulators' engineering laboratory representative.

27. UL, the longshoreman's union representative.

GAME I

THE PLAYERS' INTERESTS

28. MR, the media (newspaper) reporter.

29. TE, the truck tank engineer.

30. CL, the county legal prosecutor.

GAME II

THE WITNESS' WHOLE STORY

BENNER'S LAW

Everyone and everything always have to be

someplace doing something.

Adapted from a humerous anecdote learned during my adolescence.

3 Key Investigation Principles

1. *THINK EVENTS.*

   One actor + one action = an EVENT. Trace the actions of an actor step by step from place to place during the accident period being investigated.

2. *BREAK DOWN EVENTS.*

   Keep dividing events into their component subevents until all the actions of actors involved in an accident can be reproduced.

3. *MAKE MENTAL MOVIES.*

   Trace an actor's actions until you can see them in your mind in a mental movie that doesn't have any blank frames or gaps.

EVENTS ARE AN INVESTIGATOR'S BUILDING BLOCKS!

GAME II

THE WITNESS' WHOLE STORY

Only people or things can give you data about an accident. This is a game about acquiring data about accidents from people. Understanding ways to help a witness provide data to an investigator is indispensible to every investigator, and can make or break an investigation.

PURPOSE OF THE GAME

The purpose of this game is to demonstrate how an investigator can elicit from a witness to an accident the whole story the witness is capable of recalling, by utilizing the Benner's Building Blocks methods.

GAME OBJECTIVE

The objective of this game is to prepare an analysis of a witness statement and interview, to determine a) whether the witness told the truth, and b) if the witness can add any additional data that might help the investigator understand the accident.

THE APPROACH

An accident case will be furnished, and a witness' statement about the accident will also be furnished. First, the statement will be analyzed, using the Benner's Building Blocks method. Next, that analysis will be used and supplemented during a simulated followup interview with the witness. Finally, the resultant display will be tested to validate the data furnished by the witness, and to determine whether the witness can possibly supply even more data of value to the investigator.

THE ACCIDENT

The accident is the same accident used in GAME I. The witness who will be simulated is the longshoreman who was standing at the door of the shack on the pier, and who was injured by the ensuing events during the accident.

At this time, please go back to THE ACCIDENT described in GAME I, and reread the accident account.

THE PLAYERS

The only "actor" involved in the game is the witness. For this game, the instructor - who has been supplied the witness' whole story - will play the role of the witness, as well as continuing his role as the instructor. He will wear "two hats" during the game so students can recognize which role he is playing each time he speaks.

The students play the role of "interviewers" who represent the interests identified in GAME I. In other words, the student who played the role of the truck driver in GAME I will play the role of the representative of the truck driver who has an opportunity to review the

longshoreman's statement about the accident, and who then has the opportunity to participate in the followup interview of the longshoreman with the investigative group. Each student is expected to identify with the party he represented in GAME I during this game.

At this time, turn to the list of PLAYERS in GAME I and review the roles of the students, as well as their interests in the investigation as they emerged during GAME I.

THE GAME

The game consists of two stages, the Statement Analysis stage, followed by the Interview Stage. For both stages students will be supplied 6 3x5 index cards for use in playing the game.

The game begins by reviewing the witness' statement. The instructor will read the statement. As the statement is read, players will record the events described by the witness in his statement, in rotation from the instructor's left. When the statement describes an "action" i.e., event, the player to the instructor's right will record the first event, the next player the second event, and so forth in rotation around the class until the entire statement and all the events have been recorded on 3x5 index cards. For example, if the statement reads: "I checked into work at 8 AM and went right to the pier super's office." the first player to the instructor's right will record "checked into work" on a card, and the second player will record "went to pier super's office." on a card.

The longshoreman's statement follows.

My name is CHARLIE W. BROWN. I am a longshoreman out of Local 31. On Thursday morning, I was at ths shape-up and got called to go out to _____'s Pier to load a dry cargo freighter. So I went over to the pier and went to the peir super's office, and he gave us our jobs for that day. A little later, I was in the doorway of this here leanto after I had taken the chill off my face, and I saw this truck headed down the pier toward us. He stopped and started backing up to the big gas tank. All of a sudden, as he was backing up, I seen this white smoke come out from under the truck and start rolling toward me. All of a sudden there was this big fire and explosion that knocked me on my can. I got up and helped some of the guys try to put out the fire. All of a sudden, there was this giant explosion that lit everything up in a bright orange color. It looked like the sky was burning. Somebody came and helped me get up, and walked me past the firemen who were hurt. We got into a car and they took me to the hospital. My clothes were stuck to me.
That's all I can remember.

(s) Charlie W. Brown.

The next step is to take the recorded events and arrange them into chronological order by placing them in a line on the floor, or by sticking them to a wall with masking tape.

GAME II

After the events are arrayed in sequence, each player, in rotation, tries to assign a TIME to the event on his card. As he decides on the time to enter on the card, the rationale for its selection should be described to the other players. At this stage, the other players should listen without comment. Estimated times are acceptable at this stage.

After the times are assigned, each player,in rotation, selects one question that he would like to ask of the witness, to bring out a point that he believes is in his best interests to establish. Keeping in mind that every player wants to understand what happened, focus the questions on data that will be useful to the investigation. As each player selects a question, that player should describe the criteria which prompted him to propose the question, i.e., if he gets the answer from the witness, so what will it tell him. The other players should remain silent except when called on by the instructor during this stage.

At the completion of this stage, the display of the witness' statement will be disciplined by the time estimates, and by the spatial progression of the witness as he moved from place to place during the accident. This completes stage 1.

The Interview Stage begins when the instructor dons the "second hat." At this time, the players begin to question the witness, using the planned questions from Stage 1, and proceeding in rotation when called upon by the instructor.

After each player asks his question, the witness' answer is to be recorded on 3x5 cards, using one card for each event described by the witness. As soon as each event is recorded, it should be added to the row of cards on the floor or wall in the appropriate sequence. The player adding the event then tests its location by affixing a time of occurrence to that event, and concluding whether or not the witness could have been where he had to be for the event to occur, and whether or not the witness could have done that action at the time specified on the card. Each card added to the row must pass these tests before the next card can be added BY ANY PLAYER. After five questions have been asked and answered, players MAY CHANGE THEIR QUESTIONS FROM THOSE THEY HAD PLANNED TO ASK.

During the testing step for each event, any player may challenge the player who added the event to the row to justify the logic of the added event, its relevance to the investigation,or the accident, or the criteria on which the justification is based. These challenges simulate the conflicts that arise during an investigation, and indicate how the events charting methodology provides a mechanism for a) identifying divergent criteria and perceptions, as well as interests, and b) resolving conflict by focusing on the entries in the events sequence chart. In the interest of an orderly instructional experience, players should not comment unless recognized by the instructor, especially during this step of the game.

GAME II

Several precautions for all players are in order. First, avoid badgering the witness. Any threatening signal received by the witness will trigger the instructor to "turn off" any time the threatening player asks a question of the witness. The intent is to simulate real life reactions by witnesses involved in accident investigations.

A second precaution is to switch roles with the instructor, in the sense that players should shift gears when the instructor plays the witness, and then when the instructor reverts to his instructor's role. Sometimes this can create confusion, if players do not follow the instructor's role.

A third precaution is that players should remain civilized in front of the witness. This means no raised voices, intimidation by inuendo or other means, or threatening non-verbal communications among the players during the interview. If the simulation arouses the interviewers to behave that way, the simulation has served its purpose.

The game can be curtailed if the interviewers begin to use the Benner Building Blocks skillfully toward the end of the interview, and the simulation begins to produce diminishing returns.

DEVELOPING ACCIDENT "TEST PLANS"

An ACCIDENT is a "PROCESS" in which a perturbation transforms a homeostatic activity into unintended, interacting changes of state with a harmful outcome.

4 Principles for debris examination.

1. *APPLY MBO DISCIPLINES.*

   Examination of every piece of debris should be performed to achieve some explicitly stated objective and contribute to a better understanding of the phenomenon.

2. *KEEP IT RELEVANT.*

   The mental movie framework should control hypothesis development, and debris testing should be limited to identifying or confirming changes of state during the accident. Test outcomes should provide solid building blocks for the accident reconstruction.

3. *USE THE 4 P's.*

   Extract data from debris by conferring with PEOPLE, by observing relative POSITIONS, by inspecting or testing PARTS, and by reviewing PAPERS to establish expected behavior.

4. *NO PLAN, NO TESTS!*

   Never permit any destructive testing of any debris without a test plan agreeable to all affected parties with a legitimate interest in the test results.

GAME III

DEVELOPING ACCIDENT "TEST PLANS"

This is a game about acquiring accident data from things which have survived an accident. The need to strike a balance between the various interests, purposes, resources and time constraints facing an investigator is most sharply focused when tests on accident debris are being explored. "Test plans" can help investigators cope with the conflicts.

PURPOSE OF THE GAME

The purpose of this game is todemonstrate the considerations that influence the examination of accident debris, to show how these considerations can generate conflicts during an investigation, and to show how these conflicts can be handled by an investigator in charge of an accident investigation.

GAME OBJECTIVE

The objective of this game is to develop an accident debris "test plan" that will be acceptable to all parties interested in the accident.

THE APPROACH

The approach is to use the accident from the first two games to identify the debris that each party would like to see tested, and then engage in negotiations among the parties that will culminate in a debris test plan acceptable to all.

THE ACCIDENT

The accident is the same accident used in GAME I. Except for the LP gas in the truck tank and in the storage tank, all the things present in the accident have been recovered, in varying states of damage. The storage tank broke into three pieces, including the west end which was propelled 750'westward, the east end which was propelled against the vessel hull, but did not penetrate it, and the center third, which was found as a flat plate covering the damaged tank truck. The truck and tank piping were all found under the center section of the storage tank. The badly burned cargo, pier facilities, vessel, fire trucks and gear, and shack and contents are still where they were after the fire had been put out. The weather has remained cold and dry, but snow is forecast for Sunday evening.

THE PLAYERS

The players in this game are representatives of individuals who have an interest in the outcome of the accident for the reasons found during Game I. The order in which students are assigned roles has

been changed slightly, to assure that a sound mix of players is reached in smaller classes. The order for assignment of roles is:

1. The Inquiry Manager
2. The Investigative Specialist in charge of the DEBRIS TEST GROUP
3. The Truck Owner's investigative consultant
4. The Pier Owner's investigative consultant
5. The Union Representative for the truck driver
6. The Pier Engineer who designed the pier facility
7. The vessel owner's investigative consultant
8. The manager of the truck safety regulatory agency
9. The National Pier Safety Code committee chairman
10. The tank truck cargo tank and piping engineer
11. The manager of the vessel loading regulatory agency
12. The engineering laboratory representative (private)
13. The government engineering laboratory representative
14. The county prosecutor's chief assistant attorney
15. The fire chief's deputy in charge of fire investigations
16. The Union representative for the longshoremen
17. The claims manager for the LP gas producer
18. The engineer who designed the storage tank
19. The pier builder's investigative consultant
20. The truck owner's attorney
21. The pier owner's attorney
22. The pier insurer's chief investigator
23. The truck insurer's chief investigator
24. The newspaper reporter
25. The truck driver's attorney

26. The longshoreman's attorney's consultant

27. The Congressman's aide

28. The inquiry manager's technical specialist

29. The pier supervisor who will have to handle debris to get it hauled away for testing

30. The TV station's reporter covering the meeting

The biographical sketches in Appendix I are supplemented,for the players not previously assigned in GAME I, by the sketches in Appendix IA.

As before, the players are expected to act civilly during the game, and should speak when called upon by the Instructor, or when asked a question for clarification by one of the other players.

THE GAME

The game consists of two phases. During the first phase, the players will discuss, in turn, the debris that is of interest to each and indicate why it is of interest. During the second phase, the Inquiry Manager will attempt to arrive at a test plan for the debris.

The game begins at a meeting of interested parties following the preliminary investigation, called by the Inquiry Manager on Thursday, the second morning after the accident. Not everyone has seen all the debris. Witness interviews have been essentially completed. The assembled group has been told the purpose of the meeting is to determine what tests will have to be run to assure that the necessary data for the investigation has been developed.

The Inquiry Manager opens the meeting by polling the attendees to find out who is present, and their affiliation. He next explains his objective, which is to develop a "test plan",and describes how the meeting will be conducted. Following these remarks, he begins asking each player, in turn, to identify the debris that the player wants to have examined, and why the examination is necessary. The players' answers are recorded on a chalkboard or other visual display so all the players will have the information before them at all times. After eahc player has had his say, the game proceeds to phase 2.

During phase 2, details that will constitute the test plan will be developed. Each player, in turn, will be asked to describe the test method he wishes to have used for each piece of debris he wants tested, whom he recommends to do the testing, what the test outputs should be and how they relate to the investigation, what alternatives might be considered to the tests he is advocating, the time frame or schedule(s) for the tests, how they should be funded, to whom the

results should be supplied or distributed, and how the Inquiry Manager is expected to evaluate the results of the test to determine if they have been completed and are acceptable or unacceptable.

During this phase, clarifying questions about any of the points made by a player may be asked by any of the other players. Thus the form of the negotiations will be through questions that bring out the points each player wishes to establish.

Each player should be prepared to make a commitment to the plan that is being formulated by the Inquiry Manager and his staff. This commitment will be expressed by silent concurrence when the inquiry manager asks for additional changes or amendments; in other words, silence will be interpreted as concurrence at that point. In this decision, each player should take into account available resources and the stakes in the outcome of the investigation while making the tradeoffs for this decision. If the plan is unacceptable, the player is expected to announce what he plans to do, recognizing that title to the debris may limit the options available. The instructor will point out some of the difficulties with independent action as the game progresses.

GAME IV

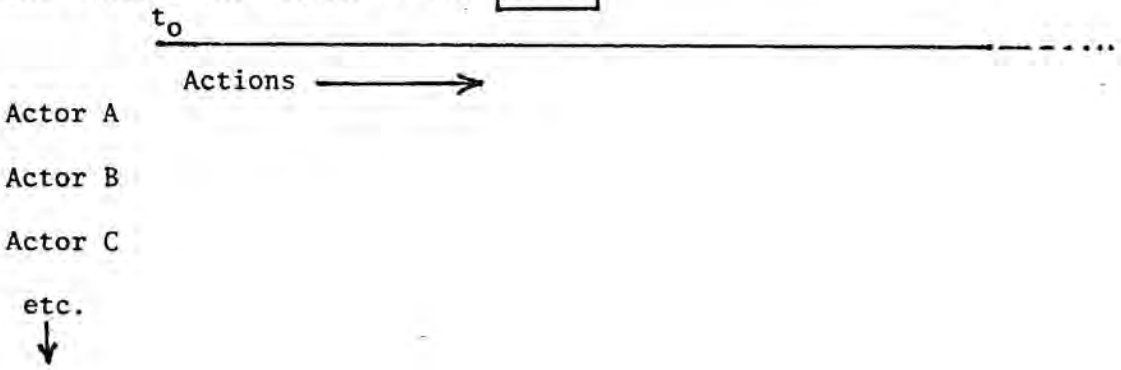
ORGANIZATION AND ANALYSIS OF ACCIDENT DATA

4 key DIA→GRAMS Investigation System Elements

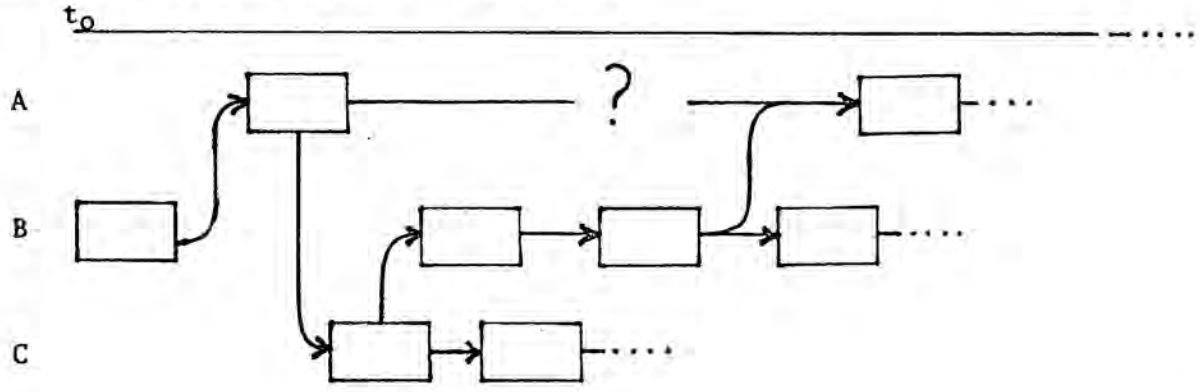
1. The TIME LINE to discipline the sequencing of events:

2. The EVENTS MATRIX to display events and their chronological relationships:

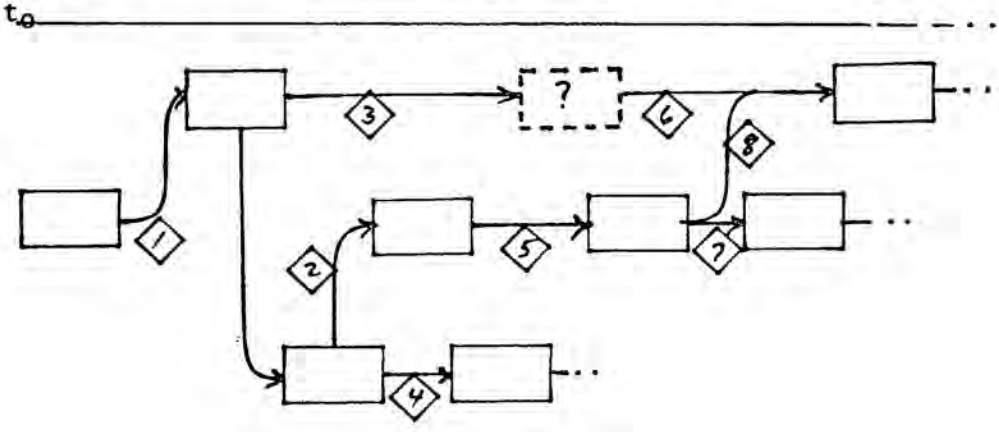
one actor + one action = an EVENT



3. The ARROW CONVENTION to show the interactions among actors and to test the proceed/follow logic of the display:



4. The COUNTERMEASURE TABS to identify risk-reducing action options:



GAME IV

ORGANIZATION AND ANALYSIS OF ACCIDENT DATA

This is a game about organizing and analyzing the data generated by an accident investigation. The way such data are organized and presented will determine the credibility of investigator's report of the accident and his explanation of how and why it happened. The way the data are analyzed will determine what action should be proposed to reduce future accident risks. It can also affect other uses of the investigative findings.

PURPOSE OF THE GAME

The purpose of this game is to show how data acquired during an accident investigation can be organized, tested and displayed in a way that will serve the interests of most users, and to show a method for identifying potential countermeasures to reduce accident risks.

GAME OBJECTIVE

The objective of the game is to prepare an annotated accident logic chart (ALC) from a narrative accident report, marked to indicate potential countermeasures that should be considered to reduce future risks.

THE APPROACH

A narrative report of an accident investigation prepared by an accident investigation team will be converted into actions by each actor involved in the accident (events.) Each event will then be displayed in a format derived from the Interactive Multilinear Events Sequences Theory of accidents, called an Accident Logic Chart. When the events are organized, actions which would disrupt, alter or redirect the progression of events will be noted on the chart to indicate potential countermeasures.

THE ACCIDENT

The accident investigated by the team involves a fatal injury which followed the entry into a deep shaft by several persons. This type of accident is not uncommon, in that rescuers became victims. The accident investigation report is found in Appendix 3. The report is based on an actual case, with the names changed to give privacy to all involved in the incident.

THE PLAYERS

The players in this game are the individuals who had a role in the accident and its investigation. Each player is played by a student who is asked to assume the identity of the individual in the case. This identity should be retained even during the markup of the chart during the countermeasure development process.

GAME IV

The degree of involvement by each player varies substantially, as reported by the accident investigator. To reduce the unevenness of the workload for the students, each role should be studied to identify both the explicitly described actions in the report, and also the implicit actions suggested by report and the events of the accident. In smaller classes, multiple roles can be assigned to students with lesser roles, at the discretion of the instructor.

The players who have a role in the game include:

1. Arty, a RCC laborer
2. Bob, a RCC electrician
3. Charley, a RCC laborer
4. Davey, a control room operator
5. Eddy, a RCC advisory engineer
6. Harry, an RCC laborer
7. Jack, who gave Harry his job assignments
8. Kenny, an RCC welder
9. Ron, an RCC safety supervisor
10. Tom, an RCC fire and safety officer
11. Wan, an RCC safety supervisor
12. Zack, Arty's supervisor
13. Gerry, a member of the local rescue squad
14. Argon, the welding gas
15. Mack, the RCC 1st shift supervisor
16. Air, in the pit
17. Sam, the RCC Chief Safety Supervisor
18. Oren, the RCC Area Safety Manager
19. Yank, the RCC Construction Superintendent
20. Pat, the Korn County Sheriff
21. Irv, a government inspector
22. Len, the Riverbend shift supervisor
23. Nick, an RCC 1st shift supervisor
24. Hal, the government inspector who prepared report
25. Val, a government inspector
26. Frank, Charley's supervisor
27. Fan(s), which ventilate the pit
28. Line, used to hoist victim(s)
29. Lew, the Riverbend Director of Purchases
30. Hugh, the Riverbend Chief Engineer

The assignment of students to play the role of "things" is designed to show how the actions of things need to be incorporated in an explanation of an accident, and in development of countermeasures. The students playing these roles should be encouraged to work with each other before the game is played, to try to determine the implicit behavior that should be expected during the accident. The need to predict the behavior of things is an important requirement for safety analysts.

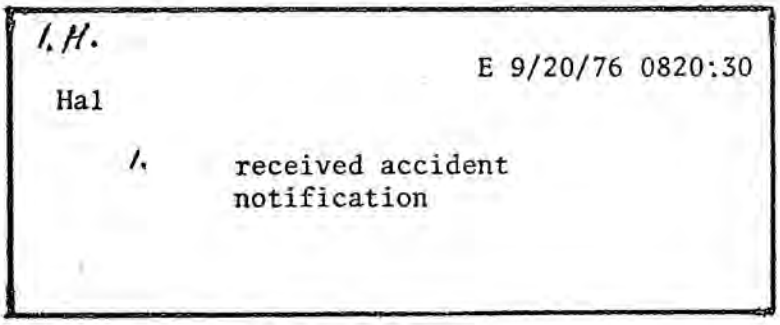
GAME IV

THE GAME

This game consists of a preparatory phase, a data organization phase, and a countermeasure identification phase.

During the preparatory phase, each player is to prepare a set of 3 x 5 index cards containing the actions by that player as described in APPENDIX 2.This is accomplished by reviewing the investigator's report of the accident to identify each discrete action by the player which is reported by the investigator in the narrative of the accident report. For example, the student playing the role of Hal would record "received accident notification" on the first card. To aid in retrieving the action during the game, both the card and the report should be noted "1" in the left hand margin for the first event; each successive event should be sequentially cross-referenced in the same manner. The third step is to record the time of the event in the upper right hand corner of the card, including both the date, hour, minute and second. When exact times are not available, estimate the time, and prefix the numbers with an "E" to indicate that the time is estimated, subject to correction at a later date.

A completed card should look like this:



While reviewing the investigator's report, students should be looking for implied actions. For example, Hal presumably established some contact with the RCC Assistant Superintendent of Construction at the site, and others to set up a conference. Hal's actions would be recorded on a card in a manner deemed appropriate by the student playing the role. This is especially important for students playing roles during the time of the accident; it is not vital for actions by the investigators but may be helpful during the review of the investigation during phase 2.

At the completion of the preparatory phase, each student should have a set of cards containing each action for the player(s) analyzed to use as building blocks for the next phases. The conversion of written or verbal information into "events" by specific actors is an essential skill for the application of the Benner Method of analysis of accidents. Before proceeding to the next phase, each card should be checked against the criteria in Appendix *4*, RULES FOR RECORDING ACCIDENT EVENTS.

GAME IV

The data organization phase consists of arranging the cards with the events by each player in a sequential order along parallel rows using one horizontal row for each player. The cards in the top row will be laid out in their time sequence by the first player. The cards in the second row will be laid out by Player 2 in their time sequence, with the additional constraint that they must be fit into the time sequence of the cards in row 1 at the same time. If an event in row 2 occurs between two events in the row above, the cards in row 1 must be shifted to the right to permit the row 2 card to fit into its correct time slot, relative to row 1. For convenince and consistency it is recommended that the left edge of each card be aligned with the time when the event began. At a later stage of this phase, ways to represent the duration of events will be discussed.

It will be found quickly that a "time scale" inserted above row 1 will be useful for arraying the cards along the rows used for each actor. This time scale can be uniform initially, but if students find it necessary to expand the scale during certain parts of the accident, this can be accomodated easily without compromising the sequencing discipline being applied to the data.

When a rough time scale has been established, each student can be assigned a row along which to lay out the cards for that player, and the cards can be laid out quickly thereafter. When questions arise about the "correct" order of the card placement, these questions should be discussed among the students involved in or affected by the placement of the card in question, and a placement decision reached as quickly as possible. If the question can not be quickly resolved, the card should be noted with a " ? " and placed in an approximate time slot, subject to further testing or additional data. When the question has been resolved, the " ?" should be removed from the card.

As soon as all the cards have been laid out in their related time sequence, the "arrow convention" will be applied to the display. The arrow convention is a method for linking events in a precede/follow logic which reflects both sequential time and spatial relationships. For example, if the event 12 in row 7 led directly to the event 8 in row 4, link R7E12 to R4E8 with an arrow. If R7E12 led to two events such as R4E8 and R11E6, draw arrows from R7E12 to both R4E8 and R11E6. Alternatively, if R1E4 and R2E5 both had to precede R3E6, draw arrows from both to the R3E6 event to show their precede follow relationship.

Before inserting any arrows, the events set(s) to be linked must pass both a time sequence test and a spatial sequence test. Arrows must always flow from the earlier event to the later event in time, and they must always flow from the earlier location of the actor to the later location of the actor. For example, an arrow can not be drawn from an event occurring at the bottom of the steps in a fall to an event occurring at the top of the steps, because the event at the top of the steps occurred earlier both with respect to time and placement of the actor.

As the arrow convention is applied, gaps in the flow of events, which reflect gaps in the understanding of the accident, will be seen by the students. In the case reported, several gaps will be identified. A discussion of ways to bridge these gaps in the understanding of the accident phenomenon will be led by the instructor. If time permits, a "fault tree" can be constructed to show how fault tree arrays can be used to organize speculations about what might have occurred during the accident, and to bridge the gap in the logic of the accident. This exercise can also be related to the development of the related "test plans" for future examination of witnesses, debris, or other data development methods.

At the completion of the organization phase, all students will be able to see the relationships of their actions to the total events constituting the "accident" and see where gaps in the accident logic exist. They should also be able to see how the accident logic chart can be used to guide further data acquisition efforts, how the chart can aid preparation of narrative reports of the accident, and how the chart can be used for future accident investigations and for training purposes, to name a few.

The countermeasure identification phase of the game consists of a review of each event on the accident logic chart to determine how that event might have been avoided, rescheduled or otherwise affected by some safeguard or procedure. During the examination of individual cards, strategies and tactics used in the safety field should be tested against their likely effects on the occurrence of that event in the time and spatial relationships required for the accident scenario to continue to its harmful outcome. Next, their potential for introducing alternative scenarios with harmful outcomes can be examined against the accident logic chart, to determine if the proposed safeguard or procedure may have unexpected alternative consequences. The method used is to track the actions of the involved actors in that part of the accident scenario to estimate what new actions can be expected to occur if the change is adopted. Students will probably observe that this phase leads to identification of simulations that may be needed to arrive at the estimated consequences of the proposed countermeasure being examined.

By applying a step-by-step method for identifying ways to change the time or spatial relationships among actors involved in accidents, students will also be better prepared to argue in support of the recommendations they offer after their accident investigations are completed. Other effects will also be observed.

APPENDIX I

Biographical sketches of the players in Game I.

1. IM, the Inquiry Manager for the United States Risk Evaluation Commission (the REC, for convenience) is a middle-aged civil servant who has risen through the ranks to a GS 14 level during his 22 years of governmental service. He is a trained Chemist, has worked in 4 laboratories studying munitions behavior in accidents for a Federal defense agency. He recently transferred to the REC, and was made an Inquiry Manager one month ago. Can be characterized as ambitious but open and fair.

2. IS, the investigative specialist, has a backgroud in the LPgas industry, has 13 years accident investigation experience including a brief time as an insurance claims analyst for his employer. Feels especially competent as an interrogator of witnesses. Was never a manager in his previous jobs, but has had MBO as well as investigative training courses. Anxious to learn.

3. TD, the truck driver, is 20 years old, has been working for the LPG distributor for five months, and has an accident-free record. Is very concerned about his role in the accident. Was on TV during the fires, and has little recollection of what he said. Bad burns.

4. PL, the pier longshoreman, was in the shack when he should have been loading the vessel. A thoughtful individual who has six children to support, wife doesn't work. Doesn't know how long injuries will prevent him from working, because they are serious and will require a long time to heal and expensive skin grafts.

5. TO, the truck owner, just invested his and his family's savings and credit in the distributorship seven months ago. Small firm of about 12 employees. Pier supply was one of his bigger contracts. All the equipment he acquired was to industry standards, as was recommended by the LPG producer. Was proud of his operation.

6. PO, the owner and operator of the pier facility, was from an old area family which had owned the pier for generations and had prospered handsomely from its operations. Had considerable political influence. Had had problems with longshoremen over the years, but currently was enjoying good labor relations because of threat to the pier's traffic from a new pier facility in another nearby port that handled containers.

7. UD, the union rep for the truck driver had just been elected president of the local six months ago, due in part to successful organizing drives among small truck operators in the area. Term of office before reelection was 3½ years. 28 years old.

8. RT, the manager (Director) of the regulatory agency that wrote regulations convering the design and operation of the tank truck. Old line bureaucrat who operated primarily by copying industry

APPENDIX I (continued)

codes and standards as regulations. Only four more years before he could retire. Proud of his record of coming up through the ranks without any formal education. Never worked anywhere except in the government, in a regulatory role. Enjoyed the power over industry that a regulator can exercise.

9. MC, the TV station's news director who preempted network programs to air the fire for several hours. A friend of the local congressman. Had worked with the congressman to develop and get passed statutes that protected TV film outtakes from "freedom of information" access, and protected all TV film under copyright provisions.

10. PE, the pier engineer, was project manager for a pier rennovation project that had been complete 4 years earlier. A mechanical engineer with 27 years experience in all phases of waterfront facility designs; was hired six years ago by failing engineering company to turn the company around in this engineering area. Served on national codes and standards committees, trade organization safety committees.

11. VO, the vessel owner, operated a small fleet of six dry cargo vessels in the highly competitive North Atlantic trade area. Marginal operations were on the verge of going under when the fire occurred. First casualty of this type. Vessel involved was 23 years old. Cargo belonged to large firms who were steady shippers for his firm.

12. PI, the pier insurer, was a large insurance firm with experience in marine insurance. The representative had insisted that his firm take the pier's insurance business as a high profit account because of the recent rennovation, and had set the premiums to win the account from a competitor two years ago. No technical experience.

13. RP, the regulations division manager for a regulatory agency which issued vessel loading regulations. His agency was seeking new laws to authorize the agency to exercise regulatory authority over the design and operation of pier facilities such as the one where the accident had happened. The new authority would probably mean a substantial improvement in his position and grade. Hardnosed, clever. Worked in governmental laboratories just prior to transferring to the agency, 14 years ago.

14. TL, the truck owner's lawyer. Young, experienced, first large accident case involving trucks. Had handled numerous highway accident cases involving "safety defects" in the vehicles, and won substantial settlements in two. Used to working with variety of expert witnesses. No previous experience with REC investigations.

15. PB, the pier builder, was a local contractor who did what had to be done to make a profit. Pier was largest contracting job he had handled in 10 years in business. Firm employed aggressive foremen who had opportunities to share in the firms' profits (using many subsidiary companies engaged by the contractor.) Had not worked with to pier engineering company previously.

Appendix I (continued)

16. SE, the design engineer who designed and supervised the erection of the storage tank, was also an officer of the small firm which had built this kind of tank to national codes for 15 years. He was also an officer in the professional society which prepared engineering standards for such vessels. A mechanical engineering graduate of a prestigious engineering school, for which he served on a fund-raising committee.

17. CA, the congressional aide for the district's congressman was a young, politically ambitious ex newsman, who happened to be in the city when the accident occurred. His congressman served on the committee which was considering safety legislation about pier safety.

18. FC, the fire officer who handled the pier fire, was on the scene within 4 minutes of the ignition of the released gas which was escaping from the damaged truck. Some of his men were injured when the storage tank explosion occurred. They were attempting to cool the storage tank with water when it exploded.

19. NC, the code committee chairman, was an elderly fire safety engineer who had served as committee chairman for 9 years, and had been a member of the committee for 28 years. He prided himself on his ability to bring about a consensus among committee members during the standards development process. He was a mechanical engineer with a minor in chemistry.

20. IS, the investigative specialist for REC, considered himself an expert in witness interviewing, but had recently been reassigned to head up other analytical activities in the agency. For this project, he was interested in heading up the witness group activities, because he felt the case would be interesting.

21. GP, the gas producer's representative, was the only claims agent available for the firm at the time the accident happened. He had a record of successfully defending his firm against accident liability claims in transportation accidents, usually based on the premise that the carrier was liable for such accidents. He happened to serve on the same national code committe as NC, for the past 6 years.

22. TI, the truck owner's insurance rep, made a practice of engaging private investigators in accident with large claim potentials, and did so in this accident. His investigators had already reported back on their findings. He was middle-aged, quiet, and very professional in the conduct of his activities, but had never worked with the REC before. His firm also carried the group hospitalization insurance for the truck driver.

23. PB, the pier boss, was a rough-and-tumble supervisor who worked well with the longshoremen, and was respected by the longshoremen as a decent kind of guy. He winked at the longshoremen's construction of the shack when it was first built, and felt they compensated for their time in the shack by better work on the dock and in the vessels. He also defended the shack to the pier owner on that basis from time

APPENDIX I (continued)

to time in the past. He was the pier owner's cousin, and had worked on the pier for 31 years.

24. LL, the longshoreman's lawyer, has handledworkmen's compensation cases for the longshoremen for 21 years. He was a competent trial lawyer, but had never been involved with an REC investigation before. He had also handled workmen's compensation cases for the trucking employees' union in the past, so he know much about the trucking business and its problems.

25. EI, the engineering lab's representative, was responsible for business development for his organization, as well as for the lab's deliverables to the customers he landed. He was a renowned accident reconstructionist, as well as a PhD Chemical Engineer. He had never before performed any accident work for any of the interested parties involved in this accident. He was on a first name basis with the Congressman.

26. RE, the representative from the government laboratory, had worked very closely with both the Inquiry Manager and the truck regulatory agency in past accident investigations. He was a physicist, and his lab had a wide range of test capabilities. The lab had performed dangerous commodity classification tests for the regulatory agency in the past, also, and these tests were used in the preparation of the agency's regulations.

27. UL, the longshoremen's union representative, had been president of the longshoremen's union for 22 years. In that time, he had gotten to know most of the longshoremen on a first name basis. All the longshoremen who were injured were his friends. He had earned a reputation for a hard, no-nonesense negotiating ability.

28. MR, the media reporter, had interviewed many witnesses at the scene and in the hospitals immediately after the fire, andhhad prepared an extensive record of the casualties and witnesses. Some of his photographs were carried by the wire services with his story. His were the best photos available. LHe had already made up his mind about the cause of the accident, and had printed it in his story.

29. TE, the engineer who designed and supervised the cargo tank and piping installation on the truck was a young engineer who went by the book. He insisted that the installation meet all code requirements; except where it was necessary to improvise designs not covered by the codes, due to vehicle characteristics, he abided by the code and its interpretations. This was the first time any tanks he had designed had been involved in an accident of this type.

30. CL, the county prosecutor, had political ambitions, too. He had the authority to bring charges against the parties involved in the accident. The police investigators knew they would have to satisfy his "curiosity" with their investigation of the accident.

APPENDIX IA

Supplemental biographical sketches for GAME III, and cross-reference to Appendix I.

1. See 1.

2. See 2.

3. The truck owner's investigative consultant is a mechanical engineer who retired from a truck builder's firm about 2 years ago. His former employer had used him to investigate accidents to determine if engineering designs should be changed. He wants to protect his client.

4. The pier owner's investigative consultant is a former marine inspector whose duties included enforcement of regulations, as well as accident investigations. He has a reputation as a tough enforcer who knows the regulations inside and out, and helped shape some of the regulations.

5. See 7.

6. See 10.

7. The vessel owner's investigative consultant is a university professor at a local university who specializes in accident analysis, and has frequently testified in court cases involving hazardous materials accidents.

8. See 8.

9. See 19.

10. See 29.

11. See 13.

12. See 25.

13. The government engineering laboratory representative is an engineer who also is expected to "sell" new projects for his laboratory to undertake; he has been unsuccessful with the regulatory agencies whose regulations may have applied to the operations in this accident.

14. The county prosecutor's chief assistant attorney is dedicated to a high conviction rate in cases he develops for prosecution, and he is interested in acquiring evidence that will stand up in court.

15. The fire chief's fire investigator is an arson specialist whose work has led to numerous convictions, so he too is interested in evidence that will stand up in court. He also makes recommendations for code changes for his jurisdiction.

16. See 27.

APPENDIX IA (continued)

17. See 21.

18. See 16.

19. The pier builder's investigative consultant is a marine architect who was formerly employed by the engineers who designed the pier before he retired three years ago; he is a strict codes and standards man.

20. See 14.

21. The pier owner's attorney is a skilled accident attorney whose first interest is in protecting his client.

22. The pier insurer's chief investigator is an experienced insurance claims and accident investigator, who is interested in subrogation possibilities.

23. The truck insurer's chief investigator is an experienced insurance claims and accident investigator who is also interested in subrogation possibilities.

24. See 28.

25. The truck driver's attorney is experienced in claims supplemental to workmen's compensation claims, and is interested in getting the best possible settlement for his client.

26. The longshoreman's attorney's consultant is a fire analysis specialist who has appeared as an expert witness many times in former litigation by the attorney in personal injury cases.

27. See 17.

28. See 20.

29. The pier supervisor who must get the pier in operation again as soon as possible is not interested in any accident investigation needs, because they would only hold him up while he was trying to get the debris clened up, and adversely affect his bonus from the pier owner.

30. The TV station's reporter has some excellent footage, and is interested in protecting his "product" which is copyrighted, but he also is very interested in the cause of the accident for news purposes in the future.

APPENDIX 2. SUPPLEMENTAL INFORMATION ABOUT WITNESS BROWN

The following is information that should formthe basis for the instructor's replies as a witness. The instructor is free to invent any added detail which might be useful to the students to make a point as the events chart takes shape during the exercise.

Brown is a longshoreman and works thru a hiring hall. Longshoremen take their orders from their working foreman, a fellow union member. The injured longshoreman did not take orders from the pier super, even though he was a personal friend. The gang started handling cargo about 8:40 AM on the day of the accident, working about 15-20 minutes, then taking 5 to 10 minutes off to warm up in the shack. The delivery truck arrived at the pier about 9:35 AM. Brown watched the truck from the time it drove through the gate at the pier entrance, as it passed among the stored freight on the pier apron and as it headed onto the wooden pier. The pier was about 100 feet wide, but cargo was stacked along the water's edge, so the truck driver had to wend his way through the cargo to get to the storage tank. He saw the driver head down the center of the pier until he got to a place where he could turn the truck around and head it toward the other end of the pier so he could back it into the area where the storage tank was located. (See diagram Brown made.) He saw that the driver made one false start before he backed the truck up to the storage tank area. Brown heard the driver shut down the truck engine about 10 seconds after Brown noticed the white smoke coming out from under the tank and moving toward the shack, apparently staying below the tops of the boxes stored along the edge of the pier. These boxes were piled about 16-20 feet high. As Brown saw the smoke moving toward the shack, he stepped inside to warn his fellow workers about the smoke that was headed their way. While he was still in the shack, he first detected the odor of gas. He decided to flee from the smoke or gas,and just as he reached the door, the gas in the shed ignited, blowing him through the door and onto the pier decking. He noted his clothing scorched and smoldering, but managed to beat out the glowing embers in his clothes in a minute or two. He saw that the fire had spread to the storage tank, and saying to his buddies that he wanded to look for his fiends in the shack, he reentered the burning shack. Choking and gasping for air in the burning rubble, he found one of his friends badly burned about the face and head, and proceeded to pull him from the rubble. During this rescue attempt, his clothing caught on five again. With the help of some of the longshoremen who had come from elsewhere on the pier, and some of the Pier supervisory personnel, he helped rescue three other longshoremen from the shack, each time experiencing some additional burns. He then remembered the truck driver, and started to look for him. This was about 13-14 minutes after the initial ignition. By this time the fire department had arrived, and ambulances were then starting to arrive to take away the severly injured longshoremen. When he found the truckdriver, the driver talked to him freely, telling Brown how he had tried to extinguish the fire with the hand extinguisher he had on the tuuck, but he hadn't been able to put the fire out. The firemen were setting up hose lines, but Brown noticed they couldn't get water from the hydrants. The driver told Brown the hydrants were all frozen up. Just when he saw water beginning to flow from the firemen's hoses, the storage tank made a loud noise like a car running over a big

Appendix 2. (continued)

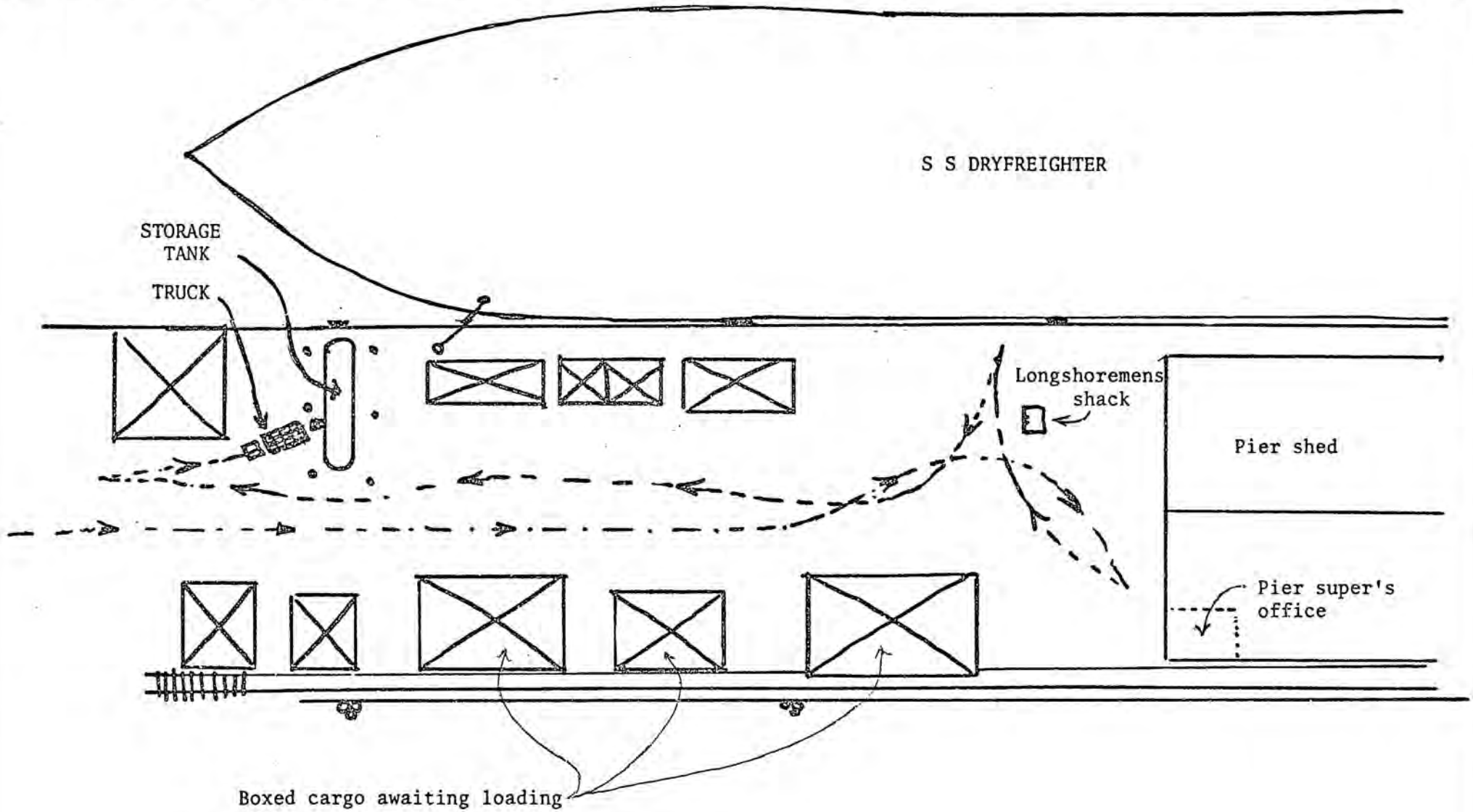
steel plate used to cover holes in roads temporarily. Then the whole world turned into a fireball, so fast that Brown was only able to turn his head and part of his body the other way. That is when he really got burned, and his dacron coat melted to his body. He remembers getting knocked down, and almost passing out from pain before some ambulance attendants picked him up and laid him in a stretcher. He remembers being carried to the ambulance and being rushed to the hospital. He thinks he remembers walking past some firemen before he was put on the stretcher, but is not clear on this point, because he was in so much pain.

He recalls hearing the firemen cursing because of their problems getting water flowing, but he could not identify who they were. He did notice one of them had a white hat on, (the fire chiefs wear white hats,) and the guy was telling the others they had to hurry and get water on the storage tank. Brown thought the truck was also burning, but he heard a loud sound like air at high pressure coming from the truck tank. He thought he was safe because the firemen were much closer to the storage tank than he was, and since others were burned worse than he was, he wasn't in any hurry to go for an ambulance ride until the others were taken care of. There was a lot of confusion all this time, but he remembers seeing the pier super and the ship's captain standing by the door of pier shed just before the storage tank exploded.

Brown noticed that the clock at the entrance to the pier area on a bank sign was reading 10:16 as the ambulance drove by. From the talk he had heard on the ambulance radio, he thought it was a bad one.

At the hospital, Brown remembers seeing the truck driver again, and the truck driver telling him that he couldn't understand why the extinguisher didn't put out the fire, and why he couldn't shut off the gas escaping from the truck when he worked the valves on the truck just as the first fire started. He also remembered the driver saying that he always did have trouble backing up when there was something on the blind side of the truck. This was in the emergency room at the hospital.

Shortly after that, the doctors knocked him out, and the next thing he knew it was night outside.



VIEW OF ACCIDENT SITE SHOWING MOVEMENT OF GAS TRUCK AND PLACEMENT OF CARGO ON THE PIER. THE ENTRANCE TO THE PIER IS AT THE LEFT. THE PIER SHED EXTENDS TO THE RIGHT FOR SEVERAL HUNDRED FEET. THIS PART OF THE PIER IS SURROUNDED BY WATER.

APPENDIX 3

INVESTIGATOR'S REPORT OF ACCIDENT INVOLVING FATAL INJURY

On 9-20-76, between 8:00 and 8:30 AM, I was notified that a possible catastrophe had occurred earlier that morning, at the construction site of the Riverbend Nuclear Power Station. Officer Pat of the Korn County Sheriff's office reported to me that a fatality and multiple hospitalization had occurred at the site. Shortly thereafter, I proceeded to the site accompanied by two other inspectors, Val and Irv. After the 50 mile trip by automobile, we entered the site at about 10:40 AM. At that time we arranged to meet with the Assistant Superintendent of Construction for the Regular Engineering Corporation (REC), the prime contractor on the site. He introduced us to Sam, Chief Safety Supervisor at the site, also an REC employee. An abbreviated conference was conducted at this time (11:10 AM). This conference included identifying ourselves, presenting our credentials, stating the purpose of our visit, which was the investigation of the alleged incident, extending an invitation of accompaniment to the employer's representatives and informing the employer's representatives that we would be available for more extensive discussion at a later time. Sam confirmed the report of the accident in part, denying that any hospitalizations had taken place, and agreed to accompany us to the accident site.

On 9-21-76, accompanied by Irv, I met with the following:

6:00AM and throughout- Sam

6:15AM Charlie, Laborer, REC
Interview (witness)

6:15AM Arty, Laborer, REC
Interview (witness)

6:15AM Harry, Laborer, REC
Interview (witness)

7:30AM Tom, Fire and Safety Officer, REC
Interview (witness)

7:40AM Wan, Safety Officer, REC

8:10AM Len, Shift Supervisor for utility company
(Management representative)

9:30AM Oren, Area Safety Manager, REC (Home office)

9:50AM Yank, Construction Superintendent, REC

In addition to on-site interviews, formal written, question and answer

In addition to on-site interviews, formal written, question and answer statements were taken from three witnesses off the site. These statements were taken by Inspector Val at the following times:

Charlie- 3:10PM 9-30-76
Harry- 2:10PM 9-30-76
Arty- 10:00AM 10-5-76

On September 20, 1976, I went to the accident site briefly to observe the conditions, layout and dimensions of the area, accompanied by Val, Irv, and Sam.

On September 21, 1976, the party, now consisting of three inspectors and REC representatives returned to the site at about 9:20AM to observe more carefully the surrounding area.

On September 24, 1976, at about 1:00PM, Val and Irv conducted a follow-up investigation of the accident site to assure that proper procedures were being followed in regard to entry of the area.

FACTS DISCLOSED BY THE INVESTIGATION

Refer to accompanying drawing . This shows approximate layout and dimensions of the Safeguard No. Two valve pit area, where the accident occurred.

The entry permit for this area was first issued by Ron, Safety Supervisor, on 9-15-76. It was renewed on 9-16-76 (Thursday) by Ron. On Friday, 9-17-76, it was again renewed, this time by Wan, Safety Supervisor, at about 8:16AM. No new or renewed permit was issued for Saturday, 9-18; Sunday 9-19; or Monday, 9-20-76.

The work normally being done in this pit was pipe welding. The welding crew apparently worked each day through Friday, 9-17. The type of welding performed was inert gas shielded arc welding, using Argon as the inert gas shield. On Friday, 9-17, Kenny, one of the pipe welders, left two argon lines turned on into the pit. Normally these supply lines would be turned off at the shift end and disconnected, according to Sam. The room at the bottom of the pit is about 8x10x24, according to Arty, which would be 1920 cubic feet.

The pit is normally ventilated by one or two Coppus ventilating fans exhausting the pit through separate ventilation hoses approximately 8 inches in diameter. Upon examination on 9-21, these hoses were connected in an unsatisfactory manner, but due to the size of the fans, probably would provide sufficient exhaust, according to Irv's estimate. On 9-24, Irv again noted that the exhaust line in use at that time was

nearly closed. Make-up air comes down the shaft from the rooms above, presumably from outside through the stairway and door. The fan(s) is/are normally left on at all times, according to Sam. Arty reported during the interview on 9-21 that he noticed the ventilation fans were not running when he entered the pit on Sunday morning, 9-19, about 24 hours prior to the accident. No information was disclosed during the investigation to explain how or why the fan(s) was/were turned off between Friday evening and Sunday morning. The control switches for these fans are located on the fans themselves, which are placed on the roof of the Safeguard Number Two area. Material is stored on the roof adjacent to the fans. Arty stated that as a normal duty he entered the Safeguard Number Two valve pit hundreds of times, the most recent (prior to the accident) being on Sunday morning, 9-19-76, about 24 hours before the accident occurred. He noticed nothing unusual and felt no discomfort or exhibited no other symptoms resulting from oxygen deficiency at that time. Arty stated that his duties on Sunday, 9-19, required him to descend into the pit and tend the ground water removal pump(s), so that his breathing zone was in the lower two or three feet of the pit.

On Monday, 9-20, Charlie and Harry, both laborers, ate lunch together. Following their lunch break, Harry told Charlie that he would walk with him on his rounds tending pumps for awhile, as Harry was caught up with his duties. (Time- 4:30AM) The two men entered the Safeguard Number Two area and Charlie prepared to descend the fixed ladder, from either the 272 elevation or 256. (This point was not cleared up- Sam told me 256, but I suspect it was 272 because Harry said that he is unable to climb ladders, which he would have to do to get to 256.) Shortly after starting down the ladder, Charlie remarked that the "heat was rising up" from the pit. Harry suggested that he skip that pump until it could be cooled down, but Charlie said he would just pump out the water rather that hooking up a new pump, and this would only take a few minutes. Charlie continued to descend into the pit. Charlie stated that he began to feel weak and sick about halfway between the 256 elevation and the bottom. He felt he could not climb back out of the shaft, and so he attempted to reach the scaffold below for fear of falling. The last thing Charlie remembers, he said, was being on the ladder 2-3 rungs above the scaffold. Harry stated that he saw Charlie fall to the scaffold platform from a few rungs above it. He knew that he could not climb the ladder due to a heart condition and so he went to summon aid. Using the intercom system, Harry called Arty telling him that Charlie had fallen. Arty went to get help from the first aid station. He spoke with Tom, who went to get his oxygen analyzer, realizing the possibility of a deficiency. Eddy, an Advisory Engineer for REC was familiar with the entire site, and apparently responded to Harry's call for help. When Harry returned to the Safeguard area, he saw Eddy standing at the top of the pit, shouting to Charlie below, Harry left again, meeting Tom and Arty at the Safeguard entrance. Tom stated that he proceeded to the shaft and dropped the probe of his oxygen analyzer over the side. No one was at the top of the shaft when Tom entered. Looking over the adge to observe the progress of the probe, Tom saw Eddy just a few feet below the top (256 level). Before he could warn him to come out, Eddy fell, striking his head at

least once, possibly several times against the pipe and shaft walls. Eddy landed on Charlie, who was still unconscious. Tom stated that the oxygen reading at the bottom of the pit at that time was 5%. Tom returned to the intercom and called a "code one" or emergency. A rescue operation was begun, directed by Tom. Exhaust ventilation and air compressors were started. The air compressor hoses were dropped into the shaft. The argon valves were observed by an electrician, Bob, who noted that two of eight flow meters showed argon moving throught the lines. The valves were closed immediately. (This information was given by Sam.) REC employees wearing self-contained breathing apparatus managed to enter the pit and secure a line around Eddy. Only one of them, Davey,was able to stay in the pit, due to apparent problems with the apparatus or experience. Davey, after securing the line around Eddy, followed up the ladder as he was hoisted. As Eddy neared the top of the shaft (256 level), his body was dropped. The cause of this incident is not clear. Sam stated that he understood that a nylon line had been spliced (knotted) to a manilla line to achieve the necessary length. The nylon to manilla knot did not hold and the line parted. Eddy was at that time no more that 7-8 feet below the top. Davey stated that Eddy's body had stopped at that point because his foot had caught in the light fixture on the shaft wall. The workers above did not understand the signals Davey attempted to give and continued to attempt to pull Eddy up. Davey remembered only that Eddy fell against him. Tom stated that he did not know the reason, but Eddy fell and knocked Davey off the ladder, so that both men fell nearly the full length of the shaft, once again landing on Charlie. Davey stated that the next thing he remembered was regaining consciousness at the bottom with his alarm bell ringing to alert him that only another 5 minutes of air remained in his air pack. As Davey regained his bearings, Charlie began stirring and awoke. The oxygen content had apparently reached respirable levels again, and Charlie climbed out of the shaft without assistance. Davey climbed out with assistance. A member of the local rescue squad, which had just arrived, Gerry, entered the shaft with self-contained breathing apparatus and secured a harness on Eddy. Eddy was not hoisted out without incident, but was pronounced dead on arrival at the local hospital in Korn City. Davey stated that Eddy had been breathing but with difficulty, prior to the first attempt.

On the third shift, supervision is not highly structured. Harry states that he has no third shift supervisor, and his supervisors are Mack and Nick on the first shift. He says that his work instructions are given by Jack, who works either first or second shift, through a note left with his time card. Charlie stated that he has no foreman on the third shift. He said that his foreman is Frank who works second shift. He also said that Arty is a working foreman (a'lead man' typ e position) and tells him anything new. Arty stated that he has no foreman on third shift. He said that his supervisors are Zack and Frank, who are both on second shift. Arty said that he has been a "working foreman" for about a month and a half, and that when he became a foreman, his supervisor, Frank, told him that his duties were "just to do my work and look after

the laborers". Arty further stated that he does supervise Charlie, but does not supervise Harry.

REC has a confined space entry procedure cutlined as part of their safety program. My understanding of the outlined procedure is as follows:

-Certain spaces are defined as confined spaces. How they are determined, who makes the determination and how they are designated was not clearly explained.
-Entry into these spaces is controlled. Only when a valid permit has been issued and when all its provisions are followed may a space be entered.
-Permits are issued by the safety department for each job to be performed in a confined space, and, in some cases, on a regular basis for spaces in which routine regular work is done. The safety supervisor is required to do oxygen and combustible gas tests, as well as any indicated tests in special circumstances. The safety supervisor is then required to evaluate the condition of the space and indicate on the permit other required precautions to be observed. This could include such typical items as are indicated on the attached permit.
-The worker entering the confined space is to be responsible for following the instructions on the permit and for signing the permit to indicate his entry. In addition, the standby man is required to sign the permit.

Arty stated that he had worked at this site for 5 years and nine months, nearly 3 years of that time on the pump crew. The duties of the pump crew are to maintain pumps which remove water from the spaces in which it accumulates. These spaces would often be confined spaces. Arty stated that the safety procedure which he was told to follow when entering confined spaces was to "use a lantern if the pits weren't checked". When asked how a safety lamp (lantern) is used, he replied,"I let it down on a rope. If it is still burning, I put it back in there and go down". Arty did occassionally ask the safety department to check confined spaces for him, but often used this safety lamp procedure for an oxygen check. Arty did not know anythingabout fresh-air ventilation or respirators, combustible gas tests, or disconnection of lines into the confined space. Art states that in regard to the locking, tagging and disconnection of lines, switches, etc., he "figured this was the welders' job". About 1/10 of the time, Arty says he had a standby man outside the space. Arty says that he always looks for an entry permit, but that the only place he has ever seen one is at either #1 or #2 valve pit. He has never signed a permit, although he has made hundreds of confined space entries. He said that he "didn't even know I was supposed to sign one". Arty cannot read. Concerning safety belts and lifelines, he said,"No one ever told us about wearing one in there" and he confirmed that he never had.

Harry stated that he has worked at the site for 3 years and 9 months

and on the pump crew for 2 years and 4 months. His safety instructions were:

> "My foreman told me not to handle the electric cords when they were wet unless we had rubber gloves and boots on. They said if the safety lamp is out, don't go in".

Harry has sometimes had the safety department check confined spaces prior to entering, but he also uses the safety lamp for an oxygen tester "about half the time". Harry did not disclose any recognition of the ventilation required or of airline or self-contained respirators. He also had no apparent knowledge of combustible gas tests. Like Arty, he never checked lines, switches and valves for lock-out, tag-out, or disconnection. He never wore a safety belt and lifeline. He claims always to have a standby man, although he normally works alone. He also says he always looks for an entry permit, but he has never signed one.

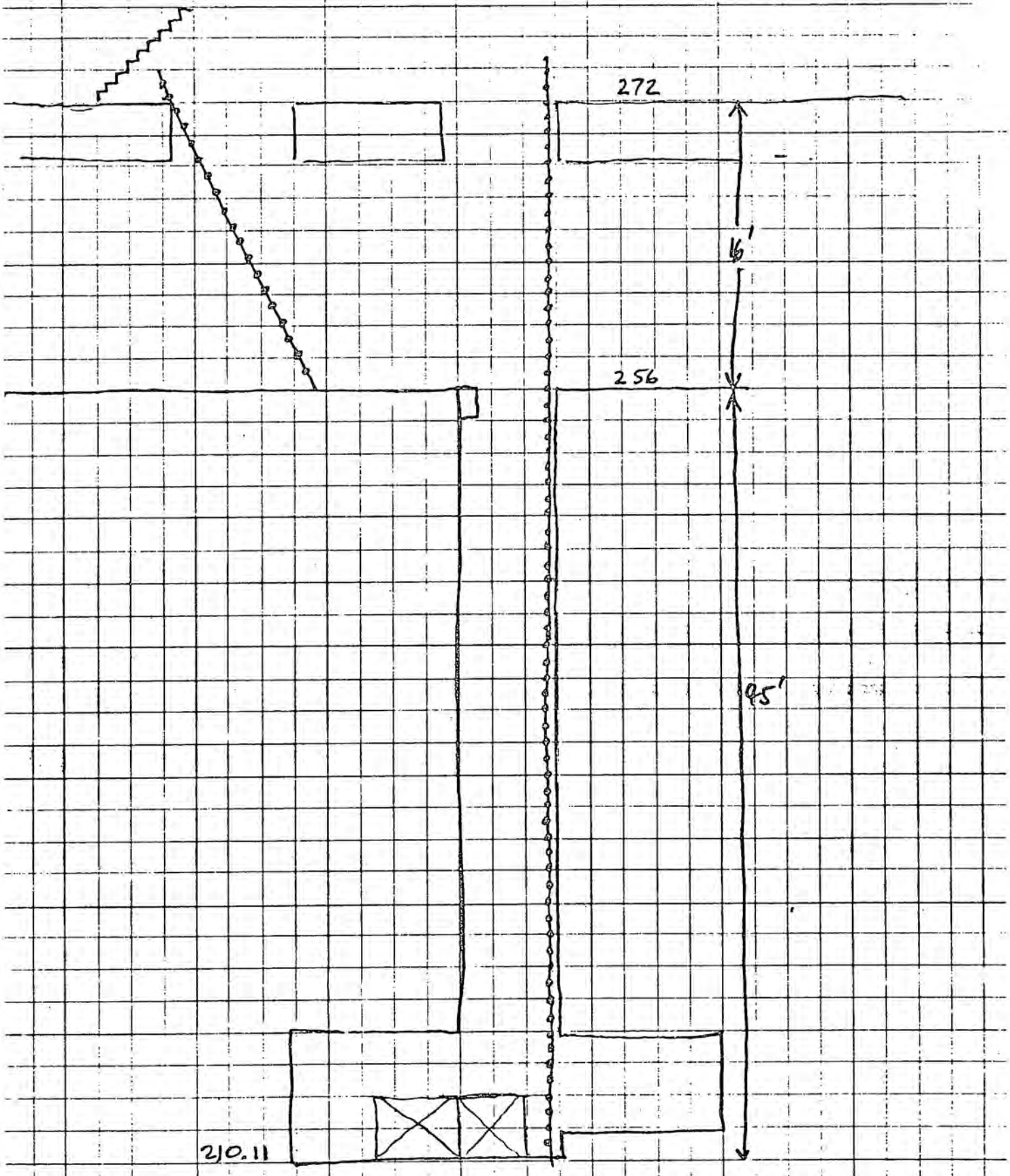
Charlie has worked at the site for about 14 months, about 5 weeks on the pump crew. His safety instructions in regards to confined spaces prior to the accident were:

> "Make sure the safety lanterns were burning. If not get back out".

Although he agreed that it is impossible to see whether a lamp in the pit is burning prior to entering, he says that he "was never told to take a lantern in or lower one on a rope prior to the accident". He expressed no knowledge of fresh-air ventilation or of air-line or self-contained respirators. He did not indicate any familiarity with combustible gas tests. When asked if he ever check to see that lines, switches, valves, etc. were locked, tagged, or disconnected, he replied,"It wasn't my job to do this". He never wore a safety harness and lifeline, and only had a standby observer about 10% of the time. Although Charlie always looked for an entry permit, he never signed one. He stated further that he never read them , because he assumed the safety department kept them up-to-date and that it was routine to enter these areas without the space being checked by the safety department. In fact, Charlie had never had a space check prior to entry.

Tom told me that permits are issued on request of supervisors for areas where work is to be done. Some spaces are routinely checked and permits issued. Safeguard Number Two valve pit is one of those areas. The safety supervisor would normally test the pit for oxygen content each weekday (M-F) morning and issue the permit at that time. His check would also include evaluation of ventilation and instructions to the workers regarding safety equipment and precautions required to enter. I asked Tom if a combustible gas test is part of the permit issuing procedures. He replied that it was not, that if an abnormal oxygen content is indicated then a combustible gas test might be done. The permit is normally issued about the time of the shift change from 3rd to 1st shift, and expires the following midnight. No interim tests are made unless specifically requested. The safety department claims to enforce the entry procedure. Although no documentation of disciplinary action could be produced, Tom and the three laborers all stated that no verification that they followed procedures or disciplinary action was ever done. They all said that thir supervisors apparently had no interest in their procedures, Arty going so far as to state that "all he (Yank) cared about was if the pump was out". Tom stated that Eddy had been verbally chastised many times for not following confined space entry procedures in his duties as an advisory engineer, but no entry was made in his personnel file. The safety department says that it enforces the requirement that foremen hold Monday morning tool box safety meetings, at which safety procedures and requirements are reportedly discussed. However, the three labor-

SIDE VIEW OF VALVE PIT



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ers interviewed stated that no safety meetings had ever been held on their shift, for the last 2 years and 4 months, at least. The ladder into the valve pit of the Safeguard Number Two is approximately 64 ft. in length. It is on a well 32x54 inches. No ladder safety device is used. Charlie replied when asked what safety equipment he was given for this confined space entry job,"a flashlight". The primary gas used for gas welding in the area is LP or propane gas. The lower explosive limit of propane is 2.1%

APPENDIX 4

RULES FOR RECORDING ACCIDENT EVENTS

This appendix contains the rules for recording an event for use in the DIA - GRAMS investigation systems. Each event is a building block that must be recorded properly to make it useful during subsequent steps. Attempts to take shortcuts inevitably result in more work later, so try follow the procedure faithfully.

This list can be used as a check list for quality control purposes.

1. RECORD EACH EVENT ON A SEPARATE PIECE OF PAPER WITH A PENCIL.

   Changes in the wording of an event arise frequently enough to use pencils for making the notations. As understanding of the accident improves during an investigation, additional events may have to be added, so use a business card or 3 x 5 card for your entries.

2. ALWAYS ENTER THE NAME OF THE ACTOR BEFORE ANYTHING ELSE.

   Give each actor, animate or inanimate, a name and use only that name thereafter. Avoid plural nouns. The entry should be the name of the "doer" of the action, rather than someone who had something done to them.

3. NEXT ENTER THE ACTION VERB, USING ACTIVE VOICE, PAST TENSE.

   The verb must describe an action that initiated a change of state. Actions include observations, decisions, movements, separation, etc. This verb may be further described with adjectives or with prepositional phrases to achieve specificity, if necessary to meet subsequent events sequence tests. Never use "and."

4. NEXT ENTER THE TIME THE EVENT BEGAN AND ENDED.

   To get events into sequence, the beginning time must be shown on the card, preferably in the upper right hand corner. This may require day, hour, minute, second, or fraction of a second, depending on the nature of the accident and the duration of the event. The ending time is optional; it may be essential for events such as communications, reactions, etc. Use the prefix E before the time entry if the time is estimated.

5. INDICATE THE SOURCE OF THE EVENT NEXT.

   During analytical steps, reference to the source for greater detail is frequently required, so establish a code or key to note on both the event card and the source to facilitate retrieval of the information. An optional step is to record a "T" after the source code, to indicate that the event has only been established tentatively, and may need verification through further interviews or tests. When the event has been verified, the "T" can be removed. This flags uncertainties for the analysis steps.

APPENDIX 4

RULES FOR RECORDING ACCIDENT EVENTS (cont'd)

6. ENTER THE CARD SEQUENCE NUMBER WHEN AVAILABLE.

   Fore each actor, the events should be sorted into their chronological sequence and then numbered before they are used in any of the charts or for analysis. Enter the sequence number for that actor's cards along the left margin near the center of the cards. If cards must be added to the sequence, use suffixes such as 3A, 3B, 3B1, etc. to keep the cards sequenced properly.

7. ADD ANY ADDITIONAL CODES REQUIRED BY THE INVESTIGATION.

   Investigators may find it necessary to indicate added data about an event. Use whatever codes are desired, but make notes about the codes used so they can be described in any text that follows the analysis of these events. For example, events may have been identified by simulations, by filmed records, taped records, or other means, rather than eye witnesses, and the sources referenced may be reports of these data records. Some users may need to have this information for claims or litigation purposes, for example. Spatial references may be needed to track actor's movements, too. It may also be useful to enter the code or standard citation when an event is governed by a regulation or standard.

8. DO NOT RECORD SPECULATED EVENTS IN THE SAME COLOR AS PROVEN EVENTS.

   Use of different color for events that you are guessing about will highlight the work that remains undone during the investigation. Guess if you want to, but make your guesses different on the cards so the guesses will stand out like a sore thumb! A guess is where you have no evidence to suggest an event, as contrasted by a tentative event that is suggested by known events before and after the event you enter.

9. RECORD EXPECTED EVENTS IN ANOTHER, DIFFERENT COLOR.

   When an expected events sequence is relevant to the investigation, follow the same rules, except record the events in a special color.