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INDUSTRIAL HARDENING: 1981 TECHNICAL STATUS — REPORT

FINAL REPORT

for

FEDERAL EMERGENCY MANAGEMENT AGENCY
WASHINGTON, D.C. 20472

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Contract No. EMW-C-0701
Work Unit 1124D

SCIENTIFIC SERVICE, INC.

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The report presents progress made over the last year in a continuing program to define, develop, and test options that industry can apply in advance of a disaster to reduce vulnerability and accelerate recovery.

Progress discussed in the report covers a variety of topics where additional work was undertaken in 1981 to augment the self-help procedures in the industrial hardening manual previously developed at Scientific Service, Inc. Among the topics discussed are: approaches taken to foster development of

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industry interest in emergency preparedness; and investigation into expedient methods an industry might apply to supply onsite utilities when public utilities are not functioning, prevent or reduce toxic materials releases, or reduce damage from rapid shutdown of facilities. In addition, assessments of the production processes and equipment inventories of a number of industries are described which were analyzed to identify the nature of common production elements that critical industries require for their operations. Assessments or other end-users of these or similar production elements were also initiated to establish some non-critical industries among them who could act as sources for substitute elements in emergencies.

(DETACHABLE SUMMARY)

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by

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for

Federal Emergency Management Agency
Washington, D.C. 20472

Contract No. EMW-C-0701, Work Unit 1124D

Scientific Service, Inc.
517 East Bayshore, Redwood City, CA 94063

(DETACHABLE SUMMARY)

INDUSTRIAL HARDENING: 1981 TECHNICAL STATUS-REPORT

This report presents the results of the first year of a five-year program to improve and augment a self-help disaster preparedness manual for industry. The purpose of the manual is to enable U.S. industry to reduce its vulnerability to disaster, whatever the causes. The manual is intended to provide industry with practical options that can be applied in advance, or on short notice where there is warning time.

Under earlier programs, the manual was first developed to counter a nuclear attack, then revised to make it more general; tests and demonstrations of the options were conducted in conjunction with these efforts. In the present period, a variety of tasks and subtasks have been undertaken that are intended to lead to development of information and options that will reduce industry vulnerability to the complete gamut of emergencies — from day-to-day emergencies to nuclear attack — and to methods that might influence industry to apply them. From those that provide the broadest coverage, simultaneously, new booklets or supplements to the manual will be developed that will be more likely to be implemented by industry because of immediate realizable benefit. Through greater participation by Scientific Service, Inc. in a local industry organization, it is expected that improved information exchange and development of rapport with industry (and local government) members will enhance the opportunity to test both the options and the methods to get them in place. The report summarizes the status of these efforts.

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ACKNOWLEDGEMENTS

We are indebted to Dr. Michael A. Pachuta for providing many important insights in the process of striving to develop practical self-help guidance for industrial emergency preparedness. Herein, we have undertaken to initiate development of perspective on one of these important insights — actually delivered in the very early days of industrial hardening — what to do about utilities, particularly electric power, in a national disaster.

We also wish to thank Dr. Pachuta for appreciating the critical importance to program objectives of developing and maintaining rapport with industry. This required SSI to share day-to-day emergency preparedness problems and solutions on a continuing basis as a key element in establishing credibility and acceptability. Thus, we are also indebted to James O'Donnell, and the South County Industrial Emergency Council (SCIEC), for helping us develop contacts with local industry.

Among local industry, especially helpful contacts include Phil Marquis of Litton Industries, John Steele of Ampex, Ken York of Chem Waste Management, and Mark Green of Raychem; we thank them for their interest and effort to help us (and SCIEC) wherever and whenever they could. Among more remote supporters (geographically) we would be remiss if we failed to thank Honey Harkenrider (with the State of Minnesota Division of Emergency Services) and Al Baert, who were instrumental in providing us with contacts in another region.

On our own staff, Hway-ling Hsu has been our chief goodwill emissary to industry, handling that job with rare talent to produce results beyond our hopes. (Hway-ling became reporter, photographer, editor, to produce the Tie Line regularly, just one aspect of the SSI goodwill endeavor.) Major contributions to the technical effort were provided by a key consultant, A.B. Willoughby, while supporting technical effort was supplied by another consultant, Joseph Boyes, and staff members Gregor J. Cuzner and Gordon M. Shephard, Jr.

For yeoman work on typing and editing, we wish to thank Evelyn Kaplan; for the artwork we are indebted to Maureen Ineich; and for typing and other support work we wish to thank Larue Wilton and Michele Boyes.

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Section 1
INTRODUCTION AND BACKGROUND

This report summarizes the results of a continuing program to improve and augment a self-help disaster preparedness manual for industry. The manual's basic objective was to provide industry with practical procedures to reduce vulnerability to nuclear attack, but natural disaster preparedness was integrated into it to provide the necessary impetus for acceptance by industry.

The original work commenced with the development of a working draft of the manual (Ref. 1), which was developed by Scientific Service, Inc. (SSI), for the Defense Civil Preparedness Agency (now, Federal Emergency Management Agency) under Contract No. DCPA01-77-C-0228. The draft manual was demonstrated and tested with industry involvement the following year under Contract No. DCPA01-78-C-0278 (Ref. 2). Based on the results of the demonstration and test program, the manual was subsequently revised under Contract No. EMW-C-0154. In that study, further analytical and experimental work was begun -- to develop additional hardening techniques and to provide better estimates of vulnerabilities; the manual revisions were tested within selected industries, and potential inducements that might stimulate industry to plan and prepare for emergencies were considered (see Ref. 3).

In the most recent study, conducted under Contract No. EMW-C-0701, work has been continued to accomplish four major objectives: provide new analytical and experimental input to the manual, develop refinements (particularly the integration of preparation for everday exigencies and natural disasters, which will augment preparedness for nuclear disaster), establish additional industry contacts (through which to test and evaluate the new inputs and refinements), and improve SSI/industry rapport so that SSI may maintain its capability to obtain industry participants. The work this year has been undertaken through six tasks, which are identified in more detail later in this section and which are the main subject of the body of this report.

The objective of the manual, to which this work applies, is to guide users in identifying and organizing activities that employ, upon instructions to relocate, plant personnel and resources to accomplish the related tasks of protecting production equipment — and employees and their dependents — in a disaster emergency. The objective is to increase significantly the post-disaster survival of people and local production resources required to maintain them. The approach is two-part and requires preplanning. It involves moving everyone — and everything critical and particularly susceptible — away from vulnerable areas to outlying regions where they can be dispersed and protected more simply, and it involves protecting key production resources that are left in the impacted region. In lieu of a program to provide disaster shelters for the population at large at two key locations, at home and at work (as has been done in Sweden), and/or to foster greater permanent dispersion of human and industrial resources, this is the most promising option having a significant positive impact on survival of the general public in the event of a national emergency.

The procedure wherein people move out of an incipient (or an established) disaster area and disperse into lower risk areas is as old as mankind and quite common today in the hurricane zone of the gulf coast. In FEMA parlance it is termed Crisis Relocation, and it is logical to expect the process will be more efficient if planned and organized in advance of a disaster than if it is left to chance; i.e., to occur sporadically (if at all). Moreover, in an industrial society, loss of a significant portion of industry will be a disaster unto itself. Consequently, it is important to post-disaster survival of the populace that steps also be taken to ensure that industry survives. The procedure whereby industrial vulnerability is reduced has been termed "hardening". Development of methods to achieve and to constantly improve upon this hardening is the main objective of the continuing effort.

Industrial hardening encompasses virtually any method to protect industrial resources (both personnel and equipment) against: damage from ground motions and building collapse; crushing, overturning, and impact; hurricane winds, and flying missiles and debris; fires; and also the electromagnetic pulse (EMP) phenomenon, associated with nuclear weapons. Equipment protection methods include:

(1) Evacuating equipment — particularly vulnerable or critical control and subassemblies — out of th. pending disaster area
(2) Shielding remaining equipment against building collapse, missiles, flying debris
(3) Using expedient measures to strengthen underground facilities so they are less likely to collapse
(4) Preventing equipment from sliding and/or overturning under hurricane-like wind forces
(5) Removing combustibles and eliminating ignition sources
(6) Disconnecting long conductors, such as antennas and power cables, from electronic and electrical equipment (or installing EMP protection on communication equipment)

Methods, required resources, and alternatives for hardening have been compiled into an integrated collection of booklets, each of which is designed to be self-contained (including instructions, worksheets, and examples) and to be compatible with Crisis Relocation. The booklet arrangement also facilitates updating, expansion, and revision as new findings, policy changes, etc. may warrant periodically. Figure 1-1 identifies the ten booklets, and their relationship, in a flow diagram.

The manual is arranged so that each of the booklets can be assigned to a coordinator to plan and supervise the completion of each of the activities (concurrently, if necessary). The booklets are designed for immediate application to guide the user towards a more efficient appraisal of resources and methods to protect equipment, using locally available options. (It is anticipated that later versions will augment, rather than change, information and procedures provided.) There are two phases to the process: the planning phase, which is best completed well in advance of any disaster; and the execution phase, which can be carried out in a short time period on warning of an impending disaster. Priorities for hardening attention are established in the planning stage, systematically, by plant personnel, applying in-house perceptions of the relative importance of equipment to company production objectives. In the execution phase, resources are allocated according to the earlier ranking, and the hardening activities carried out.

CRISIS RELOCATION INDUSTRIAL HARDENING PLAN

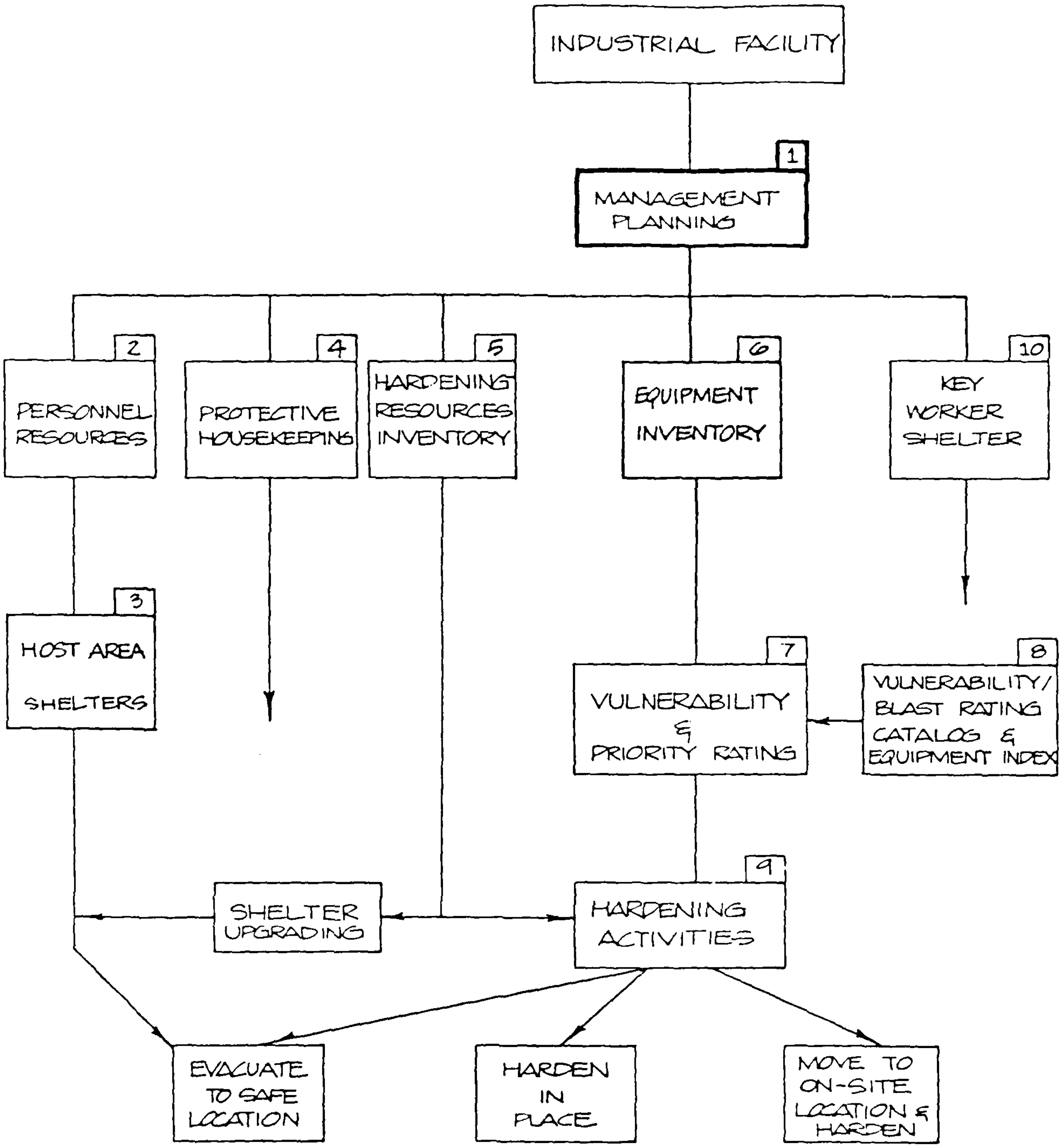


Fig. 1-1. Crisis Relocation Industrial Hardening Plan.

In this contract year, the work was divided into six technical tasks that affect all ten of the booklets (see Figure 1-1) plus two other important facets of industrial preparedness: industry and community involvement, and training and education. The six tasks are:

(1) Work on Protective Housekeeping (Booklet 4) to provide input in support of Task 4 (a) Utilities alternatives, (b) Toxic materials management, (c) Shutdown guidance.

(2) Work on Equipment Inventory (Booklet 6) to provide input on typical or common production elements.

(3) Work on Catalog and Equipment Index (Booklet 8) to provide a comprehensive listing of common elements of production that would be found in non-essential industries.

(4) Work on expanding rapport with industry to (a) improve relations with participants, (b) increase the number of participants, (c) develop practical information on emergency preparedness (all hazards) and methods to provide this to participating industries.

(5) Incorporate results of field experiments and other accomplishments into pictorial form for easy application, for training and education, and for public information purposes.

(6) Integrate portions of Task 5 and other materials into a simplified vulnerability ar 1 hardening decision procedure.

Because of the diversity of the subjects investigated under Task 1, three sections of this report are devoted to this task: Section 2 - Utilities Alternatives, Section 3 - Hazardous Materials, and Section 4 - Rapid Shutdown. Tasks 2 through 6 are discussed in Sections 5 through 9, and general conclusions and recommendations are presented in Section 10.

Section 2
TASK 1a - UTILITIES ALTERNATIVES

INTRODUCTION

The objective of Task 1, of which utilities alternatives is a part, was to work on Protective Housekeeping aspects of Industrial Hardening (see Figure 1-1) to initiate the development of emergency preparedness information that would particularly attract industry's attention and interest. The strategy is to achieve better preparedness in industry for natural, hence nuclear, disasters by developing solutions to common problems that provide the broadest possible range of benefits. The rationale is simply that these are more likely to lead to industry action. For this iteration, some of the special concerns that have been expressed by industrial reviewers of the Industrial Hardening Plan, and by participants and observers at industrial hardening exercises (Ref. 2), were selected for investigation. Specifically, the items reviewed were:

(a) Utilities alternatives (this section)
(b) Hazardous materials; handling, storage, and containment (presented in Section 3)
(c) Rapid process shutdown (presented in Section 4)

The approach taken to carry out this task was to: (1) develop a list of options, (2) develop data on option specifics – including applicability and overall impact to be expected from implementing, (3) acquire additional data needed to tailor a set of end-user self-help guidelines for the Industrial Hardening Plan, and (4) organize the information in the form of decision-tree flow charts. Not part of this year's effort (but a subsequent step in the sequence), will be to apply the decision-tree flow charts developed this year to draw up self-help guidelines (in a format compatible with Ref. 1 booklets) –– then have the technical aspects assessed by experts in the field (where necessary), and the practical feasibility and clarity of guidelines assessed from industry's point of view by participants.

Ready availability of utilities is a basic industry requirement for production. Industrial utility service needs include:

(1) electric power
(2) water
(3) communications
(4) waste disposal
(5) transportation

The last item is not considered a utility, but is indispensable to the flow of raw materials and products. All these named services have been studied, most fairly extensively (Refs. 4 - 29), in terms of vulnerability of the supplying utility, and to some extent even with regard to alternatives (Refs. 5, 7, 10, 13, 18, 21, 22). However, little effort has been expended from strictly an industry point of view to identify possible actions that might be taken by an industry to make itself more independent in event of a disaster (e.g., a postattack world).

Moreover, it will make a great deal of difference whether these actions are completed before the disaster, or not initiated until afterward. (Naturally, the range of options post-disaster will be severely restricted by sudden widespread demand; for example, it will be easier to obtain a standby power system before everybody else wants one, and this would also provide time to learn how to use it.) Thus, this task has been approached from two directions: alternatives available with advance planning and action, and the more limited alternatives of an entirely post-disaster response. One objective of this two-direction approach is to illuminate the relative difficulty of solving problems after, versus before, a potential disaster occurs.

The above utility requirements of industry were investigated in turn, with several receiving concentrated attention this year. Two of them, electric power and water, are discussed in this report.

ELECTRICAL POWER

Major electrical energy alternatives to reestablish industrial production in the post-disaster world are limited. Perspective on the various preferred alternatives that would be available with advanced planning and preparation is provided by information gathered on five commonly used, onsite power alternatives: cogeneration, small-scale hydro plants, wind generation, geothermal, and standby engine-generators. These five alternatives are evaluated in relation to a "sample area" covering the generating capability in northern and central California within the Pacific Gas & Electric (PG&E) service area (roughly 3% of the nation's generating capacity). This selection provides a broad spectrum of the mix in power generation over a wide geographic area and a diverse industrial economy.

Both current and future generating capability of the significant alternatives according to PG&E in its California service area are shown in Table 2-1 (Ref. 30). As may be expected, the data contain some uncertainties. An important uncertainty the utility is plagued with is how to offset with alternative options the generating capacity of nuclear power plants that are not brought on-line on schedule.

This circumstance is important to emergency planners because it opens the door to implementing a strategy to improve general disaster preparedness; i.e., through a program to support development of many more private-utility power plants, ***onsite*** *— particularly in rural areas.*

Of interest to planners, then, is how rapidly the utility can adjust its strategy to accelerate the development of alternatives (cogeneration, small-scale hydro plants, wind generation, etc.) at industrial end-user sites.

Cogeneration

Cogeneration is the simultaneous production of usable thermal energy (steam) and electric power. In its simplest form, cogeneration is the coupling of a heat source (boiler) to a turbine-generator, with process heat being available as needed. Cogeneration systems vary in equipment configurations and generating capacity.

TABLE 2-1: GENERATING CAPABILITY PG&E AREA, SEPTEMBER 30, 1981

Generating Capability ***

PGandE Area
September 30, 1981

Type of Facilities (a)	Complete as of 1/1/78 Total MW (b)	Complete as of 1/1/78 % of Total (c)	Completed/Contracted as of 9/30/81 Total MW* (d)	Completed/Contracted as of 9/30/81 % of Total (e)	Under Active Consideration for Operation by 1988 Combined MW** (f)	Under Active Consideration for Operation by 1988 % of Combined Total (g)
Conventional (Oil/Gas)	7,309.0	51.5	7,309.0	37.4	7,193.0	35.1
Combustion Turbine	253.0	1.8	418.0	2.1	418.0	2.0
Cogeneration****	179.0	1.3	487.6	2.5	1,627.8	8.0
Geothermal	502.0	3.5	1,129.0	5.8	1,319.0	6.4
Hydroelectric <30MW	341.7	2.5	731.8	3.7	869.7	2.0 +
Hydroelectric >30MW	4,656.3	32.8	5,934.4	30.4	5,971.8	29.2
Nuclear	938.0	6.6	3,128.0	16.0	3,128.0	15.3
Wind			383.3	2.0	399.3	2.0
Other			10.0	0.1	10.0	nil
Totals	14,179.0	100.0%	19,531.5	100.0%	20,936.6	100.0%

* Column (d) includes those facilities complete as of 1/1/78 plus those completed/contracted for since 1/1/78.

** Column (f) adds to (d) the facilities under active consideration; an adjustment for future reductions in capabilities is included for conventional (oil/gas) units only.

*** Capability: PGandE unit values are net normal operating capability. Other area hydro is dry year capability.

**** Includes solid waste.

+Note: *This number should be 4.2, not 2.0.*

They are normally located where there is a large requirement for both process heat and electric power.

Present limitations to implementing a cogeneration system are related to individual industry energy consumption demand and to regulatory requirements. For instance, if process steam demand is less than 50,000 lb per hour, cogeneration is ordinarily not a feasible alternative. This requirement may not necessarily preclude installation of a cogeneration system; two neighboring industries with dissimilar energy requirements might find it profitable to integrate their steam and electric needs to achieve the minimum requirement and initiate a joint-venture cogeneration partnership. Cogeneration has been made most viable for those implementers who have a major requirement for a steam supply (i.e., far in excess of 50,000 lb per hour) through the expedient of allowing excess electrical energy generated to be sold to the local utility.

Cogeneration is not a new "buzz word", as onsite generating steam production facilities have operated for many years. Nationwide, cogeneration capability has declined from 15% of generating capacity in 1950 to less than 4% in 1978. In northern California (PG&E area) total cogeneration capacity was 1.3% in 1978 (Table 2-1). But cogeneration facilities are increasing in number. By 1988 PG&E predicts onsite generating capacity from <u>cogeneration alone</u> to be 8% of total capability. This projection and the range of projections by S.P. Blake and Associates (Ref. 31) are shown on Figure 2-1. Extending PG&E's projection from the 1981-1988 period to the year 2000 would have cogeneration at 17% of total generating capacity. This projection is probably not overly optimistic, for at least four reasons:

(1) Federal and State monetary incentives developed specifically to induce utilities and industries to install cogeneration
(2) The environmental and regulatory constraints on nuclear power
(3) The lack of available, economically developable, major hydropower sites
(4) Expected increases in electric rates because of fuel costs and amortization of costs of unlicensed or incomplete nuclear plants.

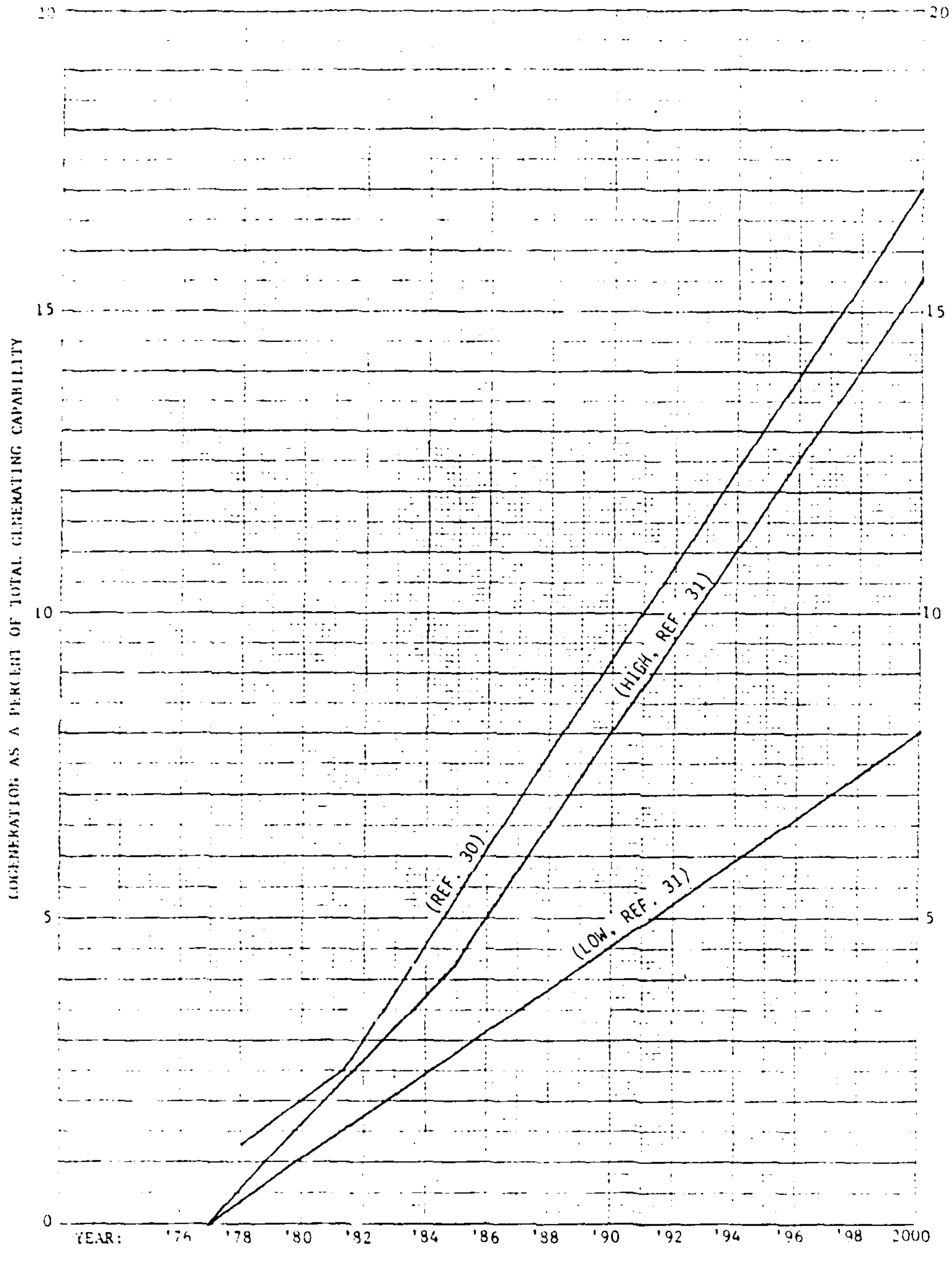


Fig. 2-1. Industrial Cogeneration Projections to the Year 2000.

The most critical barrier to the development of more cogeneration facilities is the important criterion for investing capital; i.e., the return on investment. The cost for borrowed capital has recently ranged from 17% to over 22%. For industry to invest in cogeneration facilities, the return on investment must exceed these values significantly. In comparison with industries, public utilities have no competition for their sales; i.e., they have a "basic areawide monopoly", receive a guaranteed profit, and thus borrow funds at rates lower than industry when investment capital is needed. A comparison of required rates of return — applicable several years ago — is shown graphically on Figure 2-2 (Ref. 31). Though not applicable today on an absolute basis, the ratio of return required by industry versus public utility, to stimulate investment, is around two to one. Industry requires the higher rate because energy generation is not its main line of business and, therefore, constitutes a higher risk than for a public utility.

The greatest potential for cogeneration lies in six major industries (because, among them, they account for 80% of all industrial energy use nationwide). These six industries are listed in Table 2-2, ranked in the order of energy consumption, nationally (indicative of potential); the expected cogeneration capacity proposed for installation in northern California (the sample area) by each industry by the year 1988 has been included.

TABLE 2-2: DEVELOPMENT OF COGENERATION CAPACITY IN THE SAMPLE AREA*

SIC Code	Industry	Number of Plants Implementing	Capacity (MW)
33	Steel mills	0	----
29	Petroleum refining	9	746.0
28	Chemicals	5	62.3
26	Pulp and paper	12	152.5
20	Food	6	92.3
22	Textiles	1	1.7
	TOTALS	33	1054.8

* Northern California

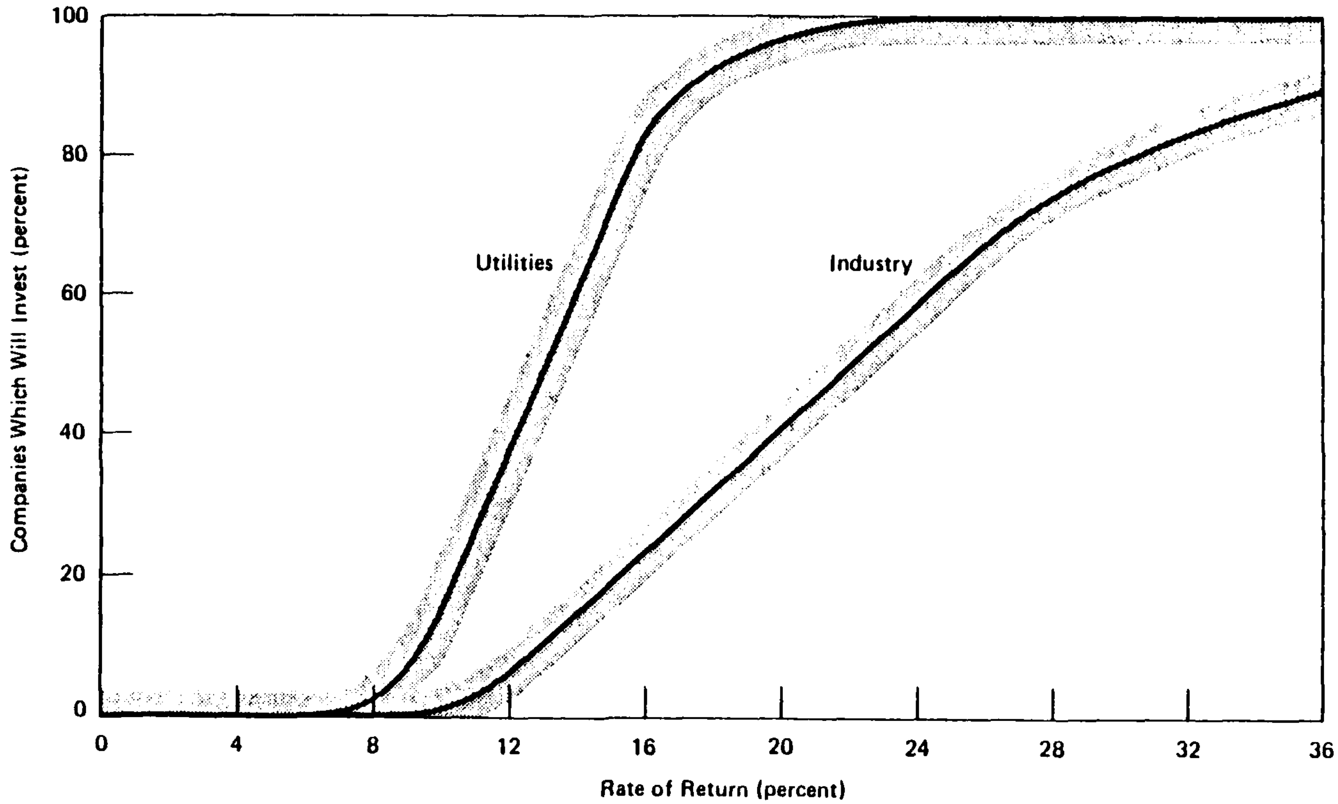


Fig. 2-2. Return Required to Invest by Industry versus Public Utility (June 1976).

All of the plants represented in this table have contracted with, or are negotiating with, PG&E for sale of excess generating capacity, and thus are providing cogeneration capability under an incentive program.

Although an incentive program is very helpful, it may be insufficient to encourage widespread implementation. Note the ranking industrial end-user, steel, should have the greatest potential benefit, yet steel has elected not to develop cogeneration capability in the sample area. For whatever reasons, industry commitments in the sample region do not follow the national-potential rankings (suggesting the Department of Energy concept for identifying where to concentrate attention requires further consideration). In any case, from a national defense standpoint, a concerted effort to develop generating plants at end-user facilities seems a preferred course over new public utility generators that would put all of a service region's industrial power-supply "eggs" in one central basket.

Perhaps coordination between the Department of Energy (DOE) and FEMA could prove beneficial in this area. The DOE -- *through its forerunner*, ERDA -- was created to deal with the national threat of a major disruption of energy supplies to the United States and seeks (among other options) to reduce foreign energy supply needs by reducing domestic demand. Similarly, FEMA seeks to reduce the threat from a potential disruption of the power supply and distribution systems (particularly in case of nuclear attack). Both of these agencies' objectives are served by widespread development of onsite cogeneration facilities; FEMA, because these will then be both dispersed and where needed -- the DOE, because there will be energy savings. During the current adjustment period, while public utilities seek to reduce dependence on nuclear power plants, there is an unprecedented one-time opportunity for both these agencies to influence large capital expenditures (by utilities and by industry) at a small price.

Small Hydropower Installations

Power production from small, onsite hydroelectric facilities is destined to be another significant option. Output can be determined from water flow and discharge head:

$$\text{Power} = K \times \text{flow} \times \text{head}$$

where K is an efficiency factor based on the system used. The quantity of water is the critical item to evaluate. Streamflow is dependent upon intensity, duration, and frequency of rainfall, the size, shape, and soil type of the drainage basin, the geology of the region, and the extent of vegetation and prior water rights. Seasonal fluctuations are attenuated by installing a dam.

Environmental concerns limit the number of large hydroelectric sites, but small sites are more easily available, particularly those using existing stream diversion facilities. Fortunately, streamflow data have been recorded at numerous sites in each state by the U.S. Geological Survey and are supplemented by local irrigation and water district data. Such information will be necessary for any site being considered.

In addition, the use of computers for data analysis has made available:

- o data translated from watershed areas to adjacent ungaged areas to determine many of the parameters needed to evaluate water yield of a potential site
- o synthesis of streamflow data from rainfall, evaporation and other data available in the general region, for use within the watersheds being studied.

In the final analysis, the data compilation results in the development of a flow-duration relationship. This relationship is used to determine the potential power output from a stream. Figure 2-3 (Ref. 32) depicts a typical flow duration curve for a stream with a hypothetical annual power output relationship superimposed. It should be emphasized that hydropower plants being considered as alternative sources in the industrial hardening concept should be developed on streams with existing diversion facilities; i.e., run-of-the-river plants, in order to reduce the six- to seven-year leadtime necessary to bring plants on-line to two to four years.

Different geographic areas in the United States have varying potential for small hydropower development. (The PG&E service area has a potential that is higher than average.) Figure 2-4 depicts the potential development capacity for

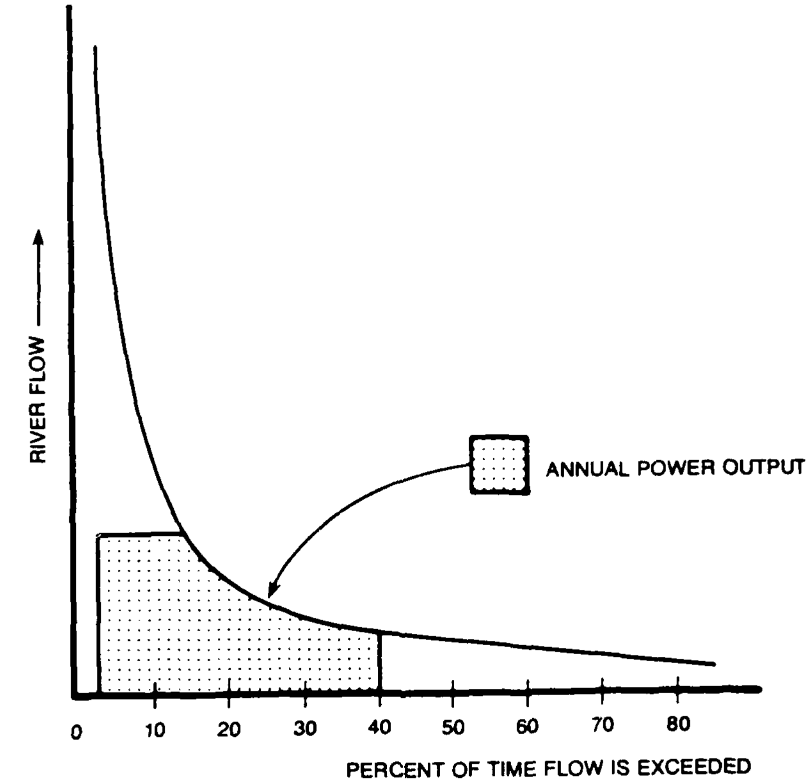


Fig. 2-3. Flow Duration versus Expected Power Output Relationship.

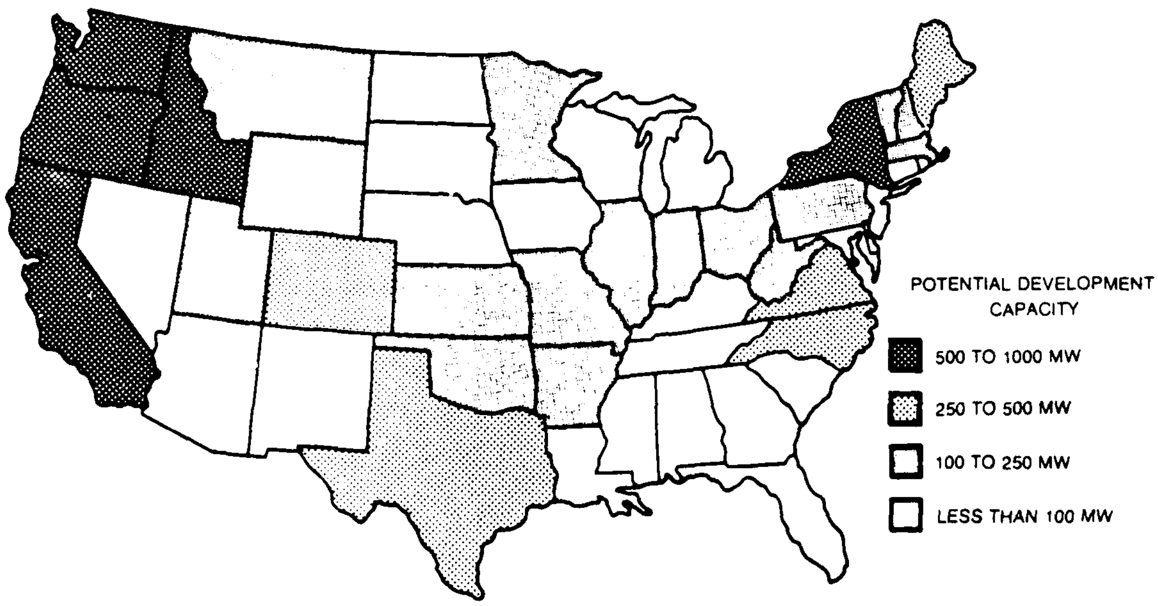


Fig. 2-4. Potential Development Capacity for Hydropower in the United States.

Source: Sheahan, Alternative Energy Resources (Ref. 32) hydro plants in the United States (something less than 10,000 MW or approximately 2.5% of current national power generation capacity).

Expected increase in generating capacity in northern California from construction of small hydropower plants has been shown on Table 2-1. This includes plants that have been proposed as well as those already contracted. Table 2-3 identifies plants already contracted (and indicates leadtimes required to get one on-line). By 1988, hydropower generating capability is expected to be about 4.2%; this power source is in addition to cogeneration. At present, PG&E has ongoing contracts or is negotiating 15 power purchase agreements for small-scale hydropower (Ref. 30). Average capacity will be 5.5 MW. It is important to note that the majority of these plants are being developed using readily available facilities owned by irrigation districts. Some impetus for development is available from the crude oil windfall profit tax of 1980, which allows an 11% energy tax credit for small run-of-the-river sites.

Small Wind Power Installations

Power production from wind installations is determined by selecting sites with a minimum wind speed of 8 to 10 miles per hour, and a full-load wind speed of 20 to 30 miles per hour. Wind speeds of 45 to 60 miles per hour result in shutdown of the wind turbines to avoid damage. This operation criterion is shown schematically on Figure 2-5 (Ref. 32) as a wind duration relationship. This relationship also defines the size of typical wind turbines. Maximum power output of wind systems approaches 2.0 MW per wind turbine. Based on the projections of PG&E, 400 MW of wind-powered generating capacity is expected by 1988; this total amounts to 2% of expected 1988 generating capacity. The dynamic loading problems on large wind turbines are difficult to predict and control, and the costs for maintenance and repair to turbine and transmission components may limit their long-term development. Wind power remains an emerging energy resource with many technical problems.

The geographical potential for wind energy conversion machines, based on average annual wind speeds is shown in Figure 2-6 (Ref. 33).

TABLE 2-3: HYDROELECTRIC PROJECTS GREATER THAN 100 KW

Pacific Gas and Electric Company

No.	Project Location	Date Contract Signed	MW	Projected Date of Operation
1.	Bear River near Colfax, California	June 30, 1978	11.0	operational
2.	Mokelumne River near Ione, California	February 10, 1981	29.0	1983
3.	Mokelumne River near Ione, California	February 10, 1981	11.0	1983
4.	Lost Creek near Forbestown, California	March 26, 1981	13.0	1983
5.	Rubicon River near Foresthill, California	June 3, 1981	0.5	1982
6.	12 miles northeast of Redding, California	July 20, 1981	3.6	1981-1983
7.	Putah Creek near Winters, California	September 1, 1981	11.5	1983
		TOTAL	79.6 MW	

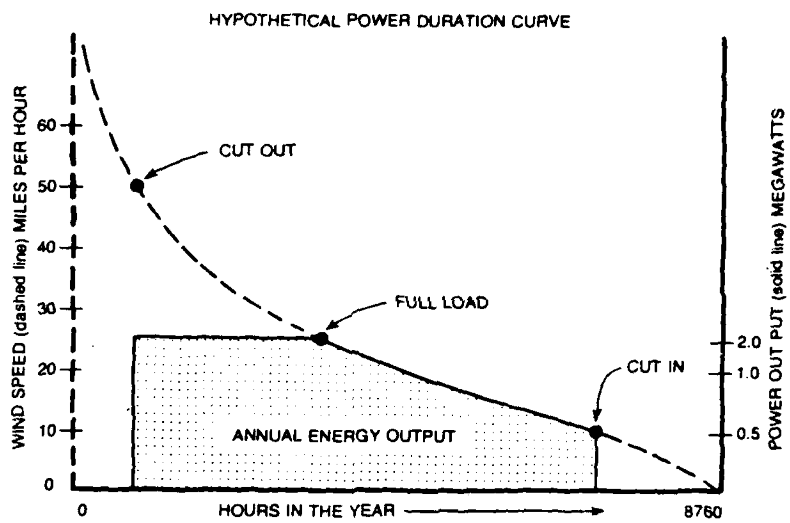


Fig. 2-5. Wind Generation Power Output - Duration Relationships.
Source: Sheahan, Alternative Energy Resources (Ref. 32)

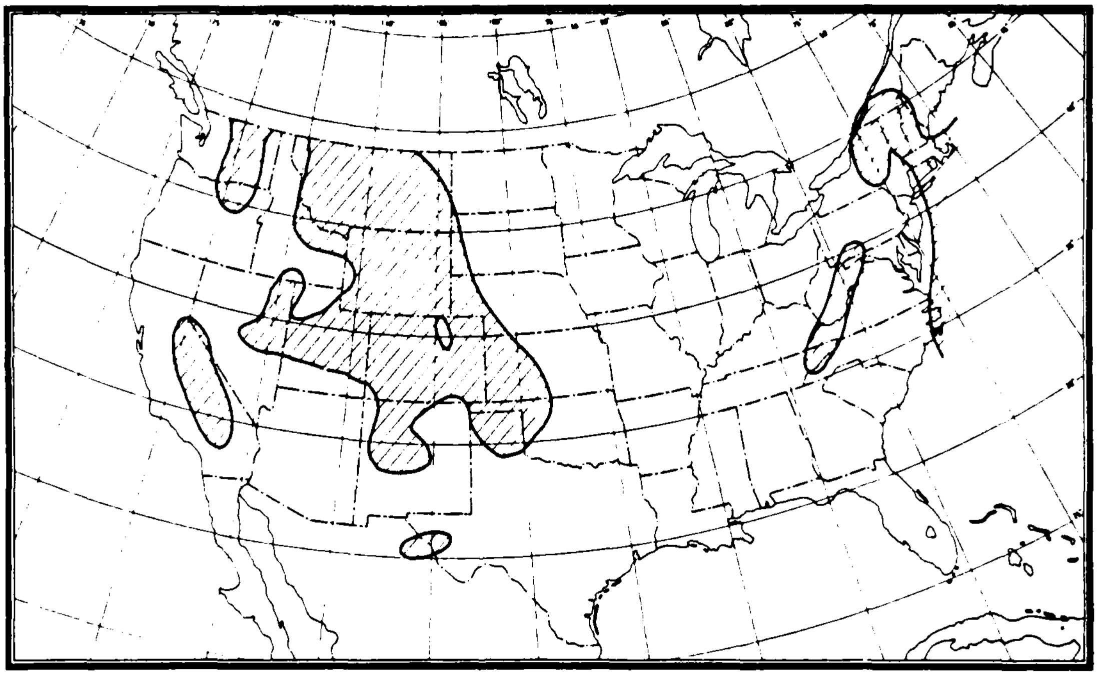


Fig. 2-6. Areas With Potential for Wind Energy.

Source: Eldridge, Wind Machines (Ref. 33)

Geothermal Resources

Geothermal resource areas cover 3.25 million acres in ten western states, see Figure 2-7 (Ref. 34). The only operating commercial field is in the Geysers area north of San Francisco, California, which produces in excess of 500 MW of electricity for PG&E. By 1988 this resource is expected to produce over 6% of total generating capability, or 1,350 MW. The development of geothermal energy involves solving legal problems with respect to water and mineral rights, and the need for substantial make-up water for reinjection into geothermal reservoirs.

Standby Engine Generators

Standby engine generators vary in size from 1kW to over 5,000 kW (5MW), are manufactured using a variety of internal combustion engines and fuels, and operate at a variety of running speeds and voltages. Typical configurations available are listed below:

Fuel Type	Size Range
Gasoline	2.5 kW to 20 kW
Diesel	20 kW to 6,000 kW (6 MW)
Ash free distillate (turbine)	500 kW to 7,700 kW (7.7 MW)

Other fuel types are also available in the smaller size ranges; e.g., LP, propane, and butane.

The northern California division of Pacific Gas & Electric Company conducted a survey of approximately 11,000 industry customers with engine-generator units to determine the feasibility of using standby generating capacity of customer units as a method to help relieve peak demand in summertime. That the utility would even consider this program is an indication that such units might be a significant factor. The program is based on deferring the utility connected load on a reimbursement schedule to any customers that have standby generating capacity. Those customers with power generators larger than 500 kW are reimbursed on a flat rate, plus fuel cost, basis. The geographic area covered by the survey ranged from Bakersfield-Santa Barbara to the Oregon border. The replies are summarized in Table 2-4.

GEOTHERMAL RESOURCES

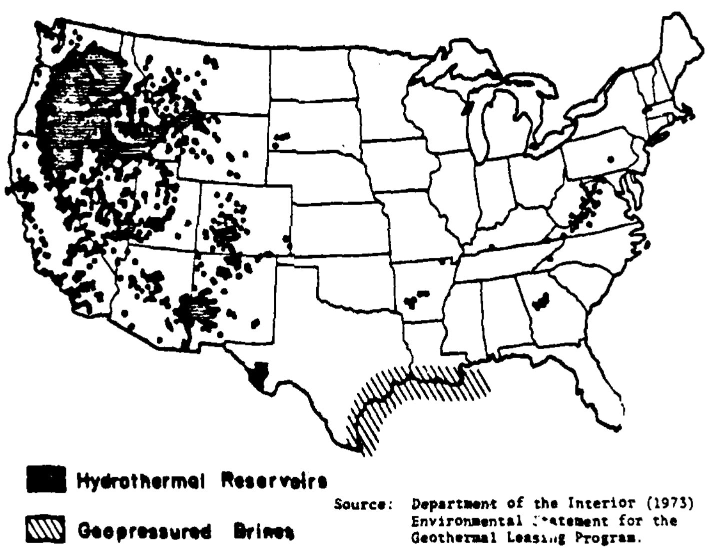


Fig. 2-7. Geothermal Resource Areas in the United States.

Source: U.S. Water Resources Council (Ref. 34)

TABLE 2-4: STANDBY POWER FACILITIES IN NORTHERN CALIFORNIA*

Number of Customers	**Generating Capacity in Kilowatts**
3	> 10,000
6	4,000 to 10,000
56	1,000 to 4,000
81	500 to 1,000
326	100 to 500
472	

* Verbal communication with PG&E personnel

Total generating capacity of the engine-generator units in this area approaches 300,000 kilowatts (300 MW), which corresponds to 2% of the total capacity in the (PG&E service) area. While a small percentage of the total, this capacity could provide important flexibility in an emergency.

The specific geographic location of a given facility with a standby unit is privileged information and not available from the PG&E; however, some general data are available. Among industries, standby capacity is located primarily in the chemical, oil, and electronics industries, where industrial processes cannot tolerate power interruptions. In addition:

- o all hospitals must have standby power by State law;
- o most high-rise buildings in San Francisco and Oakland have standby power;
- o some critical military installations in the area require standby capacity;
- o telephone companies provide standby power capability for emergency operations.

Most of the standby capacity in the PG&E service region lies within the San Francisco Bay Area (San Jose to the North Bay) rather than the more rural San Joaquin Valley (which does not have any significant standby generating capacity). What this assessment has indicated is that the 2% of the electric power demand of industry that could be satisfied in an emergency by the existing engine-generator unit supply (in northern California) is mostly in metropolitan high risk areas. To make maximum use of this resource in a nuclear attack emergency, these units will have to be either disconnected and removed, or relocated to sites of facilities within the risk area with critical shutdown problems and installed in hardened structures.

An important factor to consider with regard to dependence on engine generators is the fuel requirements. The logistics of the fuel supply for a typical industrial sized diesel generator at 150 kW consuming 8 to 12 gal/hr (depending on connected load) would require a fuel supply of 4 to 6 drums/day on 24-hour continuous duty, or a small tank truck full per week. A 1 MW diesel plant would require two large tankers per week and a 7,500-gallon storage tank onsite, while a 1 MW gas turbine generator would consume at a rate about 30% to 40% greater.

Overall Assessment of Postattack Power Situations

Based on the sample area studied, roughly 8% of the power generating capability is already diverse, and dispersed in the form of "onsite" facilities rather than concentrated in the form of a major generating public utility plant. By 1988, this portion (slated to reach 21% of the total) will certainly increase to 15% in the sample area. Because of public outcry against nuclear power plants, it may be assumed that widespread impetus for alternative power will be an incentive to this kind of increase nationwide. It is also reasonable to assume that such power generating facilities will generally, of themselves, be too small to warrant targeting consideration. A rough estimate of such facilities located within the host area of the sample region is 55% to 60%. This figure might be somewhat higher, but would require a fair effort to pinpoint.

Based on work reported in Ref. 35 for an area comparable to the PG&E service area, power facilities and industries that survived a nuclear targeting scenario were fairly evenly matched percentage-wise (60% versus 55%, respectively).

Thus, there would not be a power shortage, per se, rather the problem would be the time required to get the distribution system back in service.

Information obtained from Ref. 36 provides a means to assess the recovery of the transmission system after a major area disaster (Hurricane Camille in 1969); Figure 2-8 shows a plot developed to indicate the portion of the transmission system reinstated versus time elapsed after the disaster. The figure shows that 30% of the customers were on-line on day one and 90% on day ten, so that, with all the other problems, the period of power outage was not a very serious problem for most customers. However, there is at least one (and maybe more) important factor required to weight this recovery picture for Camille to make it more pertinent to the outage time from a nuclear attack situation. Ninety three percent of the linemen required for repairs after Camille came from <u>outside</u> the impacted area (and so did some of the materials). Assuming that resources would not be available from "outside" an area in a postattack environment (as all areas would be affected), then based on resources <u>within</u> the impacted area, recovery of the transmission lines could take well over <u>one year</u>, (lower scale, Figure 2-8), assuming damage equivalent to Hurricane Camille. About 40% might be back in service within one month, with 10% per month added thereafter for five months.

Priorities for reestablishing lines and for connecting loads appear to be a major factor requiring consideration in the postattack era. Such a study must consider the locations of surviving utilities (and capacities), critical industries (and their demands), onsite power facilities (and their capacities), the availability of engine generators units for interim service, salvage rate for transmission line components from the downed system, and rate of replacement possible with trained (and, possibly untrained) personnel, all of which is a sizable study in itself. This information is not necessary input to development of alternatives for industry, <u>but it could decide their effectiveness.</u>

To be of value, options for electric power initiated postattack would have to be "quick fix". That is, options that have in excess of a few months technical lead time might be considered very desirable — but the really critical period (see Figure 2-8) is the first three to five months. Successful response in the early period will require heavy reliance on particularly efficient management to allocate surviving utilities among essential end-users. This will involve such things as establishing priorities for replacing downed lines between surviving utilities and essential

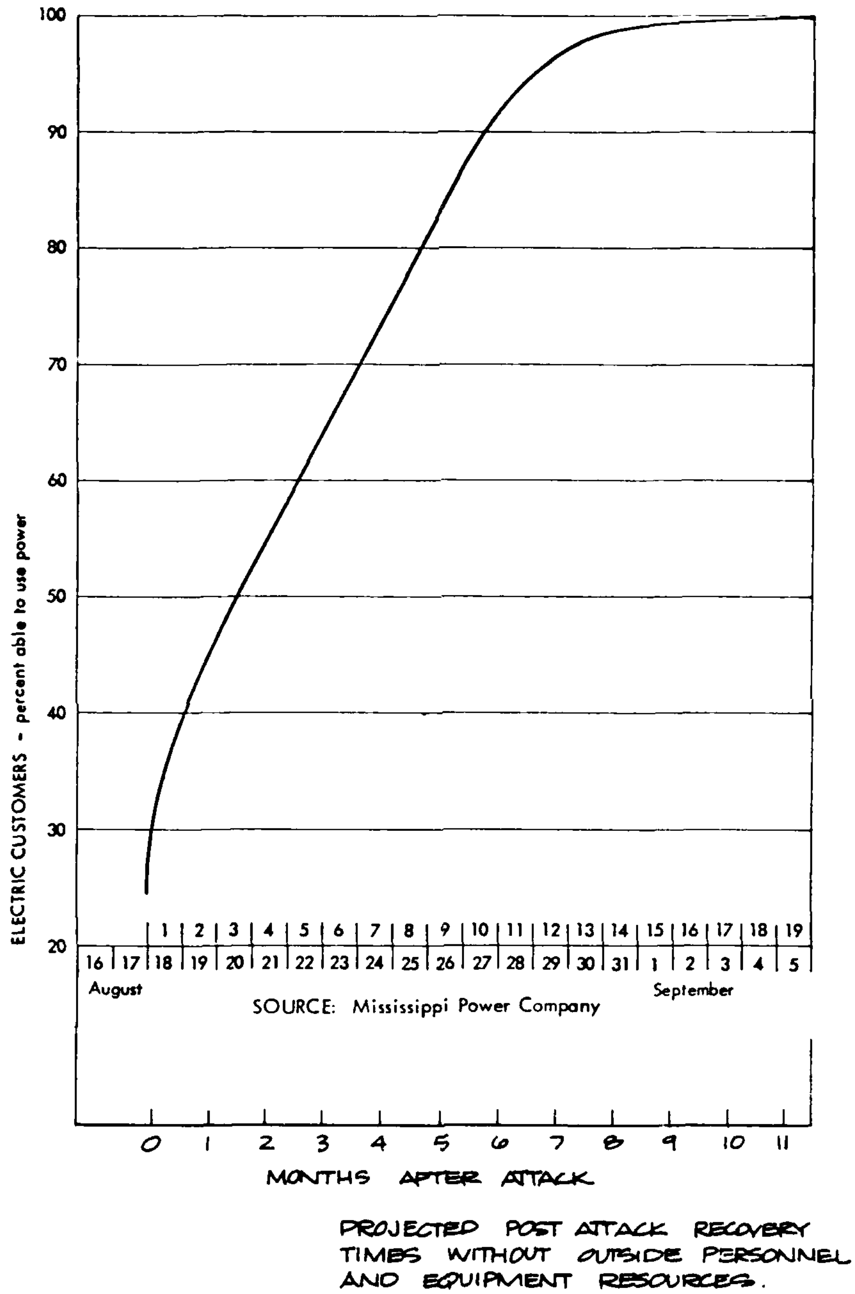


Fig. 2-8. Hurricane Camille Time-phased Recovery Effort of Electric Transmission System, and an Estimated Recovery Effort Without Outside Assistance.

industries, and allocating mobile or movable generators to serve essential industries where lines cannot be quickly replaced. Postattack, there are few electric power alternatives with lead times measured in weeks.

Electric Power from Induction Motors: One option (studied by the Defense Civil Preparedness Agency) that could be implementable on short notice postattack is to improvise an induction generator by converting an induction motor. This conversion requires an electrician, a welder and a mechanic, and a few special parts being fabricated and kept on hand (Ref. 37). The major component needs are: a prime mover, an induction motor, and an excitation source (heavy-duty capacitors). An induction motor should have at least two times the horsepower rating of the load expected to be connected when improvised as an induction generator. Figure 2-9 shows the relationship between expected electric power output obtained from an induction generator driven by a given size engine. A more detailed discussion of this concept is provided in Ref. 37.

An example of the induction motor used as a generator is the pumped-hydro installations of recent development, which are used by some of the major hydropower producers. During the day, when electric demands are the greatest, water from a high level reservoir is passed through a turbine driving a generator, and at night, when electric demands are low, excess generating capacity is used to drive the generator as a motor to pump the water back to the high level reservoir for reuse during peak demand periods.

Large induction motors are reasonably plentiful in the United States. In 1979, there were 42,000 induction motors sold in this country in the 50 to 250 horsepower size range.* Assuming that the average motor lasts for five to seven years, the national inventory of induction motors in this size range would be approximately 250,000 to 300,000 units. Even if a major proportion of them were destroyed by an attack, and/or were required by key industries for essential uses as motors, there would still remain a sizable pool of induction motors suitable for emergency conversion to generators. Assuming the Ref. 35 assessments of industry survival

* Source of production, service life, and total inventory information was Ray Jokerst, Chief of AC Motor Sales for Gould, Inc., St. Louis, Missouri.

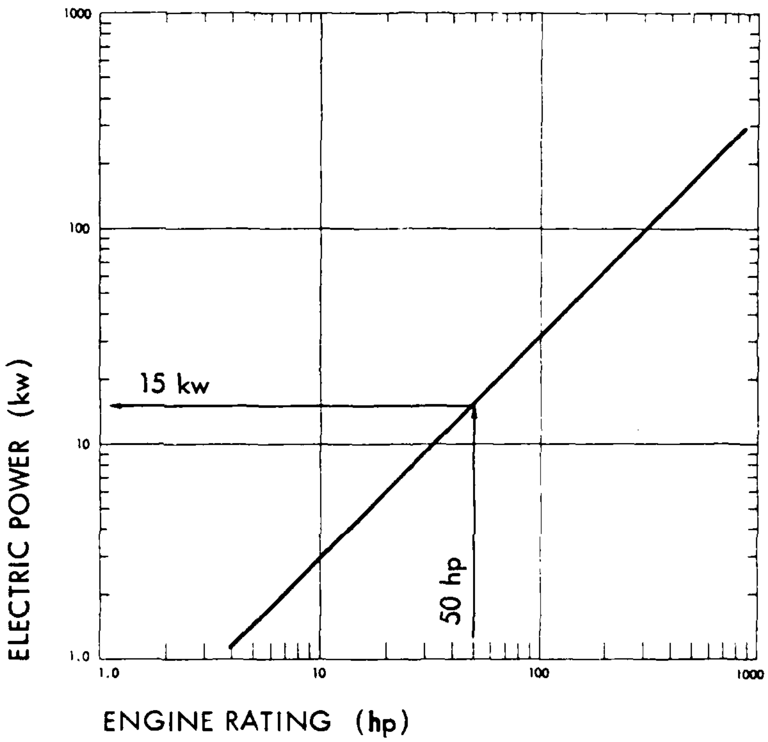


Fig. 2-9. Output of Induction-Motor Generator versus Prime Mover Horsepower.

were generally applicable, then about 55% of industry would remain relatively undamaged. If induction motors are assumed uniformly distributed, one would expect around 150,000 units to survive. If these were divided, roughly, into equal lots for use as generators and as motors, a total generating capacity of 4,500 MW could be improvised with appropriate motive power. This corresponds to approximately 1% of present-day electric power generation capacity, nationwide. Even added to the 2% engine-generator units, these mobile power sources seem insignificant — but they are extremely flexible, and it is possible their impact could exceed several times their capacity with astute management attention.

Power Alternatives Assessment

Table 2-5 provides a brief assessment of factors that bear on industry's selection process for implementing practical power alternatives. Some of the alternatives have value mainly in emergency situations; all would be particularly valuable in the event of nuclear attack. The latter is by virtue of the fact that such systems are onsite, hence relatively disperse in comparison with public utilities.

The particular significance of the table is that the majority of the systems listed there would have immediate and everyday value in a great many plants, and their numbers are increasing daily under the driving force of a random collection of incentives. The fact that such incentives are not applied uniformly across the nation and that, to date, none is known to be slanted for purposes of civil defense provides two opportunities for generating significant benefits for civil defense through a minor Federal effort.

TABLE 2-5: INDUSTRIAL POWER ALTERNATIVES FOR NUCLEAR ATTACK PREPAREDNESS

INDUSTRIAL POWER ALTERNATIVES FOR NUCLEAR ATTACK PREPAREDNESS

ALTERNATIVES	TYPE SERVICE	PRACTICAL SIZE RANGE (KW)	GEOGRAPHICAL CONSTRAINTS	CONSIDERATION & PROBLEMS	COST $/KW AT KW SIZE	INCENTIVES 1/	IMPLEMENTATION LEAD TIME	FUEL SUPPLY: TYPE &	FUEL SUPPLY: VULNERABILITY TO INTERRUPTION	EQUIPMENT VULNERABILITY
COGENERATION	RELIABLE EVERYDAY	50 TO 300,000	NONE	NEED PROCESS HEAT DEMAND > 50,000 LB/HR; ENVIRONMENTAL ISSUES		FEDERAL (INVESTMENT TAX, OCCASIONAL ENERGY TAX) PLUS LOCAL UTILITY (STATE & UTILITY PROGRAMS)	2 YEARS MINIMUM TO OVER 5 YEARS 2/	LIQUID GAS SOLID	SEVERE HEAVY TO MODERATE MODERATE TO LIGHT	SIZE AND LOCATION DEPENDENT SHOULD BE INSTALLED IN HARDENED OR HARDENABLE STRUCTURES
RANKINE TOPPING		50 TO 15,000			175 AT 50 110 AT 15,000					
INTERNAL COMBUSTION		150 TO 25,000			600 AT 150 800 AT 1,300					
RANKINE BOTTOMING		500 TO 15,000			710 AT 500 490 AT 15,000					
GAS COMBUSTION (TURBINE)		500 TO 100,000			400 AT 500 500 AT 18,000					
RECIPROCATING STEAM		5 TO 5,000			580 AT 1,000 220 AT 5,000					
COMBINED CYCLE		1000 TO 150,000			440 AT 2,500 390 AT 20,000					
FUEL CELLS		15 TO 5,000			544 AT 5,000 TO 25,000					
HYDRO	RELIABLE, EVERYDAY 3/	200 TO 15,000	HEAVY, LOCAL	NEED RIVER & RIGHTS	1,000 TO 2,000 AT 5,000	*	~ 2 YRS RUN OF THE RIVER 6-7 YRS OTHERWISE	WATER FLOW	LIGHT TO NIL 2/	RURAL, DISPERSE
WIND	SPORADIC 4/ EVERYDAY	100 TO 2,000	MODERATE REGIONAL, SEE FIG 2-6	MINIMUM WIND 8-10 MPH MAXIMUM WIND 20-30 MPH STORAGE LIMITED	1,000 TO 3,000 AT 2 TO 10	*	> 3 YEARS	AIR FLOW	NONE	RURAL, DISPERSE
GEOTHERMAL	RELIABLE, EVERYDAY	50,000 TO 100,000	SEVERE REGIONAL, SEE FIG 2-7	NEED WATER AND MINERAL RIGHTS	UNKNOWN	UNKNOWN	> 3 YEARS	GEOTHERMAL	NIL	RURAL
STANDBY ENGINE GENERATOR	PERIODIC NONSTEADY EMERGENCIES	5 TO 10,000	NONE	ENVIRONMENTAL ISSUES	PER SET (1980) GASOLINE: 0-5 KW $491; 5.1-15 KW $1,574; 15.1-35 KW $2,950; 35.1-100 KW $7,587; 100.1 → $44,598 DIESEL: 14 KW $3,493; 14.1-50 KW $7,350; 50.1-100 KW $12,896; 100.1-200 KW $16,603; 200.1-400 KW $28,947; 400.1-1000 KW $62,715; 1000.1 → $330,487	INVESTMENT TAX PLUS LOCAL UTILITY	1-7 DAYS RENTAL 2-10 WK. PURCHASE	LIQUID GAS	SEVERE HEAVY	EVACUATE
CONVERTED INDUCTION MOTOR	EMERGENCY ONLY	1 TO 300	NONE	NEED CONVERSION KIT, PRIME MOVER SPARE MOTOR	UNKNOWN	NONE	1-2 DAYS WITH CONVERSION KIT	DEPENDS ON PRIME MOVER	HEAVY TO SEVERE	EVALUATE

1/ FOR UNITS OVER A CERTAIN SIZE, CALIFORNIA UTILITY PROGRAMS OFFER GUARANTEED POWER COST PLUS $10,000 ANNUALLY TO STAY "OFF-LINE" DURING PEAK DEMAND SEASON

2/ MINIMUM TIME FOR SMALL UNITS AND WASTE HEAT UNITS, LONGER TIMES ARE FOR LARGE SYSTEMS

3/ SUBJECT TO SEASONAL INTERRUPTION ON SOME STREAMS

4/ SUBJECT TO DAILY INTERRUPTION

WATER

Industrial Water Needs

Another critical utility, with regard to maintenance of essential production, is water. The main sources of water for industrial use are surface supplies (reservoirs and streams) or ground water. Usually, municipal systems supply industry from these sources, although some industries, typically large plants such as steel and paper mills, develop their own sources. Water service for industry is basic to heat transfer, power generation, and process uses.

Industry capitalizes on the heat transfer properties of water for heating and cooling of production processes. In other applications, water is used as a conveyance medium, in washing procedures, and as a raw material.

A typical example of water as a conveyance medium is the pulp & paper industry. A 1,000 ton/day capacity paperboard plant may use 20 to 30 millions gallons per day, with 80% to 90% for conveyance. The pulp produced after screening is 93% water, and the finished sheet is 2% to 3% water. Much of the process water is reused. Other examples of conveying can be found in food canneries and in coal processing.

Many industries use water for washing; an example is the nuclear industry, which uses large quantities of water to remove radioactive particles. Washing uses are usually categorized as dilution, displacement, or extraction. The electroplating industry is an example of dilution, with the many chemical solution tanks used in the plating processes. The microelectronics industry requires extremely high quality water, ion free, and without suspended matter. The production of this high quality water is a specialized industry, and requires extensive filtration and demineralization techniques. The pulp and paper industry is an example where industry uses displacement methods to remove cooking liquors from the pulp as it passes over vacuum filters. The textile industry uses a similar process to remove caustic soda from cotton fabric. Extraction washing is used in domestic oil refineries to remove salt from crude oil, in sugar refineries to remove molasses from refined sugar, and in the aerospace industry to remove debris from air and provide the correct humidity in "clean" assembly rooms.

Water is used as a raw material in many important industries including the manufacture of ammonia, the drug industry, and in a variety of beverage industries.

Manufacturing plants may require large amounts of water, dependent upon the product produced. Table 2-6 (Ref. 38) lists water use in a few key industries.

TABLE 2-6: WATER USE FOR SELECTED INDUSTRIAL PRODUCTS

Product	**Unit of Production**	**Typical Use** Gallons/unit
Canned Apricots	Case: No. 2 Cans	80
Canned Beans	Case: No. 2 Cans	250
Coke	Ton	3,600
Oil Refining	Barrel	770
Paper	Ton	39,000
Leather (tanned)	Ton	16,000
Rayon hosiery	Ton	18,000
Woolens	Ton	140,000
Steel	Ton	35,000
Electricity (Steam)	kW-hr	80

About 80% of industrial water is for cooling purposes, so need not be of high quality. Water for process purposes or for boiler feed, however, must be of good quality, and in many cases, must be of higher quality than drinking water.

Postattack Assessment

Water is essential, and in a postattack industry recovery environment, significant problems in terms of sufficient quantities of water will probably exist.

Destruction of storage and supply line facilities in targeted areas will cause loss of storage in the fringe areas where damage may be minimal. In addition, there will be no power to operate pumps and treatment facilities.

In the Civil Defense literature, virtually all assessments and analyses that deal with water utilities concentrate on the potable requirements in recovery areas and the radiological contamination of water supplies. If approximately 80% of industrial water is used for cooling purposes and need not be of high quality, the most likely problem would seem to center on quantity and distribution. Distribution includes major underground conduits (e.g., Hetch Hetchy in California), which serves a large urban target area in the San Francisco Bay region, and aboveground canals (e.g., Delta-Mendota), which serves a major agricultural area in the Central Valley of California. Targeting of the aboveground canals may result in some new unplanned reservoirs being blasted out of the valley areas. This may, depending on circumstances, destroy or only temporarily interrupt this important distribution system. The disruption of water systems in target areas will involve mainly large supply conduits and local storage facilities (dams, reservoirs), distribution mains, and pumping stations. A very real problem is that rupture of local mains may drain reservoirs by gravity flow. These problems will affect recovery of industrial production at the fringes of the risk areas. It is difficult to say how long such ruptures might take to repair. (It is worth noting that a January 1982 storm in California -- equivalent to a 100-year return period in total rainfall in the areas affected -- restricted water use in the Santa Cruz area to all customers for two weeks because of a single failure; i.e., a 24-inch transmission main.)

Industries requiring water for any production purpose will need to assess their needs in a postattack environment in terms of partial production. Each industry should prepare a water balance sheet. This sheet should provide a quantity versus quality statement of production needs for each product or component manufactured. Once this statement is complete, alternatives can be analyzed and supplies allocated accordingly.

Industries in fringe areas should consider the installation of a standby well-pump system. The system may be installed in a below-grade reinforced concrete vault (hardened) and still be easily accessible to connecting portable generators for supplying power in emergencies. The size and depth of the well should be based on emergency partial production needs, the capability to extract the water from the underlying aquifers, and water quality needs based on the previously prepared water balance sheet. The pump horsepower needed is a function of well depth and pressure volume needs. The switchgear should be installed in a manner such that emergency power units may be easily connected to the system.

In host areas, inadequate pumping and distribution systems may cause supply shortages because of the influx of people, but this is a problem that can be minimized by careful selection and assessment of the crisis relocation areas. (This is not an industry problem, but how this is done will affect industry viability postattack.) Present effort by SSI is being devoted to industry requirements. Information on typical distances of industries from existing and substitute water supplies would determine the requirements for lightweight agricultural pipe, submersible pumps, and emergency power units, to provide alternative delivery systems. This particular solution would place additional demands on already scarce power units, however, so could be applied only to very essential operations.

Ref. 39 describes a fairly simple mobile stream-diversion system (designed and built for the Environmental Protection Agency), which can pump three million gallons per day a distance of 3/4-mile over open ground. Table 2-7 has been selected to show the potential of this mobile system to provide expedient pumping and distribution for selected circumstances involving critical industries. With the industry water balance sheets, it is possible to develop a table that would relate daily consumption for selected critical industries within an area to provide some simple alternative water pumping and distribution system designs. To provide an example of an application, if this system were in operation to supply a steel mill similar to Kaiser's Fontana, California plant, production could be maintained at 2,000 tons of steel per day.

Another alternative to providing a supply of water for industry would be onsite storage facilities. This alternative generally would not be useful except to industries with low volume, low quality requirements (so that the stored supply can

TABLE 2-7: MOBILE STREAM DIVERSION SYSTEM OPERATIONAL MODES

Mobile Stream Diversion System (MSDS) Operational Modes

Mode			Volume Flow Rate @ .3 km Q		Volume Flow Rate @ .6 km Q		Volume Flow Rate @ .9 km Q		If Series Staged With Additional Pipe						
										Q		Range		Pipe Required	
			(m³/s)	(gpm)	(m³/s)	(gpm)	(m³/s)	(gpm)	Stages	(m³/s)	(gpm)	km	ft	km	ft
1.	s		.11	1,750	.09	1,425	.06	950	4	.09	1,425	2.4	7,900	2.4	7,900
	s														
2.	s		.22	3,500					2	.18	2,900	1.2	3,900	2.4	7,900
	s														
3.			.18	2,900	.10	1,600	.07	1,100							
	s														
	s														
	s														
4.			.35	5,600					1	.10	1,600	0.6	2,000	1.2	3,950
	s														
	s														
5.	s	B	.10	1,600	.10	1,600	.09	1,425	4	.09	1,425	11	36,000	11	36,000
	s	B													
6.			.20	3,200					2	.18	2,900	5	16,400	11	36,000
	s	B													
	s	B													
7.			.18	2,900	.18	2,900	.11	1,750							
	s	B													
	s	B													
	s	B													
8.			.35	5,600					1	.35	5,600	1.1	3,600	2.2	7,200
	s	B													
	s	B													

Note: Submersible pumps s and booster pumps B may be used singly or jointly, in series or parallel, with individual or common pipelines. The mode symbols used are descriptive of such arrays. Volume rate of flow for the system has been indicated for the two specified and one intermediate distance in the lefthand columns, possible future options in the right.

Source: Ref. 39, "A Mobile Stream Diversion System for Hazardous Materials Spills Isolation," by J.V. Zaccor. PB 82-109 679, Environmental Protection Agency, Cincinnati, Ohio.

be recycled with little makeup requirement), and with sufficient real estate to install buried tanks. Again, belowground storage facilities will require pumps and standby power.

The most promising alternative is water reuse. Few industries actually consume the water withdrawn. The carbon black industry is an example, since the process results in evaporation of most of the water used back to the atmosphere. Slight changes in some processes might enable the evaporated water to be recovered without resort to the long-term hydrologic cycle. Average water consumption, for industry as a whole including steam-electric power plants, is about 2% of water withdrawn from the original source. Thus, 98% of industrial water is available for reuse by the next downstream user. However, industry as a whole typically reuses only 80% of its own process water so has a 20% makeup requirement. This in-plant reuse must be increased in a postattack environment so that, in times when water is scarce, each industry will need to become its own downstream user.

There are three principal industry reuse systems that can accomplish this: simple recycle, multiple recycle, and cascade. Combinations of these systems are also used. A typical example of a simple recycle system is return of condensate to the boiler feed line, using condensers or heat exchangers. This a very efficient reuse system.

Multiple recycle systems are used in many industries and consist of parallel paths using various grades of process and cooling waters. This system allows for individual control of temperature, pressure, and flow rate. As an example, one of Dow Chemical Company's plants uses a multiple recycle system, which provides high-pressure cooling water, domestic water, high-grade cooling and process water, and demineralized boiler feed water in five separate supply segments. This system reuses the water eight times.

Another common reuse system is the cascade system, where a single stream flows from one process to another, and quality of the water degrades with each use. There are usually a considerable number of recycle stages. This system is used by many industries, but a classic case is the Kaiser steel plant in Fontana, California.

A schematic of the system is shown in the flow chart in Figure 2-10 (Ref. 40). This system, using 1,400 gallons per ton (compared to typical steel industry requirements shown in Table 2-6 at 35,000 gallons per ton), reuses the water 25 times.

To summarize, in a postattack environment, the greater the reuse, the more quickly an industry could reestablish production. Reuse in ordinary times is a costly endeavor, because of treatment, material handling, and disposal of the concentrated wastes generated in the system. After a major disaster, regulatory controls may be set aside. In the meantime, expanding pollution control legislation will increase the cost of treating industrial waste supplies and effluents, which will provide further incentives for reuse and the development of reuse technology. A more detailed study of reuse water technology for application to fringe area industrial production operations is needed. Such research should initially consider:

(1) Qualitative vs quantitative water requirements of a selection of critical industries.

(2) Current water use and reuse efficiencies (ratios) for each.

(3) Based on (1), maximum reuse potential with simplest possible technology.

(4) Adaptability of existing reuse technology using more than settling tanks -- and effect of reduced production levels on demand.

(5) Intra- and inter-industry reuse of available water sources.

(6) Magnitude and logistics of waste disposal problems associated with reuse.

(7) Hardening of water supplies, and development of "quick fix" onsite reuse systems (e.g., pits, liners, recycle pumps, pipes).

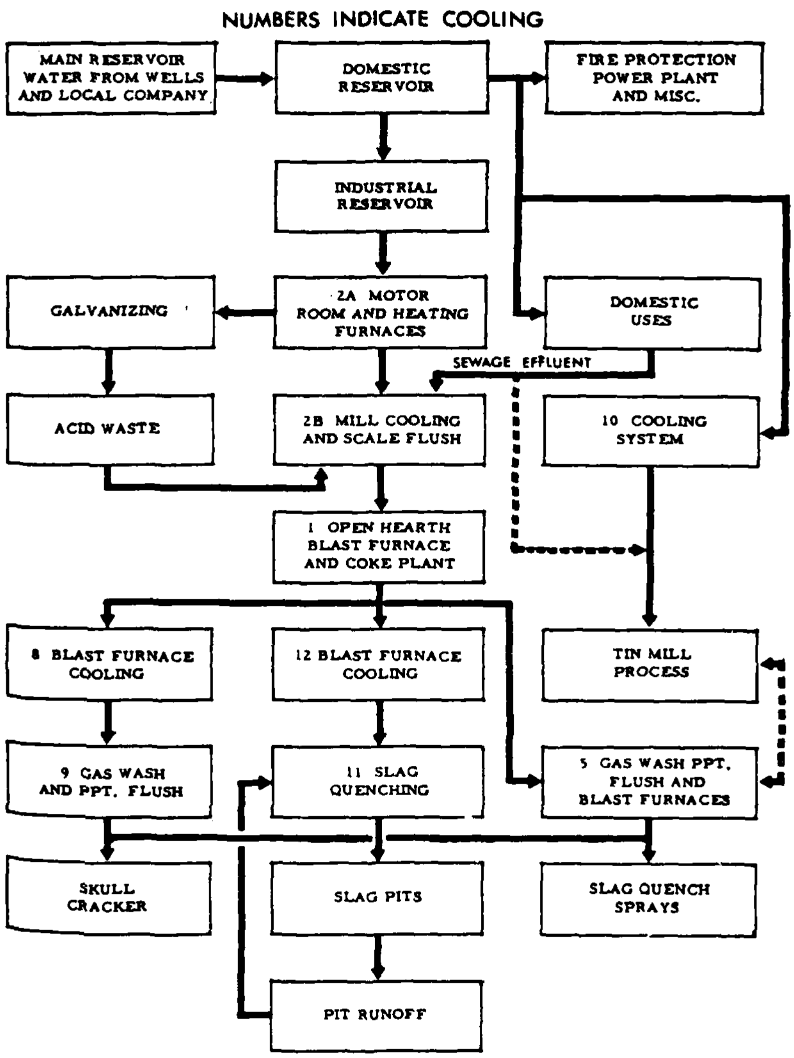


Fig. 2-10. Water Reuse at Kaiser Steel Plant, Fontana, California.

Source: ASTM Manual on Water (Ref. 40)

Section 3
TASK 1b - HAZARDOUS MATERIALS

The hazardous materials problem is a complex one under the best of conditions. Many industries have significant quantities of hazardous materials onsite (thousands of gallons of such chemicals at a single site are not uncommon). Generally speaking, most "hazardous materials" are not hazardous when confined in their containers (excepting some selected ones that can become unstable with time — even to the extent of detonating, with consequent rupturing of the container). When hazardous materials are not confined to containers, there are many parameters that affect the hazard level of a spill or release: quantity, toxicity, reactivity, demography (population exposed), environment (weather conditions such as wind and rain, and surface conditions such as topology, temperature, and thermal conductivity). To make it more complex, some of these are implicit functions of one another.

Among possible spill mechanisms, it would be difficult to conceive a situation in which there would be more ruptures of hazardous materials containers than in conjunction with a nuclear attack. Should this occur, containers would be broached in unprecedented numbers, and unstable materials left unattended in railroad tank-cars and storage tanks would explode. Such widespread releases could wreak major havoc insofar as recovery operations are concerned, with hazardous materials spread over regions where recovery personnel might need quick access. Consequently, it will be extremely important to take protective measures.

Figures 3-1a and 3-1b show a decision tree type of flow chart applicable to the general situation. The shutdown sequence for hazardous materials in process appears in Figure 3-1a, while the in storage aspects appear in Figure 3-1b. There are many levels of hazard, depending on toxicity and quantity, but the average plant might be able to implement adequate protective measures with advance planning.

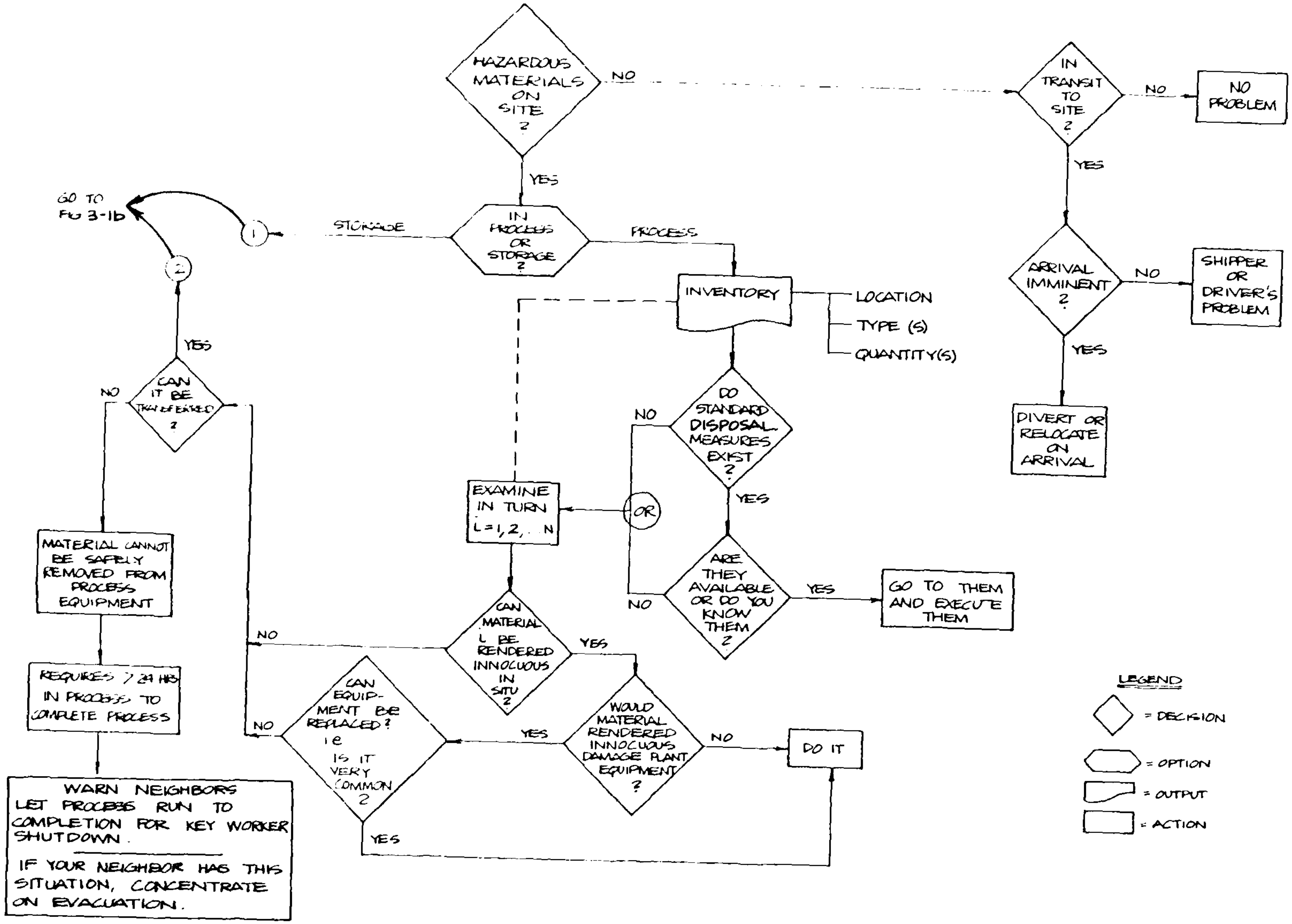


Fig. 3-1a. Decision Sequence Flow Chart, Part 1.

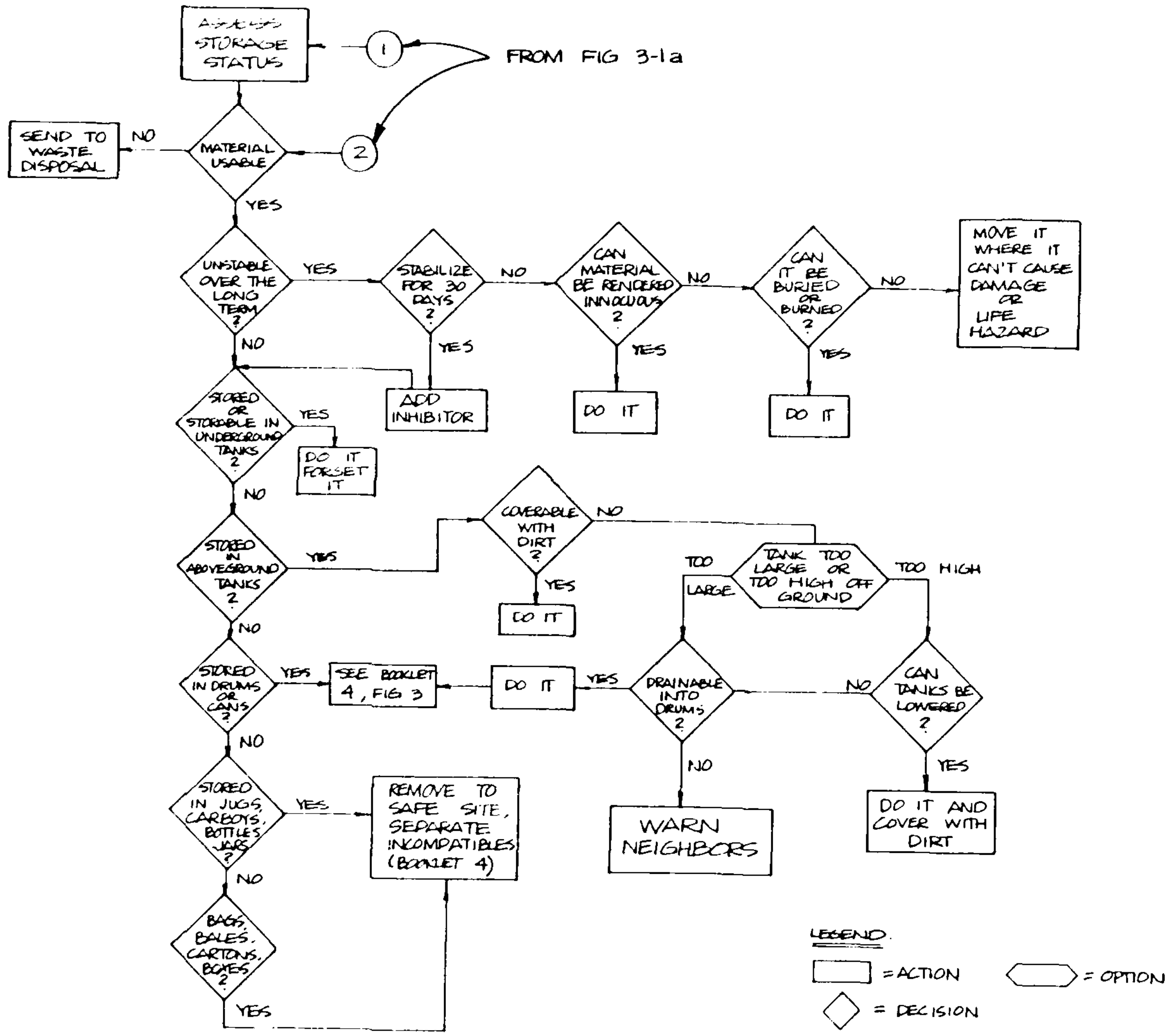


Fig. 3-1b. Decision Sequence Flow Chart, Part 2.

Even so, there will be situations where adequate protective measures are impossible to implement (for example, at tank farms), and then it will be important to warn neighbors of the potential problem. Even when protective measures can be implemented, it is impossible to make predictions about specific damage with great certainty so that it will be necessary to develop facility "plot plans" — to show precisely where different hazardous materials were located when they were hardened. These plans will be needed by postattack recovery teams to check the integrity of such dump sites or caches, before undertaking salvage or recovery operations that may expose these teams (and others, later) to areas polluted with hazardous chemicals.

It will also be important that certain equipment be available to recovery teams. Explosimeters are desirable to enable teams to avoid flammables and explosives that might have been released in ignitible concentrations. Appropriate protective clothing and related gear — with personnel trained in their use — should be available for initiating recovery operations in damaged areas and declaring the regions safe from hazardous materials. These same crews could just as well be capable of tracking radiation fields. It would also be well if all these capabilities were packaged in one or more mobile vans. Off-road capability is also desirable.

Essentially, what has been described in the previous paragraph is a hazardous materials response van. Some communities, particularly at the county level, are attempting to establish just such capabilities for day-to-day emergencies. Were such vans to exist in every county, part of crisis relocation protocol could simply require these vans to move to host areas, complete with backup inventory of cleanup materials and equipment. Such vans invariably have a variety of communications equipment aboard because they are frequently required to act as command posts. These vans would be major resources for recovery operations in a postattack period. Moreover, if there were one or two of these vans in every county, and if each contained a satellite communications system link, then a mechanism would exist to report postattack recovery progress, daily, from every county in the United States, to some central location — provided only that a satellite system still existed (or could be quickly reestablished).

Specific mitigation measures that can be simply assessed to identify the quantitative improvement to be expected in the handling and control of toxic (and hazardous) materials in a nuclear disaster situation are desirable. In line with our strategy to seek overlapping benefits, a recent heightened awareness of the earthquake risk in certain areas has led to the establishment of a program to consider some of the less obvious but potentially catastrophic secondary effects of earthquakes. One of the important secondary effects examined in the earthquake program (Ref. 41) has been the earthquake-caused hazardous material spill problem. (Logically it can be postulated that the implementation of measures developed to mitigate the effects of major earthquakes on serious hazardous materials spills should provide the implementer with some protection against nuclear disaster caused spills as well.) It is of interest to evaluate this transfer benefit quantitatively.

Initially, it might seem that the similarity of earthquake ground motion and air blast or direct induced ground motions would provide a simple key with which to compare mutual benefits from measures to resist such forces. However, this is a bit too simplistic. Where a nuclear blast is significant enough to make objects shift and overturn because of ground motion (as occurs with earthquakes) the overpressure is so severe (somewhere above 100 psi) that the objects would be much more vulnerable to the air blast forces. Looking at it another way, hardening industrial equipment and structures to withstand the direct air blast forces is more than sufficient to take care of the ground motion problem likely to occur at the same ground range. Consequently, a quantitative assessment of benefits from earthquake preparedness that apply to a nuclear disaster requires an analysis that is less direct than comparing ground shock.

Earthquake-generated forces in structures derive from inertia, so are proportional to the mass of the structure and are sensitive to the period of vibration and to damping. On the other hand, overpressure and wind forces are proportional to exposed surface area, but independent of mass, and although the period of vibration and damping of the structures are involved in the dynamic response to blast loads, they are not as significant as with earthquakes. Thus, an <u>empty</u> oil tank is much more earthquake resistant than a filled oil tank (because it is <u>easier</u> for the support structure to follow the movement of ti ground -- it is the inability of the structure to follow the motion that causes its failure). In the case where air blast is the driving force, the full tank is more resistant (because it is easier for the support structure to resist following the air movement -- it is the resistance to following the motion that prevents failure). It is far easier to fill a tank before a nuclear attack than to empty one before an earthquake -- because no warning is yet possible for the latter. Hence, the strengthening of the support structure to protect the full tank from earthquake forces will be very beneficial for the nuclear attack case.

It is of interest that objects and equipment within buildings can be damaged by earthquake ground motion even when the surrounding structure is undamaged, while significant blast damage to a building would be required ordinarily before industrial equipment inside buildings would be damaged (the exception is where jets are formed in openings in non-failing structures, see Refs. 42 and 43). In earthquakes, while a building may be only lightly damaged or even undamaged, many fires and hazardous materials releases have been caused by damage to equipment inside. Consequently, contents require attention, as well, for earthquake disasters -- most of which will provide benefits in the event of nuclear attack.

In terms of the quantitative difference between earthquake and nuclear blast forces (or loadings) the major point is that the latter can be many times more severe. It is reasonable and feasible to design and construct quite ordinary buildings to resist the majority of earthquakes without collapse, and this is now typical of California and other seismic areas where seismic codes are enforced; somewhat more effort (with limited results) is required to design and construct blast resistant structures. But high intensity earthquake shaking is, in an approximate way, comparable to a very low intensity nuclear blast, particularly in the fringe areas of blast damage to structures (where most buildings do not collapse or become severely damaged). Thus, whatever upgrading of a structure and its contents to resist earthquakes proves effective in reducing spills will also be effective in reducing spills at the outer fringes of the damage area from nuclear blast. The size of the annulus where this improvement occurs may be only from 2 psi to somewhere between 2.25 and 2.5 psi, but the areas within these annuli affected is 14% to 28%, respectively, of the total area in the damage zone. That is, one might expect 14%

to 28% fewer spills from a nuclear disaster in earthquake hardened facilities if these were uniformly distributed in a risk area. This constitutes a significant improvement -- particularly since it has 100% overlapping benefits to high risk earthquake zones.

A paper on "Earthquake-Caused Hazardous Material Releases," from the 1982 Hazardous Material Spill Conference (Ref. 44), provides a summary of the issues that can be used to compare the nuclear benefits derived from seismic disaster preparedness measures. Table 3-1 from that source lists typical earthquake damage that can lead to hazardous material spills. Using this table, each problem area can be taken in turn, and the seismic protection measures that are recommended for each one analyzed for its effectiveness in preventing nuclear blast caused spills. It is planned that this would be completed in the continuing effort, that the measures would be produced in "cookbook" form for insertion in the manual, and that this would be an integral part of industrial profiles.

TABLE 3-1: TYPICAL EARTHQUAKE DAMAGE THAT CAN CAUSE SPILLS

Component	Type of damage	Comments
vats	sloshing spills	hot or caustic fluids often used in open-top tanks for plating, cleaning, coating
unpressurized enclosed tanks	welds connecting lid to walls can fail (sloshing); "elephant's foot" bulges at base of tank (compression due to over-turning); connecting piping sheared	oil and gasoline tank leaks not unusual (similar to water tanks)
pressure vessels	connecting piping more vul-nerable than tank itself	small amounts of damage result in large releases
elevated tanks	complete collapse	elevated water tanks typically perform worse than ground-mounted structures
buried piping	fractured by soil movement	pre-existing deterioration significant; leaks difficult to locate and repair
aboveground piping	pipe hangers break, pipe joints fail	fire sprinklers receive more attention for earthquake bracing (but still occasionally fail); threaded joints weaker than welded; cast iron undesirable
industrial equipment	sliding, overturning	tall narrow objects overturn, broader shapes slide; positive restraint (bolts, straps) required to prevent movement; equip-ment generally earthquake-resistant internally
trucks	accidents due to bridge or road damage	overpass collapse is most severe hazard; California overpass retrofit program one-third com-plete
trains	derailment	standing cars and locomotives have tipped over; track damage (soils) can cause derailment
ships	landside facilities	docks relatively earthquake resistant, but other facilities vulnerable; ship itself not the problem, except if near coast for tsunamis

Source: Reitherman, "Earthquake-Caused Hazardous Material Releases," 1982 Hazardous Material Spills Conference Proceedings, Ref. 44.

Section 4
TASK 1c - RAPID SHUTDOWN

This element of Task 1 is aimed at identifying rapid shutdown measures for industries susceptible to emergency shutdown damage. The purpose is to minimize such damage as far as possible so that the startup after an enforced shutdown can be achieved as expeditiously as possible. In the face of emergencies, such as power failures, fires, or impending hurricanes, rapid shutdown of a plant's operations might be required. However, certain industries operate equipment that not only must function continuously (frequently over time spans of years), but also cannot be left unattended. Obviously these cannot be shut down easily in a matter of hours. Abandoning such equipment prematurely can result not only in millions of dollars of equipment damage, but more important, startup after the emergency may be impossible.

From the standpoint of rapid shutdown during emergency situations, industries can be divided into two basic categories: those that are sensitive to rapid shutdown, and those that are not.

The second group of industries can be shut down basically by turning off the utilities and shutting up the building. Examples of such industries would be automobile assembly plants, clothing manufacturing factories, and the like. Since these industries do not pose a shutdown problem, they are not addressed in this study.

The first group of industries, the subject of this study, needs to be identified and the type(s) of damage they may sustain from improper shutdown procedures needs to be determined if one is to be reasonably sure of being able to revive these industries in a postattack environment.

In general, industries that cannot be shut down solely by turning off the utilities would have one or more of the following characteristics:

1. Continuous processes utilizing chemicals that cannot be left in-situ;

2. High temperature processes that cannot be shut down without removal of the contents;

3. Non-continuous industries, which utilize/store hazardous materials that need to be properly disposed of before the plant can be abandoned.

Examples of the first group of industries that are sensitive to rapid shutdown would include petroleum refining and petrochemicals, rubber and plastics, and chemical and fertilizer plants. The second group includes the iron and steel industry, aluminum smelting, glass and ceramics, cement, and other metal smelting and refractory industries. A good example of the third group is the chemical explosive industry.

The damage(s) such industries could suffer from improper shutdown, though rather varied, can be classified in general categories, as follows:

1. Freezing of melt in furnace
2. Thermal damage
3. Explosion
4. Clogging and fouling
5. Corrosion
6. Fire
7. Coagulation and hardening of material
8. Warping

Freezing of metal in the furnace when a charged furnace is suddenly abandoned is of course unique to the metal smelting industry. If the metal that is thus abandoned is one with a low melting point, such as tin or lead, then it can be relatively easily remelted, the furnace drained, and repairs carried out at a later date. However, if it is a high melting point metal, such as iron or copper, then the possibility of remelting it to drain the furnace is not only non-existent, but the whole smelting facility will have to be abandoned. Hence, the only reasonable means of preserving the facility for any form of reuse at a later date first requires draining the furnace or vessel of the liquid metal contained therein. Though this may sound straightforward, it is not such a simple matter, especially when it comes to sophisticated equipment such as blast furnaces.

Associated with the problem of draining the furnace of liquid metal (to avoid damage item 1) is the problem of the subsequent cooling down of the furnace so that the refractories are not damaged by spalling and cracking, thus falling off the steel superstructures. Such problems are not unique to the metal smelting industry, but are relevant to all processes using high temperatures, such as the cement industry, refractory industry, glass industry, and other ceramic industries. This is the third item referred to in the list of damages above.

The possibility of explosion exists not only in facilities manufacturing explosives, but also in other facilities where explosive materials may tend to accumulate when the equipment is simply switched off or left untended. Petroleum refining and petrochemical industries naturally run this risk because of the high concentration of flammables and explosive gases such as methane. An important industry that is not generally known to run this risk is the iron and steel industry; the blast furnace becomes highly susceptible to explosion risks due to the accumulation of carbon monoxide when improperly shut down or abandoned.

Clogging and fouling of tanks, valves, pipes, etc., occur primarily in facilities that process suspensions, such as alumina refining plants, and other facilities that may use large stand tanks and/or mixer settlers, flotation tanks, etc. In these facilities abandonment causes the suspended particles to settle to the bottom of the vessel, and slowly harden with time, resulting in freezing of propellers and other mixing equipment within it, thus rendering them ineffective. The same solids could also settle in the pipelines, thus clogging them and making them unusable. In the best case such clogging might be slowly removed by maintenance crews chipping at the residue with, perhaps, jackhammers. In the worst case it could require total replacement of the equipment including the piping.

Corrosion of vessels and pipes is another problem that could naturally arise when material is left untended, especially when strongly acidic or basic liquids are being handled.

Fire is a risk in the rapid shutdown of many plants, for example, when molten materials must be jettisoned or dumped or when processes involving removal of volatile byproducts are interrupted.

In industries such as the rubber or plastic industry where materials to be processed are kept warm and fluid to make them workable, unplanned shutdown or abandonment would result in the material cooling down and coagulating in the process, thus clogging up processing machines, container vessels, pipes, etc.

Warping due to stresses induced by too rapid cooling is probably best known in the case of turbines, which have to be cooled down rather carefully in order to avoid this. Other equipment susceptible to such damage could be boilers, heat-exchangers, and equipment where alignment of the components is important.

The major groups of industries that are prone to shutdown damage, and the general problem areas associated with this rapid shutdown in each of these industries are summarized in Table 4-1.

Figure 4-1 shows a decision tree flow chart that enables the plant engineer who is faced with shutting his plant down in a very short period of time to quickly identify the general nature of the problem at hand, pursue this to define the specifics of the critical situations, and then proceed with specific situations and solutions applicable thereto.

Two of the specific problem areas in rapid shutdown have been studied in this reporting period:

TABLE 4-1: MAJOR INDUSTRIES SUSCEPTIBLE TO RAPID SHUTDOWN DAMAGE

	Melt Freeze	Thermal	Explosion	Clogging & Fouling	Corrosion	Fire	Coagulation	Warping
Iron & Steel	x	x	x					
Coke & Coal Chemicals		x						
Alumina Refining				x	x			
Aluminum Smelting	x							
Other Non-ferrous Smelting	x	x						
Glass & Ceramics	x	x						
Cement		x						
Crude & Natural Gas			x			x		
Petroleum Refining & Petrochemicals		x	x			x		
Rubber & Plastics			x			x	x	
Industrial & Agricultural Chemicals		x	x	x		x		
Thermal Power Plant		x						x
Chemical Explosives			x			x		

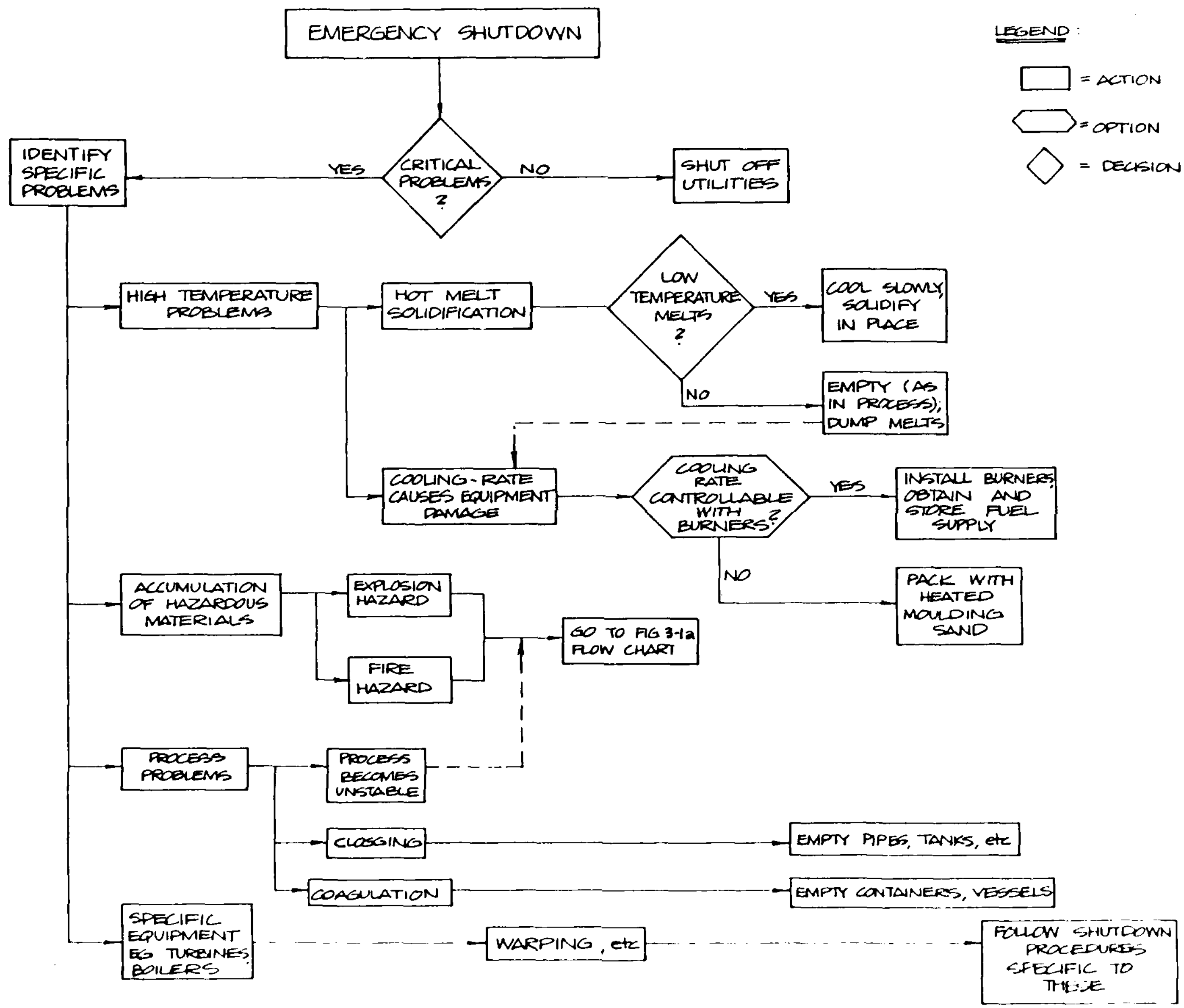


Fig. 4-1. Decision Sequence Flow Chart for Emergency Shutdown.

1. Shutdown when toxic (hazardous) materials are involved is developed under Task lb (see Figure 3-1a).

2. Shutdown when hot melt solidification is the problem; the sheet glass industry is taken as an example.

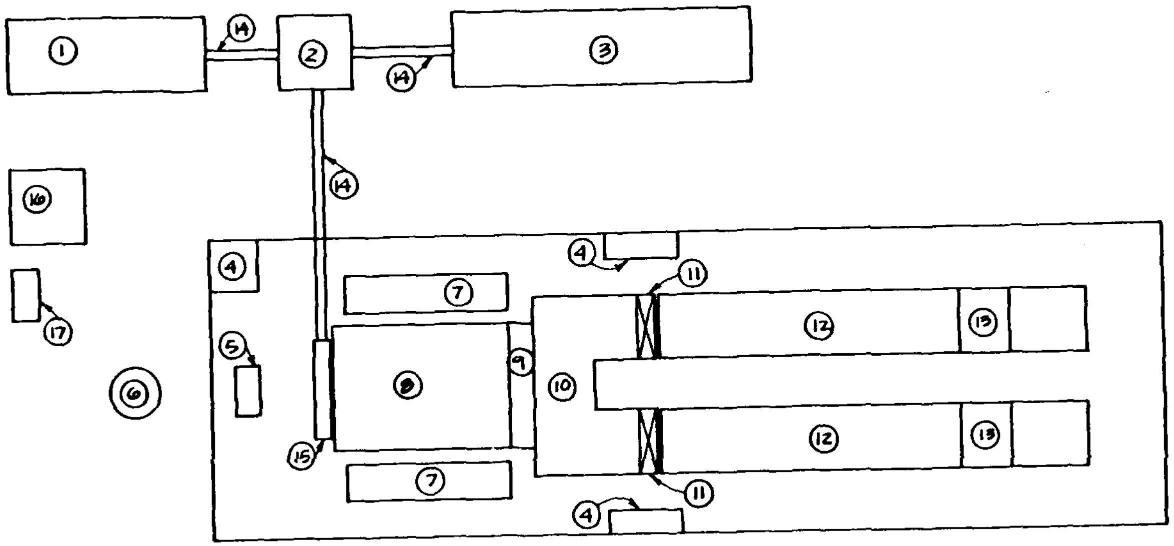
The shutdown procedure for the latter case has been developed in detail as indicative of the approach that would be used. It should be stressed at this point that, while the various metallurgical industries have several production similarities, they also have significant process differences that warrant the development of shutdown procedures individually for each of these industries. To cover these differences, and for the country to be prepared (in any reasonable way) for unexpected emergencies, it is imperative that similar detailed shutdown procedures (with flowsheets and detailed procedures) be prepared for all the critical industries. This would require onsite visits and the cooperation of these industries, hence the importance of the Task 4 effort to develop rapport with industry.

Once development of these detailed shutdown procedures is completed, the procedures will be submitted to selected industries for review and revision, before being utilized to redefine the generic shutdown procedures. This iterative process could result in a generic flowsheet applicable either to all industries or to just the industries in one group, with detailed flowsheets applicable to specific industries. Hence, while the former flowsheet will have general distribution, the latter's distribution could be limited.

Shutdown of a Sheet Glass Plant

The salient features of a sheet glass plant are shown in Figures 4-2 to 4-4, with special reference to those portions of the plant that would be specifically sensitive to rapid shutdown.

The principal danger in abandoning a sheet glass plant is solidification of the molten glass in the furnace. The main furnace is generally about 4 ft deep, 20 ft wide, and 80 ft long. The refining furnace extends another 30 ft in length (see Figure 4-2). Removal of the glass, if left to solidify, would be an impossible task.



LEGEND

1. RAW MATERIALS, HOPPERS & SCALES
2. BATCH MIXER
3. SILICA SAND STORE & SCALES
4. CONTROL ROOMS
5. REVERSAL VALVE
6. STACK
7. REGENERATORS
8. MELTING FURNACE
9. DROP CURTAIN
10. REFINING FURNACE
11. DRAWING MACHINES
12. ANNEALING LEHRS
13. CUTTING TABLES
14. CONVEYOR BELTS
15. BATCH FEEDER
16. HEAVY OIL STORAGE TANK
17. LPG/LNG TANK

OTHER MAJOR EQUIPMENT NOT SHOWN

1. DIESEL STANDBY GENERATOR (1 OR 2)
2. COMPRESSORS (2)
3. TURBO-BLOWERS (2)
4. FAN-BLOWERS (6~8)
5. COOLING WATER PUMPS (5~6)
6. COOLING TOWER OR COOLING POND WITH PUMP HOUSE
7. OVERHEAD CRANE (2~4)
8. WORKSHOP MACHINE TOOLS
9. FORKLIFTS
10. MAIN TRANSFORMER & SWITCHING GEAR
11. DUST COLLECTORS
12. CULLET CRUSHERS.

Fig. 4-2. Sheet Glass Plant Layout.

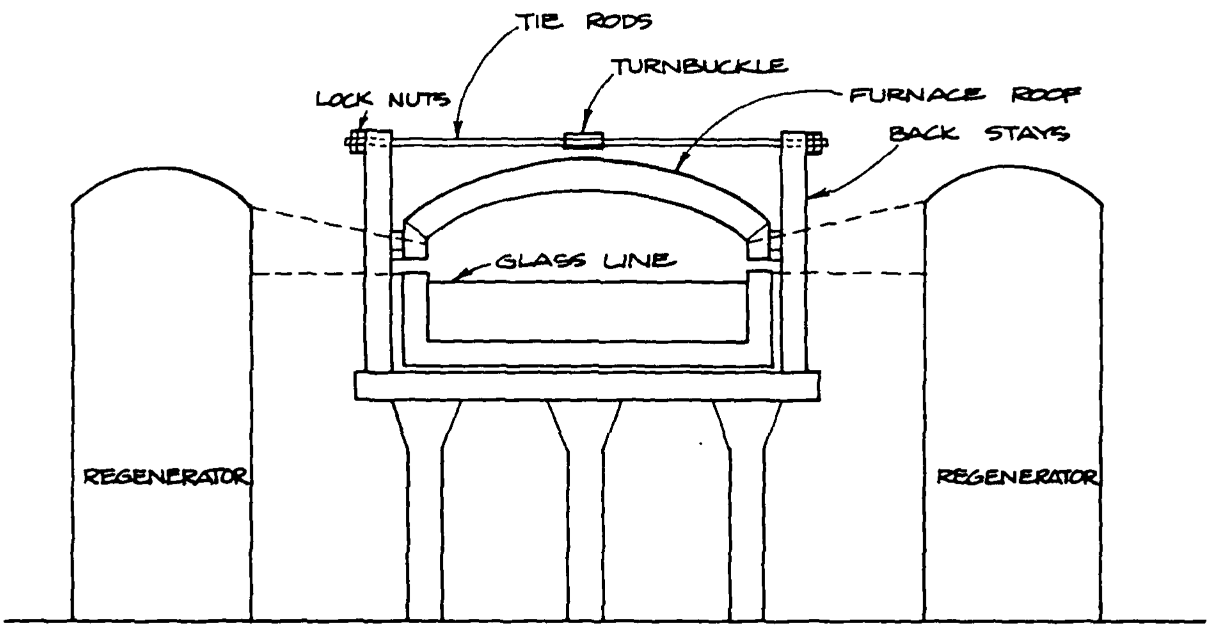


Fig. 4-3. Cross Section of Sheet Glass Tank Furnace and Regenerators.

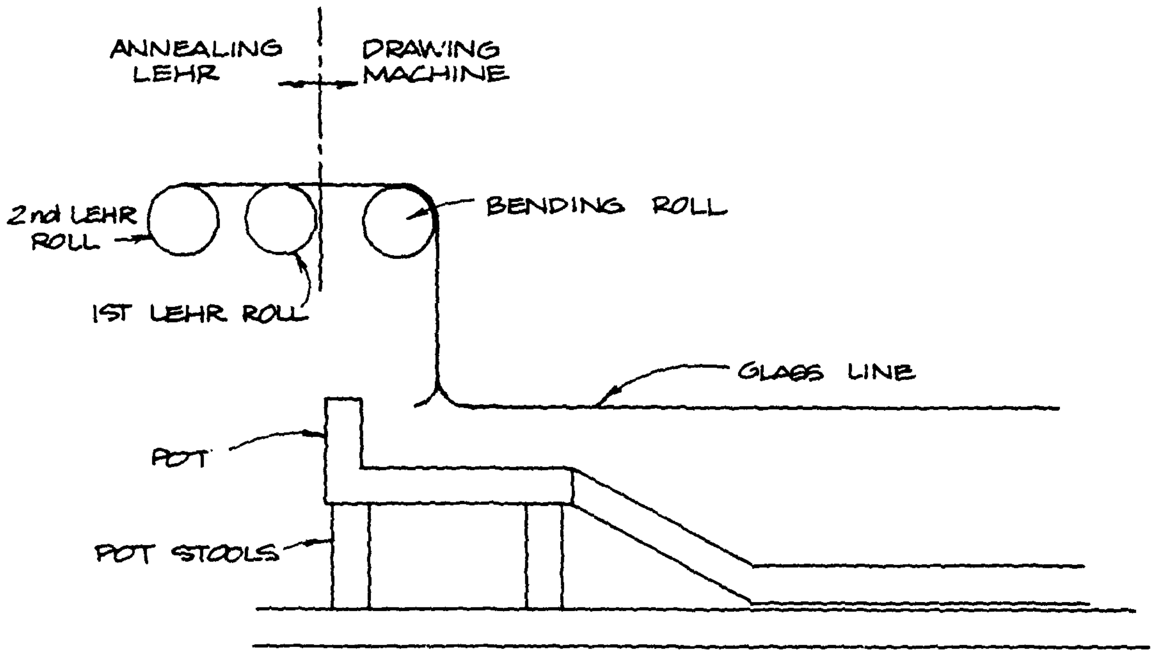


Fig. 4-4 Schematic Diagram of Colburn Type Sheet Glass Drawing Machine.

Thus, the first priority, in order to conserve the plant for later use, would be to drain the furnace of as much molten glass as possible. All furnaces are equipped with at least one drain-hole that is used for draining the furnace during shutdown repair. Under normal circumstances the draining takes 24 hours. This could be decreased to 18 hours by increasing the furnace temperature and allowing the glass to drain without regulating its flow.

After draining the furnace the crucial task of cooling the furnace begins, and under normal shutdown conditions takes about a week, but could be accomplished in 18 hours in an emergency with relatively minor damage. The main requirement is to prevent the collapse of the roof, which is an arch supported by its own tension, by controlling the cooling rate. Normally, as the furnace cools, the back stays are tightened, to provide sufficient tension for support of the roof (see Figure 4-3). It is possible to tighten the back stays while the furnace is being drained; however, this should be undertaken with extreme caution, so that the tie-rods and welds are not strained beyond their yield point.

Other portions of the plant not capable of immediate shutdown are the drawing machines and annealing lehrs (ovens for glass manufacture). Both items are vital for production, and not to be found in other industries, so need to be hardened for industry survival. A paradox exists because shutdown is required for effective hardening.

The Libby-Owens-Ford type Colburn Drawing Machine is typical, and a cross section of this machine illustrating the most essential features is shown in Figure 4-4. The bending roll is a highly polished, nickel-chromium, centrifugally cast roller, which is essential to the process. It should be removed and placed in a protected position. Likewise the pot, a refractory piece that is hand molded, aged, and slowly fired to 1000°C before being put in place. The possibility of saving the pot during cooling down is very remote. However, most sheet glass plants carry at least one or two spare pots on hand, and these should be protected from any possible damage.

The annealing lehr is used for gradually cooling the glass sheet down to room temperature. The first section, adjacent to the drawing machine, is maintained at around 800° - 850°C, and the last section at around 100°C. The main damage that would arise from an instantaneous shutdown would be warping of the rollers.

An engineer whose responsibilities included shutdown of operations in a glass plant developed the following shutdown plan to reflect the sequential order of the operations, on an hour-by-hour basis. It may have pertinence to other glass plants as an emergency expedient. The procedure assumes that there will be only about 20 to 30 skilled workers available, operating under the instructions of technical managers or engineers. The number of workers necessary for each operation is shown in parentheses after each operation.

PROPOSED SHEET GLASS PLANT EMERGENCY SHUTDOWN PROCEDURE

1st Hour

1. Turn on standby power supply, switch over from, and isolate main power supply. (2)
2. Prepare and install furnace draining equipment. (5)
3. Stop batch plant. (1)
4. Increase furnace temperature. (1)
5. Prepare to break sheet and remove bending roll. (5)
6. Turn on sheet breaker (at cutting table). (1)
7. Check original setting of furnace back-stay locknuts and turnbuckles (from construction or startup records). (3)
8. Remove batch feeder. (2)

2nd Hour

1. Begin furnace draining. (5)
2. Break sheet. (5)

3. Remove bending roll and knurl rollers. (10)
   Attach bending roll to drive mechanism outside drawing machine, and leave running to prevent warping.

4. Increase lehr speed, open all windows on lehr, and leave lehr running. (3)

5. Start tightening furnace back-stay locknuts with great care, while watching furnace roof. This has to be done with great care, making sure that neither the tie-rods nor the welds at the bottom of the back stay are strained beyond their yield point. If this does happen the results can be disastrous.) (8)

3rd Hour

1. Furnace draining continued. (5)

2. Furnace back-stay locknuts tightening continued. (8)

3. Turn off gas burners (furnace, lehr, and machine); disconnect pipeline at LNG/LPG tank, and purge all pipelines. (5)

4. Vent off all gas from tank, as necessary. (2)

5. Harden building area in which spare pots are kept. (3)

6. Check oil tank for spill protection. Build sandbag berms, if necessary, to prevent spreading of any spill. (5)

4th Hour

1. Furnace draining continued. (5)

2. Furnace back-stay locknuts tightening continued. (8)

3. Remove furnace blowers and reinstall at position of batch feeder. (Preparation for cooling down of furnace). (4)

5th to 18th Hour

1. Furnace draining continued.

2. When furnace draining completed, shut off heavy oil lines.

Section 5
TASK 2 - EQUIPMENT INVENTORY

Specifically, this task was to work on equipment inventory aspects of industrial hardening (see Figure 1-1), to determine typical production elements that affect numerous plants. The underlying rationale for special interest in these production elements is that certain plant equipment will be quite unique — either to the process or to the industry — hence, close to (if not actually) irreplaceable. Clearly, in a national disaster, unique equipment in industries essential to survival must be hardened to ensure survival of essential production capability. Common pieces of equipment may not need to be hardened at all because larger inventories are available among distributors and more of these units will survive, because larger numbers in use will increase the probability of finding undamaged units, and because those industries that are absolutely essential to survival could borrow such common elements from those that are not, during a critical survival period. The major significant benefit that will accrue from identifying these common production elements is the saving in resources (time and material) that must be committed to hardening.*

Several different approaches that could build on an existing data system have been examined. An initial list of common production elements was developed by going through an alphabetical listing of manufacturing industries in Ref. 45 and making a subjective selection of items that seemed likely to qualify — on the basis of the practical experience of the analyst. In the second approach, the literature was searched for a basis or methodology for generating a list of common items. And in the third approach, data compiled from detailed energy audits of a number of plants of different types were examined simply to find the most frequently appearing

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* For this reason, it will be of interest to assess the hardening process for these items, and even to determine if, perhaps, they might be put to use as buffers to protect other equipment.

items. (Energy audit data require a comprehensive listing of all operating equipment to reach an energy balance between supply and demand.)

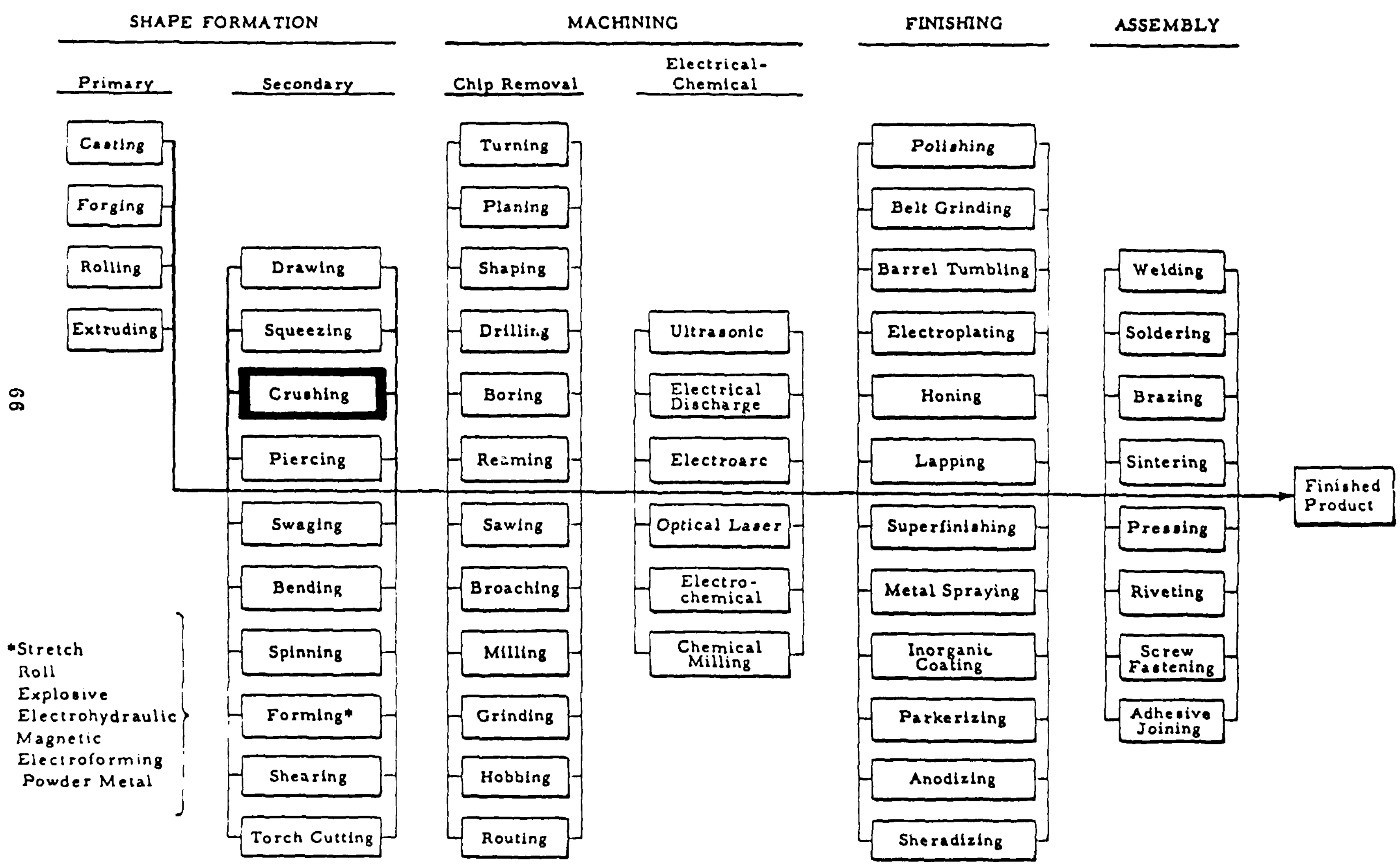
Table 5-1 lists common production elements selected by sorting through an existing alphabetical compilation of manufacturing industries contained in one section of the Standard Industrial Classification Manual maintained by the Office of Management and Budget. A major question is how to identify when the list is complete insofar as the term "common" is concerned. Setting this problem aside for the present, a related task requires defining a practical method for generating end-use information on these items. In the table, the SIC four digit classification that corresponds to the manufactured item has also been indicated. Through this numerical classification, it is possible to identify specific locations of manufacturers and probably warehouses for such equipment (but not the much larger reservoir of end-users) by resorting to yet additional sets of data available from National Business Lists, Dun and Bradstreet, and other such firms. Moreover, as part of these services, special lists can be obtained that delineate size of manufacturing company, albeit on an economic basis. Even so, an economic size breakdown will be indicative of who the big producers are as well as quantities of units each manufactures annually and what is stockpiled (inventoried) in warehouses. To identify the much larger reservoir suppliable by end-users would require some additional procedures.

Table 5-2 makes use of data presented in a report (Ref. 46) on industrial vulnerability. The table provides a generic organization of mechanical, electrical, and chemical machining processes without specifically defining a particular piece of equipment. Each entry in this table may be used to generate a whole list of different pieces of equipment that will perform the indicated operation, and some of this equipment might be common and some not; it is the operation that is common. (Keying to operations, rather than equipment, would be more versatile with regard to developing guidelines for substitution of totally different equipment to perform a given critical operation.) For each process, items could be listed that will do the indicated operation and then sorted for the property "common". However, it is important to note that following this approach would leave gaps. For example, thermal/hydraulic and optical processes are not included in Table 5-2, so common items such as heat exchangers and optical quality control mechanisms would not be

TABLE 5-1: SELECTED COMMON PRODUCTION ELEMENTS

Product	SIC
Pipe and Tubing	
Steel pipes & tubes (boiler)	3317
Copper, brass, bronze tubing	3351
Metalic, flexible	3599
Tubing, seamless steel	3312
Aluminum tubing, extruded or drawn	3354
Aluminum tubing, welded	3353
Blowers	3564
Boiler, controls	3823
Boiler, low pressure	3433
Compressors	3563
Cranes, industrial, overhead travel	3563
Pumps, hydraulic	3561
Valves, automatic control, hydraulic, pneumatic	3494
Electric controllers (electronic, ind. process)	3823
Electric furnace transformers	3612
Electric heat proportioning control	3822
Motor controls, electric	3622
Motor generator sets	3621
Motors, electric	3621
Heat exchanger, including boilers	3443
Burners, gas/oil, industrial & domestic	3433
Furnace, industrial process	3567
Tanks	3443

TABLE 5-2: BASIC MANUFACTURING PROCESSES



developed from this list, but would require a study to develop a corresponding generic organization of such processes.

The energy audit data that were used to compile a list of common equipment were obtained from proprietary data reorganized to identify items that appeared frequently at the seven plants surveyed. This procedure combines the characteristic "common" with another aspect of common, the property "prevalence," i.e., all seven plants had the item, and each plant had many of them. There were three items that readily fit this discrimination procedure, pumps, blowers, and compressors. (All three of these classifications are on the list in Table 5-1, none could be derived from Table 5-2.) These data are presented in Table 5-3. They are organized by item, voltage, and horsepower rating. Within the category "pump," the seven plants surveyed had 163 units and over a dozen (and, perhaps, two dozen) categories (data were insufficient to identify all units specifically). There were vacuum pumps, diffusion pumps, oil hydraulic pumps, air pumps, water pumps, centrifugal pumps, trash pumps, sump pumps, sludge pumps, jet-pumps, solvent pumps, etc. They operated on 110/120, 208, 220/240, 440/480 volts input, with sizes from 0.25 horsepower to 75 horsepower. Information on intake requirements and discharge head capabilities was not available. (Such information would also be necessary for decisionmaking and would be a necessary part of a useful catalog. See, for example, Table 5-4 taken from Ref. 47.)

There are benefits and drawbacks to each of these approaches, and no <u>single</u> method of developing an all-purpose list has been synthesized that would enable a straightforward transformation process to produce the desired catalog required under Task 3. Table 5-1 does enable fairly complete listings of item manufacturers (and we believe, distributors also) to be acquired among existing data bases so that specific locations of warehouses, and manufacturers' inventories, might be compiled in a catalog. The effort to take this approach to the next desired stage, i.e., to <u>identify end-users,</u> would require access to the distributors' client lists, while to determine actual <u>quantities</u> and <u>sizes</u> of items in use in the different industries (such as was acquired from the energy audits) would require the distributors' lists together with all the cumulative marketing information of all the distributors of the selected essential products over the years. The alternative would be to somehow obtain direct access to plants (as with the energy audits) to compile the desired inventory. Even then, not all plants could be surveyed — some classifications at the 4-digit level encompass 50 to 100 different industries and even more different processes. Thus, to obtain reliable data on items available at the level of a specific type of plant would require sampling from many hundreds of plants just to deal with a single 4-digit group — and there are a great many of these 4-digit groups. Nevertheless, even without data on quantities of common items of each type broken down by industries, the knowledge of most probable industrial sources would be of value.

An important factor to consider as part of the deliberations in deciding a method for obtaining the desired data is the manner of presentation that will make the data useful, and the uses that might be made of the catalog — which is the subject of Task 3.

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS

CATEGORY: PUMPS

Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
		PLANT TYPE						
Water	110/120		1 @ 0.25					
Water	440/480		1 @ 0.75					
Water	440/480		1 @ 1.5					
Water	110/120		1 @ 1.5				1 @ 1.5	
Water	440/480		1 @ 2.0					
Water	440/480		1 @ 3.0					
Water	440/480		1 @ 7.5					
Water	440/480	2 @ 40.0	1 @ 10.0					
Water	440/480		1 @ 75.0					
Mechanical	110/120				1 @ 1.0			
Mechanical	440/480				2 @ 1.5			
Mechanical	440/480				2 @ 2.0			
Mechanical	440/480				3 @ 5.0			
Mechanical	440/480				1 @ 7.5			
Mechanical	440/480				2 @ 10.0			
Feed	440/480		2 @ 2.0					
Feed	440/480		2 @ 7.5					
Feed	440/480		2 @ 25.0					
Feed	440/480		1 @ 30.0					
Transfer	440/480		2 @ 1.0					
Transfer	440/480	2 @ 1.0	1 @ 1.5					
Transfer	440/480	5 @ 5.0	1 @ 2.0					
Transfer	440/480	1 @ 10.0	1 @ 3.0					
Circulating	110/120	1 @ 1.5	1 @ 0.5					
Circulating	440/480		2 @ 2.0					
Circulating	440/480		2 @ 3.0					
Circulating	440/480	2 @ 5.0	1 @ 15.0					
Receiving	440/480		2 @ 1.5					

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: PUMPS

Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
		PLANT TYPE						
Receiving	220/240			2 @ 2.0				
Batch Receiver	440/480		1 @ 2.0					
Tank	440/480		1 @ 2.0					
Viking Ammonia	440/480			1 @ 3.0				
Notcher-Hydraulic	440/480							1 @ 3.0
Viking Ammonia	440/480			1 @ 5.0				
540	440/480					1 @ 5.0		
540	440/480					1 @ 10.0		
Cooling Tower	208						1 @ 1.5	
Cooling Tower	440/480		2 @ 75.0		2 @ 30.0	1 @ 22.5		2 @ 25.0
Condensate Feed	110/120						2 @ 0.25	
Condensate Feed	440/460		1 @ 7.5					
Discharge, Vitamin Mixing	440/480	1 @ 1.0						
Tank	440/480	1 @ 1.0						
Sump	440/480	1 @ 5.0		1 @ 5.0				
Sludge	440/480		2 @ 2.0					
Sludge	440/480		1 @ 3.0					
Hydraulic	440/480		3 @ 1.5					1 @ 3.0
Hydraulic	440/480		8 @ 60.0					1 @ 5.0
Oil	440/480	1 @ 5.0		1 @ 0.5				
Oil	220/240			1 @ 1.0				
Fuel Oil	440/480			1 @ 3.0				
Oil	440/480	2 @ 5.0		2 @ 5.0				
Fryer Oil	220/240			1 @ 1.0				
Oil System Cooling	440/480		1 @ 0.25					
S.W. Unit	440/480		1 @ 0.5					
Butter	220/240			1 @ 2.0				
Dough Mixer Door	440/480	1 @ 2.0						
Solvent	440/480		1 @ 2.0					

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: PUMPS

		PLANT TYPE						
Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
Solvent Condensate	440/480		1 @ 2.0					
Paint	440/480							1 @ 2.0
Test	200				1 @ 2.0			
Glue	440/480							1 @ 1.5
Dust Collector	440/480	1 @ 0.75						
Screen Wash	110/220						1 @ 0.75	
Vacuum	110/120				1 @ 0.33		3 @ 0.25	
Vacuum	110/120				1 @ 1.0		1 @ 0.33	1 @ 0.5
Vacuum	440/480	1 @ 1.0						
Vacuum	220/240						1 @ 1.0	
Vacuum	110/120				3 @ 1.5			
Vacuum	440/480				1 @ 5.0			1 @ 5.0
Vacuum	440/480				4 @ 7.5			
Vacuum	440/480		2 @ 10.0		4 @ 10.0			
Vacuum	440/480		1 @ 15.0					
Vacuum	440/480		1 @ 25.0					
Vacuum	440/480		4 @ 30.0	1 @ 30.0				
Vacuum	220/240		1 @ 30.0					
Vacuum	440/480		1 @ 40.0					
Diffusion	110/120				1 @ 0.2			
Diffusion	110/120				1 @ 2.5			
Diffusion	208				1 @ 3.0			
Diffusion	220/240				3 @ 6.0			
Diffusion	440/480				5 @ 15.0			
Diffusion	440/480				2 @ 27.0			
Air	440/480		1 @ 10.0					
Air	220/240						2 @ 10.0	
Roto Jet	440/480			1 @ 60.0				

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: COMPRESSORS

Type	Voltage	PLANT TYPE Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
Air	208				1 @ 3.0			
Air	208				2 @ 5.0			
Air	208				2 @ 6.0		1 @ 6.0	
Air	208						1 @ 7.0	
Air	208				1 @ 7.5			
Air	208						1 @ 8.0	
Air	208				2 @ 8.5			
Air	208						1 @ 10.0	
Air	208				2 @ 11.0			
Air	208				3 @ 11.5			
Air	208						1 @ 14.0	
Air	208				6 @ 15.5			
Air	208						4 @ 18.0	
Air	208						1 @ 25.0	
Air	208						1 @ 60.0	
Air	220/240			1 @ 1.0				
Air	220/240				1 @ 4.0			
Air	220/240			1 @ 5.0	1 @ 5.0			
Air	220/240			1 @ 6.0				
Air	220/240			1 @ 7.0				
Air	220/240				2 @ 9.5			
Air	440/480				1 @ 5.0			
Air	440/480							1 @ 6.0
Air	440/480				7 @ 7.0			
Air	440/480	1 @ 7.5				1 @ 7.5		
Air	440/480				1 @ 8.0			
Air	440/480		3 @ 12.0					
Air	440/480							1 @ 15.0
Air	440/480					2 @ 15.0		

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: COMPRESSORS

		PLANT TYPE						
Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
Air	440/480							1 @ 17.5
Air	440/480		1 @ 20.0			1 @ 20.0		
Air	440/480		3 @ 25.0					
Air	440/480						2 @ 35.0	
Air	440/480					1 @ 40.0		
Air	440/480						2 @ 46.0	
Air	440/480		1 @ 50.0	2 @ 50.0				
Air	440/480					1 @ 60.0		
Air	440/480		4 @ 75.0					
Screw	440/480							2 @ 75.0
Air	440/480		1 @ 100.0					
Air	440/480				2 @ 150.0			2 @ 150.0
HVAC	220/240			1 @ 6.5				
Chiller	208			1 @ 20.0				
Chiller	440/480	1 @ 20.0	2 @ 20.0	1 @ 20.0				
Chiller	440/480		1 @ 50.0					
Chiller	440/480					1 @ 100.0		

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: BLOWERS

		PLANT TYPE						
Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
Exhaust	110/120				1 @ 0.1			
Exhaust	110/120				1 @ 0.2			
Exhaust	110/120				3 @ 0.25			
Exhaust	110/120				11 @ 0.33			
Exhaust	110/120				10 @ 0.5		1 @ 0.5	
Exhaust	110/120						2 @ 1.5	
Exhaust	220/240			1 @ 0.5				
Exhaust	220/240				1 @ 0.6			
Exhaust	220/240				3 @ 0.75			
Exhaust	220/240				2 @ 1.0			
Exhaust	220/240			5 @ 15.0				
Exhaust	440/480		1 @ 0.25					
Exhaust	440/480		2 @ 0.5					
Exhaust	440/480		7 @ 0.75		5 @ 0.75			
Exhaust	440/480	7 @ 1.0						
Exhaust	440/480	8 @ 1.5	5 @ 1.5					
Exhaust	440/480	2 @ 2.0	2 @ 2.0	6 @ 2.0				2 @ 2.0
Exhaust	440/480	5 @ 3.0	2 @ 3.0					
Exhaust	440/480	6 @ 5.0	3 @ 5.0					
Exhaust	440/480	5 @ 7.5						
Exhaust	440/480				1 @ 9.0			
Exhaust	440/480	14 @ 10.0	1 @ 10.0					
Exhaust	440/480		2 @ 50.0					
Exhaust	440/480		2 @ 100.0					
Circulating	110/120				1 @ 0.25			
Circulating	110/120				5 @ 0.33			
Circulating	208				2 @ 0.4			
Circulating	208				2 @ 0.5			
Circulating	208				1 @ 1.0			

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: PUMPS

Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
Circulating	208				2 @ 1.3			
Circulating	208						1 @ 2.0	
Circulating	220/240				2 @ 0.33			
Circulating	220/240				2 @ 0.5			
Circulating	220/240			1 @ 1.0				
Circulating	220/240				1 @ 1.6			
Circulating	440/480				8 @ 1.0			
Circulating	440/480	1 @ 1.5						
Circulating	440/480	2 @ 2.0			2 @ 2.0			
Circulating	440/480	1 @ 3.0			2 @ 3.0			
Circulating	440/480	9 @ 5.0						
Circulating	440/480	2 @ 7.5	1 @ 7.5					
Circulating	440/480	1 @ 10.0			1 @ 10.0			
Circulating	440/480	1 @ 40.0						
Circulating	440/480		1 @ 60.0					
Condensor	208				1 @ 0.06			
Condensor	208				4 @ 0.15			
Condensor	208				1 @ 0.17			
Condensor	208				6 @ 0.25			
Condensor	208				5 @ 0.33			
Condensor	208				1 @ 0.5		2 @ 0.5	
Condensor	208						2 @ 0.67	
Condensor	208						2 @ 1.0	
Condensor	208						2 @ 1.8	
Condensor	208			1 @ 2.0				
Condensor	208						12 @ 2.75	
Condensor	220/240				2 @ 0.13			
Condensor	220/240				1 @ 0.25			
Condensor	220/240				2 @ 0.33			

TABLE 5-3: DATA SUMMARY OF MOST COMMON PRODUCTION ELEMENTS AT SEVEN PLANTS (contd)

CATEGORY: BLOWERS

Type	Voltage	Food #1 (HP)	Food #2 (HP)	Food #3 (HP)	Instr. Mfg. (HP)	Struc. Prod. (HP)	Hat Mfg. (HP)	Plastics Former (HP)
		PLANT TYPE						
Condensor	220/240			2 @ 0.5	7 @ 0.5			2 @ 0.5
Condensor	220/240			2 @ 1.1				
Condensor	440/480				2 @ 0.23			
Condensor	440/480							2 @ 0.25
Condensor	440/480	2 @ 0.5						
Condensor	440/480							2 @ 1.5
Condensor	440/480						6 @ 6.0	
Cooling	440/480	2 @ 3.0	4 @ 3.0					
Cooling	440/480	1 @ 5.0						
Cooling	440/480		1 @ 10.0					
Scrubber	440/480		1 @ 1.5					
Combustion	440/480		1 @ 20.0					
Cupola	440/480					4 @ 2.0		
Miscellaneous	110/120			2 @ 0.16				
Miscellaneous	110/120				5 @ 1.4			
Miscellaneous	220/240			1 @ 0.5				
Miscellaneous	220/240		2 @ 1.0					
Miscellaneous	220/240							2 @ 1.5
Miscellaneous	440/480		1 @ 5.0					
Miscellaneous	440/480	1 @ 7.5						
Miscellaneous	440/480		2 @ 10.0					
Miscellaneous	440/480			11 @ 10.0				
Miscellaneous	440/480		1 @ 10.0					
Miscellaneous	440/480		1 @ 15.0					
Miscellaneous	440/480	1 @ 15.0						
Miscellaneous	440/480	1 @ 30.0						
Miscellaneous	440/480		2 @ 30.0					
Miscellaneous	440/480	1 @ 40.0						
Miscellaneous	440/480		1 @ 60.0					

TABLE 5-4: EXAMPLE OF SEVEN-DIGIT SIC BREAKDOWN

PUMPS	PRODUCT CODE
Industrial pumps, except hydraulic fluid power pumps	
Reciprocating pumps	
Direct-acting steam-driven	35611 01
Power-operated, other than steam	35611 03
Turbine pumps, vertical (includes deep-well)	
Submersible, over 5 hp	35611 05
Other than submersible	
16" diameter bowl size and under	35611 09
Over 16" diameter bowl size	35611 10
Centrifugal pumps	
Single stage--single suction, close coupled	
1/2" discharge outlet and under	35611 11
3/4" and 1" discharge outlet	35611 12
1 1/4" and 1 1/2" discharge outlet	35611 14
2" and 2 1/2" discharge outlet	35611 15
3" and 4" discharge outlet	35611 16
Over 4" discharge outlet	35611 19
Single stage--single suction, frame mounted	
1/2" discharge outlet and under	35611 21
3/4" and 1" discharge outlet	35611 22
1 1/4" and 1 1/2" discharge outlet	35611 23
2" and 2 1/2" discharge outlet	35611 24
3" discharge outlet	35611 25
4" to 6" discharge outlet	35611 26
Over 6" discharge outlet	35611 29
Single stage--double suction	
Under 4" discharge outlet	35611 42
4" and 5" discharge outlet	35611 44
6" and 7" discharge outlet	35611 46
8" to 12" discharge outlet	35611 48
Over 12" discharge outlet	35611 49
Multi-stage (single or double suction)	
1 1/2" discharge outlet and under	35611 52
2" and 3" discharge outlet	35611 54
4" and 5" discharge outlet	35611 56
6" and 7" discharge outlet	35611 58
8" and over discharge outlet	35611 59
Propeller and mixed flow	
20" and under	35611 62
Over 20"	35611 64
All other centrifugal pumps (including can, etc.)	
1 1/2" discharge outlet and under	35611 65
2" to 6" discharge outlet	35611 66
Over 6" discharge outlet	35611 69
Rotary pumps	
100 p.s.i. and under, designed pressure	
10 g.p.m. and under, designed capacity	35611 70
11 to 99 g.p.m., designed capacity	35611 71
100 to 299 g.p.m., designed capacity	35611 72
300 g.p.m. and over, designed capacity	35611 73
101 to 250 p.s.i., designed pressure	
10 g.p.m. and under, designed capacity	35611 74
11 to 99 g.p.m., designed capacity	35611 75
100 g.p.m. and over, designed capacity	35611 76
251 to 500 p.s.i., designed pressure	
10 g.p.m. and under, designed capacity	35611 77
11 g.p.m. and over, designed capacity	35611 78
Over 500 p.s.i., designed pressure	35611 79
Other industrial pumps	35611 98
Total industrial pumps	

Source: 1977 Census of Manufactures (Ref. 47)

TABLE 5-4: EXAMPLE OF SEVEN DIGIT SIC BREAKDOWN (contd)

PUMPS	PRODUCT CODE
Domestic water systems and other pumps	
Domestic water systems	
Jet pump and convertible jet pump systems..	35613 13
Nonjet pump systems (except submersible)..	35613 20
Submersible pump systems, 5 hp. and under..	35613 25
Domestic hand and windmill pumps, pump jacks, and cylinders (sold separately)......	35613 70
Domestic sump pumps, 1 hp. and under	
Pedestal..	35615 73
Submersible..	35615 76
Total domestic water systems and domestic sump pumps	
Hydraulic fluid power pumps and motors	
Gear type..	35612 81
Vane type..	35612 83
Piston type	
Axial..	35612 85
Rotary or radial..	35612 87
Total, hydraulic fluid power pumps and motors	
Oil-well and oil-field pumps, except boiler-feed	
Subsurface pumps for oil-well pumping..	35615 11
Slush pumps..	35615 13
Other oil-well and oil-field pumps..	35615 15
Other pumps, except automotive (includes oil burner and appliance pumps, fire engine pumps, laboratory pumps, heating circulator pumps, etc.)....................	35615 96
Total, oil-well and oil-field pumps and other pumps	

Source: 1977 Census of Manufactures (Ref. 47)

TABLE 5-4: EXAMPLE OF SEVEN-DIGIT SIC BREAKDOWN (contd)

COMPRESSORS	PRODUCT CODE
Compressors and vacuum pumps	
Air compressors	
Stationary	
Reciprocating, single acting	
1 1/2 hp and under	35631 01
Over 1 1/2 hp to 5 hp	35631 02
6 hp to 25 hp	35631 03
26 hp and over	35631 04
Reciprocating, double acting	
150 hp and under	35631 05
151 hp and over	35631 06
Rotary positive	
Discharge pressures 50 PSIG and under, all hp sizes	35631 07
Discharge pressures of 51 PSIG and over	
150 hp and under	35631 08
151 hp and over	35631 09
Centrifugal and axial	
50 PSIG and below	35631 14
51 PSIG and over	35631 18
Portable	
Under 75 c.f.m.	35631 31
75-124 c.f.m.	35631 34
125-249 c.f.m.	35631 36
250-599	35631 37
600-899 c.f.m	35631 38
900 c.f.m. and over	35631 39
Gas compressors	
Stationary, centrifugal and axial	
Natural gas	35631 42
All other gases	35631 43
Reciprocating and rotary	
Stationary reciprocating	
Integral engines	
2,000 hp and under	35631 46
2,001-4,000 hp	35631 47
4,001 hp and over	35631 48
Other than integral engines	
1,000 hp and under	35631 51
1,001 hp and over	35631 53
Stationary rotary positive	35631 56
Pneumatic (air) power compressors and motors	35631 81
Other compressors	35631 89
Compressors and vacuum pumps--Continued	
Vacuum pumps, except laboratory	
Low vacuum, 29.5 inches mercury vacuum and lower	35631 93
High vacuum, 29.6 inches mercury vacuum and over	35631 94
Total compressors and vacuum pumps	
Value of drivers (drivers sold with driven units reported above, excluding value of pumps and compressors)	
Industrial pumps	35611 00
Hydraulic fluid power pumps and vacuum pumps	35600 13
Oil-well and oil-field pumps and other pumps	35615 00
Compressors	35631 10

Source: 1977 Census of Manufactures (Ref. 47)

Section 6

TASK 3 - CATALOG AND EQUIPMENT INDEX

The objective of this task was to work on the Catalog and Equipment Index (Booklet 8) to develop a comprehensive listing of elements available in non-essential industries that could be adapted, cannibalized, or procured for use by essential industries. This is visualized as a separate section, or catalog, in itself.

The original concept behind this task assumed that only equipment in non-essential industries would be studied as replacements for essential elements in essential industries. Further analysis indicates that this concept should be expanded to include analysis of non-essential elements of essential industries as well. For example, it has been found that many elements in an essential industry are not required for operation during a crisis period. A case in point was a cannery where it was found that most of the equipment would not be required during a crisis period if minor changes were made in the way the product was packaged and changes in the quality of the product would be allowed. This unused equipment, however, is a valuable resource to replace damaged equipment in the industry where it is located and in other essential industries as well and should be included in the index.

This does two things. It greatly increases the amount and types of equipment that will be available for adaptation and cannibalization by essential industries and effectively eliminates the need to distinguish between essential and non-essential industries for purposes of developing this catalog and equipment index.

To be of value, the catalog would need to provide sufficient specifications for each production element to enable replacements (or substitutes) to be selected, and it would have to identify industry elements where they can be found. What is needed is a method that will put the development of a serviceable catalog on a practical basis. By using a simple initial base, the catalog could then be made more comprehensive, in gradual steps, so that at each successive step another facet of information will be delivered that is immediately useful and usable — but at each stage the system would be operable.

To keep track of the data as it is assembled, a process flow chart will be developed that describes the entire sequence of operations, and breaks it down by wet and dry process lines (Figures 6-1a, 6-1b, and 6-1c). This breakdown will define whether pumps, pipes, valves, and tanks — or conveyors, motors, switches, and bins — are used for material transfer (and storage) between processing operations. On the flow chart, at an industrial operations node where the process involves a common production element, information will be provided that identifies other end-users, by type, likely to have such equipment. At the start of this process, and purely for our use in assembling it, this will be coded in the form of the SIC that categorizes the industry. Figure 6-2, adapted from a flow chart in Ref. 48, indicates an example of the procedure, where four-digit SIC classifications (based on the 1967 system) were used.* The Office of Management and Budget has since changed most of these classifications.

For some industrial groupings, the four-digit level may include 50 to 100 industries, and real process differences, so that a more detailed breakdown will be required to reveal this, e.g., by applying the seven-digit system (Ref. 47). At the seven-digit level, some types of industries in the same four-digit group will be more likely than others to have a specific common production element. This can be brought out in a later stage of catalog development by deleting those types of industries not likely to have the item and ranking the remaining ones — with the most likely source at the top. Even so, there are some situations that will not be discernible from the catalog. For example, a plant involved in a wet process for producing cement will have pumps, pipes, and tanks on hand, but a plant using a dry process will not. (Even at the seven-digit level of breakdown, this difference does not appear.)

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*For the actual catalog, the industry types will be listed for each common production element, by name — e.g., for SIC 2042 (see Figure 6-2) the listing would include "producers of: dog and cat food, canned; fish meal; horse meat; [and eighteen other listings] . . . ."

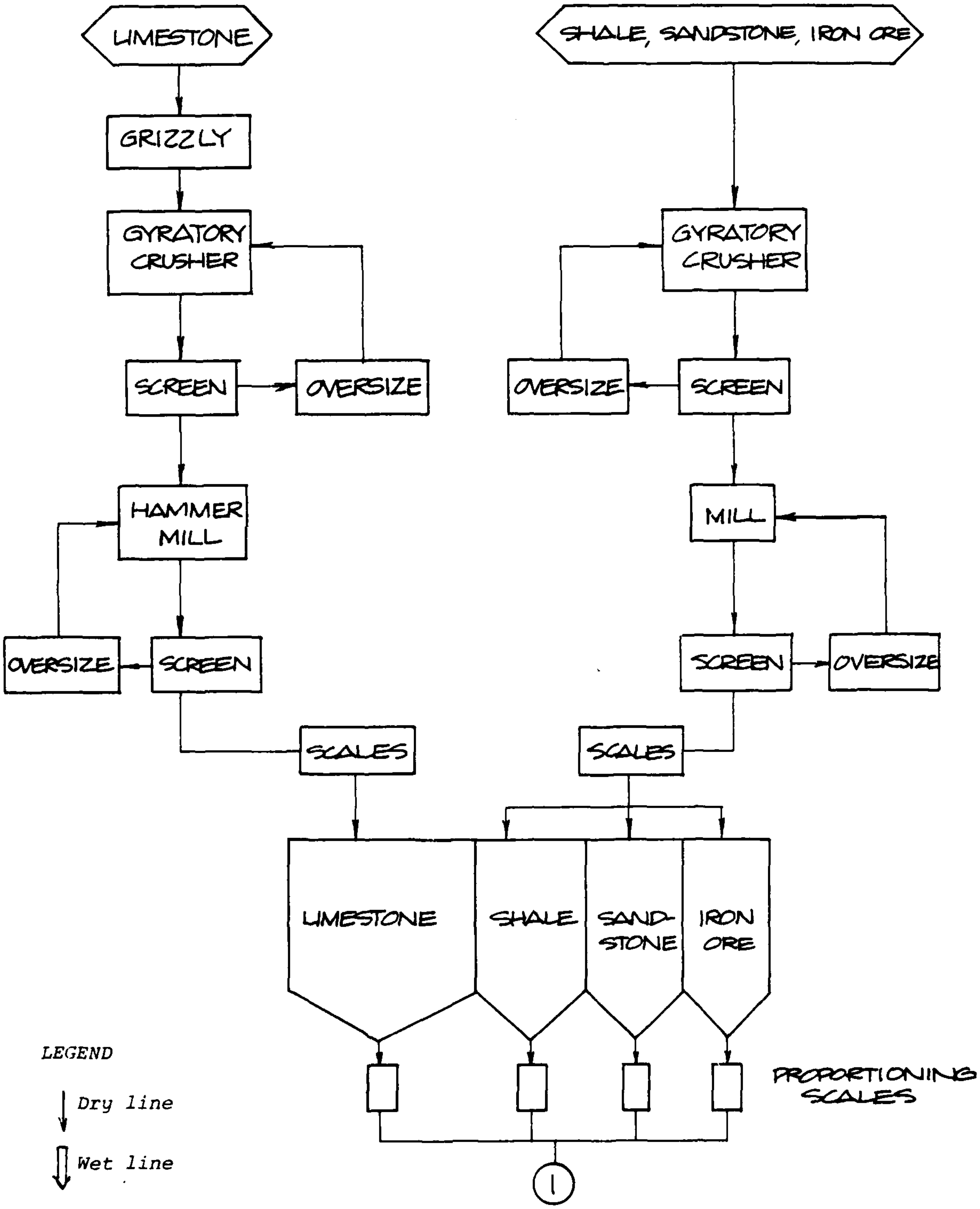


Fig. 6-1a. Flow Chart for Portland Cement Manufacture (SIC 3241), Part 1.

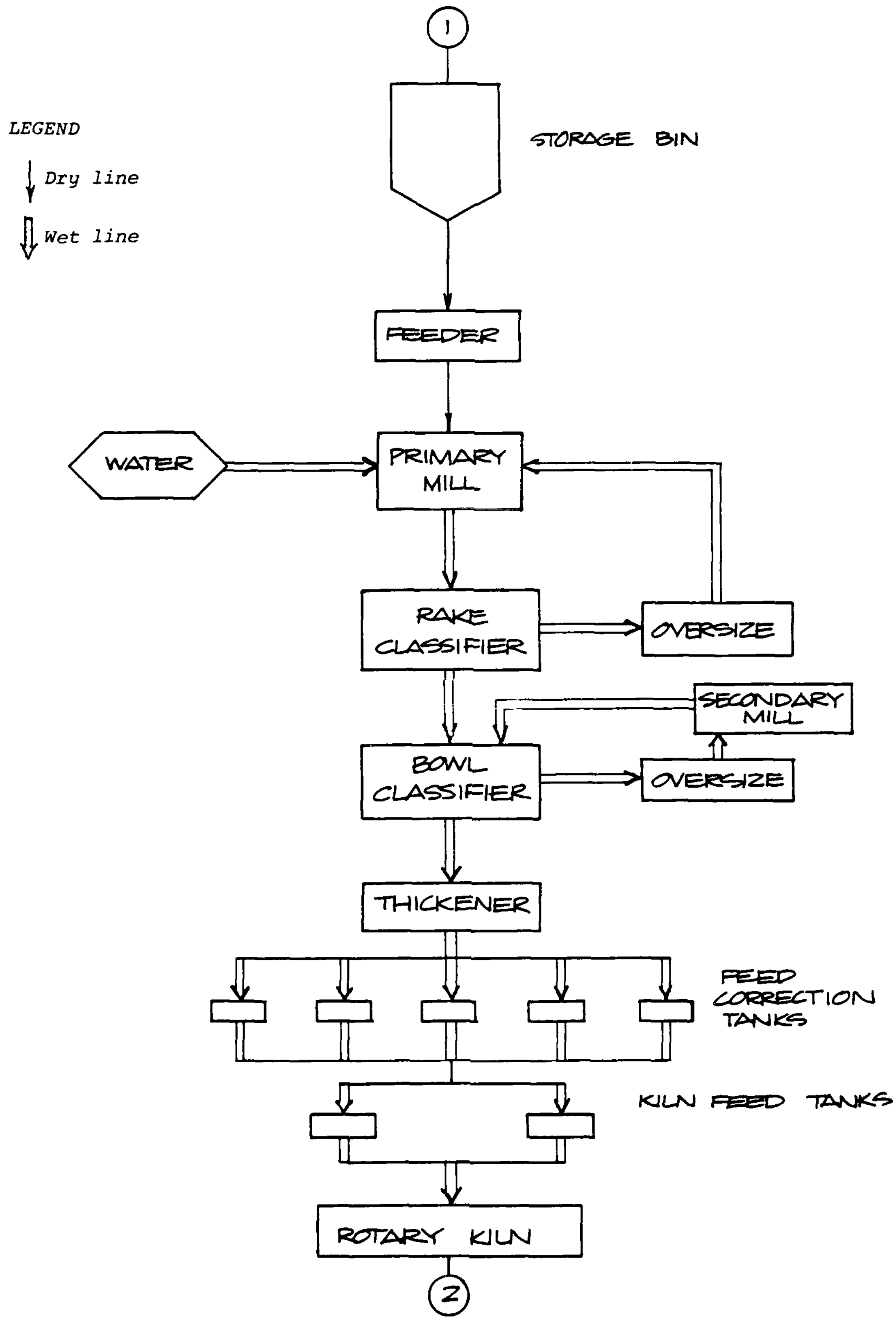


Fig. 6-1b. Flow Chart for Portland Cement Manufacture (SIC 3241), Part 2.

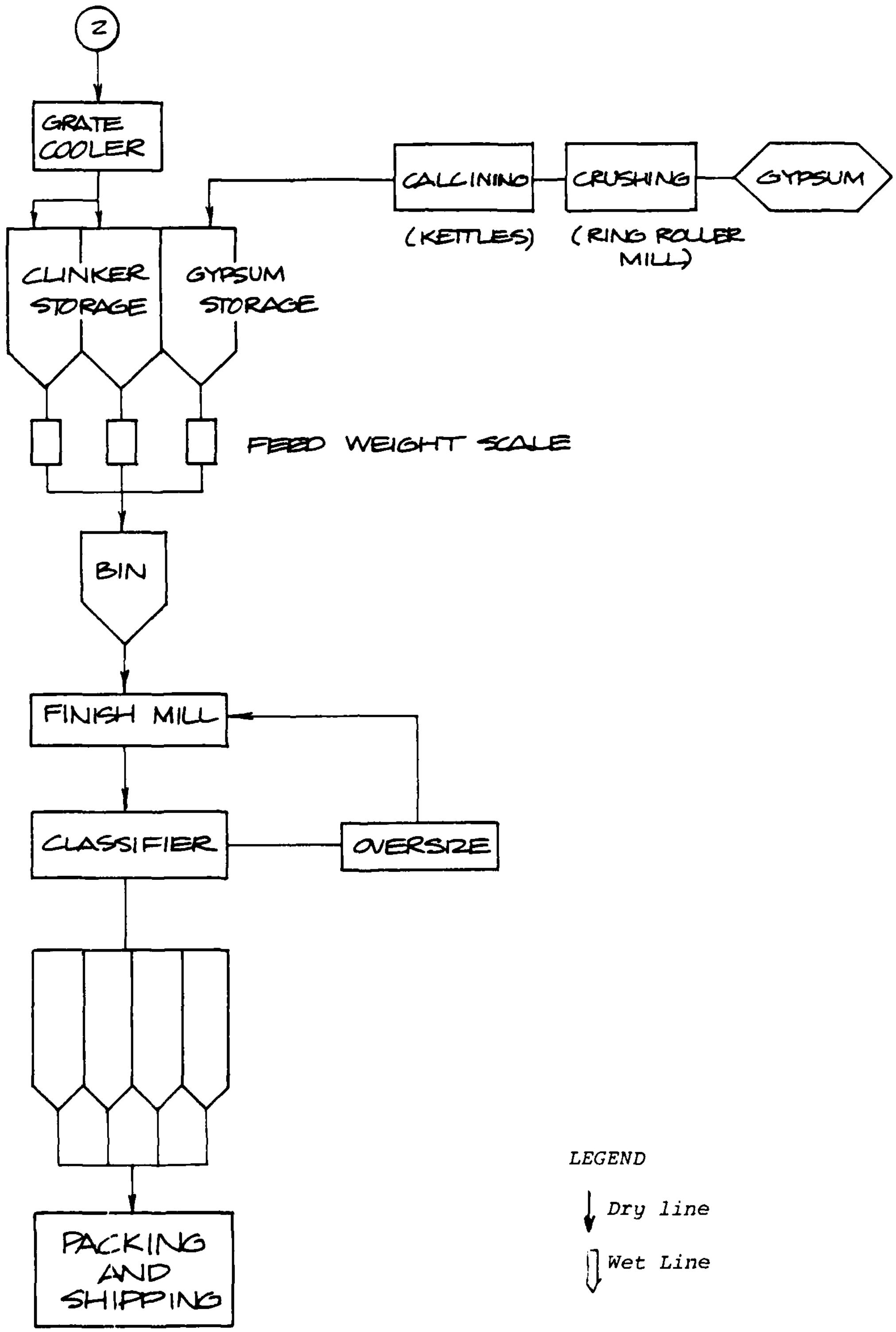


Fig. 6-1c. Flow Chart for Portland Cement Manufacture (SIC 3241), Part 3.

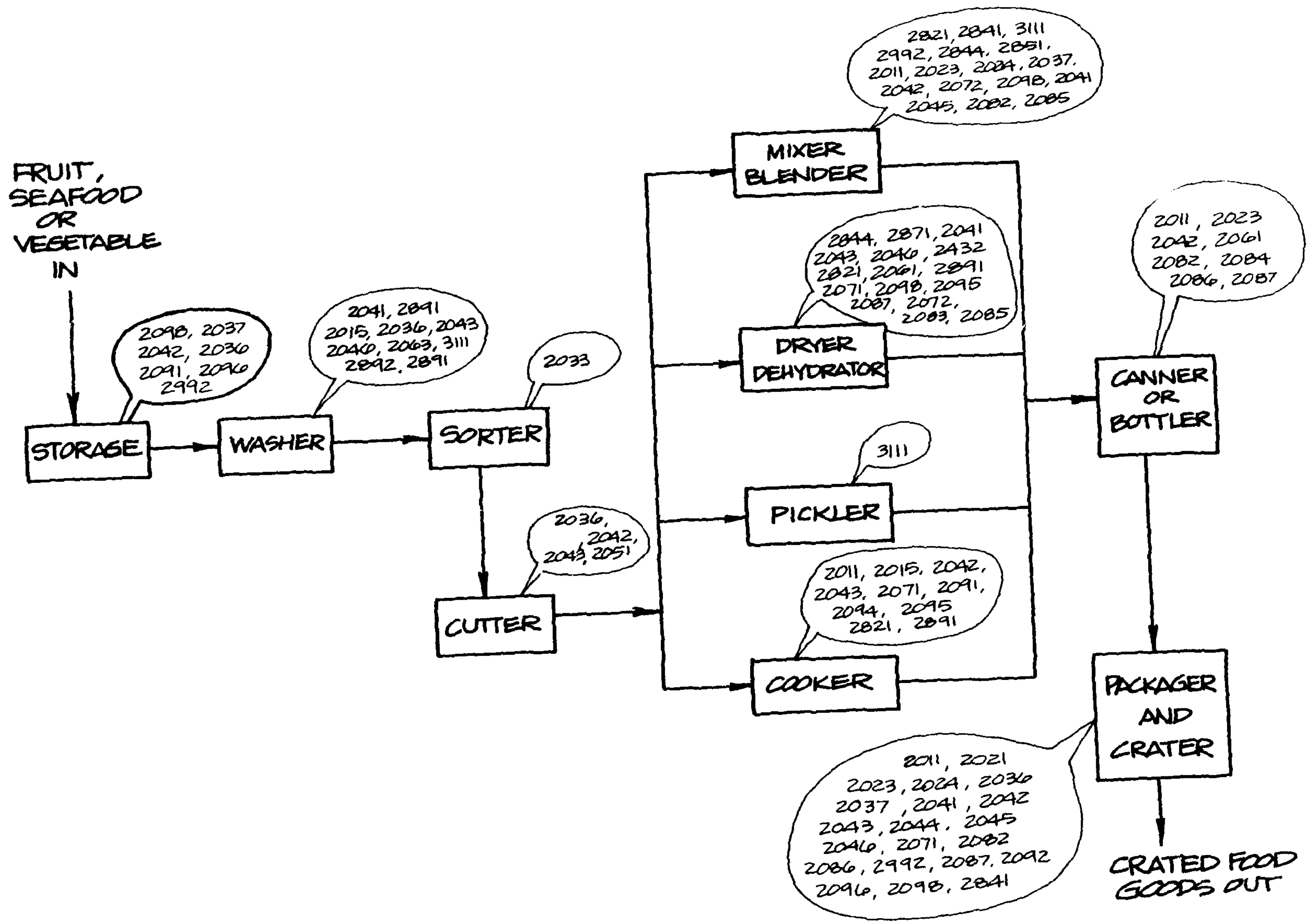


Fig. 6-2. Flow Chart for Canned and Preserved Seafood, Fruits, and Vegetables (SIC 2031).

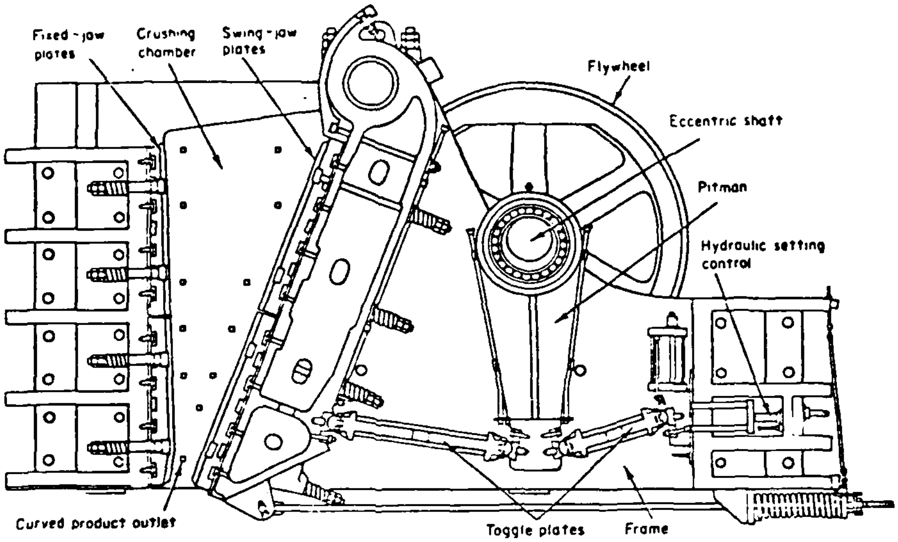
Eventually, should it become desirable to do so, to the extent that agencies such as Dun and Bradstreet and National Business Lists can provide data on names and addresses of end-user industries versus SIC's, it would be possible to determine geographical locations (through zip codes), as well as more specific locations where a plant for a particular class of industry might be found, and to compile catalogs for different regions. This form of the catalog might require frequent updating to reflect plants that were shut down or relocated, products that were changed, or other such events.

In the future, less common pieces of equipment, but items in widespread use, could be added without affecting the utility of the existing catalog at any stage. With such a decision, it could be elected to take the concept of locating replacement sources one stage further, to identify opportunities for substitution. Table 6-1 provides an example, using the fairly common manufacturing process of crushing, identified in Table 5-2.

This overall approach developed here should add flexibility as the effort progresses and provide a usable product at the end of each stage.

TABLE 6-1: Crushing and Grinding Equipment

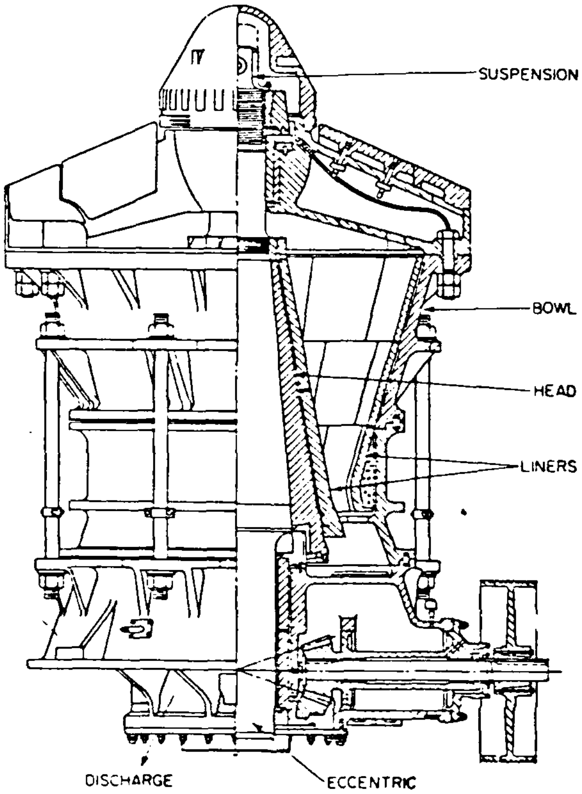
JAW CRUSHER



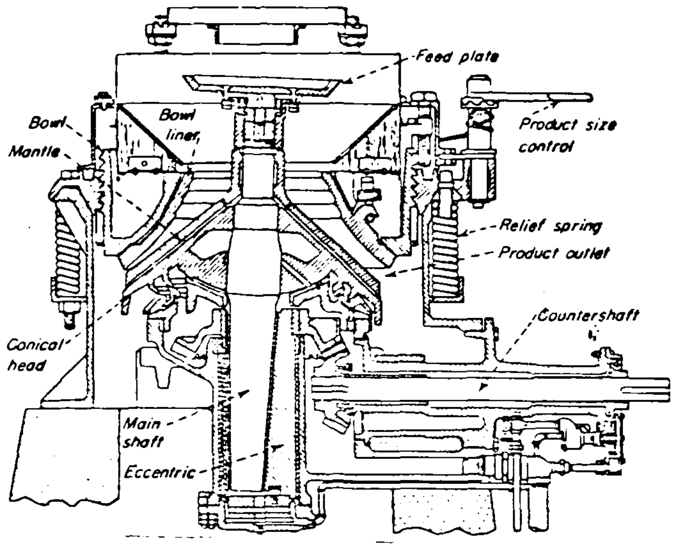
Blake jaw crusher. (*Allis-Chalmers Mfg. Co.*)

DESCRIPTION	INDUSTRIES WHERE USED
Primary crushing of large blocks (greater than 12 in. in diameter) of hard material	Mining and milling, stone quarries SIC: 1011, 1021, 1031, 1041, 1051, 1061, 1081, 1092, 1099, 1111, 1211, 1422, 1423, 1429

TABLE 6-1: Crushing and Grinding Equipment (contd)
GYRATORY CRUSHERS



Primary gyratory crusher with spider suspension.
(Nordberg Mfg. Co.)



DESCRIPTION

Hard ore and mineral crushing (screened or prescalped). Subdivisions of this are made on feed and product sizes or design features, e.g.
Primary gyratories
Secondary gyratories
Cone crushers

INDUSTRIES WHERE USED

Iron ore

SIC: 1011, 1021, 1031, 1041, 1051, 1061, 1081, 1092, 1099, 1111, 1211, 1422, 1423, 1429

AD-A119 934 SCIENTIFIC SERVICE INC REDWOOD CITY CA F/G 15/3
INDUSTRIAL HARDENING: 1981 TECHNICAL STATUS-REPORT.(U)
SEP 82 J V ZACCOR, R D BERNARD, R E PETERSON EMW-C-0701

UNCLASSIFIED SSI-8145-7 NL

2 OF 4
AD A
119934

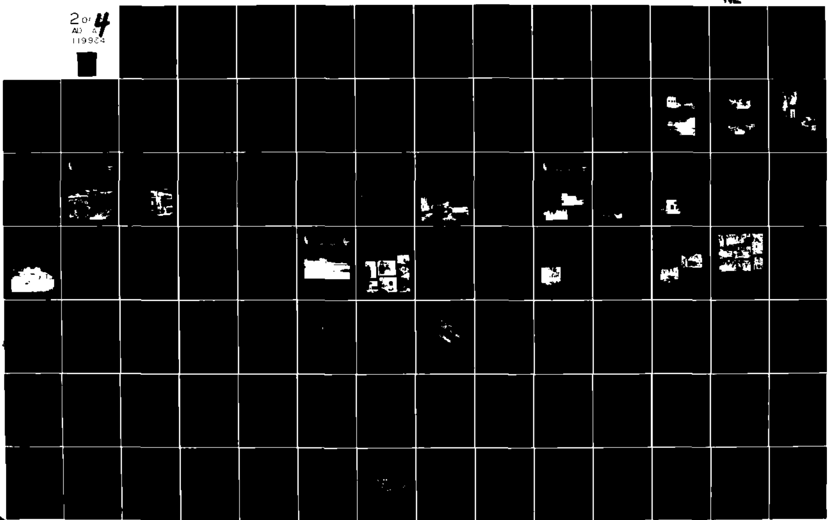
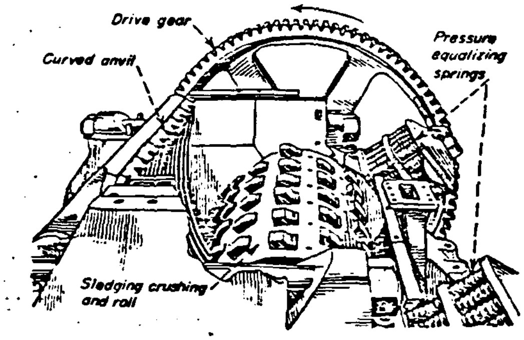


TABLE 6-1: Crushing and Grinding Equipment (contd)

ROLL CRUSHERS

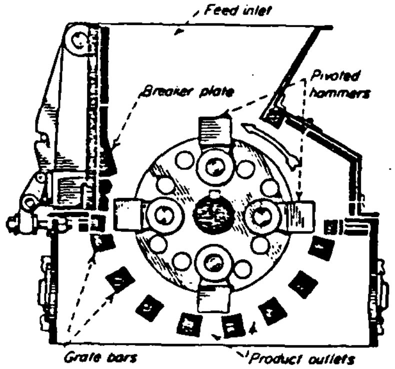


Fairmount single-roll crusher. (Allis-Chalmers Mfg. Co.)

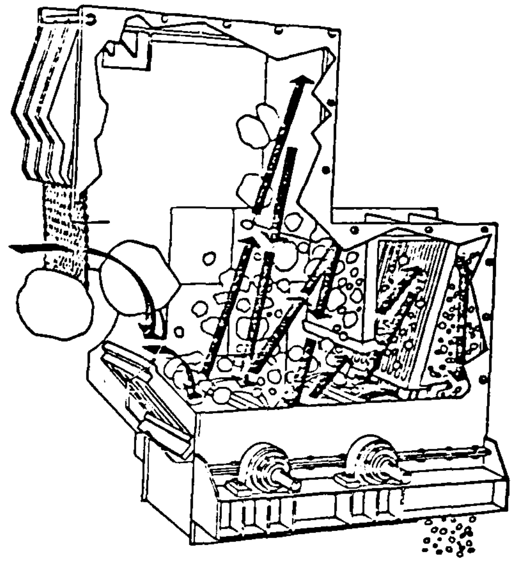
Two rolls of the same diameter are rotated toward each other at the same or different speeds. The distance between the rolls is adjustable. There are several types:	
Single-roll tooth crushers, for wet and sticky material	Limestone, dolomite, shale, phosphate, coal, lignite, petroleum coke, soft gypsum, fireclay, chemicals SIC: 1211, 1422, 1429, 1453, 1475, 1492, 1549, 3312
Double-roll tooth crushers	Presscakes, phenolic plastics, alkali, cellulose sheets, sheet glue, naphthalene, resins, bark, lump pitch, asphalt, floor tiling SIC: 2074, 2075, 2076, 2821, 2823 2865, 2899, 2952, 3292

TABLE 6-1 : Crushing and Grinding Equipment (contd)

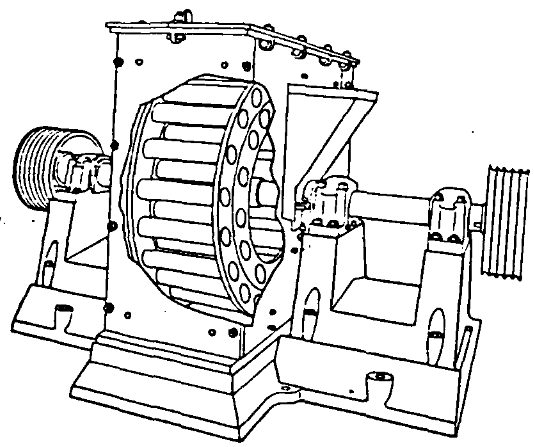
HEAVY-DUTY IMPACT MILLS



Hammer crusher. (*Jeffrey Mfg. Co.*)



Dual-rotor impact breaker. (*Kennedy Van Saun.*)



Two-cage disintegrator. (*Stedman Foundry & Machine Co.*)

DESCRIPTION	INDUSTRIES WHERE USED
Consists of heavy-duty hammer crushers and rotor impact breakers for primary crushing. Hammer mills: pivoted hammers are mounted on a horizontal shaft. Crushing takes place between the hammer and breaker plates.	Soaps, gums, resins SIC: 2821, 2841
Rotor breakers: the rotor is a cylinder to which is affixed a tough steel bar. Breakage occurs against this bar or on rebound from the walls of the device.	Limestone quarries, bituminous coal SIC: 1211, 1422

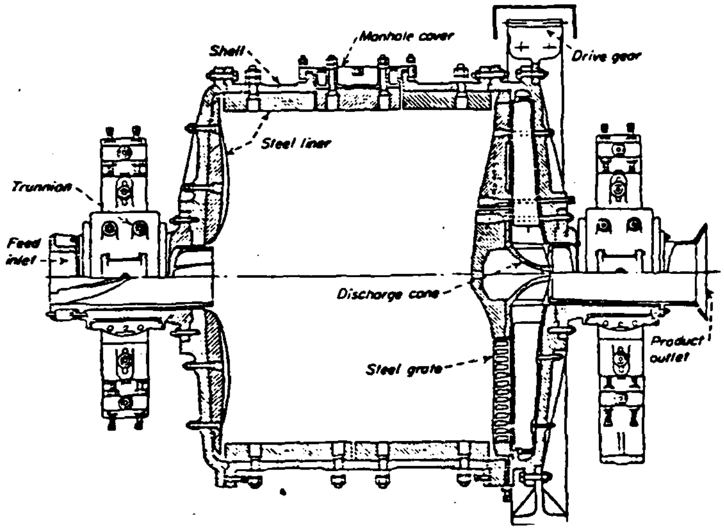
TABLE 6-1: Crushing and Grinding Equipment (contd)

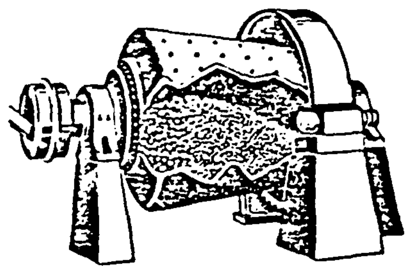
HEAVY-DUTY IMPACT MILLS

DESCRIPTION	INDUSTRIES WHERE USED
Cage mills	Quarries, phosphate, fertilizer, colors, presscake (e.g. vegetable oils), asbestos, alumina SIC: 2076, 2079, 2819, 2874, 3292, 3295

TABLE 6-1: Crushing and Grinding Equipment (contd)

TUMBLING MILLS



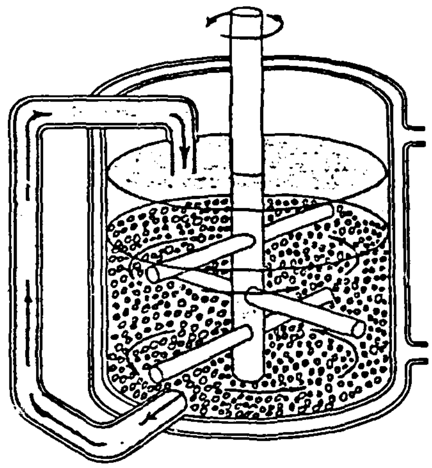


Tri-cone mill. (*Hardinge Co.*)

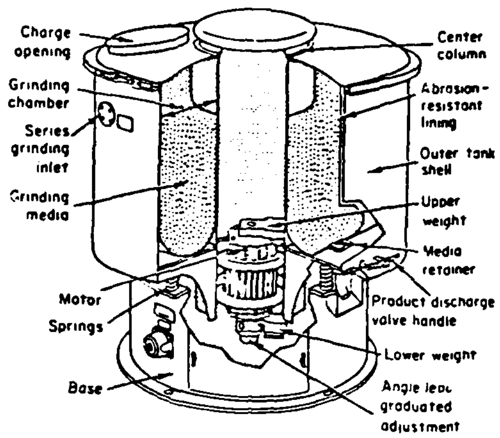
DESCRIPTION	INDUSTRIES WHERE USED
These have a cylindrical or conical shell, rotating on a horizontal axis, and are charged with a grinding medium such as balls of steel, flint, or porcelain, or with steel rods. Ball mills Tube mills Compartment mills Rod mills Pebble mills Rock-pebble mills	Iron ore SIC: 3241, 3262, 3295, 1499, 1459, 1446

TABLE 6-1 : Crushing and Grinding Equipment (contd)

NON-ROTARY BALL OR BEAD MILLS



The Attritor (*Union Process Co.*)



Vibro-Energy mill. (*Sweco Inc.*)

DESCRIPTION

These are stirred and vibratory types. In the first type, a central paddle wheel or impeller armature stirs the media at speeds from 100 to 1500 rpm. In the second type an eccentric motion is imparted either to an armature or to the shell at frequencies up to 1800/min.

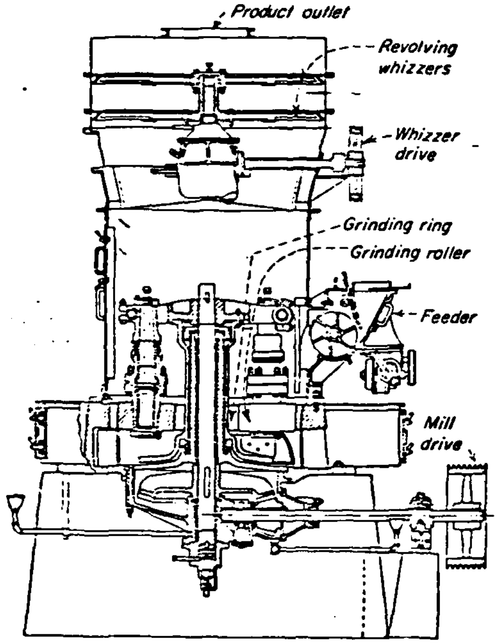
INDUSTRIES WHERE USED

Soft-grinding of dyes, clays, $CaCo_3$
SIC: 2819, 2865, 3295

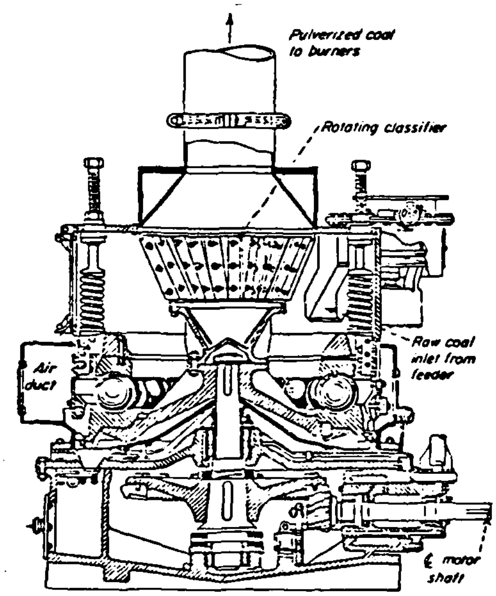
Hard-grinding of $ZnSiO_4$, SiO_2, TiO_2, Al_2O_3, etc.
SIC: 1099, 1446, 3291

TABLE 6-1: Crushing and Grinding Equipment (contd)

RING-ROLLER MILLS



Raymond high-side mill with internal Whizzer classifier.



B. & W. pulverizer, Type E. (Babcock & Wilcox Co.)

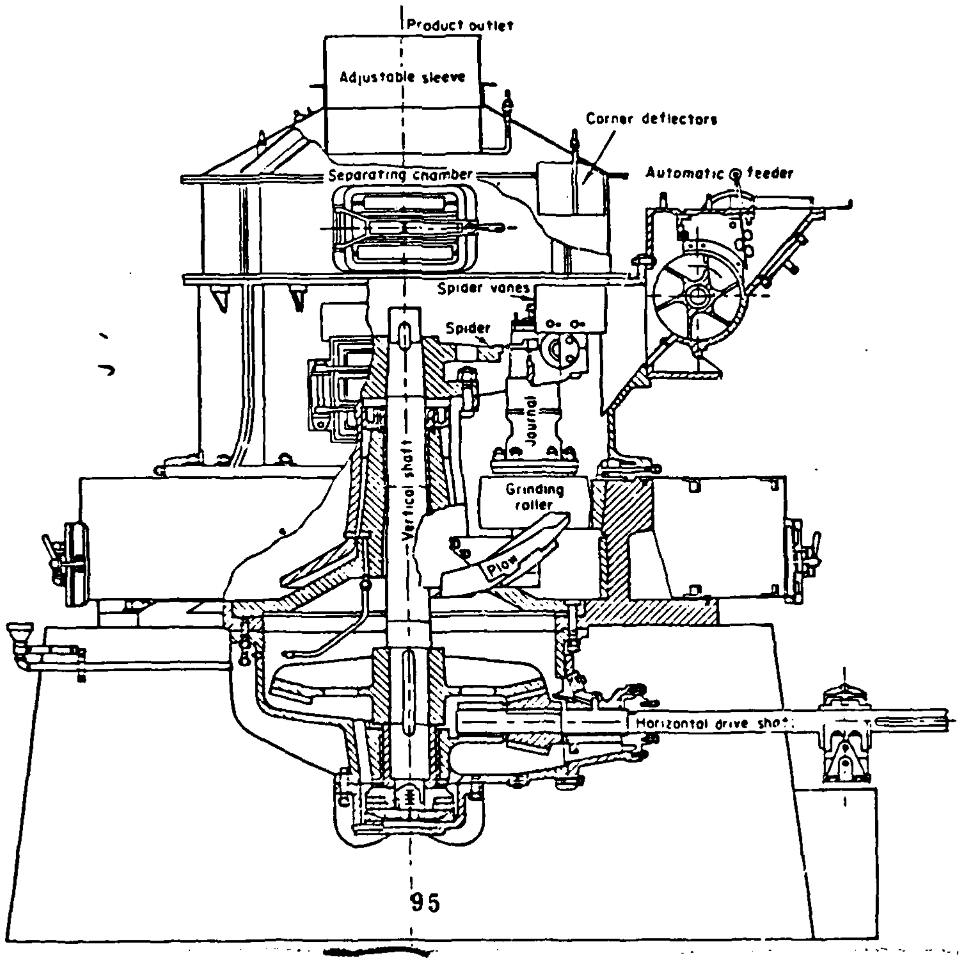


TABLE 6-1: Crushing and Grinding Equipment (contd)

RING-ROLLER MILLS

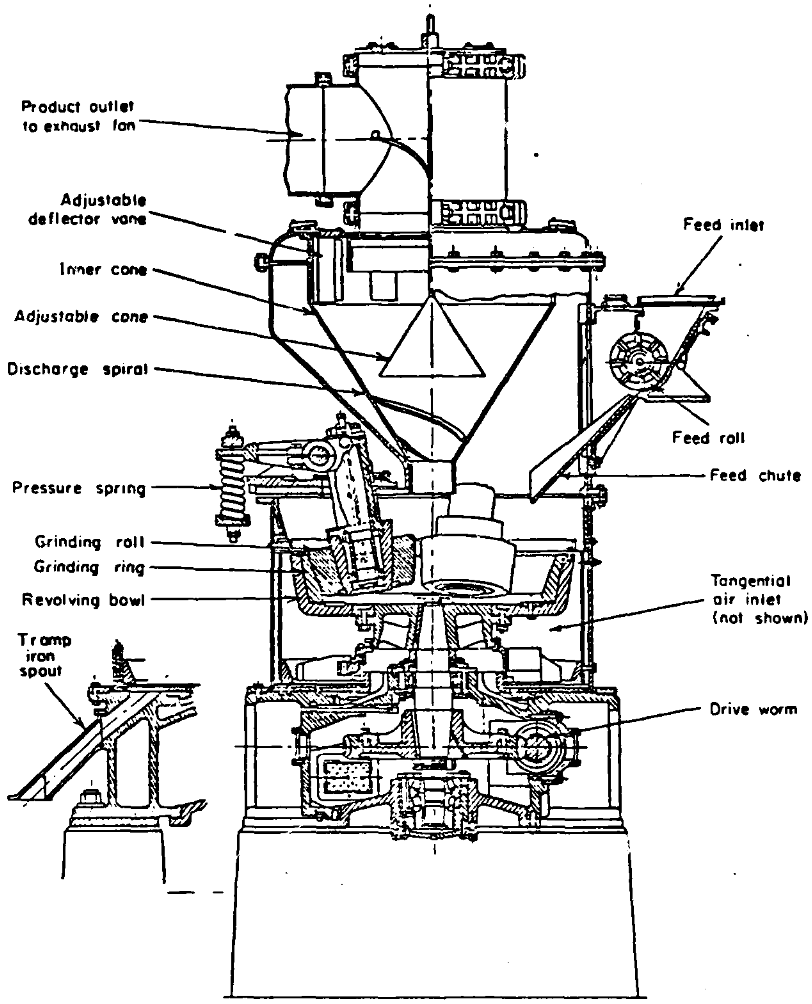


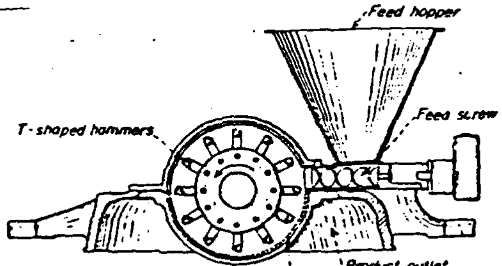
TABLE 6-1: Crushing and Grinding Equipment (contd)

RING-ROLLER MILLS

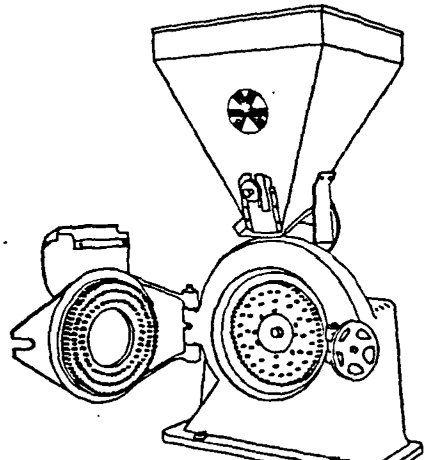
DESCRIPTION	INDUSTRIES WHERE USED
These are equipped with rollers that operate in conjunction with grinding rings. Grinding takes place between the surfaces of the ring and rollers.	Limestone, phosphate rock, bauxite, coke, magnesite, iron oxide pigments, sulfur, talc, graphite, calcium phosphates, sodium phosphates, organic insecticides, powdered cornstarch.
Bowl mills	Pulverization of coal for direct boiler firing SIC: 1422, 1475, 1051, 1061, 1477, 1496, 2816, 3295, 2819, 2879, 2046, 3312

TABLE 6-1: Crushing and Grinding Equipment (contd)

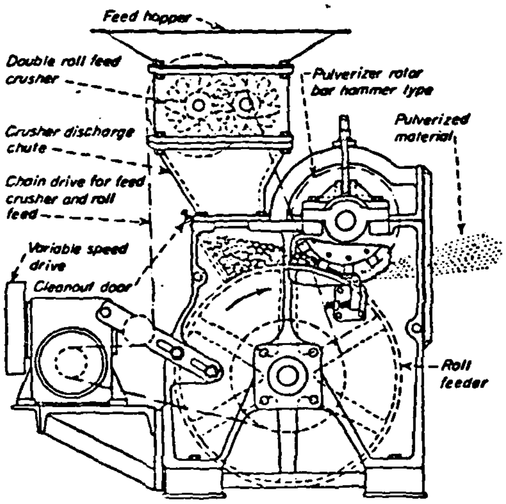
HAMMER MILLS



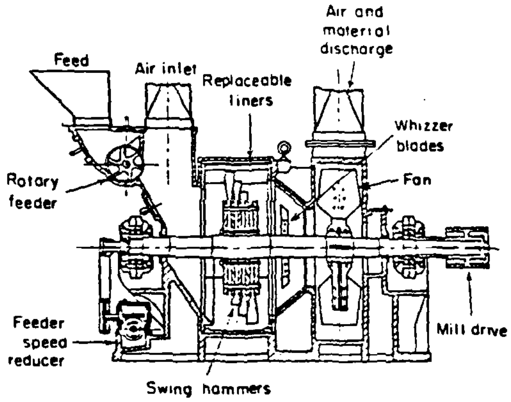
Mikro-Pulverizer hammer mill. (Pulverizing Machinery Co.)



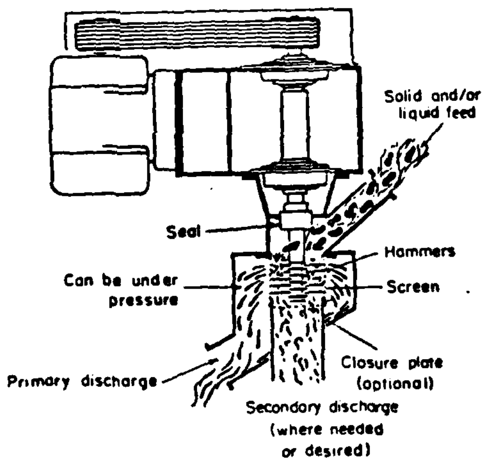
Alpine-Kolloplex mill. (Alpine American Corp.)



No. 2 S.P. Mikro-Pulverizer. (Pulverizing Machinery Co.)



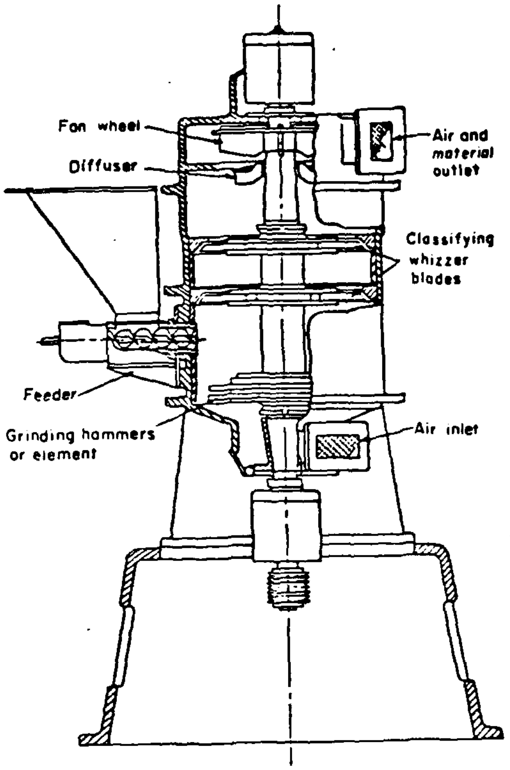
Whizzer air classification applied to Raymond Imp mill.



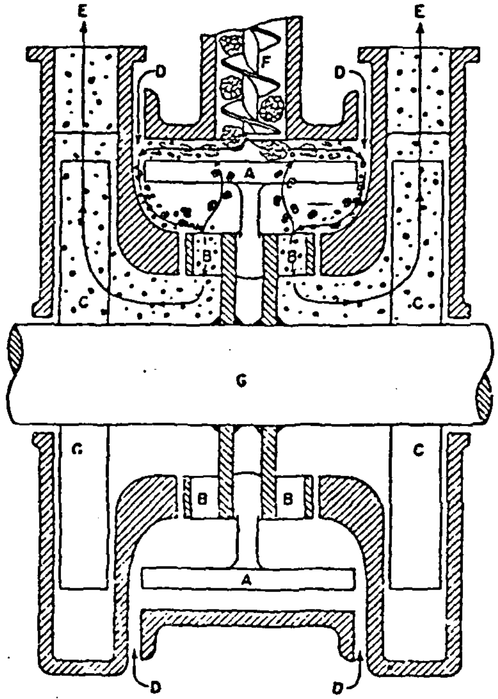
Rietz disintegrator. (Rietz Mfg. Co.)

TABLE 6-1 : Crushing and Grinding Equipment (contd)

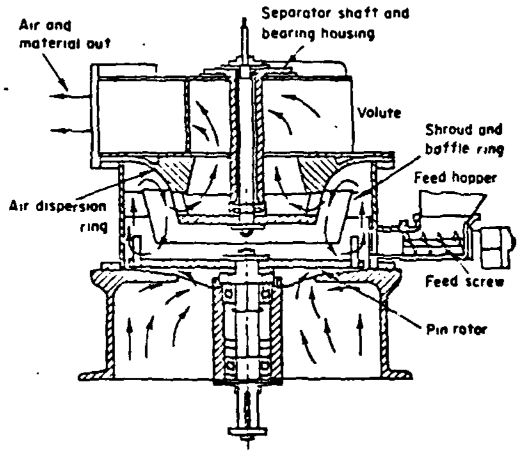
HAMMER MILLS



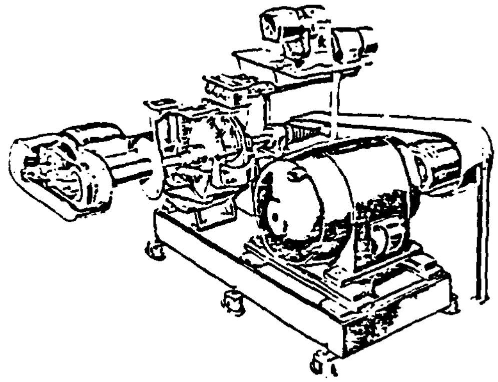
Raymond vertical mill. (*Raymond Div., Combustion Engineering Inc.*)



Mikro-Atomizer operating principle. [*Ind. Eng. Chem.*, 38, 672 (1946).]



Section of Mikro-ACM pulverizer, illustrating air and material flow. (*Pulverizing Machinery Co.*)



The Pulvocron. (Strong Scott Mfg. Co.)

TABLE 6-1: Crushing and Grinding Equipment (contd)

HAMMER MILLS

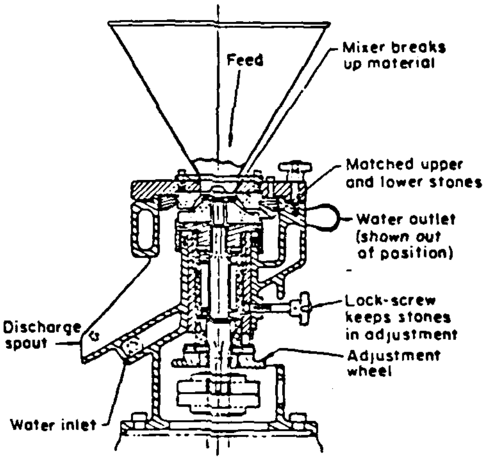
DESCRIPTION	INDUSTRIES WHERE USED
Used for fine grinding. There are several types, some of which have been developed for specific uses.	Clays, chemicals, pigments, food products, sugar, carbon black, pharmaceuticals, plastics, dyes, cosmetics, soybeans
Mikro-Pulverizer S.P. Mikro-Pulverizer (capable of taking plastic material)	Plastic, mixtures for tile manufacture DDT, benzene hexachloride, insecticide SIC: 2865, 2869, 2879, 3079
Blue Streak dual-screen pulverizer	Resins, chemical salts, plastic scrap, food products SIC: 2819, 2821, 2899
Atrita Pulverizer	Coal SIC: 1111, 1211
Aero Pulverizer	Coal, pitch, coke SIC: 2861, 2865, 2911, 3312
Disintegrator (Rietz)	Horseradish, detergent delumping, color coat, cooked meat, polystyrene, corn, asbestos-cement slurry, chemical fertilizer delumping, animal fat, wood chip shredding, bagasse depithing SIC: 2011, 2013, 2035, 2041, 2421, 2061, 2816, 2821, 2841, 2874, 3241, 3292
Tornado Mills	
Fitz Mills	Food industry SIC: 2011, 2013, 2041, 2044
Turbo-Pulverizers	
Turbo-Mills	
Pin Mills	

TABLE 6-1: Crushing and Grinding Equipment (contd)
HAMMER MILLS

DESCRIPTION	INDUSTRIES WHERE USED
Kolloplex Mills	Soya meal, other feed industries, chemicals, pharmaceuticals, cosmetics, pigments SIC: 2041, 2044, 2812, 2819, 2841, 2844, 2869, 2899
Entoleter Impact Mills	Plastics, rubber asbestos, grain, flour, coal, clay, slag, salt SIC: 2041, 2044, 2661, 2899, 3011 3031, 3041, 3079, 3292, 3295, 3664
Imp Pulverizer	Soya SIC: 2041, 2821
Automatic Pulverizer	
Raymond Vertical Mill	
Hurricane Pulverizer-classifier	Asbestos, kaolin SIC: 3292, 3295
Mikro-Atomizer	Sugar, PVC, calcium carbonate, nickel carbonate, lead oxide, dry colors SIC: 2099, 2816, 2819, 2821
Micro-Bud Pulverizer	Chocolate industry for grinding cocoa SIC: 2066, 2099
Micro ACM Pulverizer	Ammonium phosphate, calcite, dyestuff, glue, graphite, potassium sulfate, resin SIC: 1499, 2819, 2865, 2874, 2891, 3295
Pulvocron	Sucrose, sodium chloride, urea-formaldehyde, para-formaldehyde, casein, corn flour, soy flakes, lactose, alumina, cinnamon SIC: 2023, 2041, 2043, 2819, 2824, 2873, 2899

TABLE 6-1: Crushing and Grinding Equipment (contd)

DISPERSION AND COLLOIDAL MILLS



Model M colloid mill. (*Morehouse-Cowles Inc.*)

DESCRIPTION

These mills are used when very little breakdown of individual particles is required, when the objective is to disrupt lightly bonded clusters or agglomerates
Morehouse Mills
Premier Mill
Charlotte Mill

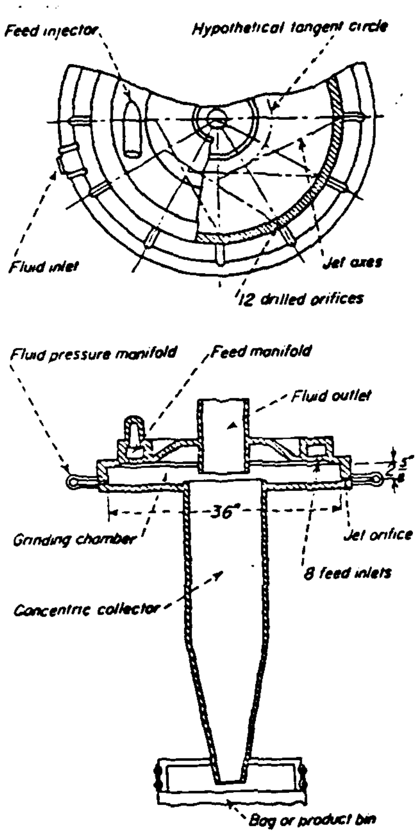
INDUSTRIES WHERE USED

Purees, food pastes, pulps, syrups, sauces, milk, ointments, creams, lotions, asphalt, water-paint emulsions, mayonnaise, salad oil

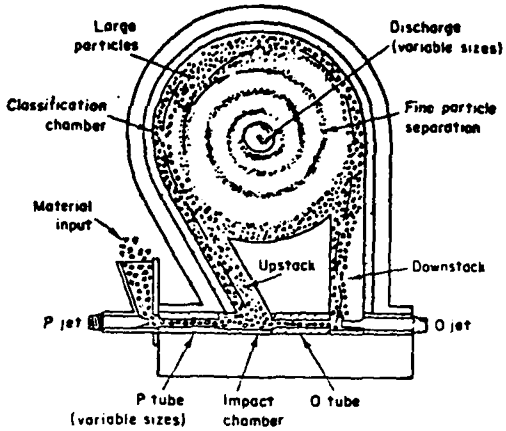
SIC: 2021, 2023, 2024, 2026, 2045, 2046, 2061, 2062, 2063, 2066, 2087, 2099, 2844, 2851, 2899 2951

TABLE 6-1 : Crushing and Grinding Equipment (contd)

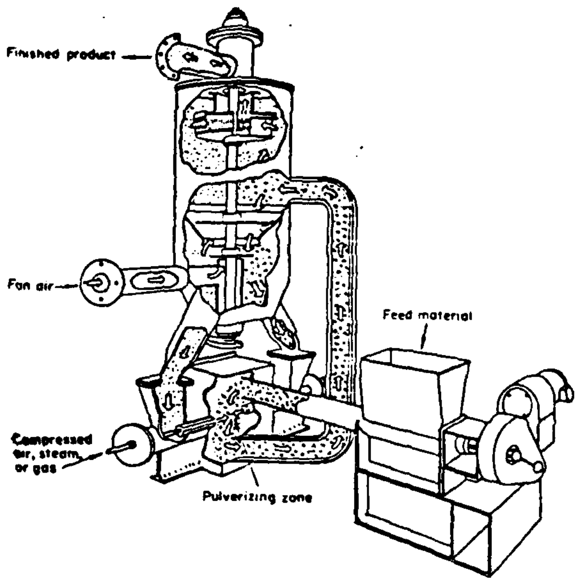
JET MILLS



Micronizer fluid-energy (jet) mill.



Trost jet mill. (*Plastomer Corp.*)



Majac jet pulverizer. (*Majac Inc.*)

TABLE 6-1 : Crushing and Grinding Equipment (contd)

JET MILLS

DESCRIPTION	INDUSTRIES WHERE USED
Micronizer Jet Pulverizer Jet-O-Mizer Majac Jet Pulverizer	Graphite, cryolite, limestone, hard talc, silica gel, barite, coal, resin, sulfur, wolframite ore, alumina, feldspar, mica, rare earth ores, paint SIC: 1061, 1099, 1422, 1496, 2816 2819, 2821, 2879, 3295, 3312

Section 7

TASK 4 - INDUSTRIAL EVALUATION PROFILE

The objective of this task was to initiate the development of an Industrial Evaluation Profile that would provide each cooperating industry with a valuable overview of its particular facility and insights into benefits of developing emergency preparedness plans, mutual aid groups, etc. The intent of this task was to develop the means to improve industry emergency preparedness, in general, and nuclear attack preparedness, in particular.

Past experience with industry on the subject of nuclear attack preparedness has shown that industry feels there is little impetus for taking action on the subject. Industry's reason is that day-to-day exigencies take most of its attention and capital so that infrequent events do not register on its list of concerns. A number of industry's members, however, are interested in certain natural disasters. In realization of this, a program element was implemented to continue to develop rapport with industry by supplying it with general emergency preparedness support anywhere there were overlapping benefits regarding nuclear attack preparedness.

Adequate preparation for natural disasters; e.g., earthquakes, floods, hurricanes (and associated hazardous materials spills) would clearly provide some benefits for any other disaster, including nuclear (through planning emergency shutdown, evacuation, conducting emergency exercises, etc.), so part of the effort was devoted to developing some first stage preparedness procedures and estimating overlapping benefits.

The broader aspect of this task, then, was to continue to develop rapport with industries in order to maintain the capability to test emergency preparedness concepts among various industry types, to evaluate practical aspects of industrial hardening, and to provide input to their disaster planning. The approach taken to this task involved several elements.

As one element, SSI began developing an Industrial Evaluation Profile that can be supplied to cooperating industries to provide each with a means to make a preliminary assessment of its general vulnerability to a variety of hazards, together with some initial ideas for options that could increase the probability of surviving an emergency with minimum impact. As another element, SSI has started to develop an emergency preparedness "clinic" that will provide the opportunity for dialog on Industrial Profiles. Then, interested industries can bring the preliminary assessments of their plant and operations vulnerability problems to a one- or two-day session to discuss their emergency plans and options directly with SSI staff and with other experts in the local area on the subject of emergency and disaster preparedness. In a third element, SSI became a member of a local mutual aid group comprising a coalition of industry, fire and police service organizations.

Development of the Industrial Profile element of this task started with a method to reduce earthquake damage to industry. The method, which originated at SSI as part of a research project funded by the National Science Foundation (Ref. 41), was applied under this project to a large electronics plant of Litton Industries. Entitled "Computer-Aided Earthquake Analysis and Planning for Businesses and Organizations," the method utilizes a microcomputer program (COUNTERQUAKE) to estimate earthquake effects and assess the effects of upgrading measures. It includes consideration of emergency planning options, and engineering measures to achieve them. This seismic work, tested in industry, provided the pattern for further progress in the development of effective methods to assist industry in dealing with nuclear and natural hazards.

The approach taken to evaluate COUNTERQUAKE involved using it to analyze the vulnerability of the as-is facility to a major earthquake, and comparing this with the engineering judgment of three structural engineers qualified to make such assessments. The agreement was relatively good, and all four assessments concluded that severe earthquake damage to the structure, in the event of the ground motion expected at the site, was likely, because of several key weaknesses. Assuming that the major structural weaknesses were corrected with retrofit measures (in this case, adding steel connections between walls and roof framing, and between wall panels), a second run of COUNTERQUAKE, and a second set of assessments from the engineers, was obtained. In this comparison the "contents" portion of the program showed that contents were the ranking problem after the first corrective action. And, it provided the interesting conclusion (again, with substantial agreement among the four analyses) that the structure would be expected to perform well (as modified) but that the valuable (electronic equipment) and hazardous (poisonous gases) contents of the building would still present major risks. A third set of analyses was then conducted assuming a case in which suggested retrofit measures for anchoring equipment, piping, and other nonstructural components in the building had been implemented. This indicated that only a small amount of damage and disruption to the facility could be expected after retrofitting.

As no readily available sources on earthquake resistance upgrading were found, options and cost estimates were developed for the structural modifications, and for structural plus contents restraint modifications. This cost information was provided to Litton Industries as part of the profile package to assess building, contents, and related personnel vulnerability. Several of the options have now been implemented in that plant, and the plant safety engineer plans to present the results of this study at Litton's national headquarters.

In addition to applying the engineering portion of this procedure at Litton, a prototype emergency plan for earthquakes was developed. This proved valuable to the Litton plant manager as well because many emergency planning countermeasure suggestions have other hazard benefits. For example, adequate preparedness for earthquakes involves identification and development of post-event hazardous material and fire response procedures; exercise and training programs; backup power, water, communication, and material supplies; liaison provisions (communications, mutual aid) with other industries in the area; etc. Thus, this seismic preparedness procedure and the methods required for hardening and dealing with other natural hazards have quite similar underlying considerations, and industry will require many of the same procedures whether the hazard is an earthquake or some other natural or man-made disaster (including nuclear war). Based on this premise, a preliminary industrial profile format was initiated as a slide show and lecture and presented to a group of business and industry participants in St. Cloud, Minnesota, as part of an emergency preparedness seminar fostered by the Minnesota Division of Emergency

Services. It did not generate many questions so that it was concluded industry and business would profit somewhat more directly if an extremely simple checklist and "cookbook" approach were developed to enable them to improve their emergency and disaster preparedness. (This material could then be issued before the seminar, and a clinic conducted using the completed forms as the basis.) Subsequently, the new format was initiated, and worksheets developed. The completed material appears in Appendix A.

The second element of our approach to maintaining and developing rapport with industry expands the first element (essentially a monolog) to obtain the benefit of dialog. This will be done be conducting what we have chosen to call a "clinic" wherein the participants will examine the inadequacies of emergency preparedness at their facilities to see how it can be corrected.

The clinic will provide the opportunity to test the procedure and format being developed (see the preliminary version of the geographical risk portion in Appendix A) for its ability to enable the participants to produce better emergency plans. After the test on local industries in the November clinic, modification will be made as necessary and copies sent to the Minnesota group to enable us to make a comparison of the benefits from conducting a seminar in conjunction with the checklist exercise versus doing it as a monolog. Feedback of the "cookbook" to the Minnesota group will enable us to keep in contact with the agency there, and through responses to the material, identify those industries with strong interests in planning and preparedness.

For the third element of this task, SSI has become involved in activities with the South County Industrial Emergency Council, SCIEC (in San Mateo County, California). This involvement is premised on the belief that, if emergency preparedness is to work (i.e., if it is to be in the right place at the right time), it must be an ongoing phenomenon. This means continued communications between all elements involved, and regular exercising of emergency response, both major objectives of the SCIEC. As a member of that organization, SSI has helped plan and critique emergency exercises, has participated in development of emergency preparedness seminars, and has taken over responsibility for the publication of the quarterly newsletter. It is extremely important to establish credibility for unbiased, accurate, and pertinent reporting to this group, and the newsletter does provide the unique opportunity to provide emergency preparedness information and input. For example, the following article appears in the latest issue, announcing the forthcoming multi-hazard emergency preparedness clinic. (The clinic will contain a segment that will specifically introduce participants to industrial hardening concepts, including the ten booklets.)

Disaster Planning Clinic

An intensive one-day "hands-on" disaster planning clinic for industry is being offered by Scientific Service, Inc. (SSI) in November. Clinic participants will learn specifics for developing or refining their own "all-hazards" programs. Each person will be given 1) an SSI step-by-step "Disaster Planning Manual" with worksheets, 2) practical hazard reduction and disaster response information for earthquakes, fire, hazardous materials, floods, security, power outages, and nuclear threats, and 3) opportunity to ask experts specific questions about his own facility or organization.

During the morning session, each type of disaster will be discussed by an expert in that field, using the sequence of steps in the Disaster Planning Manual: assessing the hazard, identifying practical countermeasures, and formulating a disaster program, including writing of plans. The afternoon session will be devoted to small group interaction between participants and experts--structural engineers, disaster planners, safety engineers, fire experts, etc.--to allow specific questions to be raised and answered. In addition, several microcomputers with programmed disaster risk analyses and response plans will be available so participants can see how computer-aided disaster planning works.

Each participant should bring:

-street map showing exact location of facilities

-plot plans of facilities

-knowledge of the status of the organization's disaster planning, plus copies of written plans, drill and training schedules, etc.

-information on number of employees, essential processes that must be maintained during and after disasters, schematic organization chart, daily staffing/shift patterns, typical contents of buildings, etc.

-questions

By the end of this seven-hour clinic, participants will be able to decide what to do next in their disaster planning, and where to get information, products, and services. For more information on the clinic, contact Robert Reitherman, Scientific Service, Inc., 517 E. Bayshore, Redwood City, CA 94063, (415) 368-2931.

Section 8
TASK 5 - PICTORIAL DOCUMENTATION

The objective of this task has been to continue to substantiate achievements in emergency preparedness and to document methods, pictorially wherever possible, with appropriate acknowledgement of cooperating industries. The underlying aim of this task is to develop means to influence industries to develop emergency preparedness programs and give recognition to those that do — as well as provide information on how to do it.

Photographs, slides, movies, TV tapes, pertinent to this task, all provide valuable records, whether gathered from field tests, laboratory tests, training excercises, emergency exercises, real emergencies, prepared and staged episodes, or interviews, and however presented: data sheets, newsletters, slide shows, TV tape recordings. To date, two data sheets, three newsletters, one slide show (with synchronized audio tape), one slide show with narration, viewgraphs with narration, and part of a TV tape program on emergency planning and an emergency exercise have been assembled under this contract effort. A revised slide show with synchronized audio tape, a third data sheet, and the remainder of the TV taped show are in production.

In another aspect of this task, to capture pictorial information, one of the most valuable entrees to industrial plant sites was developed this year through SSI participation with the local industrial mutual aid group, SCIEC. Production of the newsletter (three issues are included at the end of this section) has provided SSI with access to decisionmakers in industry and to lines of information and communication otherwise impossible. In turn, this has resulted in the establishment of good relationships between SSI and about a dozen industries, but because of proprietary processes and concerns for regulatory agency discrimination, photography inside plant facilities is generally not allowed.

On the other hand, through involvement in emergency exercises planned by SCIEC and production of the newsletter, some excellent photographs and TV tapes have been assembled which demonstrate some of the problems and the importance of emergency preparation, and how much can go awry when there is no plan — or when a plan is not exercised to find flaws. Figures 8-1 through 8-6 are some photographs taken from a recent emergency preparedness exercise planned by SCIEC, which involved participants from 16 public and private emergency response organizations (fire, police, ambulance, hospital), 10 public support agencies (EPA, coroner, etc.), and 20 private sector businesses, industries, and organizations (through support and donations) in a simulated fire and hazardous materials release at a major local plant. Referees were strategically located, just as in war games, and individuals and units that were engulfed in the simulated vapor cloud with operators not dressed out properly and wearing self-contained breathing apparatus were judged overcome or dead and out of the action to contain the spill and fire. These kinds of exercises serve as eye-openers not only to industry, but to the whole community. (Coverage was provided by one local radio and four TV stations.) More such exercises in California could reduce the property damage and lives lost in event of a major earthquake or other disaster.

The strategy that SSI has been working toward is to develop the newsletter into a forum for discussion and critique of emergency response capabilities in real emergency situations in the community, as a means to improve response capability and a way to present general emergency preparedness concepts. Data sheets that can be kept handy will be developed wherever there appears to be interest (see Floods and Earthquakes factsheets attached to the newsletters herein), and slide shows and TV tapes will tell what emergency preparedness is in general and SCIEC (mutual aid groups) in particular.

It is intended that the TV tape currently being developed provide convincing information on the benefits of mutual aid groups as an effective means of dealing with the larger emergencies. It is hoped the tape, when completed, will tell a story of varied large and small companies that participate in the local mutual aid group: Litton, Ampex, Diamond Shamrock, GTE Lenkurt, Varian, Dalmo Victor, Eureka Federal Savings, Pacific Gas and Electric, Folgers Coffee, Kaiser Hospital, Amfac

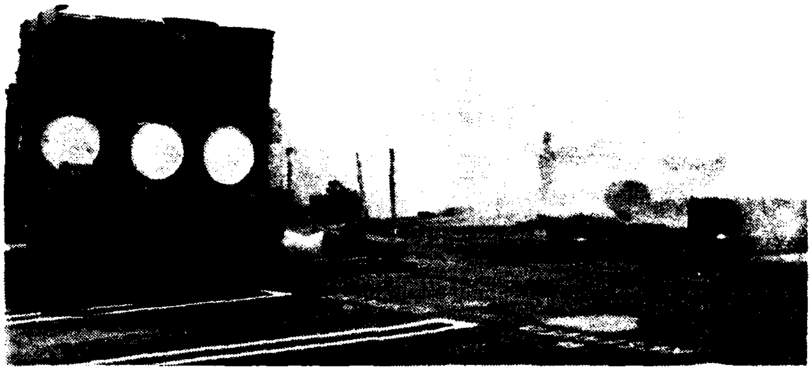


Fig. 8-1. Staged Accident, Spill, and Fire.

Fig. 8-2. Observers in the Background.

Fig. 8-3. Respondents "Killed or Incapacitated".

Fig. 8-4. Control Center.

Fig. 8-5. Getting it Together.

Fig. 8-6. Properly Dressed Response Team. (Note: Suits are Sealed Below Water Level)

Hotels, and Holiday Inns, etc. A key factor in an organization such as the SCIEC is the regular exercising of the entire community system for emergency response. Just as standby power systems frequently fail to function when needed after long periods between exercise of the system, response systems need regular testing and fine tuning if they are to function when needed. As many agencies may become involved at one time in some emergency response situations, it is important that they all participate in exercises. Developing broader community interest on the part of both industry and government is required to achieve this. Therefore, SCIEC, SSI, and FEMA interests are all served by such mutual aid groups, their programs, and their exercises. SSI is attempting to capture the urgency and benefits of this on tape.

Participation in SCIEC has enabled SSI to obtain access to many slides and TV tapes made of local emergencies and disasters, exercises as well as real, which can eventually be incorporated into training, educational, and informational material. The first iteration of a combined training and informational tape is scheduled for completion in the next quarter. Examples of the mutual aid group newsletter follow.

THE INDUSTRY AND FIRE SERVICE TIE LINE

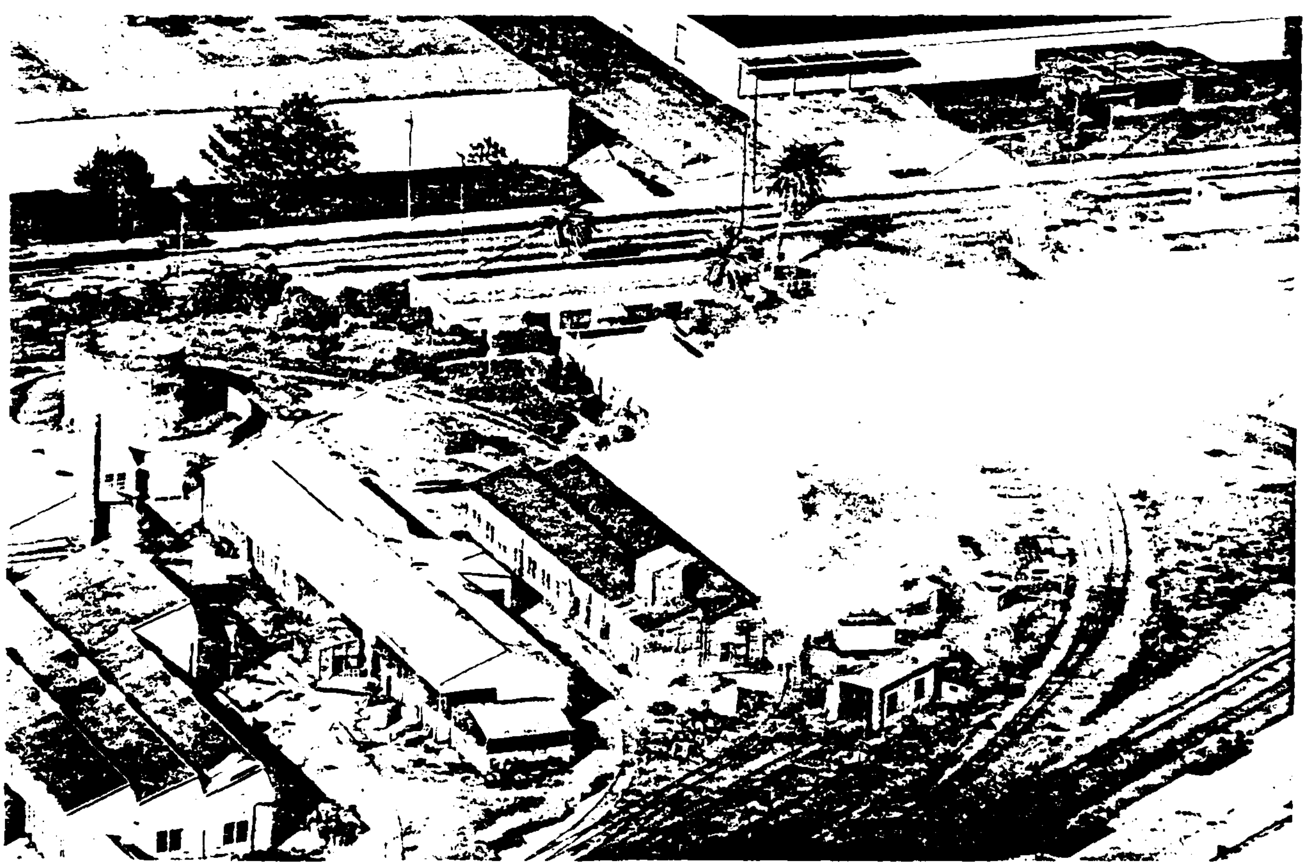
Volume 3 Edition 1 A Quarterly Publication of the South County Industrial Emergency Council 4th Quarter, 1981

SILICON TETRACHLORIDE SPILL

South San Francisco, August 21, 1981--A delivery truck at a chemical plant backed into a 20,000 pound upright tank, cracking in two places a 1¼-inch iron pipe used to transfer liquid into the tank. The tank contained approximately 4,000 gallons of silicon tetrachloride, a highly toxic material that forms hydrochloric acid and silicon dioxide upon contact with water.

(please turn to p. 2)

Aerial view of silicon tetrachloride cloud.



San Francisco Examiner photograph by Chris Hardy

SOUTH SAN FRANCISCO SPILL

by CHIEF J. L. DRAGO

The South San Francisco Fire Department was called at 3:36 p.m. Through preplanning, the Fire Department knew the plant layout. The identity of the spilled material was given by the caller. Two engine companies, one truck company, one rescue unit, and one chemical rig responded. On the scene were the Fire Chief, Fire Marshal, Battalion Chief, Training Officer, and sixteen men.

As the first responding units arrived, they observed a large volume of white vapor coming from the plant. The vapor cloud extended approximately fifty feet upward, then fanned out in a northeasterly direction. At times, it appeared to cover a quarter mile by one mile area.

The Police Department was called immediately to begin evacuation of all downwind areas and to set up road blocks at intersections to prevent entry into the affected area. Other agencies notified included the U.S. EPA, the U.S. Coast Guard, the sewage treatment plant, Cal OSHA, and PG&E.

Two firefighters, Richard Johnson and Ed Hill, donned hazardous environment suits to enter the immediate area of the leaking tank to make a closer inspection. After evaluating the situation, the Fire Department considered five alternatives for controlling the flow of material:

1. Cut the pipe where it connected to the tank, then plug it.
2. Cut the pipe above the leaks, then plug it.
3. Freeze the material in the pipe to form a plug.
4. Crimp the pipe at the leaks.
5. Let the material drain, and contain it.

Due to the configuration of the piping, Option #1 was not possible. It was felt that Option #3 would take too long, as equipment used for freezing the pipe would have to be retrofitted first. Options #2 and #4 seemed the best. Option #4 was chosen because the crimping tool was more readily available.

The two firefighters entered the area two more times to attempt to shut off the flow of liquid by crimping the pipe with a hydraulic pipe crimping tool borrowed from PG&E. On each trip, they had essentially a twelve minute air supply. The configuration of the piping and the location of the leaks made the pipe crimping tool difficult to use. In addition, the hydrogen chloride vapors combined with the silicon dioxide that coated the firefighters' face masks made visibility almost zero. They were unable to stop the flow. One protective hose line was laid in at this time. It was then decided to await the arrival of IT Corporation personnel, in hopes that they had equipment to stop the flow and remove the contaminated material in the sump.

At approximately 8:30 p.m., an IT Corporation representative arrived. By 10:00 p.m., it was decided that the leak from the tank was no longer of primary concern, as the contents of the tank had been reduced to a point where material was no longer flowing. Attention now turned to the plant's drainage system, where the material had collected. Plant personnel had shut down the sump pumps, keeping the material from entering the City's storm sewers. Material in the plant's drainage system continued to react with water in the air and in the sump. Because the continuing reaction was exothermic, IT Corporation was unable to pump material from the drainage system, for fear of damaging their pumps and rubber lined tank. Upon the recommendation of IT Corporation and chemical plant officials, firefighters then set up a hose line to flush the drainage system in order to dilute the material and speed up vaporization. This was successful, but flushing had to be suspended when the limits of the drainage system's holding capacity were reached.

At approximately 3:30 a.m. on August 22, additional maneuvers were discontinued as vapor production started to diminish. By 12:15 p.m., vapor had diminished enough to allow entry into the area. By 3:00 p.m., IT Corporation had transferred the remaining liquid in the sump/sewer area to their tanker for disposal. There remained 200 gallons of unreacted liquid sealed in the upright tank.

The main problems encountered in trying to stop the leak were:

1. Poor visibility in the work area
2. Limited duration of air in the self-contained breathing apparatus
3. Delay in getting a pipe crimping tool to the scene

Problems #2 and #3 can be remedied by the purchase of two additional breathing apparatus capable of longer air duration, and some pipe crimping or pipe cutting tools. In addition, two more hazardous environment suits for backup would be useful, and would expand the Fire Department's capability.

Six members of the Fire Department suffered irritation to their faces and necks from the acid fumes. Two members also reported some throat and lung irritation.

Overall, the City's various departments operated fairly well. What could have been a disastrous set of circumstances turned out to cause inconvenience to some people, and some property damage. Most importantly, it appears there were no serious injuries encountered during the emergency. See picture on page 7.

South San Francisco firefighter and SCIEC representative Richard Johnson shows the hazardous environment suit he wore trying to stop the leak. Johnson is the department's Hazardous Materials Officer.

San Francisco Examiner photograph by Eli Reed

SCIEC'S POTENTIAL HAZMAT CAPABILITY

Picture this: At 3:00 on a Monday morning, a motorist discovers three unmarked, unlabeled 55-gallon drums leaking a clear liquid onto the pavement of U.S. 101 in San Mateo County. He contacts the California Highway Patrol. The CHP dispatcher relays the report to the County Communications dispatcher, who sets a well-planned first response in motion by making contact with the appropriate organizations and individuals. Within minutes, one of the County's two Hazardous Material Response Vans, staffed by two trained firefighters and equipped with special communications, response and containment equipment, arrives at the scene of the spill. A short time later, a volunteer industrial chemist arrives, transported from her nearby home by a local police vehicle. The chemist, relying on a combination of her own experience, her training in hazardous material first response, and information she can obtain by directly contacting a special hazardous materials resource center, is able to determine the general hazards of the material. The firefighters, using the appropriate protective equipment and containment materials, are able to keep the spill from spreading while they wait for a commercial chemical spill cleanup company to arrive. Thus, a potentially harmful situation is brought to a quick, successful conclusion before the onset of rush hour traffic.

Hazardous material spills like this are common around the Bay. Unfortunately, first response as well coordinated and effective as in this hypothetical case is rare. More commonly, response to a spill is delayed while the proper authorities are contacted, while appropriate people are found to identify the material, while equipment is brought to the scene, etc. In the meantime, the public is inconvenienced and possibly subjected to health hazards. Remember last year's incident of a mysterious white powder spilled on the San Francisco Bay Bridge that halted commuter traffic for ten hours while the substance was identified and removed?

To remedy the current lack of prompt, effective, coordinated first response to hazardous material incidents, the South County Industrial Emergency Council proposes a three-phase program to be implemented in San Mateo County. This program is currently in the planning stage, and any input from Council members is welcome. Tentatively, the program is set up as follows:

Phase I: Establish a Hazardous Materials Resource Center and stock it with training aids, books, periodicals, manuals, films, etc. on hazardous materials to loan to all Council members. In addition, the Resource Center will have a mini-computer to store and list information on hazardous materials produced, used, and stored in the County. A resource list of private sector chemists willing to volunteer their expertise to help identify spilled materials will also be stored in the computer.

Phase II: Purchase two Hazardous Material Response Vans and equip them with detection, identification, and containment apparatus, and with protective gear for the response personnel. Each van will have direct communication capability with the computer at the Resource Center. The vans will be housed in fire stations, one at the north end of the County, and one at the south end. They will respond to incidents at Council members' facilities, and on public thoroughfares.

Phase III: Develop a training course in all aspects of hazardous material emergency response, suitable for employees of both government and industry, to be offered in conjunction with a local community college. Employees of SCIEC member companies will receive tuition discounts.

Funding for this program will be solicited both from government agencies in the County and State, and from industrial firms in the County that handle hazardous materials.

Committees will be working on different aspects of this proposed program. They are as follows:

Training and Education

Sam Loy, BWS Distributors (Chairman)
(707) 546-2484
Ken York, Chemical Waste Management, Inc.
Ed Sawicki, Intel Corporation
Gerry Sward, David Schmidt Co., Inc.
Jim Newman, Caltrans

Hazardous Material Handling and Emergency Response

Fred Scibuola, Chemical Waste Mgmt,Inc.(Chairman)
(408) 946-5094
Bill Harris, H&H Ship Service Co.
Brian O'Neill, Safety Specialists
Gary Norton, IT Corporation
Rich Lodge, Crowley Environmental Services Corp.
Mike McCaskell, Chemical Waste Mgmt,Inc. ENRAC

Marketing

Earl Heiman, Allfire (Chairman)
(415) 365-7067
Bruce Lepore, Back Dynamics Institute
Herschel Sparber, Fire and Life Safety Consultants

SCIEC members interested in working in a committee or otherwise contributing to the proposed program are welcome. Contact either the committee chairman or Jim O'Donnell at (415) 593-8011 ext. 41.

A MESSAGE FROM THE PRESIDENT

Although our organization is still relatively young, we can be proud of our many accomplishments. Our original South County Industrial Emergency Council has grown and will become the Bay Area Industrial Emergency Council, with chapters all around the Bay. We have been recognized and praised by organizations across the country.

Our growth over the past year can be attributed to the enthusiasm and dedication of our members. I think it is very important to maintain this high level of interest. To do so, we must gear our programs to address the needs and concerns of the greatest number of people. May I urge each one of you to provide any ideas, criticism, or suggestions that cross your minds? The organization is only as strong as its members.

Sam Loy

ANNOUNCMENTS

SCIEC's annual disaster drill and seminar are tentatively planned as follows:

Seminar	March 29,30, 1982	Circle Star Theatre
Drill	March 31, 1982	Marine World/Africa USA

* * * * * * * * *

The American Red Cross has moved to:
1870 Ogden Dr.
Burlingame, CA, 94010
Telephone no.: (415)692-5240

The Red Cross maintains safety training programs at:
3540 Middlefield Rd.
Menlo Park, CA, 94025
Telephone no.: (415)366-3851

SCIEC MEMBER PROFILE—AMPEX

Each issue of "The Tie Line" will feature an interview with a SCIEC member to find out who our members are, why they joined, and what they would like to see SCIEC do. This issue features separate interviews with two Ampex employees: Doug Dedea, Corporate Safety Environmental Affairs Administrator, and Lou Gilmore, Building 22 Safety Coordinator.

DOUG DEDEA

Q. Who is Ampex?

Doug: Ampex is a subsidiary of Signal Holding Companies. We produce recording tape—audio, video, and computer—cameras, tv cameras, video tape recorders, all used by professional people—broadcasting companies, recording studios, professional recording artists, that type.

Q. Where is Ampex?
Doug: We have facilities all over the world. Corporate headquarters are in Redwood City, about 1600 people work here.

Q. Why is Ampex a member of the South County Industrial Emergency Council? What do you expect to get out of it?
Doug: The reason we are a member is that it is a professional organization that provides us with community involvement. Other large companies in San Mateo County participate, exchanging ideas and information. There's a wide variety of people in the Council, a lot of sources of information, so that if I need information on fire regulations or earthquake engineering, I know where to go for assistance. Membership gives us a lot of professional acquaintances to fall back on if we have a problem, plus the opportunity to help someone else out with their problems. This builds a network of information resources.

Q. What does Ampex contribute to SCIEC?
Doug: We can provide technical and administrative resources. I can take questions or problems back to other people in the company for feedback.

Q. How is Ampex's corporate safety department set up?
Doug: We have a corporate safety manager, John Steele, who's responsible for all safety, health, and environmental issues. Reporting to him are an occupational health specialist and me. I handle the environmental and industrial hygiene problems, and spend about 30 percent of my time on safety. Each building in Redwood City has a safety coordinator responsible for identifying and communicating safety problems. There are about fifteen people on a Facility Safety Committee who survey for safety hazards, and basically work together to ensure a safe workplace.

Q. What qualifies Safwty Coordinators for the job?
Doug: First, you have to have an interest in safety. Our Coordinators actually have other jobs that take up most of their time. For example, they may be engineers or administrators who are willing to spend part of their time on safety. Ampex provides training in fire extinguisher use, CPR, first aid. Corporate safety puts on the classes. Instructors are from the National Safety Council or other outside sources. Any employee can sign up for the classes.

Q. Does Ampex have an in-house fire brigade?
Doug: No. With the fire extinguisher training, people will be able to put out a small fire in a trash can, but we don't intend to fight structural fires. We are developing prefire plans with the Redwood City Fire Department to map locations of our hazardous material storage and our unique operating equipment, so the Fire Department will know where and what the hazards are before they get here.

Q. How does Ampex handle on-site spills of hazardous materials?

We provide kits for our employees to clean up and control small spills (spills of less than five gallons). Fortunately, we haven't had any large spills. We do handle some hazardous materials, and its important to have people trained to contain a spill. We hope SCIEC will be developing training for large spills.

Q. What do you think is the biggest problem businesses face in industrial emergency preparedness?
Doug: The feeling that, "It will never happen to us."

Q. Why bother preparing for emergencies when they happen so rarely and when preparation is so expensive?
Doug: It will cost more to pay for the consequences after they happen than it will to prevent them in the first place.

■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■

LOU GILMORE

Q. What do you think is the biggest problem industry faces in industrial emergency preparedness?
Lou: Getting management behind safety. The purpose of having a company is to make a product and make money, so management has other priorities such as production and research, things that keep the company running, and that sometimes puts safety on a lower level. It's not that management is not safety conscious, it just isn't foremost in their minds at all times. It is a question of using the money that's available effectively. For example, if management is truly behind safety and really pushing it, even when operating funds are restricted, they'll make sure some of it, even if it's only a small sum, gets allocated to safety. They'll make sure there's a lot of communication with employees, even if they can't buy expensive safety equipment.

Q. Safety doesn't make money for the company. Why should management bother with it at all?
Lou: Bunch of reasons. They're required to by law. People in general have a moral obligation to look out for each other, and management has the authority to do something about that obligation. Safety has also been shown to be a great morale booster for employees. The extra attention to their well-being helps them perform better.

Q. Is it possible for safety and emergency preparedness to be profitable for a company?
Lou: Yes, I believe so. For example, paying a few dollars for a pair of safety glasses is much cheaper than having an employee hurt his eyes and bring legal action against the company. That's just a small example.

Q. What creates the biggest potential safety problem at Ampex?
Lou: In general, our diversity. Hazards are different in each department, and keeping people in different departments aware of each other's hazards is a problem. That's why I'm glad we have John Steele now at the corporate level.

Q. What was it like before John Steele was here?

Lou: Each division had their own safety person. Each division was unaware of the safety needs in other divisions. When you're busy you don't get over to other buildings to visit people and see what their safety needs are.

Q. Now you have had a full-time corporate safety officer for about two years. How have things changed?

Lou: Now we have someone who's higher up on the corporate ladder with more authority handling safety, who's involved with all divisions. He can draw all the sections together and enact policy that applies to all the divisions. Also, he has power to enforce safety guidelines. I can definitely see the difference over the last two years in my building. Now we can go to our corporate safety manager, who has more power behind him, who can pull strings and make sure that the major things we need are enacted, and when new laws come out he can look at those and develop company-wide guidelines.

Q. So the planning is better. Has the number or severity of safety problems decreased?

Lou: They have in our case. We get more training programs now, such as back injury prevention. We get backing for these types of training, at the corporate level. Response to the need for training is much faster also. Because production is of primary importance at the Section or Division level, sometimes these training programs would have to be put on the back burner temporarily.

Q. Do you get training in hazardous materials handling?

Lou: Yes. We have a program of getting safety films on chemical hazards, lab safety, fire safety. We can't afford to send our employees to a professional training center—the cost would be too much and their time away from work would be too long—but we can show them the safety films. Corporate safety organizes a little seminar that lasts for a few hours, and answers questions. Sometimes corporate safety gathers the information, then gives it to the safety coordinators in each department to present in their own way, tailored to their department's needs. Before we had to gather the information ourselves, which took a lot of time.

Q. SCIEC is working on a program to develop training courses in hazardous material handling for industry and government personnel. Do you think Ampex employees might be sent to these courses?

Lou: From my point of view, any information on chemical safety would be useful to the people in my building. The number of employees who would go would depend on the cost of the course, and time away from the job. The cheaper it is and the less time it takes, the more people can go. If it's expensive and time consuming, probably only the safety coordinators will go, then present the information to the employees.

Q. Would you be interested in hazardous material **response** training?

Lou: No. Our purpose for being here in this department is to make magnetic tape. When employees are being trained in CPR, multimedia first aid, fire extinguisher use, self-contained breathing apparatus, hazardous material cleanup and a multitude of other things, pretty soon they're doing more of that than they are working. They need some information on hazardous material spills so they can work safely, but to have all the equipment and training for doing it themselves is more than they would be able to do. It's like trying to fight a major structural fire when we have a fire station right next door. That's their expertise—firefighting—so we would call them and rely on them. For a major chemical spill, we would call in a professional cleanup company.

Q. Is there a particular activity or topic that you would like to see SCIEC undertake or address?

Lou: Yes. Earthquake preparedness. There was a disaster drill at Eimac a few months ago that involved a plane crash and a hazardous material release. Nobody has put together a drill like that on earthquakes. They should have a drill where the fire department sends their engines to an incident, then someone puts a sign up that says,"There's a big crack across this road—now what are you going to do?" Are they going to sit behind that crack and wait, or are they going to try to drive across, or are they going to build a bridge real fast? What if shaking of the Bay floods everything out? The water will cause a lot of destruction, everything will be torn up and in disarray, transportation will be cut off, gas lines will be broken, fires might pop up—I've never seen or heard of a disaster drill that includes all these things. SCIEC ought to work on it.

Q. Can they do it at Ampex?

Lou: As far as I'm concerned, sure.

1981 OFFICERS

President	Sam Loy, BWS Distributors
Vice President	Buzz Moulton, Diamond Shamrock
Secretary/Treasurer	Dave Kay, EIMAC,Div. of Varian
Advisors	Jim O'Donnell, South County Fire
	Bob Wirth, GTE Lenkurt
	Phil Marquis, Litton Industries
	Tom McCaffery, Raychem Corp.

JANUARY MONTHLY MEETING

The next SCIEC meeting will be held January 26, 1982. Please try to attend, as we will be electing Officers for 1982. (You wouldn't want to miss the meeting where you were elected, would you?) Meetings are usually held the last Tuesday of each month at the South County Fire Training Station, 895 Brittan Ave., in San Carlos, at 8:00 a.m.

THE "TIE LINE" LIVES

Our SCIEC newsletter, "The Tie Line," is back by popular demand. Quarterly issues will be forthcoming, with articles in the following areas:

- SCIEC business and activities
- Industrial emergency incident reports
- Industrial preparedness and response issues
- Profiles of member companies

In addition, letters to the editor will be printed. Limited advertising space will be available, at the rate of $25.00 per quarter page, camera-ready copy please. Announcements and articles from members on pertinent topics are welcome. Please direct questions, comments, criticism, and offers of assistance to Hway-ling Hsu at (415) 368-2931.

SANTA CLARA'S CHAP

A novel approach to preventing and responding to hazardous material spills has been developed and partly implemented by the Santa Clara Fire Department. The City of Santa Clara, home of dozens of high technology industrial facilities and site of several major traffic arteries, experiences an average of three reported hazardous material spills per week. Two years ago, after incidents where firefighters and citizens were injured by exposure to hazardous materials, the Fire Department began developing the Chemical Hazard Assistance Program (CHAP).

First, the Fire Department needed to know what hazardous materials firefighters could expect to encounter. A survey was taken of every commercial occupancy in the city to determine types, quantities, and locations of stored hazardous materials. Information from the survey is being incorporated into fire preplans, and steps are being taken to computerize the data. Assistance was received from both the City Council and the Chamber of Commerce in 1) modifying the Uniform Fire Code to mandate the survey, and 2) encouraging local industry to support the program and provide the requested information. To keep the data up to date, businesses will continue to be inspected for hazardous material storage. Frequency of inspection depends on occupancy. Occupancies are divided into three groups, based on the relative hazard of the contents. For example, hospitals and libraries will be inspected once per year, while machine shops, gas stations, and dry cleaners are inspected twice, and while chemical plants and plating shops are inspected four times. Each inspection costs the business fifteen dollars. The purpose of the inspections is to gather and provide information to correct potential problems, not to search out and punish wrongdoers.

After analyzing the survey results, the Fire Department realized that firefighters had neither the expertise nor access to the equipment needed to adequately respond to hazardous material incidents. This realization led to the concept of a Chemical Hazard Assistance Unit, consisting of a van with special protection, detection, and containment equipment, and two chemical specialists to staff it. Equipment—including chemical protective suits (totally encapsulating), chemical splash suits, disposable coveralls, 4 kinds of gloves, self-contained breathing apparatus, a combustible gas and oxygen detector, a Draeger multi-gas detection kit, a heat scanner, radiation detection sets, a variety of conventional and non-sparking tools, absorbants and neutralizers, communications equipment, a 24 volume reference library, and a list of equipment available in other places—has been acquired and is being kept in a car until the van is ready. The van should be ready within three months. One of the chemical specialists, Bob Campbell, has been hired. A second chemical specialist is now being sought by the Fire Department. Currently, Bob Campbell's duties are to respond to all incidents involving hazardous materials, respond to industrial structural fires to monitor conditions for the firefighters, provide consultation to businesses to identify and correct potential problems, and conduct training sessions on general chemical awareness for fire department personnel.

Aside from the containment and abatement materials carried in the van, firefighters will have access to materials owned and stored by industrial facilities on site. The modification of the UFC requires that owners "provide on-site materials and equipment necessary for containment, neutralization and removal, including necessary safety equipment for personnel. An inventory of the above items shall be provided to the Fire Department."

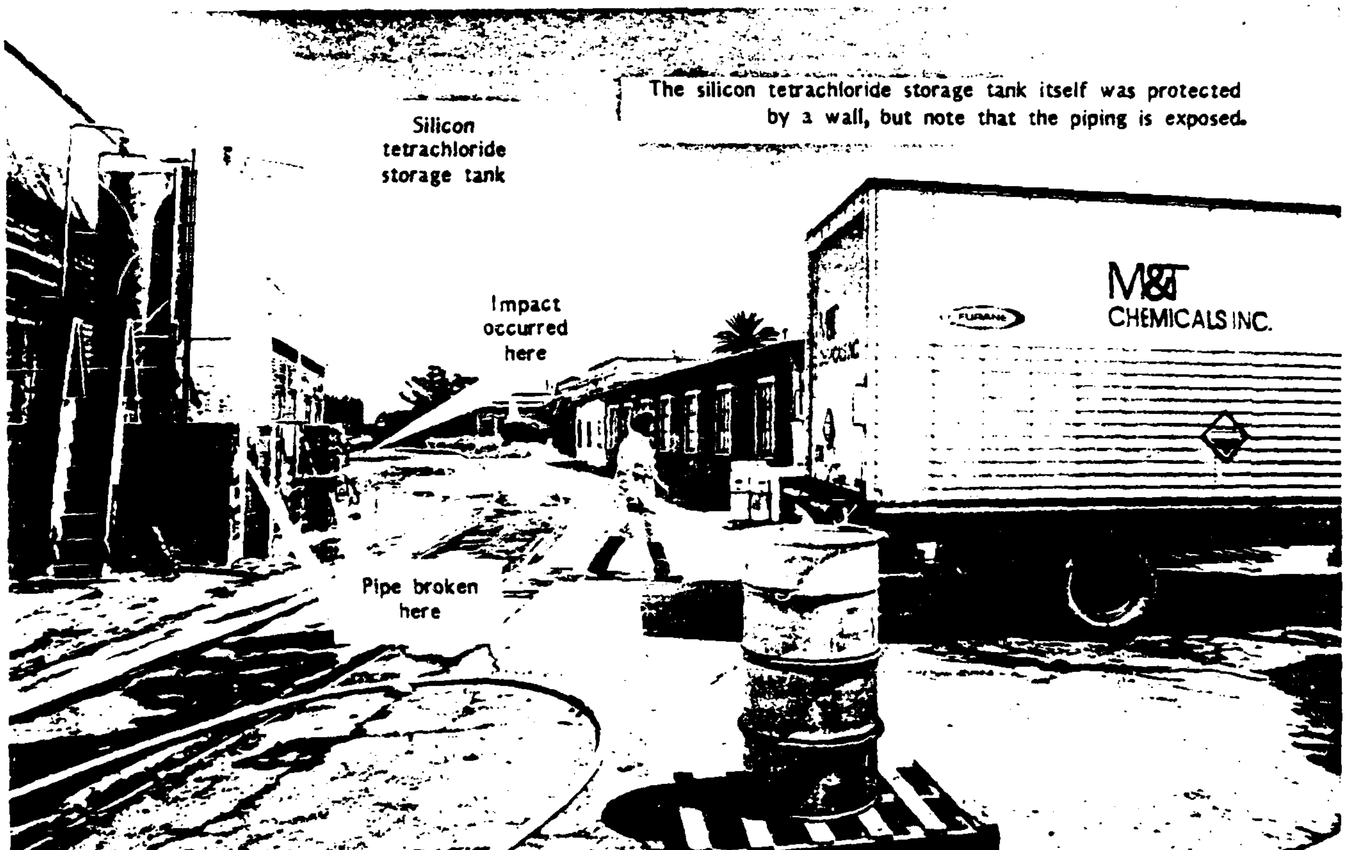
A major component of the program still in the planning stage is a "Center of Excellence"—a facility that combines research, development, and testing of hazardous materials prevention and response techniques and technology with practical training for both industry and emergency service personnel. This facility would be operated in conjunction with Mission College in Santa Clara. It appears that Santa Clara has developed a progressive, practical approach to a problem common on the Peninsula.

INDUSTRIAL EMERGENCY PREPAREDNESS MANUAL

One of our member companies, Scientific Service, Inc. (SSI), has been awarded a five-year contract with the U.S. Federal Emergency Management Agency (FEMA), to develop an industrial emergency preparedness manual for natural and manmade disasters. SSI hopes to integrate preparedness measures that are appropriate to all types of disasters in order to produce a manual of cost-effective preventive actions for industries to adopt. SSI has turned to SCIEC for assistance in this project. Input is needed from member companies on the specific problems industry faces when trying to prepare for disasters. This is an excellent opportunity for Council members to help develop a practical manual that is useful to all industries, and especially to our own members. By contributing our input, we will be raising issues of special concern to us, and keeping the manual realistic and usable.

In return for information and feedback from SCIEC members, SSI has undertaken the task of gathering, analyzing, and editing information for this newsletter.

The silicon tetrachloride storage tank itself was protected by a wall, but note that the piping is exposed.



San Francisco Examiner photograph by Eli Reed

SCIEC GOES BIG TIME

SCIEC has landed its first paid job—we are a subcontractor to the Association of Bay Area Governments (ABAG) on a hazardous materials contract with the U.S. Department of Transportation. ABAG's aim on this project is to "develop a coordinated hazardous materials accident prevention and emergency response program to serve the San Francisco Bay Area." SCIEC's role as a subcontractor is to complete the following three Tasks:

1. Analyze personnel training needs.

   Identify existing prevention and response training programs available to both government and industry personnel in the Bay Area. Examine these programs to determine appropriateness of each for different job descriptions; strengths and weaknesses of each; areas of training still lacking; etc.

2. Organize a prevention training program.

   After identifying organizations, industries, and personnel that need prevention training, outline curricula for prevention courses, including packaging, labeling, and handling of hazardous materials.

3. Assist ABAG's Training Subcommittee in developing regionwide standards and priorities for training response personnel.

   Identify parties in need of response training, type of curriculum needed, and where and how training courses should be offered. Establish qualifications or experience requirements for on-scene coordinators, and possibly for other response personnel. Examine the feasibility of using video television for training a large audience.

Tasks 1 and 2 are currently underway. SCIEC members have been mailed questionnaires on their hazardous materials training programs and needs. Please return these as soon as possible to:

SCIEC
South County Fire Station #5
895 Brittan Ave.
San Carlos, CA 94070

If you or your organization are not involved with hazardous materials, please pass the questionnaire on to someone who is. Any comments, criticism, questions, assistance, etc. will be appreciated. Please send them to Jim O'Donnell at the address above.

BEWARE OF FLAMMABLE LIQUIDS

by Hank Schmidt, South County Fire Marshall

Gasoline is the most commonly used—and misused—flammable liquid. More than two-thirds of all flammable liquid accidents involve gasoline. Most of us do not realize just how dangerous gasoline is. Do you know that gasoline and many other flammable liquids have heavier-than-air vapors that can flow invisibly along the ground and be ignited by a flame or spark from a considerable distance? For example, gasoline spilled during a tank truck accident in a small town flowed into a crawl space under a house a distance away. Vapor was drawn up into a gas-fired water heater, where ignition occurred. There was a flashback to the crawl space, and an explosion took place that destroyed the house and killed one person.

Precautions must be taken when flammable liquids are used:

- Never store gasoline in the trunk of your car.
- Do not siphon gasoline by mouth. Just a small amount of gasoline in your lungs can be fatal, so if gasoline is accidentally swallowed, do not induce vomiting.
- Start charcoal fires only with fuels explicitly labeled as charcoal starters—not gasoline. Don't add fuel to the fire after it is started because the flames could travel up to the can and cause an explosion.
- Do not fill the tanks of gasoline powered equipment while the engines are running or while they are hot.

It cannot be stressed enough: flammable liquids are dangerous products. Always follow directions on the containers, and handle with care.

South County Industrial Emergency Council
South County Fire Training Facility
895 Brittan Avenue
San Carlos, CA 94070

THE INDUSTRY AND FIRE SERVICE TIE LINE

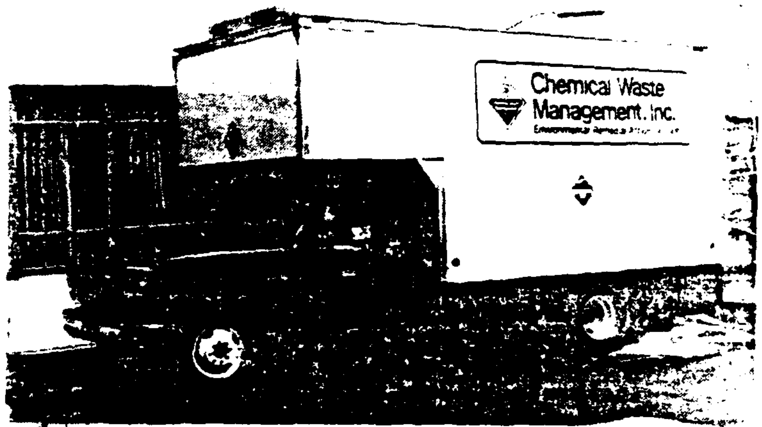
Volume 4 Edition 1 | A Quarterly Publication of the South County Industrial Emergency Council | 1st Quarter 1982

NEW SCIEC PROGRAM

SCIEC members will soon have the opportunity to have hazardous materials spill demonstrations conducted in their own facilities. Chemical Waste Management, Inc. (ChemWaste), a multinational hazardous waste management firm, has stationed a fully equipped spill response vehicle on the Peninsula. ChemWaste's Project Coordinator Ken York, who designed and built the van, is willing to take it to the facilities of interested SCIEC members to demonstrate the equipment and its use. The first session is scheduled for April 14, at Duolite International in Redwood City, and will include demonstrations of how to build a dike and how to plug a leaking drum.

Anyone interested in participating in this program should contact Jim O'Donnell at (415) 593-8011 ext. 41.

In a related program, Ken York is teaching a 40-hour course on hazardous material spill first response for the South San Francisco Fire Department, through the College of San Mateo.



Above: The spill response van.
Left: Ken York teaching hazardous material spill first response to South San Francisco firefighters. (See photo on p. 3)

PREPLANNING

- *During* last August's silicon tetrachloride spill at a South San Francisco chemical plant, firefighters were able to determine the plant's layout and respond quickly because the facility had been preplanned.
- In 1978, EIMAC Division of Varian Associates in San Carlos conducted a training exercise with several local fire departments, simulating a fire in one building. Five days later, a real fire broke out in a power supply in the same area of the same building. According to Safety Manager Dave Kay, fire department response was "like clockwork. Everyone knew just where things were, where to go, and what to do. The loss from the fire was about $75,000, but could have been astronomical." He attributes the effectiveness of the response to the previous week's exercise.

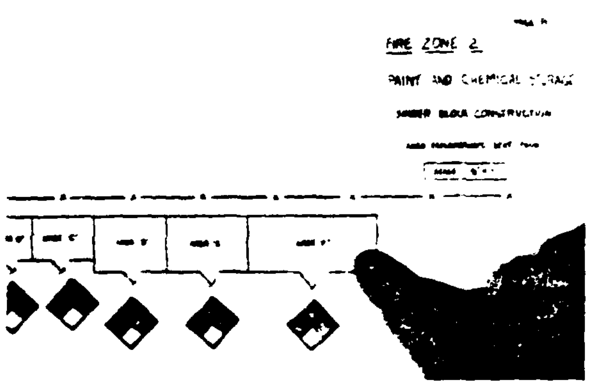
Fire service response to fires and other incidents at industrial, institutional, and other commercial facilities can be more effective when firefighters know what to expect at each site in terms of facility layout, hazards, and resources. To help minimize injuries and property loss, each fire department should have a detailed, up-to-date "preplan" consisting of maps, notes, and a resource list for each commercial occupancy in its jurisdiction. However, time and money constraints keep most fire departments from gathering as much preplanning information as frequently as they would like. Industries, businesses, and institutions can help themselves by working with their public fire departments to preplan their own facilities.

The Redwood City Fire Department began preplanning major commercial occupancies in detail in 1979. Battalion Chief Brad Brooke developed a model that specified types of information to gather, plus a format for storing the information, using 11 in. by 14 in. looseleaf binders and plastic-covered pages. This format was subsequently adopted by SCIEC as a model. The first facility preplanned was Diamond Shamrock (now Duolite International.) Completion of their plan took about 100 hours of fire department personnel time.

In 1980, a summer student intern hired by Litton Industries in San Carlos gathered and documented pertinent preplanning information on the entire facility, at a cost of approximately $2000 to the company. According to Phil Marquis, Litton's plant manager, "Two thousand dollars may sound like a lot, but consider the consequences of firefighters trying to fight a fire without knowing what or where our hazards are. Compared to those consequences or the replacement cost of the facility, the cost of the preplan is really low." South County Fire keeps a copy of the preplan.

Once your preplan has been completed, it can be used for training exercises by plant and fire department personnel.

Following is a general checklist for a preplan. Check with your local fire department first for any additional information or special format they might like.



Objective: Provide information on facility layout, hazards, and resources to be used for decisionmaking by the fire department in case of an incident.

Information Needed:

Plot Plan—Map the general layout of the facility, number or label each buildings or zone, and indicate locations of
- -utility shutoffs, and the consequences of shut-off, if any
- -water hydrants and mains
- -standpipes
- -house-lines
- -water supply
- -control valves
- -sprinkler areas and connections
- -street boxes
- -storm drains
- -any barriers to access (fences, railroad tracks, etc.)

Floor Plans—For each building or zone, show
- -emergency exits
- -stairs and elevators
- -fire alarms
- -special equipment and control panels
- -occupancy or activity
- -number of employees, their hours, and any physically handicapped
- -structural notes (wall and roof construction, ceiling height, fire doors,etc.)
- -access routes (vertical openings, fire escapes, etc.)
- -name and maximum likely quantity of each hazardous material stored (by proper shipping name is best, unless the storage containers are labeled with brand names. In this case, list the brand name on the preplan, with information on the composition, hazards, precautions, and first aid procedures. For brand name listings, include an alphabetical index by name, in case the material is found in an area where it is not indicated on a map.

Resource List
- Provide the names, titles, and telephone numbers of personnel that should be contacted in case of an incident, either during or after business hours. List an alternate for each contact.
- -Indicate the type, quantity, and locations of any hazardous material spill abatement materials such as sorbents and neutralizers.

Organization and Format: A useful way to organize your preplan is in a looseleaf binder. Sheets can be easily added or removed. Plastic covers for the sheets will help them last longer. Be sure to include an index in the front.

Updating: Include the date of compilation on your preplan. Keep your preplan up to date. Notify the fire department any time your facility undergoes significant changes, such as new *construction*, *rearrangement* of hazardous material storage, changes in key personnel or their telephone numbers, etc. Send them updated pages with the new information.

Your completed detailed, up-to-date preplan will be used by the fire department to help protect your property, your employees, their employees, and the public.

(Background material for this article was contributed by the Redwood City Fire Department, Litton Industries, and th South San Francisco Fire Department.)

"HMIRS"

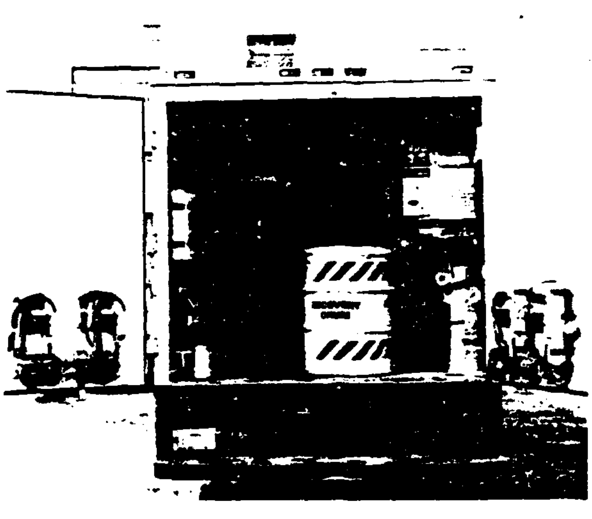
SCIEC's three-phase Hazardous Material Incident Response System (HMIRS) for San Mateo County is making progress. This proposed program involves 1-establishing a Resource Library and Data Bank on hazardous materials, 2-acquiring and equipping two hazardous material response vans, and 3-developing a prevention and response training program for employees of industry and government. By having prompt, well-trained responders and appropriate equipment available locally, both industry and the public will benefit. Therefore, funding is being sought from both the private and public sectors.

- At the end of January, the San Mateo County Area Disaster Council, which represents nineteen political jurisdictions in the County, agreed to provide $50,000 to the project, subject to the approval of each City Council and contingent upon financial support of $50,000 to $100,000 from industry.
- We have applied for State funds from the California "Superfund."
- Technical and financial support is being requested from local companies.

Copies of the proposal are available from Jim O'Donnell at (415) 593-8011 ext. 41. Because SCIEC is a non-profit organization, contributions are tax-deductible.

HAZ MAT TRAINING

As you may recall, SCIEC is working with the Association of Bay Area Governments (ABAG) on a U.S. Department of Transportation contract to develop a Bay Area hazardous material incident prevention and response program. To date, we have produced three documents to be used by ABAG in their reports. All three deal with industry's hazardous material training needs, and are based on the results of surveys and interviews of SCIEC members. Thanks to all of you who participated. Copies of the documents are available from Hway-ling Hsu, Scientific Service, Inc., (415) 368-2931.



Rear view of ChemWaste's spill response van.
(Story p. 1)

MEMBERS IN GOOD STANDING

1982 dues have been received from the following members:

Amfac Hotel
Adhesive Engineering
Allfire Equipment Co.
American Red Cross
BWS Distributors, Inc.
California Safety and Supply
Center for Planning and Research
Chemical Waste Management, Inc.
E.I. duPont
EIMAC Div. of Varian
EQE, Inc.
Eureka Federal Savings
Fire and Life Safety Consultants
The Folger Coffee Co.
GTE Lenkurt
GTE WESGO
H&H Ship Service Co.
Holiday Inn of Belmont
Hunt Research Corp.
Intel Corp.
International Plant Research
IT Corp.
Kaiser Foundation Hospital
Liquid Carbonic Corp.
Litton Industries
Marine World/Africa USA
Marvin Ross
PARGAS
Pyromet Industries
Quantic Industries, Inc.
Reichhold Chemicals, Inc.
San Mateo County Firefighters, Local 2400
San Mateo County Sheriff's Office
Scientific Service, Inc.
South San Francisco Fire Dept.
Spencer Kellogg Div. of Textron Inc.
Western Fire Equipment
Willard Products

We won't embarass the rest of you by printing your names, but please pay up. If you never received your renewal notice, or you can't find it, or whatever, please contact Earl Heiman of Allfire Equipment Co. at (415) 365-7067. Your dues will be spent on administrative costs (paper, postage, printing, mileage, etc.) and refreshments for the monthly meetings. (That's why you should attend.) Annual dues are a mere $25 for companies employing fewer than 50 people, and $50 for those employing more.

THE TIE LINE

The "Tie Line" is a quarterly publication of the South County Industrial Emergency Council, a non-profit educational organization dedicated to fostering cooperation between industry and government in the field of emergency preparedness. Letters, articles, and announcements from readers are welcome. Limited advertising space is available at $25.00 per quarter page, camera-ready copy, please. Please direct questions and comments to Hway-ling Hsu at (415) 368-2931. This issue includes an Emergency Planning Fact Sheet for Floods, compliments of Scientific Service, Inc. Keep it in a dry place.

—— PROFILE —— SPENCER & NATIONAL

Hazardous material safety training is currently a topic of interest to industry, government, and the public. This issue features separate interviews with Spencer Kellogg Division of Textron's plant manager, Fred F. Furrer, Jr., and National Semiconductor's Fire Protection and Personal Safety manager, Bill Buckman.

FRED F. FURRER, Jr. SPENCER KELLOGG

Spencer Kellogg's San Carlos plant employs 25 people and produces materials for the coatings industry—alkyd resins, water dispersible resins, urethane, and co-polymer resins.

Q. How do you conduct your safety training?
A. Each employee, when he is hired, gets a complete set of safety equipment—shoes, rubber boots, goggles, safety glasses, hard hat, gloves, respirators, and coveralls—instructions on how to use them, and a safety manual. Each shift foreman is responsible for seeing that each employee has the required safety equipment, and follows the proper procedures. Every month, we have a safety meeting, about 45 minutes long, that all employees attend. We discuss subjects such as safety equipment use, any accidents that may have happened since the last meeting, plant housekeeping, new product procedures, and employee training.

Q. What information is in your safety manual?
A. Instructions on using the safety equipment, all of the company's safety rules, plus instructions on the proper handling and labeling of hazardous waste, emergency procedures in case of fire, lockout procedures when cleaning tanks or kettles, forklift operations, and other information employees may need to know.

Q. Do they really read their manuals?
A. All employees are expected to know all the safety procedures that apply to their jobs. We can and have dismissed people for violating safety procedures.

Q. How does hazardous materials training fit into your safety program?
A. We inform the employees as to which materials are hazardous and the proper procedures to use when working with them. Material safety data sheets are kept available to the employees, and are also on file in the office and laboratory.

Q. Do you change your processes or products frequently?
A. Most of our products have been around for a few years. When we do change products or processes, we usually have assistance from our technical staff in Buffalo, New York. A chemist or chemical engineer come out from the research center to train our employees to work with the new product or process.

Q. How is your employee turnover?
A. Very low. Some of our people have been here over 20 years. The average is about seven or eight years. We don't have assembly work—our people are doing different jobs and working with different products every day. The jobs require them to use their heads and perform different tasks in the course of the workday.

Q. What role does your insurance company play in your safety program? Do they provide incentives for training?
A. We are well monitored by Aetna and Factory Mutual. They provide us with resources—training films, speakers. Also, many of our raw material suppliers have training programs. They'll even run personal checks on the employees, like putting a charcoal pack on their backs, then at the end of the day seeing what kind of vapors they've picked up. They go through the plant with monitors to see if they can pick up traces of vapors in the atmosphere. Both the suppliers and the insurance companies help us provide a safe environment for our employees and neighbors.

Q. Why is Spencer Kellogg so safety conscious?
A. You've got to do everything you can for the people you invite to come work in your facility. To have a safe place for them to work, you've got to train them so they'll know what they're working with, and what the problems could be if they don't adhere to the safety program—aside from the fact that they could get fired. I don't think anyone wants to bring people into a chemical plant without protecting them. It's the employer's responsibility to provide a safe workplace—not like the old days when you gave a guy a pick and a shovel and sent him down into a hole in the ground and the poor guy came out with black lung disease—in today's society, no industry can operate like that.

Q. How do you calculate the costs and benefits of your safety program?
A. The benefits are the reduced amount of lost time from injuries and illness, like respiratory problems and skin disorders. We have had no lost time accidents in over 140 weeks in this plant, and only one lost time accident in the last five years. We're in an incentive program of Textron's right now, where prizes are awarded for every six months with no lost time accidents. The program was initiated two and a half years ago; after the first six months with no lost time, we had a safety meeting and all the employees were presented with pen and pencil sets. After one year, everyone got a smoke alarm for his home. After eighteen months, they came out with brochures with all kinds of gifts you could chose from. Now we're up to two years and the prizes keep getting better—some of the guys are wondering when we get our free TV sets. This program provides both incentive and peer pressure to be safety conscious. You don't want to be the one to have a lost time accident and mess it up for everyone else. A program like this costs money, as does putting together our safety manual and conducting our monthly safety meetings. But preventing one accident pays for it. Accidents aren't cheap. The insurance company lets me know how much it costs them when an employee has an accident, no matter how minor, and believe me, it's cheaper to prevent accidents. We've kept track of all our accidents for the last five years.

Q. Do you have plans for larger scale emergencies—earthquakes, fires, spills, explosions?
A. Yes. We have a spill prevention plan mandated by EPA. We have diked some tanks, and cemented some troughs in a truck loading area so that if we had a spill, it wouldn't get in the street. As for fire, we've given plot plans and information on the contents of each tank in our plant to the South County Fire Department. We've had two fires and explosions since 1958. A lot of work has been done since then on the systems so that there are automatic shutoffs—everything has backups.

Q. Why do you belong to SCIEC?
A. We have a policy of working with all the people and organizations in our area—our neighbors, the fire department, the city fathers. These people are trying to help us, so we try to work with them. The company spends a lot of money on safety, we're very safety conscious, and SCIEC is an organization aimed at safety related problems.

Q. What benefits do you expect from belonging to SCIEC?
A. Information exchange. We need to meet and talk to other people to learn new things. We might pick up only one tidbit of information in a year's time, but that information might help save someone's life.

Q. Are there any specific activities you'd like to see SCIEC undertake?
A. Something I'd like to do is get CPR training for all our people. But, because we operate three shifts it's difficult to get everyone together at one time. Maybe SCIEC will come up with a program for someone to come to the plant to train the people.

BILL BUCKMAN *NATIONAL SEMICONDUCTOR*

National Semiconductor's facilities in Santa Clara and Sunnyvale are its world headquarters. Ten thousand people are employed there, producing integrated circuits for use by toy manufacturers, the automobile industry, instrumentation companies, and others.

Q. How is safety training conducted here?
A. We have a Corporate Training Department of about fifteen people, who do all kinds of training, including safety. Then we have a Corporate Safety Department of seven people, who develop safety training programs for Corporate Training to conduct. We (Safety) get the program on its feet, then turn it over to Training to administer, and we QA it.

Q. How is hazardous material training conducted?
A. About a year ago, we developed a training program for all employees that mix, handle, or transport hazardous production materials. There are three parts to the program: a self-paced instruction workbook that takes about six weeks to complete, a written test, and a practical test where the employee has to demonstrate his ability to perform certain tasks, like manipulating and connecting valves properly, putting the fittings on properly, and so on. Every six months, they must be recertified by either taking the tests and passing them, or by taking a another course (shorter than the original) and passing the tests. If any item in their area changes, we send the information to them right away. We've found that recertification every six months rather than annually is cost-effective because we change our materials and processes so often that employees need the more frequent testing.

Q. How do you calculate the costs and benefits of this program?
A. By going through our computer files and comparing the number of accidents we had before the Certification Program to the number we have now. The number now is just a tiny fraction of the number we used to have. Every time an accident occurs, cost to the company is incurred in a number of ways: 1) A minimum of five people from our Emergency Response Team respond to each accident. Now the company has to pay their salary, even though they are no longer on their regular job. We calculate the time they spent on the emergency, and bill it to the department that had the accident. 2) Every time we evacuate an area, those people are being paid, but are not working. 3) When we evacuate, the production process is interrupted and we may lose products. For example, the product may remain in a furnace too long and be destroyed. 4) The worst loss is losing customers through business interruptions, by not being able to deliver a product on time.

Q. So, as a result of having fewer incidents, you've reduced lost time, lost product, and business interruptions. Do you attribute this to the Certification Program?
A. Yes. In addition, having fewer incidents is good for employee morale. Before, when one building evacuated, other buildings would evacuate too, just in case.

Q. What did it cost the company to develop the Certification Program?
A. About $5000 for the initial development. Corporate Training administers the program, and we (Safety) update and upgrade it. The program costs about $300 per employee in terms of time away from their jobs studying and taking the tests, if they do their studying on company time. It's up to each department whether they study on company time—most departments do allow a certain amount of time. We've found that this program is cost-effective and tremendously successful. The purpose of the Safety Department is to make the workplace safer, and to increase employee productivity. This Certification Program has done just that—the employees feel safer and make a better product. As for cost-effectiveness, our department is just like anywhere else—we have to justify our expenses.

Q. How do you keep your accident records?
A. We have all of our accident reports on a computer, so we can pull them up by person, department, building, floor, type of accident, type of injury, for every accident that's happened since 1968.

Q. What do you do with that data base?
A. Set priorities for area inspections. We (Safety) do one inspection per week.

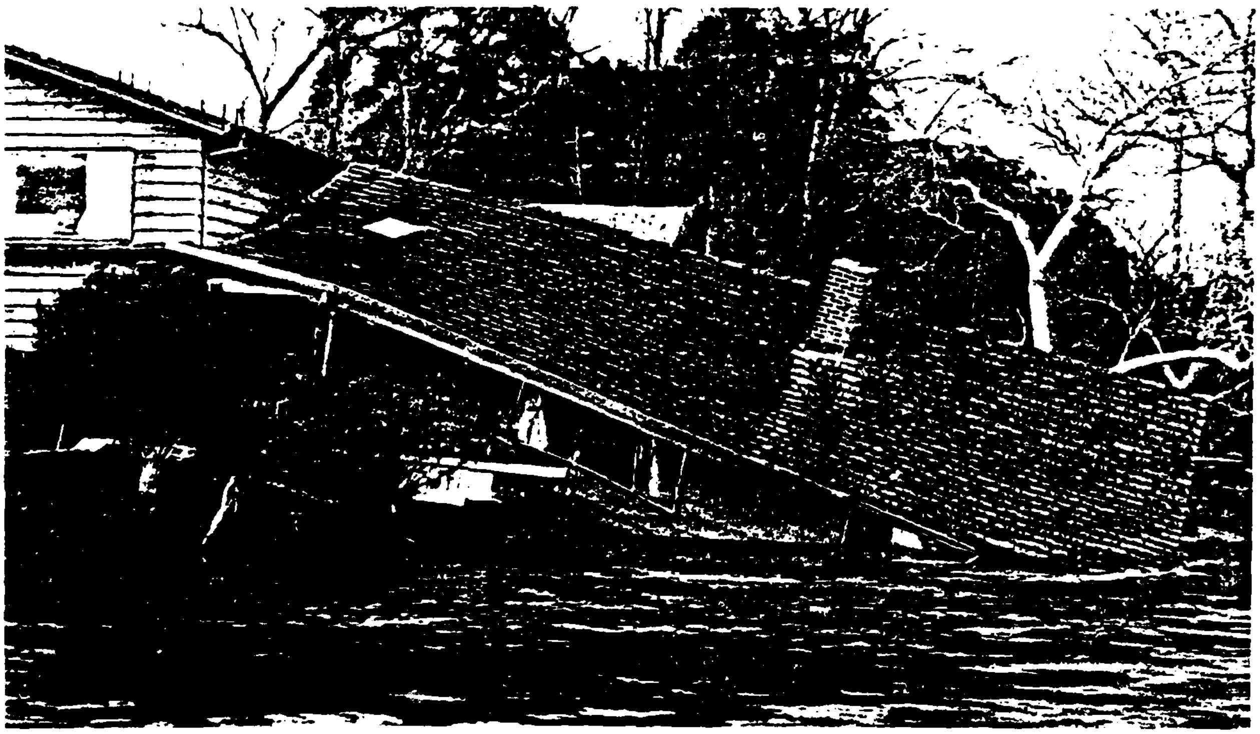
Q. How often is each area inspected?
A. It depends on the area—those with a high accident rate or frequent material changes are inspected more frequently.

SAN MATEO'S "CAD"

San Mateo County's first "Computer-Aided Dispatch" (CAD) Communications Center is now in operation in the City of San Mateo, serving the San Mateo Police and Fire Departments, Hillsborough Fire Department, and Foster City Police and Fire Departments. According to Communications Supervisor Ken Diddens, the new system has reduced by 50% the time required to receive, process, and dispatch a call. All "911" calls in the jurisdiction, as well as after-hours calls to the San Mateo Department of Public Works, are routed through the Center. The Center's dispatchers take information from the callers and enter it into the computer, which searches its files and gives response information to the dispatchers, who then relay it to the responding agency. For example, a dispatcher asks a caller reporting a fire for a description and the location of the fire, then enters the corresponding codes on a computer terminal. Within a fraction of a second, the computer-terminal screen displays the recommended response equipment, the specific units currently available, and any "premise information"; that is, any special hazards that exist at that address. The recommended response equipment is keyed to the type and location of the incident; the premise information is obtained during Fire Department inspections. From the time a call is received to the time it is dispatched, approximately 45 seconds elapse.

Dispatchers Mike Zarrella and Sandy Weissel point out that there are some drawbacks to the CAD system. One, the information the computer produces is only as good as the information that it receives from the dispatcher. Entering a wrong code at the outset results in the dispatch of inappropriate information. Two, the computer occasionally "crashes". To prepare for this inevitable happening and to allow for monthly maintenance, the computer is deliberately shut down one day each month, and all dispatchers use a manual backup system (the system they used before CAD) to keep in practice.

This house in Pescadero collapsed into floodwaters during January's storms. (Peninsula Times Tribune photograph by Art Ray)



READY-MIX RESOURCES

As a result of their experiences during January's storms, Pacific Ready-Mix, a local building materials supplier, has offered to open up two of their yards in San Mateo County during future flood emergencies to make sand and bags available to those in need. Upon request by local officials during emergencies, the company will open its San Mateo and Redwood City yards where several hundred tons of sand, several thousand bags, tools, and other flood control materials are ordinarily kept for sale. Peter Empey, Pacific Ready-Mix vice-president, sent a letter to each of San Mateo County's city managers and the County manager making the offer and listing the names and telephone numbers of four company managers who can open the yards any day, any time. According to Mr. Empey, the offer is not charity, as the company will charge for the materials. However, they will charge only their regular rates, and will open during non-business hours and provide whatever assistance they can. During January's storms, the Redwood City yard was opened at the request of the Redwood City Police Department, and employees worked long hours without extra pay to assist people who came in for sandbags.

SANDBAGS IN SAN MATEO

On a typical day, twenty cubic yards of sand are stored in San Mateo's City Corporation Yard for both routine and emergency use, along with hundreds of bags. During the January storms, this preparedness paid off. In response to telephone calls from local residents, Department of Public Works (DPW) employees filled and placed sandbags where needed, plus made sand, bags, and shovels available to the public at the Corporation Yard. According to Al Bergeron, DPW's maintenance manager, 900 sandbags and 18 tons of sand were used. The City had about 1000 bags on hand, and now stores 2000 in a warehouse and 800 in the Corporation Yard.

SOLUTIONS IN SAN BRUNO

Over a dozen downtown San Bruno merchants whose businesses were damaged by storm waters last January met with City representatives to work out some prevention and response plans for future floods. A preliminary identification of potential problems and solutions was completed by the end of January. Some suggestions for flood preparedness were:

-Individual building flood preplan—The City should work with each high hazard property owner or tenant to identify and minimize his potential flood problems, e.g. identify highest probable flood level in each building so valuables can be stored above mark.

-Safety inspection—Identify safety hazards such as electrical panels, motors, vents, and alarms, and either relocate or clearly mark them.

-Resource availability—Identify equipment, barricades, and volunteers available during a flood. Stockpile sandbags and train volunteers.

-Communications—Establish a telephone call fanout system to notify merchants, owners, etc. that a flood potential is imminent.

A FEW GOOD PERSONS

If your community experiences a flood, an earthquake, a major fire, or any other event where people suddenly need all kinds of assistance, you know the American Red Cross (a SCIEC member) can help. But do you know whom to contact, or exactly what services they provide? (For example, do you know that they do not evacuate institutions or provide ambulance services?) According to Red Cross spokesman Bob Kinsman, the most effective way for local officials to use the Red Cross's services is through "Community Liaisons." The Red Cross would like to see each city appoint a volunteer, one who knows the area's potential problems and is familiar with the local "old-boy" network, to be trained by the Red Cross to oversee all Red Cross relief activities within their respective communities. For example, Pacifica's Community Liaison for the last ten years, Mary Beauvais, has lived in Pacifica for 28 years and knows the area's geographic quirks as well as who in the community to contact for different types of assistance. During the January 4th storm Pacifica's Police Chief, anticipating the need for a Red Cross shelter, contacted Mary. Within an hour, she had contacted the appropriate people, and a shelter was opened at a local school. In contrast, in Pescadero where there is no Red Cross Community Liaison, several telephone calls were made among several agencies before relief efforts began. A Red Cross shelter manager arrived three hours after the City's initial call for assistance, only to find floodwaters so high that she was unable to get in.

For more information on the Community Liaison program, contact Jim Begansky, American Red Cross, 1870 Ogden Dr., Burlingame, CA 94010, (415) 692-5240.

PROFILE (CONTINUED)

Q. Do you have plans for large scale emergencies?

A. We're now developing a disaster plan. We plan on having to fend for ourselves for three days after the big earthquake, so we need to provide food, water, shelter, sanitation, medical treatment, recreation for three days for all of our people. We're looking into the possibility of putting in a heliport so that supplies can be flown in. Other companies in the area could use it—small companies in the area probably don't have emergency response teams—they may have injuries or damage and need assistance.

Q. Why do you belong to SCIEC?

A. We feel the concept of government and industry working together is an excellent one. We want to support it because it's an organization that should exist.

Q. What activities would you like to see SCIEC undertake?

A. On-the-road training. It's hard for members of our Emergency Response Team to go off-site for training. However, any training would have to be tailored to each of our facilities and its materials. For example, our Santa Clara facility's ERT setup would not be appropriate for our facility in Union City.

Q. Then how could an outside traveling program train your people?

A. There's always the basics—first aid, CPR, rescue, how to use certain equipment—maybe the trainers could call ahead to find out what kind of facility it is, what the hazards are, then tailor the program to that facility.

Q. National Semiconductor has its own Corporate Training Department and Corporate Safety Department, yet you could use an outside program like this?

A. We're always open to new ideas.

SEMINARS

* * * *

This year's "EMERGENCY PREPAREDNESS FOR BUSINESS AND INDUSTRY" seminar and County-wide Disaster Drill, sponsored by SCIEC, the Area Disaster Office, PIBA, and the National Safety Council, will be on June 10, 11, and 12. Lectures will be held the first two days at Eureka Federal Savings in San Carlos; the drill and drill critique will be conducted at Dalmo Victor Division of Textron in Belmont. The first day will be devoted to emergency planning and management, and speakers will include Peter Yanev (EQE, Inc.), Kent Paxton (Center for Planning and Research), Fred LaCosse (LaCosse Productions) and Cecil Williams (Contra Costa Office of Emergency Services.) The second day's program focuses on specific emergencies, such as hazardous material spills and fires. Speakers will include Ken York (Chemical Waste Management, Inc.), Frank Moran (California Highway Patrol), Walter Dabberdt (SRI International), Al Smith (Fire and Life Safety Consultants), Dr. Don Cheu (Kaiser Hospital), and Frank Kelly and Jim Hunt (Kelly and Associates, Hunt Research Corp.) The drill, which involves an earthquake caused collision between a hazardous material carrier and a schoolbus, will be held the morning of June 12 (Saturday), with the critique immediately following. The cost (including lunch) of each of the seminar days will be $35 for members (in good standing) of SCIEC, PIBA, and the San Mateo Chapter of the National Safety Council, and $45 for all others. The drill is free of charge. Ten ft. by 12 ft. exhibit spaces will be available to members for $50 and to non-members for $75. Programs and registration forms will be available at the end of April. For more information on the program, contact Bob Kinsman at the Area Disaster Office, (415) 363-4790. For more information on exhibits, contact Sam Loy of BWS Distributors at (800) 862-4865.

* * * *

"HAZARDOUS CHEMICAL SAFETY SEMINAR"—offered by the J.T. Baker Chemical Co., sponsored the San Francisco, San Mateo County, and Central Counties chapters of the National Safety Council.

April 19 & 20	Holiday Inn Convention Center Mission and Eighth Streets San Francisco
April 21 & 22	Hilton Hotel 1250 Lakeside Drive Sunnyvale

Registration fee is $300. For more information, contact your local National Safety Council chapter or J.T. Baker at (201) 454-2500.

"SECOND ANNUAL TOXIC EXPOSURES AND OTHER INJURIES TO FIREFIGHTERS AND FIRE VICTIMS"—sponsored by the San Francisco Fire Department, the Bay Area Poison Control Center, the Center for Municipal Occupational Safety and Health, and the UCSF School of Pharmacy.

May 6 & 7	Jack Tar Hotel Van Ness at Geary San Francisco

Advanced registration (before April 28) is $20 per day, or $35 for both days. Late registration (after April 28 and at the door) is $25 per day, or $45 for both days. For more information, call (415) 666-4194.

"CALIFORNIA SAFETY AND EQUIPMENT SHOW"—sponsored by Darrell Heppner & Associates and D- Enterprises

May 26 & 27 Marin Civic Center

The cost is $45 for two days. For more information, call (415) 895-9650.

"PRACTICAL ALTERNATIVES TO THE LAND DISPOSAL OF HAZARDOUS WASTE"—sponsored by the Peninsula Industrial and Business Association (PIBA).

June 9	Rickey's Hyatt El Camino and Charleston Palo Alto

Registration is $100 for PIBA members, $150 for non-members. For more information call PIBA at (415) 965-2436.

South County Industrial Emergency Council
South County Fire Station #5
895 Brittan Ave.
San Carlos, CA 94070

SOUTH COUNTY INDUSTRIAL EMERGENCY COUNCIL
FIRE SERVICES - INDUSTRY

EMERGENCY PLANNING FACT SHEET — FLOODS

SCIENTIFIC SERVICE, INC. 517 E. BAYSHORE REDWOOD CITY, CA 94063 (415)368-2931

Emergency Planning Lessons

1. Because floods occur relatively infrequently, inadequate attention is often paid to this hazard in many community disaster plans and on the part of individuals and companies. Flood losses in the U.S. average $2.2 billion annually and are projected to increase to $4.3 billion over the next 20 years, even though these floods are largely predictable.

2. There is a general reluctance on the part of residents to withdraw from areas threatened by flood waters. Regardless of sufficient warning time or official evacuation orders, the majority of people located within an affected area may be hesitant to leave. One technique found useful in educating the public ahead of time as to potential flooding is to post historic or predicted flood levels (painted high-water lines on public buildings, sign posts, etc.). An effective evacuation plan is more than just a map indicating transportation routes.

3. Although numerous shelters and evacuation centers are typically established to house flood victims, relatively few people use these facilities for their intended purpose. It is not uncommon, however, for evacuees to utilize public shelters for disaster-related purposes other than housing. Members of separated families, for example, typically seek one another in shelters. Similarly, evacuees housed elsewhere may visit public shelters in an effort to gather information.

4. Problems of post-emergency convergence are consistently observed in flood-stricken areas. For example, there is frequently an over-response on the part of volunteers to help with activities associated with disaster relief. Therefore, it is necessary for disaster planners to determine ahead of time the manner in which disaster volunteers will be organized.

5. Regular contact and communication in the pre-disaster period among those who must respond to such events will help to insure that essential resources will be easily mobilized. Police and fire departments, or private companies and public emergency service agencies, must interact much more extensively in a flood disaster than in the more usual, smaller scale emergency. In many cases it is not the lack of emergency resources but the lack of coordination of emergency resources that is the biggest problem.

6. Post-disaster recovery may require more coordination than the response to the emergency itself. Aid, insurance, permits, resource inventories, and other post-emergency tasks require advance planning to be efficiently coordinated.

Flood Zone Maps

To determine if a particular site is in a potential flooding area, the planning department of the local city (or county if in an unincorporated area) should be contacted. The Federal Insurance Administration can also provide maps: (800) 638-6620. Your insurance agent will have access to these same maps, and should be able to tell you if you are located in a flood-prone area, as well as provide information on flood insurance.

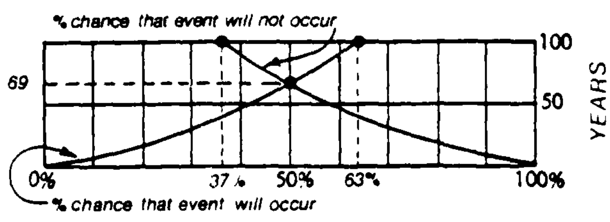
Contingency Planning Checklist

1. Consult flood maps.
2. Consult local officials in the emergency services (disaster services, civil defense) and planning departments.
3. Stockpile reasonable quantities of essential supplies; have a plan for quickly obtaining other resources if they become necessary.
4. Assume that electricity, telephone, and water service may be interrupted: If these outages would be unacceptably disruptive or unsafe, acquire generators, radios, and water tanks.
5. Know in advance how you would take advantage of the warning period (perhaps a day) that will probably be available: What preparedness measures would be taken if there is a greater than average chance of flooding because of continued heavy rains, if nearby lower areas begin to flood, if public officials announce that evacuation may be required, or if evacuations are ordered?
6. If evacuation is a possibility, consider relocation sites. Businesses may be able to operate essential functions from temporary facilities or from unflooded branch offices; families may stay with friends or at Red Cross shelters.
7. Itemize the most valuable or essential equipment or contents, and estimate how these items could be removed or raised up off the floor as high as possible. Copies of essential records—deeds, insurance policies, etc.—should be taken to another site.
8. Keep in mind that identification may be required to enter flooding areas, since law enforcement agencies will establish check points and cordons. Employees should have company ID cards, or small store owners should have a copy of a business license or other government record that identifies the name of the person and the address of the store. Generally drivers licenses are sufficient identification to enable residents to return to their homes.

The Hundred Year Flood

A 100-year flood is a flood which is estimated to occur on average once every 100 years, and the chance that it would occur in any one year is one in a hundred or 1%. There is no meteorlogical reason to prevent more than one 100-year flood from occurring in 100 years, just as there is nothing to prevent one from flipping a coin and having it land on the heads side several times in a row even though the average over a large number of tosses will be one heads out of two. Due to the statistical laws involved, there is a 63% chance that the 100-year flood will occur in 100 years.

CHANCE OF 100 YEAR FLOOD



Sandbags

Sandbag barriers are not watertight, but they are usually adequate as emergency flood barriers. Sandbags are fabric sacks which are usually filled with sand or soil at the site where they are to be used (rather than delivered pre-filled). Sacks approximately 18 to 24 inches long and 12 to 18 inches wide are available from burlap sack manufacturers, or rural hardware and farm supply stores. A local office of the U.S. Army Corps of Engineers, or a local public works department, may be able to suggest where sacks can be purchased. Locating a local source of supply and stockpiling a reasonable number of sacks for the flooding anticipated is recommended: The cost is small, the storage space is minimal, and otherwise there may be no sacks available when they are required.

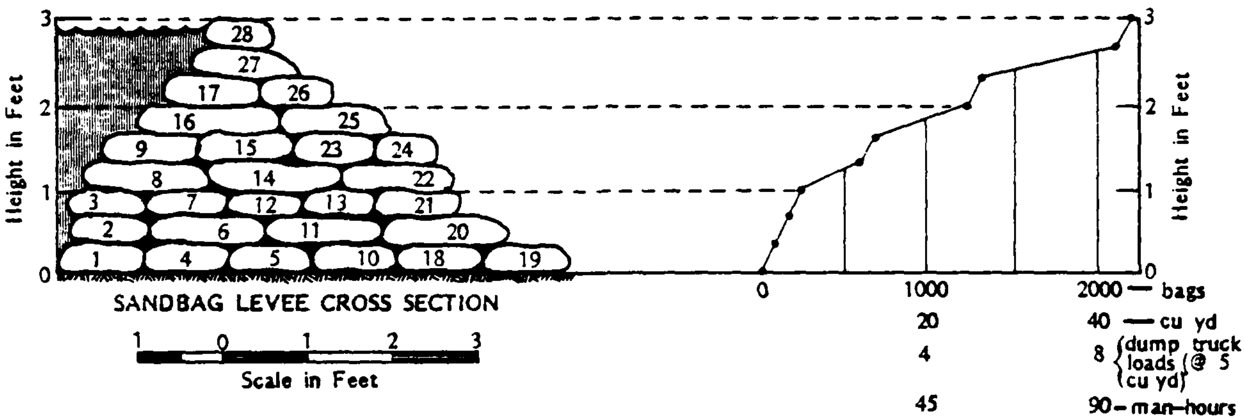
A stable wall three layers high can be formed a single sack in width; above this height, a pyramid shape is recommended. See the diagram below, which is based on information from the U.S. Army Corps of Engineers.

Pumps

Pumps are useful equipment for dealing with flood waters where the flooding is localized (as in a basement) rather than extensive (as when an entire valley is inundated).

Pumps can be purchased for less than $500, or rented from equipment rental companies. Muddy or debris-filled water requires the use of pumps that will not clog, such as trash pumps or diaphragm pumps. Electrically powered pumps must be used according to the manufacturer's directions to avoid electric shock. Combustion engine pumps are less hazardous. Common capacities range from about 50 gallons per minute to about 350 gallons per minute; the smaller size would pump enough water to drain an average residential swimming pool-size quantity of water in about 12 hours, while the larger size would pump this quantity in less than 2 hours.

Fire engines (pumpers) are high-powered pumps, but they may not be available for flood-related tasks.



Resources per 100-foot length of levee

Fill bags about half full; if heavier than 50 pounds, they will be difficult to place. Leave enough room to fold under end flaps as they are placed. Numbers on bags indicate most efficient placing sequence: first put a one-foot high single-width wall in place. Stamp each bag firmly in place to increase the water resistance of joints.

Related Hazards

Flooding may be caused by precipitation (which is discussed here) or by dam failure, tsunami (seismic sea wave), or hurricane storm surge.

Mudslides and landslides may be caused when soils become saturated with water, and in many areas these potential hazards have been mapped and can be located through the similar sources of information for flood maps. Electrical shock is a major hazard when water is present, and hence the power should be turned off in flooded buildings, and the special electrical safety warnings offered here in the section on pumps should be followed. Ironically, there may be a water shortage during and following floods, since reservoirs become filled with muddy water. For small quantities of water, the plastic bottles of water found in grocery stores are convenient, the cost is small (50 cents to a dollar a gallon), and the antiseptic precautions required to fill and store your own containers of water are avoided.

Sources of Information

Natural Hazards Research & Applications Information Center, I.B.S. #6, Campus Box 482, University of Colorado, Boulder, CO, 80309, (303) 492-6818. The Center's quarterly newsletter, The Natural Hazards Observer, is available free of charge.

U.S. Water Resources Council, 2120 L Street, N.W., Suite 800, Washington, D.C., 20037, (202) 254-6453. Several reports are available from the Council, including Cooperative Flood Loss Reduction, Floodplain Management Handbook, and Regulation of Flood Hazard Areas to Reduce Losses.

American Institute of Architects Research Corporation, 1735 New York Ave., N.W., Washington, D.C. 20006, (202) 626-7421. A report on Design Guidelines for Flood Damage Reduction is available that outlines architectural and engineering techniques for decreasing flood damage.

Federal Insurance Administration, Federal Emergency Management Agency, Washington, D.C., (800) 638-6620. Information can be provided on flood insurance maps, coverage, and rates. It is generally easier to first contact your insurance broker for this same type of information, since flood insurance is Federally supported but sold through private insurers.

THE INDUSTRY AND FIRE SERVICE

TIE LINE

Volume 4 Edition 2 | A Quarterly Publication of the South County Industrial Emergency Council | 2nd Quarter 1982

MORE PHOTOS ON P. 8

DISASTER EXERCISE

June 12, 1982--A busload of children collides with a bobtail truck hauling 30 55-gallon drums of different hazardous waste chemicals in front of Dalmo Victor in San Carlos. Some of the children are injured in the collision, while others leave the bus and become ill from exposure to the poisons, corrosives, oxidizers, and flammables released from the damaged drums. Mixing of the contents of the leaking drums results in several fires. Three damaged drums roll into a nearby creek that flows to the San Francisco Bay. (continued on p. 3)

EMERGENCY PREPAREDNESS SEMINAR

Participants in the fourth annual Emergency Preparedness for Business, Industry, and Government seminar sponsored by SCIEC, the Area Disaster Office, the San Mateo Safety Council, and the Peninsula Industrial and Business Association acquired a wealth of information running the gamut from how to set up the Incident Command System to how cows in Contra Costa County help avert disasters. Close to one hundred people attended the two-day seminar to hear:

-Ken Kidwell, Chairman of the Board of Eureka Federal Savings, and John Ward and Jackie Speier, San Mateo County Supervisors, welcome them

-Douglas Frazier and Steve Hom of EQE, Inc. explain earthquake risk potential and mitigation possibilities

-Kent Paxton of Center for Planning and Research discuss disaster planning for management

-Jay Clark of Ampex Corporation define industry's responsibility to provide the public with information following newsworthy events

-Fred LaCosse of LaCosse Productions point out methods members of the news media might use during interviews to provoke controversial statements

-Cecil Williams of Contra Costa OES relate examples of business and government working together in disaster preparedness projects

-Shelby Morris of the American Red Cross show a film on "Metropolitan Survival"

-Ken York of Chemical Waste Management, Inc. speak on contingency planning for product recovery following a hazardous material spill

-Capt. Jerry Gray of the San Francisco Fire Dept. identify SFFD capabilities in hazardous material spill response

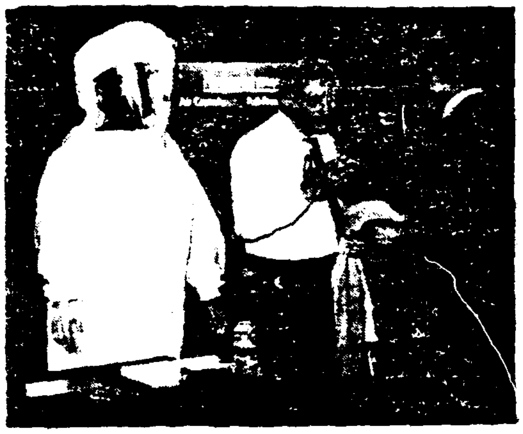
-Dr. Walter Dabberdt of SRI International address meteorologic aspects of hazardous material releases

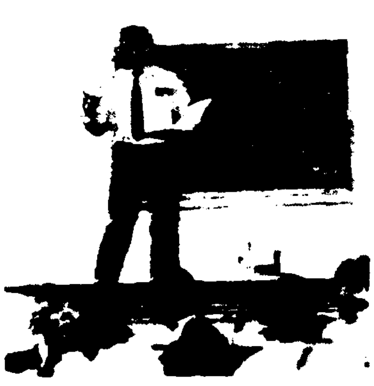
-Al Smith of Fire and Life Safety Consultants describe methods for setting up and training industrial Emergency Response Teams

-Assistant Chief Frank Kelly of the Huntington Beach Fire Dept. and Jim Hunt of Hunt Research present the Incident Command System (ICS) for on-scene disaster management

-Dr. Donald Cheu share slides and information on triage in medical disasters.

Thanks to all the speakers and participants, and to Eureka Federal Savings for providing the excellent facilities.





EXERCISE (CONTINUED)

In the meantime, some Dalmo Victor employees go to the roof of their building to watch the action. They are injured when an exploding drum of flaming chemicals lands on the roof. In all, 45 people are injured, the building is on fire, and the creek is polluted.

Fortunately, these events are merely part of a disaster training exercise conducted by the South County Industrial Emergency Council (SCIEC) and South County Fire. Several local industry emergency response teams and more than 20 local, state, and Federal response agencies participated in this simulated disaster to train in rescue, triage, chemical hazard identification and response, and building fires.

Objectives: 1) to practice multi-agency coordination at the scene of a hazardous material spill, 2) to practice the Incident Command System adopted by the State Hazardous Material Contingency Plan, 3) to exercise fire department response to a hazardous material spill, 4) to exercise the Emergency Medical System for coordination of medical triage, distribution of victims to hospitals, and hospital response to multiple casualties, 5) to determine the capabilities of industrial emergency response teams in assisting public agencies during disasters, 6) to determine the ability of the Coroner's office and the hospitals to handle chemically contaminated victims, and 7) to test communications and notification systems and mutual aid plans.

Sequence of events: At approximately 10:10 a.m., the California Highway Patrol (CHP) received the first call of a vehicle accident involving a bus. South County Fire also received the call of injuries in the bus accident. The first arriving emergency response unit was South County Engine 2. The captain, wearing breathing apparatus, retrieved the truck's shipping papers. Firefighters began triaging the victims near the leaking drums, but without using special protective clothing, so were designated victims themselves.
(continued on p. 6)

BANQUET WITH BANKERS

May 11, 1982—Eureka Federal Savings' Chairman of the Board Ken Kidwell and Regional Vice-President John Perry hosted a luncheon at EFS's San Carlos headquarters to introduce SCIEC and the proposed Hazardous Material Incident Response System (HMIRS) to members of the banking community. Representatives from banks and savings and loans institutions listened to Jim O'Donnell describe SCIEC and present reasons for bankers to be concerned with hazardous materials in the community. For example, toxic clouds from large hazardous material spills can affect anyone within range, including people in banks.

SCIEC representatives John Steele of Ampex, Phil Marquis of Litton Industries, Jim Zaccor of Scientific Service, Ken York of Chemical Waste Management, Captain Steve Ellis of the California Highway Patrol, and Bill Hern of the Peninsula Industrial and Business Association (PIBA) each spoke briefly on why their organizations support SCIEC and HMIRS.

SCIEC thanks Eureka Federal for providing this opportunity in such pleasant surroundings to acquaint the financial community with our work.

DISASTER PLANNING CLINIC

An intensive one-day "hands-on" disaster planning clinic for industry is being offered by Scientific Service, Inc. (SSI) in November. Clinic participants will learn specifics for developing or refining their own "all-hazards" programs. Each person will be given 1) an SSI step-by-step "Disaster Planning Manual" with worksheets, 2) practical hazard reduction and disaster response information for earthquakes, fire, hazardous materials, floods, security, power outages, and nuclear threats, and 3) opportunity to ask experts specific questions about his own facility or organization.

During the morning session, each type of disaster will be discussed by an expert in that field, using the sequence of steps in the Disaster Planning Manual: assessing the hazard, identifying practical countermeasures, and formulating a disaster program, including writing of plans. The afternoon session will be devoted to small group interaction between participants and experts—structural engineers, disaster planners, safety engineers, fire experts, etc.—to allow specific questions to be raised and answered. In addition, several microcomputers with programmed disaster risk analyses and response plans will be available so participants can see how computer-aided disaster planning works.

Each participant should bring:

-street map showing exact location of facilities
-plot plans of facilities
-knowledge of the status of the organization's disaster planning, plus copies of written plans, drill and training schedules, etc.
-information on number of employees, essential processes that must be maintained during and after disasters, schematic organization chart, daily staffing/shift patterns, typical contents of buildings, etc.
-questions

By the end of this seven-hour clinic, participants will be able to decide what to do next in their disaster planning, and where to get information, products, and services. For more information on the clinic, contact Robert Reitherman, Scientific Service, Inc., 517 E. Bayshore, Redwood City, CA 94063, (415) 368-2931.

THE TIE LINE

The "Tie Line" is a quarterly publication of the South County Industrial Emergency Council (SCIEC), a non-profit educational organization dedicated to fostering cooperation between industry and government in the field of emergency preparedness. Letters, articles, and announcements from readers are welcome. Limited advertising space is available at $25.00 per quarter page, camera-ready copy. Please direct questions and comments to Jim Zaccor, Scientific Service, Inc., (415) 368-2931. This issue includes an Emergency Planning Fact Sheet for Earthquakes, compliments of Scientific Service, Inc. It's your "fault" if you lose it.

PROFILE — AMERICAN RED CROSS

The American Red Cross provides a variety of services to communities and individuals to "prevent and mitigate suffering caused by disasters." Jim Begansky, Regional dministrator, describes specific services the Red Cross offers business and industry.

Q. What services does the Red Cross offer to business and industry?

A. Safety training and disaster relief. We offer first aid and CPR classes in several different ways. We hold classes at our Burlingame and Menlo Park offices, or we can arrange to send an instructor to a facility to train the employees on-site. A good method for a large company is to have one of their own people trained as a first aid or CPR instructor. That way, they'd have an instructor on the premises to train new employees and teach refresher classes. For companies that can't spare people for an eight hour training course, we've developed a 27 minute film called "Metropolitan Survival" that businesses can rent or buy to use as part of their own training programs.

As for disaster relief, the Red Cross is mandated by Congress to respond to disasters of all kinds to alleviate human suffering. We respond to major disasters, like the January floods, but we also respond to single family dwelling fires. For example, a fire department will call us at two a.m. to say a family's been burned out of it's home and has nowhere to go. We have volunteers on call who respond and arrange for the family to stay in a local motel. The next morning the family sees a Red Cross caseworker who gives them financial assistance.

Q. What if there's a fire at an industrial plant?

A. We do two things. One, if it's a large fire and the emergency workers will be there for an extended period of time, we can provide canteen service for them. Two, if employees become unemployed as a direct result of the fire, we consider them fire victims and provide them with our regular fire victim assistance—food, clothing, shelter.

If there's a major disaster, for example a large explosion, we provide a Disaster Welfare Inquiry service. This is for events large enough to be covered by the media. Anxious relatives from other parts of the country will swamp the disaster area with telephone calls to find out whether their families are all right. The Red Cross collects information from the hospitals and coroners' offices on people injured or killed, then sends that information to National Red Cross Headquarters, from where it is sent to all the local Red Cross chapters. Each local chapter then notifies news broadcasters in it's area that information on people in the disaster area can be obtained from local Red Cross chapters. This reduces the load on the disaster area phones and people. For example, after the fire at the MGM Grand Hotel, 5000 inquiries from all over the world were received within 24 hours.

Q. For how long do you help victims?

A. For the emergency phase. We would try to get them on their feet, then refer them to other agencies for longer-term assistance. Our main purpose is to help people during the initial emergency phase, say a few days to a few weeks. We're not here to support people for long periods of time.

Q. Do you help businesses with disaster planning?

A. We can give general information, but we don't have the time or expertise to sit down with individual companies to do detailed plans. We have two good documents—a prototype plan for business and industry, and a list of emergency equipment vendors in the area—available for a nominal fee. We also organize conferences where businesses can get together to look at and discuss each others' plans.

Q. Why does the Red Cross belong to SCIEC?

A. We're an emergency response organization. Disasters in industry affect people, and that's where our interest is. Also, our safety programs are important for industry.

Q. What would you like to see SCIEC do?

A. Public education. SCIEC could increase awareness among the general public of disaster preparedness, because the public is affected by disasters. For example, after a hazardous material spill, schools and businesses might have to be evacuated. SCIEC could do periodic exhibits or demonstrations at local banks, libraries, community events. It would be good public relations for SCIEC and its members. Businesses with plants may want to set up open house to educate the people living near them, to show them how clean and safe their operations are, to reduce anxiety about living near a plant.

ARC SAFETY TRAINING

- Regularly scheduled Multimedia First Aid and Cardiopulmonary Resuscitation (CPR) classes are held at the Red Cross Safety Center, 3540 Middlefield Rd., Menlo Park, CA 94025. Each class is eight hours long and costs $15.00 per person.
- Special classes can be arranged at the Safety Center or at your facility for a slightly higher fee and a minimum of ten students.
- Have one of your own employees trained as an instructor. The additional 16 hours of training costs $15.00 per person.
- Rent or purchase the film "Metropolitan Survival." The film can be rented alone or with an instructor and workbooks.

For more information, contact Shelby Morris, American Red Cross, (415) 366-3851.

CALDECOTT TUNNEL FIRE: THE HAZARDS OF GASOLINE

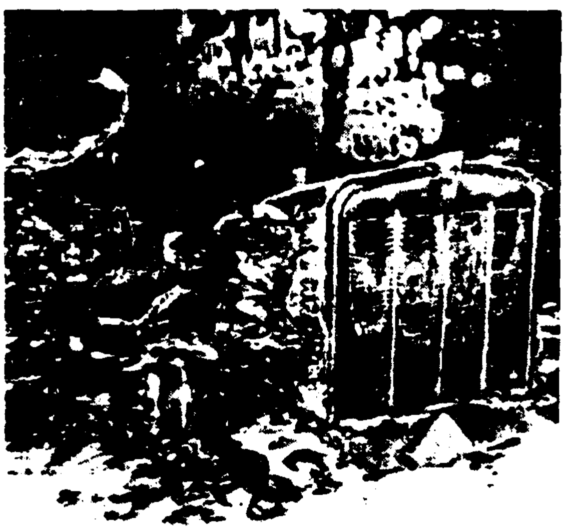
The Caldecott Tunnel disaster of April 7, 1982 can be analyzed now to provide a few hazardous material emergency planning lessons before the event fades from memory.

On that evening, shortly after midnight, a traffic accident occurred in the westbound bore of the tunnel (heading from Walnut Creek toward Berkeley) involving a tanker truck that contained 8,800 gallons of gasoline. A fire started, and with the large amount of fuel and the effect produced by the confinement of the tunnel, flame and smoke quickly filled the Caldecott. After the fire was extinguished, seven bodies were found inside.

The issues raised by this disaster concern different audiences. Use of tunnels by gasoline tanker trucks has been debated by law enforcement, the fire service, and legislators; tanker design and crash and leak resistance have been analyzed by engineers; tunnel fire fighting techniques have been reviewed by fire service agencies; legal aspects have been examined in detail by expert consultants, the Highway Patrol, and lawyers. What are the general lessons for industry?

The key point is the great destructive potential of one of the most common hazardous materials. More accidents have occurred involving gasoline than any other material.

Almost all industrial and commercial sites are exposed to the risk of a gasoline tanker truck accident, for gas stations are everywhere and gasoline delivery routes must criss cross urban areas. The size of gasoline explosions and fires can be so large that a spill on a public street can affect buildings located well off the street. The following facts on gasoline have implications for industrial and commercial hazardous material response planning.



—Gasoline's specific gravity is 0.8; that is, a gallon of gasoline weighs only 80% of what a gallon of water weighs, so gasoline will float on water. If a leak occurs near the bottom of a gasoline container, one can control the leak by running water into the top of the tank. The water will sink to the bottom and leak out instead of the gasoline. This is sometimes used as an initial step to control tank truck leaks. The El Centro, California fire department successfully used this method after the 1979 Imperial Valley earthquake damaged 18 large tanks and caused a 1,000-gallon leak from one of them. During earthquakes, large cylindrical fluid storage tanks usually suffer the most damage at their bases because the tanks try to overturn and buckle their steel plates near the foundation. Hence, this technique is likely to be useful after earthquakes in urban areas.

—According to Dr. Donald Myronuk of Scientific Service, Inc., who led the SSI investigation of the Caldecott Tunnel accident, research at San Jose State University has shown that by the time most people notice the scent of gasoline, the concentration has probably entered the flammable range. After initially smelling gasoline vapor, the olfactory senses immediately become less sensitive, so that even though the same amount is present it will not smell as strong.

—OSHA regulates gasoline storage in quantities as small as one pint. No more than one gallon may be stored in an ordinary metal gasoline can. Storage of small cans or tanks in exterior sheds is recommended.

—The Bureau of Explosives (**Emergency Handling of Hazardous Materials in Surface Transportation**, 1981) recommends an evacuation distance of 1,500 feet when large containers of gasoline are exposed to fire.

—Gasoline vapor, which is three and one-half times denser than air, will flow downhill. Gasoline spilled on streets or at gas stations can flow into storm drains, and thereby into underground sewer pipes. In a 1956 gas pipeline break in Los Angeles, gasoline penetrated all the way through the sewer system to the plumbing fixtures in a number of buildings. In a situation like this, certain measures, including evacuation, should be taken if possible. Ignition sources—open flames and sparks from pilot lights, burners on stoves or in furnaces, engine exhausts, machinery, electrical relays, and motors that are not explosion proof—should be extinguished or turned off. A drawing, perhaps a blueprint site plan highlighted with color, should be kept at hand showing the location of all underground pipes on the site.

—Gasoline does not dissolve in water, and applying streams of water to gasoline fires may cause the floating gasoline to spread. During cleanup of gasoline spilled from a tank truck in Mexico City, 34 people died when the gasoline floating on water used to wash down the spill ignited and flashed along a block of spectators.

—Under normal conditions, spilled gasoline always produces ignitable vapor.

—A spark or flame is not necessary to ignite gasoline. Gasoline that reaches temperatures above 535°F may ignite spontaneously.

—Flammable gas detectors with automatic alarms, either hand-held or wall-mounted, are available for from $100 to $300.

EXERCISE (CONTINUED)

The next responder to arrive at the scene was a California Highway Patrol officer, who, while setting up the Command Post according to the Incident Command System (ICS), also became a victim of chemical exposure. More fire units arrived, and the South County Battalion Chief set up the Command Post. At this point, a flammable liquid fire (compliments of Allfire Equipment Co.) began on the plant site. Another CHP unit arrived, and, as mandated by state law, a CHP officer assumed the role of Incident Commander. The Battalion Chief was designated Suppression and Rescue Chief. The San Mateo County Sheriff's Office arrived to assist in blocking off roads. The Command Post contacted the State Office of Emergency Services, the U.S. Environmental Protection Agency, the U.S. Coast Guard, California Fish and Game, and a Strike Team with members from the Redwood City, Menlo Park, and Woodside Fire Departments.

Ambulances from three companies arrived to work with the Coroner's Office to triage and transport the vehicle accident victims to three local hospitals. When the Strike Team arrived, it handled the building fire and rescued the victims on the roof. A second Strike Team with members from the San Mateo, Hillsborough, Foster City, Burlingame, and Millbrae Fire Departments was called for assistance. The Command Post then activated both the County Road Department to dike the creek below the chemical drums, and the Chemical Waste Management Emergency Response Van to remove the drums from the creek. Members of the news media were present throughout the incident and were kept informed by the Public Information Officer (a CHP officer) and Ken York.

Critique: Exercise participants and designated observers assembled immediately afterward to discuss errors that had been made. Areas criticized included:

-Communications—information was lost during dispatch; excess radio traffic on one frequency hindered communication; information on the chemicals involved was received by the Command Post but was not disseminated to others; communication between firefighters and medical workers was poor.

-Incident Command System (ICS)—This was the first time most participants had been exposed to the ICS. Inevitably, some confusion was the result. During the transfer of command from the fire department to the CHP, firefighters were uncertain whom to report to. Also, the Command Post was set up too close to the scene, resulting in probable chemical contamination. On the positive side, the good fire department/CHP interface was praised several times.

-Medical care and triage—rescue and triage were not well coordinated; the triage area first set up by firefighters should have been relocated by later-arriving medical workers, as victims had to be carried too far; a medical representative should have been present at the Command Post.

-Hazardous material handling—First-arriving firefighters correctly retrieved the truck's shipping papers to identify the spilled materials. They also correctly did not use the one contaminated hydrant, and did not spray water-reactive material with water. However, in rescuing contaminated victims, they should have used blankets and rubber gloves to protect themselves from contamination. As a result, several firefighters became victims themselves.

Overall, Frank Kelly and Jim Hunt, the ICS instructors, evaluated the exercise as the best they had ever been to, and the most realistic.

Over 20 organizations donated props, special effects, technical expertise, materials, equipment, time, and refreshments for the exercise. Thanks to all of you for your participation.

FREE SAFETY & HEALTH CONSULTING

Are you a small industry that can't afford a safety consultant? Cal/OSHA Consultation offers valuable on-site counseling to assist employers of small or large industries in evaluating safety and health problems in the workplace.

Employers generally think of penalties and citations when they hear "OSHA". However, Cal/OSHA offers a consultation service completely separate from the enforcement arm. All reports from a conference between the OSHA **consultant** and the employer are kept confidential; there are no fines or other enforcement actions.

By eliminating all safety and health dangers possible, an industry can avoid costly occupational illnesses and injuries. "The enormous losses paid out by industries could be reduced. The losses are in increased insurance premiums, medical and legal expenses, and wages to nonproducing injured employees, among other costs. Also employees are experiencing a lot of unnecessary injury and illness on the job due to violations," says Peter Rice, an Industrial Hygienist at Cal/OSHA Consultation.

Solutions to the most common violations found by OSHA consultants are often not complicated, and it makes sense to take care of safety problems **before** a routine OSHA regulatory inspection. Machinery violations are found most frequently; lack of sufficient guarding is usually the cause. Simple guards can be fabricated with wire mesh, drop pins, wood or plexiglass. Other common violations are electrical hazards in installation and maintenance of electrical systems, and a knowledgeable electrician must be called in for the correction.

Litton Industry's plant manager, Phil Marquis, says of his experiences with the Cal/OSHA Consultation service, "The Consultation representatives are helpful, educated, and experienced. We've had them in for air and noise sampling and they provided valuable suggestions. And they don't take a punitive attitude."

Sam Loy of BWS Distributors Inc. has worked with several Cal/OSHA consultants and is quite impressed with their abilities. He has recommended OSHA Consultation to several companies which needed safety guidance. "In every instance in dealing with OSHA Consultation that I've heard of, the customer has been very satisfied with the health and safety recommendations made. I've never known the consultation representatives to disclose any information to the regulation enforcement group."

For more information, call or write:

San Francisco Cal/OSHA Consultation Service
455 Golden Gate Avenue, Room 1161
San Francisco, CA 94102 (415) 557-1034

Or call toll-free: (800) 652-1476.

ACID SPILL

Employees of a small machine shop in San Carlos discovered about a gallon of liquid leaking from a rusty can on an adjacent lot. Not knowing what the material was, they used water to wash it toward the street storm drain. When they observed yellow fumes emanating from the runoff, they called the fire department.

South County Engine One arrived at the scene at 3:04 p.m. and found the machine shop employees still flushing the material. Firefighters stopped the flushing, then diked the runoff with nearby dirt to prevent its reaching the street storm drain. The machine shop owner, who is also the leasee of the lot, requested a professional cleanup firm be called.

Ken York of Chemical Waste Management, Inc. arrived at the scene about 4:00 p.m. and identified the material as hydrochloric acid of pH 1. Two ChemWaste technicians arrived with their response van at 4:30 p.m. They donned protective suits and respirators, applied soda ash to the runoff until the pH was between 5 and 9, swept it up into plastic bags, then packed the bags into drums.

Several 55-gallon drums on the lot, one of which was leaking acid and waste oil, were overpacked and removed. Total cost of the cleanup was about $1500.

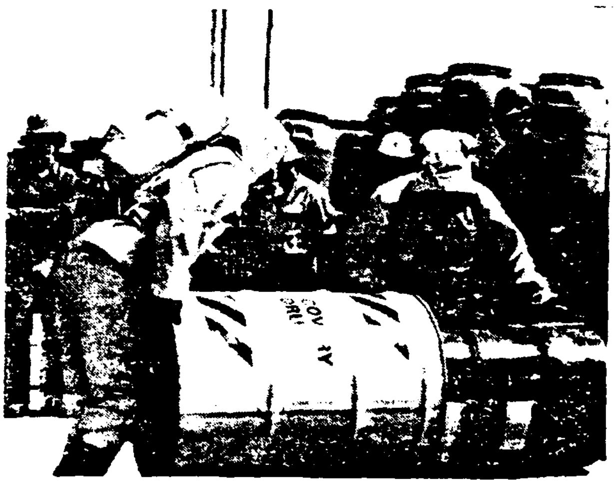
Above: ChemWaste technicians sweep up neutralized hydrochloric acid at a San Carlos machine shop.
Above Right: Same technicians show how to overpack a drum during a hazardous material spill response demonstration at Duolite International.

DEMO AT DUOLITE

April 14, 1982—Clear liquid spurted from a punctured 55-gallon drum onto the pavement. As a crowd of Duolite International employees and Redwood City firefighters watched, two men in protective suits diked the spill, took samples of the liquid, and successfully plugged the leak. The material was water, and the events were part of a hazardous material spill response demonstration done by Chemical Waste Management, Inc. in a Duolite parking lot.

Chemist Steve Williams and technicians Doug Hansen and Doug Fraser showed and explained the uses of the equipment carried in ChemWaste's emergency response van, then demonstrated some response techniques.

SCIEC members interested in having similar on-site demonstrations may contact Jim O'Donnell at (415) 592-0411.



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EDITOR'S NOTE

This marks the third issue of the Tie Line for which Scientific Service, Inc. has assisted SCIEC in the preparation of text. This task has been largely handled by Hway-ling Hsu of SSI who has been story writer, photographer, editor, and head honcho all in one. As many of you know, Hway-ling is leaving the area and returning to school on the East Coast. Her gung-ho attitude and gentle (and sometimes not so gentle) persistence in the gathering of stories and interviews for the Tie Line will be sorely missed. We wish her well and hope that she returns to us soon.

Her task will be taken over by Gretchen Smith, who recently joined SSI and has been traveling around with Hway-ling meeting many SCIEC members. We hope that all SCIEC members will get a chance to meet Gretchen soon and will also help and support her efforts to produce the Tie Line as they have Hway-ling.

☆☆☆☆☆☆☆☆☆☆☆

DISASTER EXERCISE

South County Industrial Emergency Council
South County Fire Station #5
895 Brittan Ave.
San Carlos, CA 94070

SOUTH COUNTY INDUSTRIAL EMERGENCY COUNCIL
FIRE SERVICES - INDUSTRY

EMERGENCY PLANNING FACT SHEET

EARTHQUAKES

SCIENTIFIC SERVICE, INC. 517 E. BAYSHORE REDWOOD CITY, CA 94063 (415)368-2931

Earthquake Myths

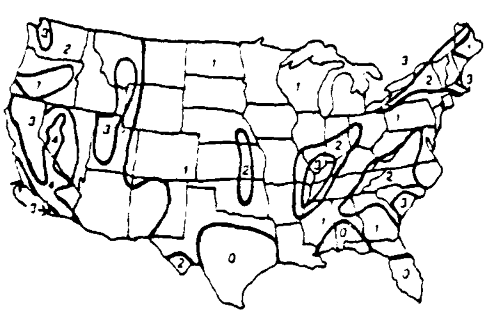
"A magnitude 8 earthquake is 10 times more destructive than a magnitude 7." Seismologists use a ten-times factor in decipering the "squiggles" recorded on seismographs, but neither damage, shaking intensity, nor energy release corresponds to a ten-times difference for one point on the scale. In general, magnitudes over 6, if the earthquake occurs in an urban area, are capable of causing major damage, and if over 7 (with about 9 being the greatest ever recorded) enough energy could be released to cause severe shaking and damage over an entire urban region.

"New buildings are earthquake-proof." Buildings built up to Uniform Building Code seismic requirements (which are commonly enforced only in some western states) are generally "earthquake-resistant" but not "earthquake proof." They should not collapse in a great earthquake, but they may well be damaged and may be costly to repair.

"Large heavy objects need not be positively attached or anchored to remain stable during earthquakes." The more the object weighs, the more force it exerts. Hence, large, heavy equipment can move during earthquakes if not positively anchored, as evidenced by the sliding of large outdoor statues, fire engines, boilers, and other heavy objects in past earthquakes.

"Some buildings are designed to give during earthquakes." All buildings give, or move and absorb energy, during earthquakes. Buildings with solid structural walls give or move less, while those with frames (steel or reinforced concrete columns and beams rigidly joined together) are more flexible and move more. Both basic types of systems can perform well.

"Part of California could fall off into the Pacific Ocean in a catastrophic earthquake." The rupture of earthquake faults causes only localized soil cracking and an offset of up to about 20 feet from one side of the fault to the other. (The big problem is that the sudden shearing of rock along the fault line releases vibrations—the earthquake.) Cutting a line through the middle of a cake and sliding the two halves along the cut is analogous to faulting: Nothing "falls off."



SEISMIC HAZARD ZONES
(source: Uniform Building Code;
0 = least risk of ground shaking,
4 = highest risk)

Historic U.S. Earthquakes

Cape Ann, MA, 1755: Moderate shaking from Nova Scotia to Chesapeake Bay.

Missouri, 1811-1812: Several huge earthquakes, about as large as any observed in U.S., but few structures in area at this date.

Charleston, SC, 1886: 60 fatalities; all of South Carolina shaken significantly.

San Francisco, 1906: 500-700 fatalities; severe shaking in 50 mile-wide area along 180-mile length of San Andreas Fault; magnitude 8.3; $333 million current-dollar loss.

Long Beach, CA, 1933: Numerous school and commercial building collapses, but only 115 fatalities because earthquake occurred at 6 p.m.; magnitude 6.3; $266 million current-dollar loss.

Hebgen Lake, MT, 1959: 28 fatalities in sparsely populated region; landslide blocked off a river and created a lake; magnitude 7.1; $26 million current-dollar loss.

Alaska, 1964: 125 fatalities, most from seismic sea waves; all of southern Alaska shaken, for up to about 3 minutes; magnitude 8.3; $1 billion current-dollar loss.

San Fernando, CA, 1971: 58 fatalities; 4 hospitals seriously damaged (2 with complete collapse of buildings); near-failure of one dam; magnitude 6.4; $900 million current-dollar loss.

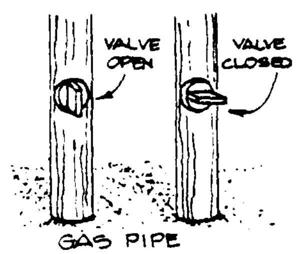
Emergency Response

During An Earthquake

1. **Take cover** under desk or furniture to protect yourself from falling objects. If outside, avoid overhead wires, masonry fences, building walls.

Immediately After An Earthquake

1. **Apply first aid** if required; if the telephones do not work, summon medical aid by sending someone in person to nearest fire station or hospital.
2. **Shut off utilities** only if your building is visibly damaged. Natural gas is the greatest potential hazard; shut it off at the meter with a large wrench. Electrical power can be shut off by turning all switches off at the panel box (fuse box). Water can be turned off either at a shutoff valve with a handle at the building, or by turning the valve usually found in a sunken concrete box at the curb (which requires a sprinkler valve type of wrench.)



3. **Maintain a fire watch,** since water systems may be damaged and numerous small fires may start because of electrical or natural gas damage.
4. **If the electricity goes out,** use a flashlight rather than candle for lighting, to avoid the fire risk.
5. **Do not use the telephone** unless you are reporting an emergency. Needless phone calls can tie up the entire telephone system.
6. **Leave written messages** saying where you have gone for family members or coworkers, if you are separated.

Earthquake Program Development

1. Evaluation of risks. Determinations of the earthquake vulnerability of a facility require earthquake engineering: the application of the seismic expertise of a licensed civil or structural engineer. (There is no separate license for "earthquake engineering.") Costs typically range from $1,000 to about $10,000 for larger buildings or facilities, though complex cases such as a hospital could be more expensive to survey for hazards and analyze with computations.

2. Identification of promising countermeasures: Countermeasures or ways of dealing with the earthquake problem include the categories of structural (such as adding steel hardware to strengthen the connection of a wall to a roof), nonstructural (such as installing retrofit anchor bolts to restrain a piece of industrial equipment), or emergency planning (such as training employees to take cover during earthquakes). For any serious risks found in step 1, the most promising countermeasures are identified. This tabulation and description of alternative ways of dealing with the problem forms the basis upon which the decisionmaker can prioritize, select, and reject.

3. Implementation: After key decisions have been made, implementation can proceed. This could mean use of engineering consultants to design seismic retrofits for non-resistant buildings, planning annual exercises, or whatever combination of measures is appropriate in a given case. The writing of an earthquake plan should be an outgrowth of an overall program, rather than a mere paper document.

Possibly Hazardous Buildings

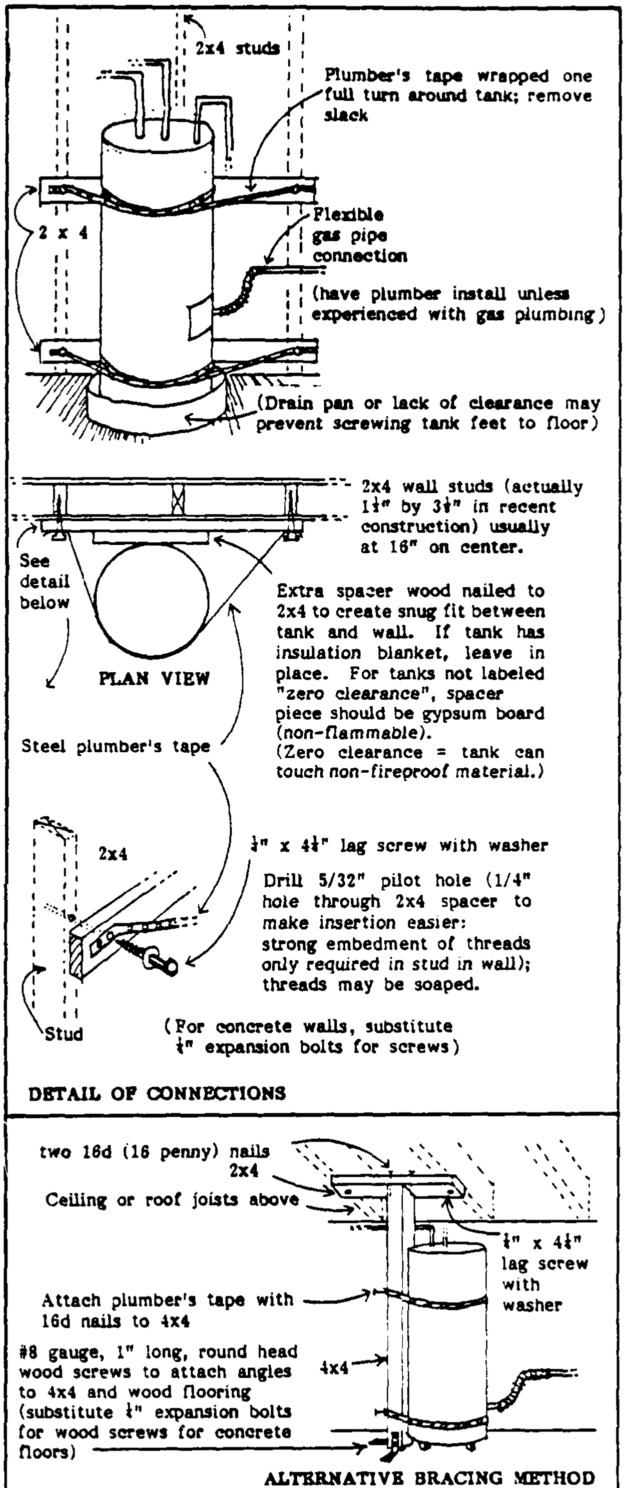
Old masonry buildings: Brick, concrete block, adobe, or stone buildings built without steel reinforcing; not only are these buildings the easiest to damage with even moderate ground shaking, but the falling debris that results is especially hazardous. Strengthening involves use of steel to tie walls more securely to floors and roof, and bracing of walls.

Newer one- or two-story commercial or industrial buildings with concrete or masonry walls and wood roof or second floor structures: The walls are often not positively tied to the wooden structure of floor or roof with steel straps; strengthening is accomplished by adding straps; walls and floors or roof are generally adequate internally, and strengthened connections are all that are required.

Reinforced concrete frame buildings (structure held up by column-beam frames without bearing walls) with "non-ductile" or brittle joints: Typically built from mid 1950's to mid 1970's; four 10-story apartment buildings of this type completely collapsed in the 1967 Caracas, Venezuela earthquake; strengthening is often expensive, but potential type of collapse is catastrophic.

Mobile homes: The "wooden box" is usually adequately earthquake resistant, but often this structure is merely propped up on blocks rather than connected to the ground; the box typically falls off its supports; twice as likely to be severely damaged as a typical house on a foundation; addition of bracing under the coach inexpensive.

House-over-garage: Houses or apartments built over parking space often have a weak link at the ground level—absence of solid walls across the front; sideways shaking results in racking of this open front; strengthening involves adding either a steel frame around garage opening, or solid plywood-sheathed walls to one side of opening.



Gas water heaters in garages should be mounted so that pilot light is 18" above floor; pedestals or boxes beneath heater should be attached to floor and tank legs.

Do not store paint thinner or other flammable materials near water heater.
Note: Gas space heaters (furnaces) present similar seismic fire hazards.

TYPICAL WATER HEATER RESTRAINT

Section 9

TASK 6 - VULNERABILITY ANALYSIS

The objective of this task has been to translate portions of analytical studies and laboratory and field experiments into a simplified vulnerability analysis and hardening procedure. A major contribution in this subject area arose out of SSI participation in MILL RACE, a recent field test at White Sands, New Mexico, which included industrial hardening experiments in a 1 kiloton weapon simulation (Ref. 49). The experiments were designed to test a hardening option for the many industrial sites that have few resources and limited available open space excepting asphalt paved parking lots. In short, for plants where equipment burial would be difficult, at best, an effective alternative is needed.

One of the most promising onsite hardening techniques where burial is not feasible and few materials are available for hardening appears to be to cluster equipment in an open area (such as a parking lot) and to secure all items together by means of welding, strapping, or banding, with sandbags, tires, lumber, or other shock absorbing material placed between and around all items. Based on MILL RACE findings, a methodology has been developed to help industry do this. Providing that the cluster can be adequately secured as a unit, all elements within it will become very much less vulnerable than standing alone. That is, they will become very much less vulnerable to blast damage due to sliding and/or overturning leading to impact, and to the impact of missiles.

The vulnerability reduction occurs in part because the cluster presents a lower profile (i.e., ratio of height to depth) to the blast wave and thus, it is much less likely to overturn and result in a damaging impact or impacts (in the case of tumbling) on the ground surface. The cluster also results in a greater ratio of total weight to area exposed to the blast so that the cluster will not slide as far, which reduces the probability of damaging impacts with other objects (or even within the cluster itself). Further, the cluster is inherently less vulnerable to missile damage because the items in the middle are protected by the outer layers of equipment. Moreover, if sandbags or a timber layer are added on the outside of the equipment (but within the banding) the missile hazard is virtually eliminated.

The survival overpressure level in pounds per square inch (psi) for blast damage varies primarily with two characteristics of the cluster: its extent, D*, in the direction of the blast wave, and its density ratio, F. (As D depends on the orientation of the cluster to the blast wave — an unknown in a practical application — it is necessary that the clusters have their widths and lengths close to equal.) The ratio F is the ratio of the average density (weight per unit volume) of the cluster to that of steel. Sample F values for various individual pieces of equipment found in a typical plant are given in Table 9-1. F values can be estimated by comparison with the sample values in the table, or preferably, by adding the weights in pounds of all items in a representative sample of the equipment to be in the cluster and dividing by 500 times the volume in cubic feet of the representative sample; i.e.,

$$F = 0.002 \times \text{weight/volume}$$

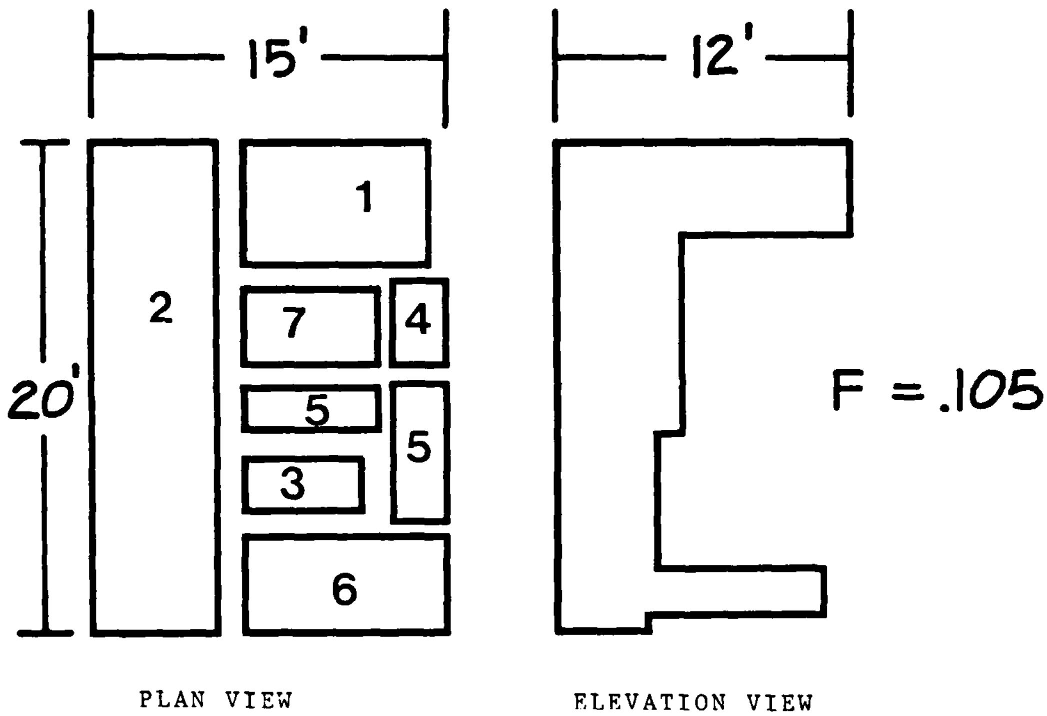
In estimating the volume, it is necessary to include the space required for the buffers between equipment. For the sample cluster shown in Figure 9-1, which was assembled from equipment items given in Table 9-1, the estimated F value was 0.10.

The vulnerability of the individual items in Table 9-1 and Figure 9-1 and the vulnerability after clustering — in terms of different overpressure levels from a 1 megaton weapon — are given in Figure 9-2. Survival in this case means that the cluster is large enough that it will neither overturn and impact on the ground surface nor slide a distance equal to the cluster depth, so that impact with other objects during sliding can be prevented.

* Survival actually depends on stability, hence the aspect ratio (ratio of cluster height to extent), but for any aspect ratio that is 1/3 or less, the variability of this parameter is not important; the requirement for the extent of the cluster to be large, to satisfy conditions to resist sliding, will generally ensure the aspect ratio is satisfactory also.

TABLE 9-1: SAMPLE F VALUES FOR EQUIPMENT

Item	Equipment	Width (ft)		Length (ft)		Height (ft)	Weight (lb)	Equivalent ρ (lb/ft^3)	F
1	Vertical Mill	5	x	8	x	7	40,000	142	.29
2	Horizontal Mill	5	x	20	x	½@12 ½@ 3	40,000	57	.11
3	Shaper	2½	x	5	x	3½	4,000	91	.18
4	Punch Press	3	x	3-3/4	x	5	3,800	68	.14
5	Turret Lathe	2	x	6	x	4	4,000	83	.17
6	Lathe	4	x	8	x	½@ 4 ½@ 3	4,000	36	.07
7	Compressor with water-filled air tank	3	x	6	x	5	3,960	44	.09
	Compressor			ditto			400	4.4	.009



Note: Numbers on items correspond to Table 9-1 numbers.

Fig. 9-1. Cluster of Equipment Listed in Table 9-1.

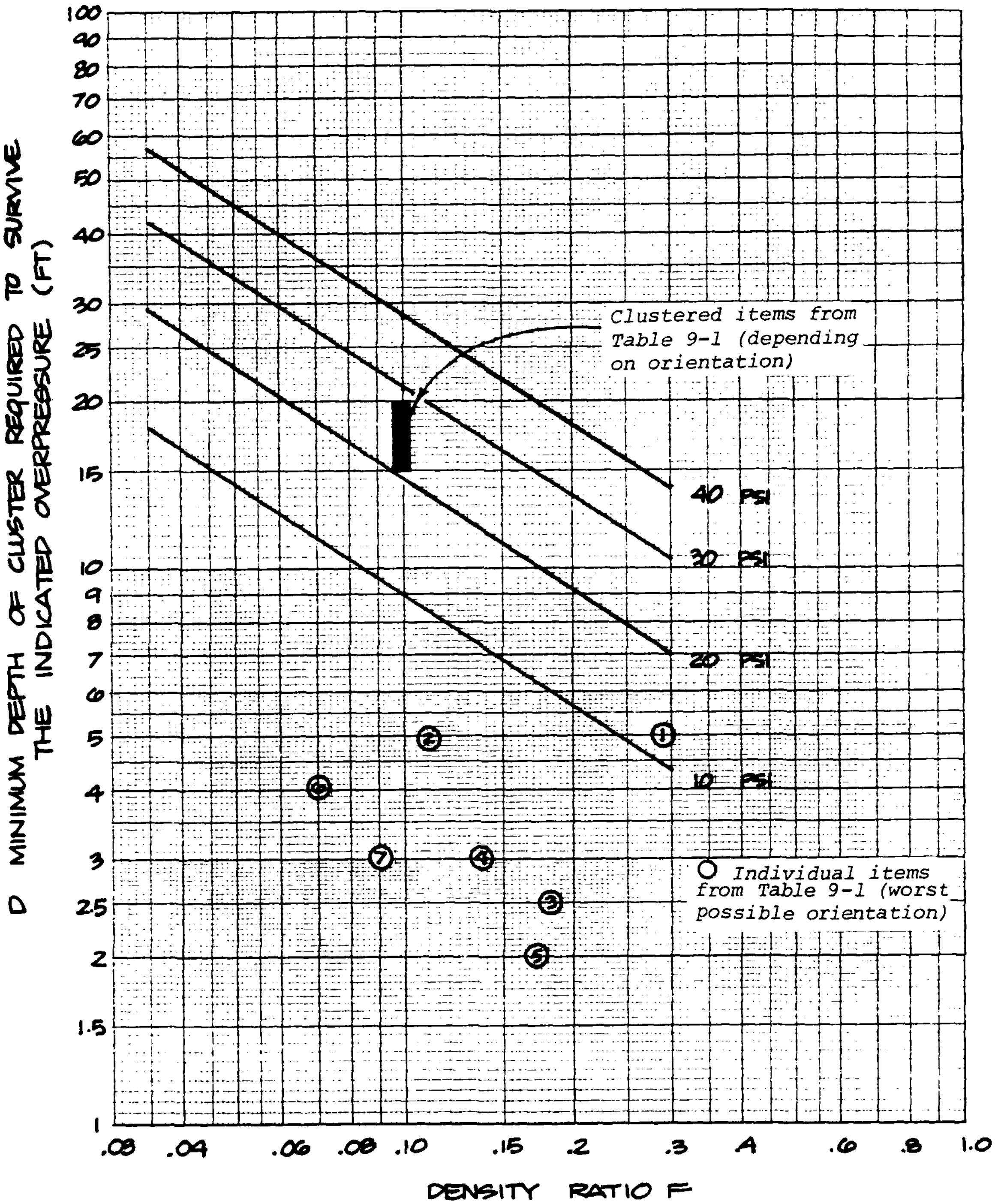


Fig. 9-2. Survival Levels of Clustered Equipment for 1 Mt Weapon.

To illustrate the use of Figure 9-2, assume the cluster of interest will have an F of 0.10 as in the example mentioned earlier. Then the depth of the cluster would need to be greater than about 9 ft to survive a 10 psi blast wave, 15 ft for a 20 psi wave, 21 ft for a 30 psi wave, and 28 ft for a 40 psi wave.

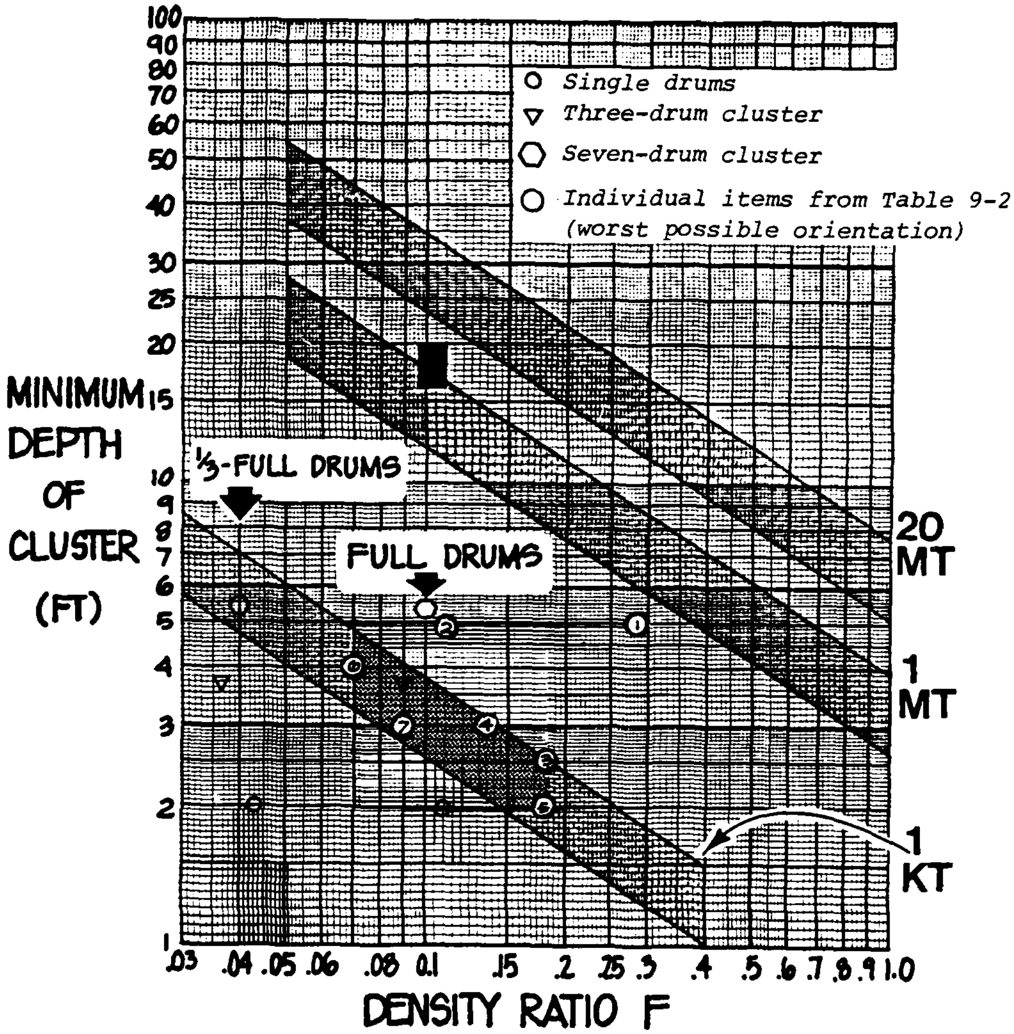
It will undoubtedly become more difficult to fasten the cluster together as its size increases, so every effort should be made to increase the density ratio. Sandbags rather than lumber or tires will help. For example, if in the previous illustration the density ratio were 0.15 instead of 0.10, the necessary depths for 30 and 40 psi would have been reduced from 21 ft and 28 ft to 16.5 ft and 22 ft.

Figure 9-3 shows a plot of the expected behavior of all the items in Table 9-2 (which includes all the items in Table 9-1 plus some test objects evaluated at MILL RACE) to show effects of weapon sizes and clustering. (To simplify clustering analysis and experiments, drums were used.) Items are plotted according to their density relative to a block of steel with the same dimensions (indicated by F value), and the minimum dimension of their bases. The circles represent single drums, the triangles represent 3-drum arrays, the hexagons represent 7-drum arrays. Again, the vulnerability of the individual items and of clustered items is indicated in the figure. The definition of survival (as in Figure 9-2) is that overturning will not occur, and that the item will not slide more than a distance equal to its minimum depth, for any weapon size less than the one whose reference "line" intersects the array depth at the appropriate F value. The reference lines are depicted as bands to reflect various uncertainties in the simplified calculation procedures, which are described at the end of this section.

Experimental Observations Compared With Theory

Based on Figure 9-3 it would be predicted that the single drums, both full and one-third full, would overturn and move a distance greater than their depth when subjected to a loading equivalent to 1 kiloton, as the points indicative of these items lie below the 1 kiloton curve; this, in fact, was what occurred at MILL RACE.

Further it would be expected that the full seven-drum arrays would not overturn nor slide a distance greater than their depth, as the indicative point lies



20 PSI SURVIVAL LEVELS OF SINGLE & CLUSTERED EQUIPMENT.

Fig. 9-3. Twenty psi Survival Levels of Single and Clustered Equipment.

TABLE 9-2: KEY INDICATORS FOR EQUIPMENT DAMAGE

Item	Equipment	Width (ft)		Length (ft)		Height (ft)	Weight (lb)	Equivalent ρ (lb/ft^3)	F
1	Vertical Mill	5	x	8	x	7	40,000	142	.29
2	Horizontal Mill	5	x	20	x	½@12 ½@ 3	40,000	57	.11
3	Shaper	2½	x	5	x	3½	4,000	91	.18
4	Punch Press	3	x	3-3/4	x	5	3,800	68	.14
5	Turret Lathe	2	x	6	x	4	4,000	83	.17
6	Lathe	4	x	8	x	½@ 4 ½@ 3	4,000	36	.07
7	Compressor with water-filled air tank	3	x	6	x	5	3,960	44	.09
8	Compressor			ditto			400	4.4	.009

	MILLRACE OBJECTS	D (ft)	Height (ft)	Weight (lb)	Equivalent ρ (lb/ft^3)	F
9	Single Drum, Filled	1.9	2.8	570	56	.113
10	Single Drum, 1/3 Filled	1.9	2.8	230	23	.46
11	Three Drum Array, Filled	3.7	2.8	1710	45	.09
12	Three Drum Array, 1.3 Filled	3.7	2.8	680	18	.036
13	Seven Drum Array, Filled	5.4	2.8	3990	49	.098
14	Seven Drum Array, 1/3 Filled	5.4	2.8	1610	20	.04

above the 1 kiloton curve. This again was exactly what occurred. The one-third full seven-drum array (which did not overturn) is marginal, since its indicative point lies within the 1 kiloton band.

The full three-drum array is also a marginal case; in one case the array overturned and in two cases it did not.

The one-third full three-drum array was expected to overturn and it did.

Technical Analysis for Clustering

Copies of the working calculations used in evaluating the clustering concept are included in this section.

Equation 5 was used in deriving Figures 9-2 and 9-3, and Equation 6 validates the statement (for the assumptions made) that the sliding distances would be less than the cluster depth.*

Some verification of the validity of the assumptions involved is also included in this section; however, it is believed that further experimental verification on as large a test scale as possible is desirable. A most important point to verify is the requirement on fastening the pieces of equipment together so they act as a unit, particularly for the larger clusters, which has the potential to provide the greatest protection. The MILL RACE tests on drums were ideal -- in terms of the uniform shape and the strength of the strapping. But random shapes and other means of fastening need to be evaluated through field tests using arrays with larger values for the acceleration coefficient and observing just what may be required to make them act as a unit.

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* Weapon parameters applied to develop Figure 9-2 were those predicted by the Ballistic Research Laboratory for the 600-ton ammonium nitrate/fuel oil (ANFO) charge at MILL RACE -- then scaled to 1 Mt.

TRANSLATION OF EQUIPMENT BY BLAST

Assume impulsive loading

thus $m\,dv = A\,C_d\,q\,dt$

or $v = (A\,C_d/m) \int q\,dt$

$v = (A\,C_d/m)\,I_q$

For units as given

$v = 144(A/m)C_d\,I_q$

Also $A/m = 32.2/D\rho$

and $A/m = 32.2/500DF$

Equation (1): $v = (9.3C_d\,I_q)/DF$

where m = mass in $(\text{lb-sec}^2)/\text{ft}$

v = velocity in ft/sec

A = area expressed in ft^2

C_d = drag coefficient

t = time in seconds

q = dynamic pressure in psi

$I_q = \int q\,dt$ dynamic pressure impulse in psi sec

D = depth of equipment normal to blast in ft

ρ = equivalent density of equipment in lb/ft^3

F = ratio of density of equipment to that of steel (500 lb/ft^3)

dv = small increment in velocity

dt = small increment in time

DISTANCE TO STOP SLIDING OBJECT

$F_R = m\ (dv/dt)$

where F_R = frictional force in lb.

m = mass in (lb-sec^2)/ft

v = velocity in ft/sec

t = time in sec.

x = stopping distance in ft.

w = weight in lb.

C_f = coefficient of friction

Assume F_R is a constant

so $\quad v = (F_R\, t)/m$

and $\quad x = (F_R\, t^2)/2\, m$

or $\quad x = (v^2\, m)/\, 2\, F_R$

or $\quad x = (v^2\, w)/64.4\, F_R$

Now $\quad F_R = C_f\, w$

Equation 2 : $\quad x = v^2/64.4\, C_f$

From "Translation of Equipment by Blast":

Eq 1 $\quad v = (9.3 C_d\, I_q)/DF$

so $\quad x = (1.33\, I_q^2\, C_d^{\,2})/D^2F^2C_f$

Now assume $C_f = 0.5$ and $C_d = 1.0$

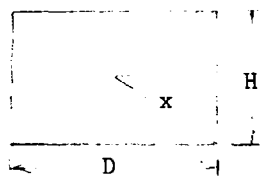
Equation 3 : $\quad x = (2.66\, I_q^2)\, /D^2F^2$

MINIMUM VELOCITY NECESSARY FOR OVERTURNING

Assumes: Impulsive loading, worst case — with equipment accelerated to final velocity (the maximum) in a sliding mode, then hitting a surface discontinuity that stops the leading edge.

For overturning: Kinetic energy > Potential energy

direction of motion ⟶



$$K.E. = \frac{w v_o^2}{2g} > P.E. = w\left(x - \frac{H}{2}\right)$$

or $$v_o^2 > 2g\left(x - \frac{H}{2}\right)$$

now $$x = \frac{(H^2 + D^2)^{1/2}}{2}$$

or $$x = \frac{D}{2}\left(\frac{1}{f^2} + 1\right)^{1/2}$$

$f = D/H$

v_o = velocity in ft/sec

w = weight in lb

g = acceleration of gravity in ft/sec^2

thus $$v_o^2 > g\,D\left[\left(\frac{1}{f^2} + 1\right)^{1/2} - \frac{1}{f}\right] \quad \text{or} \quad v_o^2 > g\,D\left[\frac{(1+f)^{1/2} - 1}{f}\right]$$

Now assume $f = 4$ and term in brackets = 0.78

Equation 4 : $$v_o > 5\,D^{1/2}$$

Now velocity achieved from "Translation of Equipment by Blast" must be less than velocity necessary for overturning

thus $$v_a < v_o$$

or $$(9.3C_dI_q)/DF < 5\,D^{1/2}$$ from Equations 1 and 4

Equation 5 $$D > [(1.86C_d\,I_q)/F]^{2/3}$$

Now the sliding distance as derived earlier is

$$x = v^2/64.4C_f \qquad \text{(Eq 2)}$$

Applying the v_o value from Eq 4 at overturning:

$$x = 0.388D/C_f$$

with $C_f = 0.5$ as before

Equation 6 $$x = 0.78D$$

COMPARISON WITH OTHER DATA

As a rough check on the validity of the assumptions involved in the foregoing calculations, comparisons were made with existing theoretical and experimental work.

In the case of velocity, the values given by Equation 1 were compared with those given by a computer calculation in Ref. 50 (see Figure 5.2 of that reference). The results are shown in Table 9-3. It can be seen that for most of the conditions the velocities are in reasonable agreement. Note that exact correlation is not expected because different sources for the blast wave characteristics were used. For the Equation 1 calculations the predicted blast wave characteristics for MILL RACE were used, while in Ref. 50 a combination of work by Brode (Ref. 51) and data in ENW (Ref. 52) was used.

For stopping distances the values given by Equation 2 were compared with experimental data given in Ref. 53 (see Figure 2 of that reference). The results are shown in Table 9-4. Note that two sets of values are given for Equation 2 ; one using a coefficient of friction C_f or 0.5 and the other of 0.6. The C_f of 0.5 was used in the previous calculations; however, it can be seen that the 0.6 value would fit the Ref. 53 data better. Note that using the 0.6 value is even better with regard to the cluster sliding less than its diameter.

TABLE 9-3: VELOCITY COMPARISON FOR 1 KT WEAPON

α (ft^2/lb)	P_o (psi)	V (Eq 1) (ft/sec)	V (Ref. 50) (ft/sec)
0.01	5	2	*
	10	7	7 (est)
	20	14	20
0.02	5	4	*
	10	14	14
	20	28	38
0.05	5	9	10
	10	35	34
	20	70	82
0.10	5	18	20
	10	70	58
	20	140	140

α = acceleration coefficient
P_o = peak overpressure
* not available

TABLE 9-4: STOPPING DISTANCE COMPARISON

V (ft/sec)	X (Eq 2) (ft)		X (Ref. 53) (ft)
	C_f = 0.5	C_f = 0.6	
10	3.1	2.6	2.8
20	12	10	10
40	50	41	39
80	200	170	140

Section 10
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Work completed in the first year of this five-year program has been directed toward developing information and hard data to provide an overview and framework with which to consider the continuing effort in industrial hardening, and in exploring methods to implement the strategy devised to improve industry's preparedness for nuclear attack. Based on the first year's results, these efforts appear to have been successful, though just a beginning has been made in terms of developing industry response.

A major and, perhaps, the single most important part of the program has been to develop a method to generate new industrial contacts, and to maintain rapport with as many industries as possible, as a means to ensure industry access. The methods used to implement this portion of the strategy -- joining, participating in, and helping develop mutual aid groups; participating in emergency preparedness seminars and exercises; following up contacts with, and making presentations to other organizations involved in emergency preparedness -- have been very successful in producing industry cooperation.

Implementation of a related portion of the strategy also seems to be working very well, in particular, SSI's approach to elicit more direct industry response to emergency (hence, nuclear attack) preparedness. The method has been to seek out present concerns of industry regarding specific emergency situations where solutions can be developed with overlapping benefits for nuclear disasters. There are no panaceas, so that this will necessarily consist of an assemblage of options none of which will find universal interest, but each of which is likely to arouse interest in a reasonable number of industries. The intent is to capitalize on these, as they are more likely to be acted upon by industry because they are of special interest already, principally because of potential impact on production (and customer) loss.

From past interactions with industry, we concluded a number of industries' emergency concerns fit the overlapping benefit condition. They included: power outages and rapid shutdown; hazardous materials emergencies – spills and containment; damage from natural disasters such as earthquakes, hurricanes, and tornadoes (depending on region); fires; and interactions of any and all of these. Study of the power outages, shutdown, and hazardous materials problems and alternatives were initiated this year (as Task 1) because of the interest expressed by industry (and the overlapping benefits in the case of a nuclear disaster). For example, industries with power outage concerns (generally those with rapid shutdown problems) will find that establishing onsite generating facilities is likely to be the only answer to their general needs. (In most cases, rental units will be neither large enough nor arrive soon enough to provide a viable alternative.) Thus, an appropriate solution to these industries' preparedness problem is an onsite emergency power supply. Implementing this will also provide better preparedness for nuclear attack providing the onsite power plant is readily hardened. As all of the Task 1 effort this year has similar immediate application in support of Task 4, it is recommended that information on risk analyses, economic cost and benefit of power outages and alternatives, shutdown, and hazardous material management and control be developed into a decisions checklist form and incorporated as part of the industry profile package.

The recommendation is supported by our interactions with industry this year, which have led us to conclude that a cookbook type of analysis of plant vulnerability to emergencies is not only desirable, but probably necessary. This has been started (for geographically related hazards), but is only partly developed; the portion completed and tested this year has met with approval by the industry representatives so far exposed to it insofar as utility and ease of understanding is concerned.

The clinic, in which it is proposed to test the cookbook approach later this calendar year, should be expanded to a series. This would enable the clinic to be improved through several iterations of interactions with industrial participants, and enable responses to be obtained regarding the inclusion of the segment on industrial hardening for nuclear attack preparedness — so that revisions could be made as needed. As long as the bulk of the clinic deals with specific in-plant problems of current interest (and the bulk of these have overlapping benefits to nuclear attack preparedness) this implementation of the overall strategy will be mutually beneficial to all.

The audio visual material under development for training and education purposes will be invaluable for the clinic approach and will enable feedback to be obtained for modification and improvement. It is recommended that such material continue to be developed and augmented for its value in training and for its use as a means to inform the public of general survivability in emergencies.

The simplified hardening scheme for use by industries that do not have resources to conduct either the vulnerability assessments for hardening, or the hardening itself, has received limited, but successful, proof testing in the field. The method has immediate application to hardening of hazardous materials in drums, but it needs further testing to validate its effectiveness for random shaped objects such as those used in industrial production. This testing is needed to assess methods of tieing large clusters together, and to evaluate drag and friction coefficients. To be definitive, the tests should be conducted in the largest possible shock tube on at least two scale sizes with a range of pressures and pulse durations and in the field at two widely different conditions of dynamic pressure impulse where the overpressure has been kept constant.

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APPENDIX A

Hazard Rating Method for Industry

APPENDIX A

The following text is the initial section of material being developed at SSI to help members of industry interested in analyzing plant facility vulnerability. The text occasionally refers to forms that have not yet been produced at this stage in the project.

The approach uses simplified procedures to identify what the major emergencies might be. It commences with an assessment of the risks from natural disasters related to geographical location of facilities so that the emergency planning can be structured accordingly. For each pertinent geographically related hazard (e.g., tornadoes in a tornado zone) there will be a summary worksheet and/or checklist developed (such as provided by the example at the end of the appendix), which will indicate the vulnerability of a facility's structures.

Subsequent sections under development will integrate consideration of structure contents, operations, and planning into the procedure to determine an overall facility vulnerability. The end objective is to provide the participant with an initial assessment of what his real problems are, ranked for his attention, and to provide him with some idea of costs and benefits of the first level of action(s) that might be taken to reduce vulnerability of his plant operation(s).

HAZARD RATING METHOD FOR INDUSTRY

GEOGRAPHIC FACTOR

General Level of Geographic Risk Factor

The first step in assessing the vulnerability of a facility to various hazards is to consider the geographic factor of site location. Knowing nothing more than the location of a facility is sufficient to determine whether certain hazards with well documented histories are potentially present. It is neither efficient nor effective to worry about every conceivable disaster; your limited time and resources should be devoted to the more probable and serious hazards present at each of your facilities. As historical records of hazards are generally catalogued against geographical location, some types of hazards may be quickly eliminated from your disaster planning list of tasks, while those that remain have been accurately defined and rated according to their probability of affecting a particular site.

Some of the hazard categories can be initially rated by identifying risk zones in a general way on a small-scale, non-detailed map of the United States; this has been done for hurricanes and high winds, tornadoes, earthquakes, and nuclear attack. Other hazards, such as flooding or hazardous materials, cannot be displayed at such a gross scale. Flood hazard is considered at a more detailed scale of map, while the geographic component of hazardous material risk is evaluated by reference to general descriptions of a particular building's location and environs.

For each of the hazards, commentary is provided to indicate the underlying premises in the geographic hazard ratings. The world is not so simple as to offer neatly delineated zones of risk or complete absence of risk, and so various degrees of risk must be analyzed. In the approach here, a three-level ranking of risk is used for simplification and convenience, corresponding as much as possible to common perceptions of high, moderate, and low risk. For some facilities, more conservative evaluations of a hazard may be warranted, and an added level of detail and higher threshold for the level of risk considered to be serious can be used.

Localized Level of Geographic Risk Factor

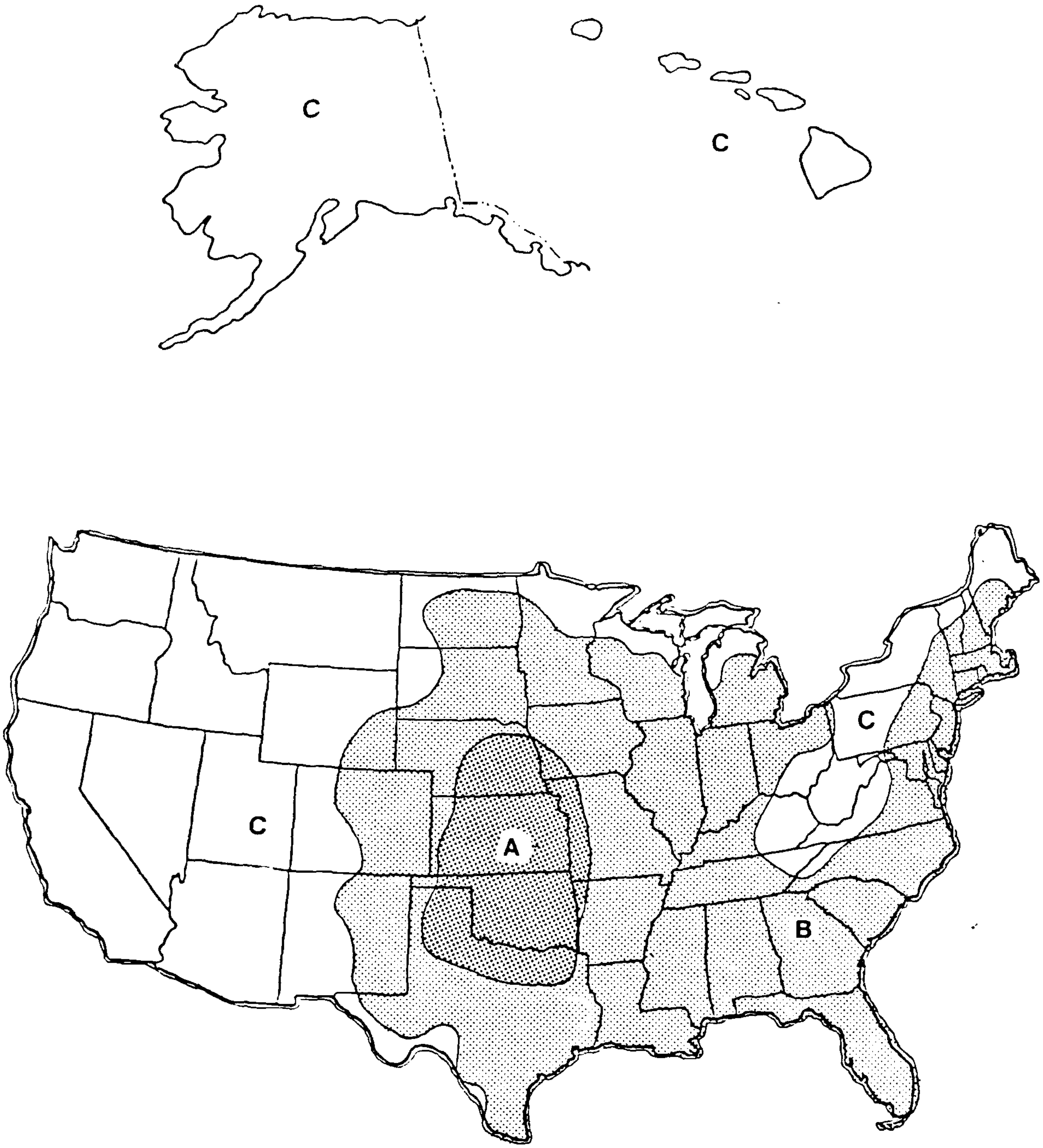
For some of the hazards, a more specific level of consideration of the location of the facility is required or can be helpful. This is not true in the case of tornado risk, which can be adequately plotted on a small-scale map of the United States, but the risk of hurricane waves or storm surge can only be determined by consulting maps that plot these predicted effects on the scale of a street map, or at least by knowing the elevation of the site and its distance from the ocean. Earthquake risk can be further defined by considering local soils and geological conditions in addition to the overall regional risk of experiencing strong ground shaking. Flood risk is only considered, at this localized level of analysis, by reference to maps that are approximately of street map scale. As mentioned above, the locational portion of a facility's hazardous material hazard is defined only by consideration of the individual characteristics, rather than by consulting maps.

1. Tornadoes

No geographic analysis at a localized scale is required, and hence the task of determining a site's approximate exposure to the hazard of tornadoes is accomplished by referring to Map 1 and merely noting whether the site is in zone A, B, or C, and then recording this information on Form 1.

Zone A is the highest risk region, zone B is the moderate risk region, and the remaining areas are placed in zone C in the category of low risk where the hazard is not sufficiently likely to justify tornado disaster planning for most businesses. Facilities with unusually high values or potential hazards, such as nuclear power plants, are not designed with this sort of map since "low risk where the hazard is not sufficiently likely to justify tornado disaster planning" is a very broad statement, subject to exceptions. For most companies or organizations, however, it will not be feasible to develop and maintain a tornado emergency plan or invest in extra tornado protection outside of zones A or B. Advising people to do so would have no effect, and this inaction would probably be a rational decision on their part. Tornadoes have occurred in all parts of the United States, but are infrequent in a large part of the country, and measures such as building tornado shelters or holding take cover drills are difficult to justify in these low risk regions.

MAP 1: TORNADO HAZARD ZONES



Zone A: 4 to 10 tornadoes per year per 10,000 square miles

Zone B: 1 to 4 tornadoes per year per 10,000 square miles

Zone C: fewer than 1 tornado per year per 10,000 square miles

Source: National Oceanic and Atmospheric Administration

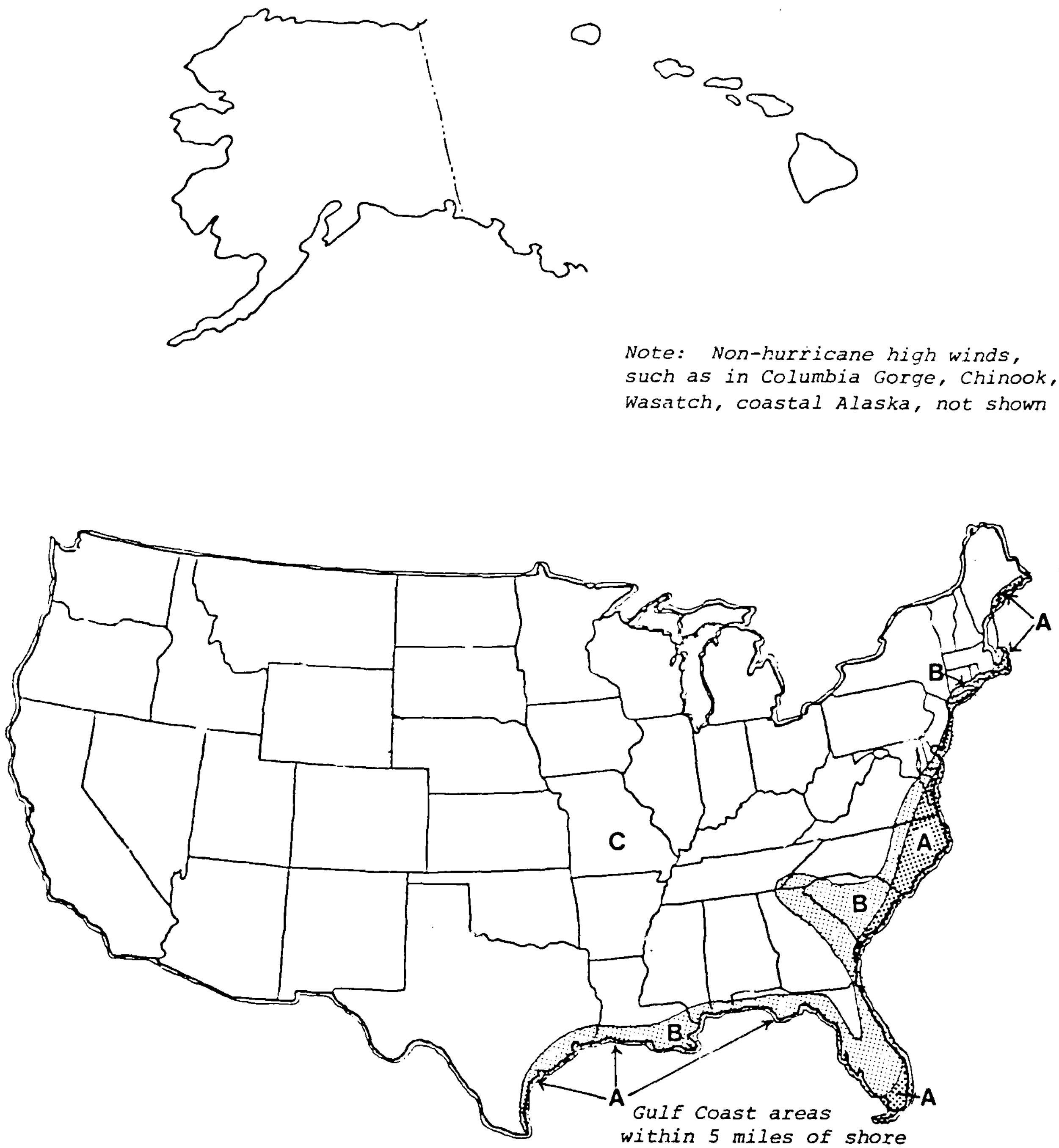
2. Hurricanes

Refer to Map 2-1 to determine if hurricanes can be eliminated from the list of disasters that must be considered in detail. This map is derived from wind speed data, and thus it deals directly only with the wind hazard of hurricanes; the areas subject to the storm surge caused by hurricanes (the rise in elevation of the sea and presence of large waves) are narrow coastal bands included well within the broader coastal area of high wind. Storm surge is a combination of destructive water effects: the sea level rises beneath the hurricane (partly because the atmospheric pressure pushing down on the surface of the water is lower) and the tremendous winds drive the water inland and create huge waves. If the site is not within high risk zone A or moderate risk zone B on Map 2-1, then there will be no storm surge hazards either. If the location in a coastal area or near large inland lakes or bays in zones A or B, storm surge must be considered further.

If the site's elevation above sea level is approximately 25 feet or greater, storm surge can be discounted. Elevation can be determined by consulting a U.S. Geological Survey or other topographical map for your area; these are widely available from map stores, or from city or county planning or engineering departments. Flooding caused by hurricane rainfall may still be a problem at such elevations, depending upon drainage patterns; hurricane flooding caused by rain, as distinct from storm surge, is considered under the flooding section. If the site's elevation is lower than 25 ft above sea level, and it is located in zones A or B, then contact the emergency services (or it may be called disaster services) office of the city, if the city is large enough to have such a department, or the county, and ask for a copy (or consult an office copy) of the local hurricane disaster plan. There should be maps plotting storm surge and indicating the evacuation routes to be used to remove people from these areas.

After determining which zone the site is in (which indicates risk of hurricane winds) and determining if the site is subject to storm surge (and if so, the predicted depth of such waves or flooding) transfer the information to Form 2. If a more in-depth consideration of a site's exposure to hurricanes is desired, consult Map 2-2, which indicates at a detailed scale the variation in the probability of a hurricane landfall occurring at locations along the Gulf and Atlantic Coasts.

MAP 2-1 : HURRICANE HAZARD ZONES



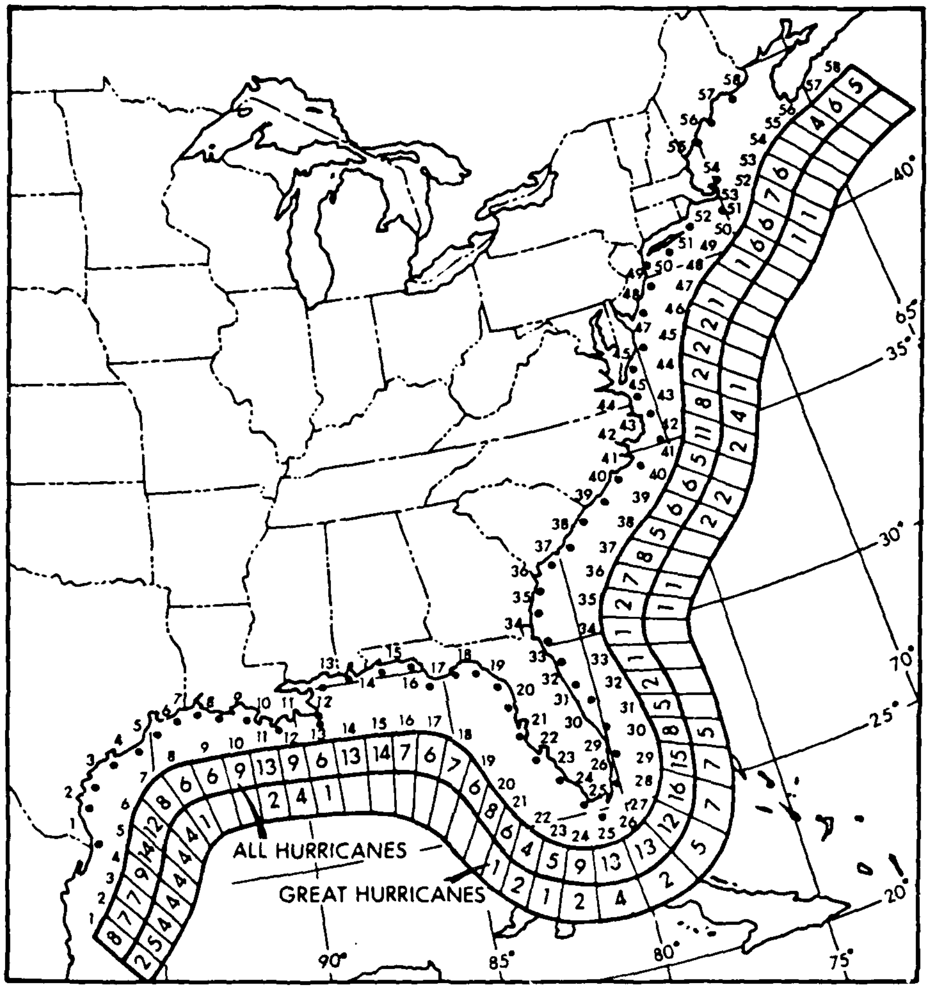
Zone A: 1% annual chance of receiving over 100 mph wind

Zone B: 1% annual chance of receiving 100 mph wind

Zone C: 1% chance of receiving 70 to 100 mph wind

Source: H.C.S Thom, "New Distributions of Extreme Winds in the United States," Journal of the Structural Division, Proceedings of the American Society of Civil Engineers, Vol. 94, No. ST 7, July 1968; 1982 Uniform Building Code for localized high wind areas of western U.S.A.

MAP 2-2: HURRICANE PROBABILITY
ALONG GULF & ATLANTIC COASTS



Probability (percentage) that a hurricane (winds exceeding 73 mph 33 m s^{-1}) or great hurricane (winds in excess of 125 mph 56 m s^{-1}) will occur in any one year in a 50-mile (80 km) segment of the coastline.

Source: Simpson, R.H., and M.B. Lawrence, Atlantic Hurricane Frequencies Along the U.S. Coastline, NOAA Technical Memorandum No. NWS SR-58, U.S. Department of Commerce, Washington, 1971, as cited in White, Gilbert F. & Eugene Haas, Assessment of Research on Natural Hazards, MIT Press, Cambridge, MA, 1975.

3. Earthquakes

Map 3-1 indicates on a general regional scale areas subject to a significant chance of severe ground shaking. Earthquakes may also trigger landslides or cause other soils and geological failures that could affect buildings, and these localized hazards are considered separately from the more regional ground shaking hazard.

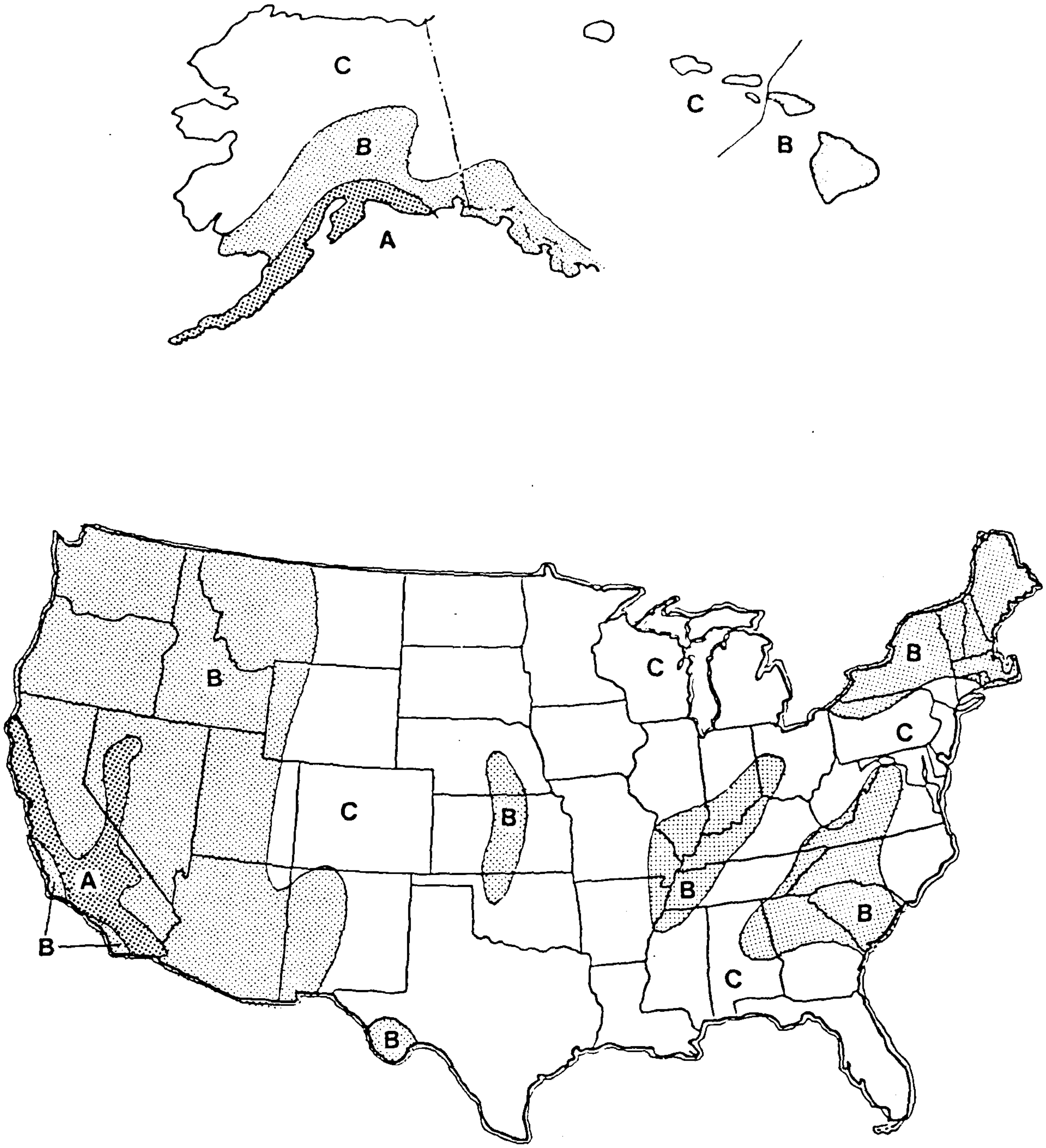
Zone A is the highest risk region, zone B is the moderate risk region, and zone C is the low risk region. As with tornadoes, the risk in zone C is generally not considered to be sufficiently great to warrant earthquake disaster planning, except for facilities such as nuclear power plants. If the site is in zone A or B, the following additional information is required:

Surface faulting: Consult Map 3-2, which indicates active earthquake faults. "Active" faults are those considered likely to rupture in the future. It is the rupturing or sudden sliding along these fault lines that releases vibration energy and shakes the ground, but there is also a localized hazard for any structure built astride a fault, since the ground on the two sides will be offset a few feet up to about 15 feet. More detailed fault maps are available, so if Map 3-2 indicates that a site may be on or quite near a fault line, a more detailed fault map should be consulted. This can be accomplished by one of the following methods:

1. Contact the emergency services and planning departments of the city and county. Inquire as to the availability of maps indicating nearby earthquake faults.
2. Contact the nearest office of the U.S. Geological Survey and inquire about maps and reports on earthquake faults for the particular area.
3. Within California, contact the California Division of Mines and Geology.

A similar process, involving contacting emergency services and planning departments and U.S. Geological Survey, is used to determine whether the following earthquake-related geological hazards are present.

MAP 3-1: EARTHQUAKE SHAKING HAZARD ZONES



Zone A: corresponds to 1982 Uniform Building Code seismic zone 4 (most seismic)

Zone B: corresponds to 1982 Uniform Building Code seismic zones 2 and 3

Zone C: corresponds to 1982 Uniform Building Code seismic zones 0 and 1

Source: 1982 Uniform Building Code

MAP 3-2: MAJOR FAULT RUPTURE HAZARDS

CALIFORNIA

Source: California Division of Mines and Geology

Landslides: Slides can be triggered by earth shaking or may happen in the absence of an earthquake. Slope, type of soil, angle of soil and rock strata, drainage and ground water, past slide activity, and other factors are considered by geologists in preparing landslide susceptibility maps.

Liquefaction: When the earth shakes and the right combination of type of soil and high ground water is present, the ground can temporarily lose its solidity and behave like a mushy fluid. Underground tanks and pipes can be damaged, and building foundations can lose support and shift.

Tsunamis: Commonly called tidal waves, tsunamis, or seismic sea waves, are caused when the ocean floor is vertically shaken. Depth of water, amount of earthquake movement, and other factors are involved. Seismic sea waves can travel across entire oceans and then cause damage as they run up on coastal shores, sometimes to heights of approximately 50 feet. Only coastal sites at low elevations are subject to this risk, which is greatest in non-continental areas of the United States: Alaska, Hawaii, Puerto Rico. If you are located in a coastal area, more information should be sought locally.

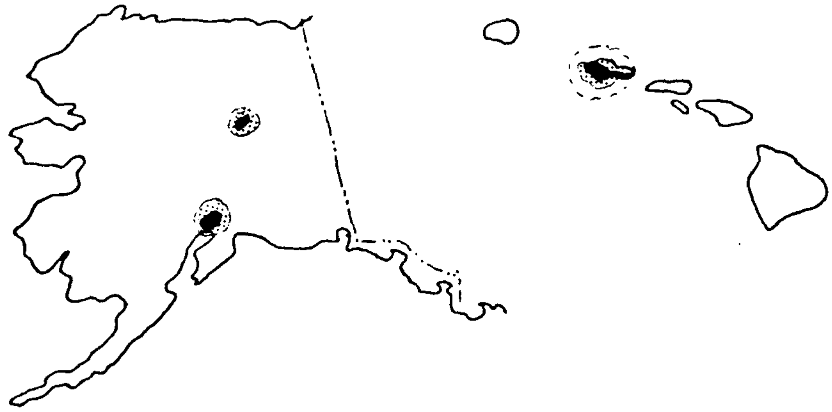
As this information is obtained, it should be recorded on Form 3.

4. Nuclear Attack

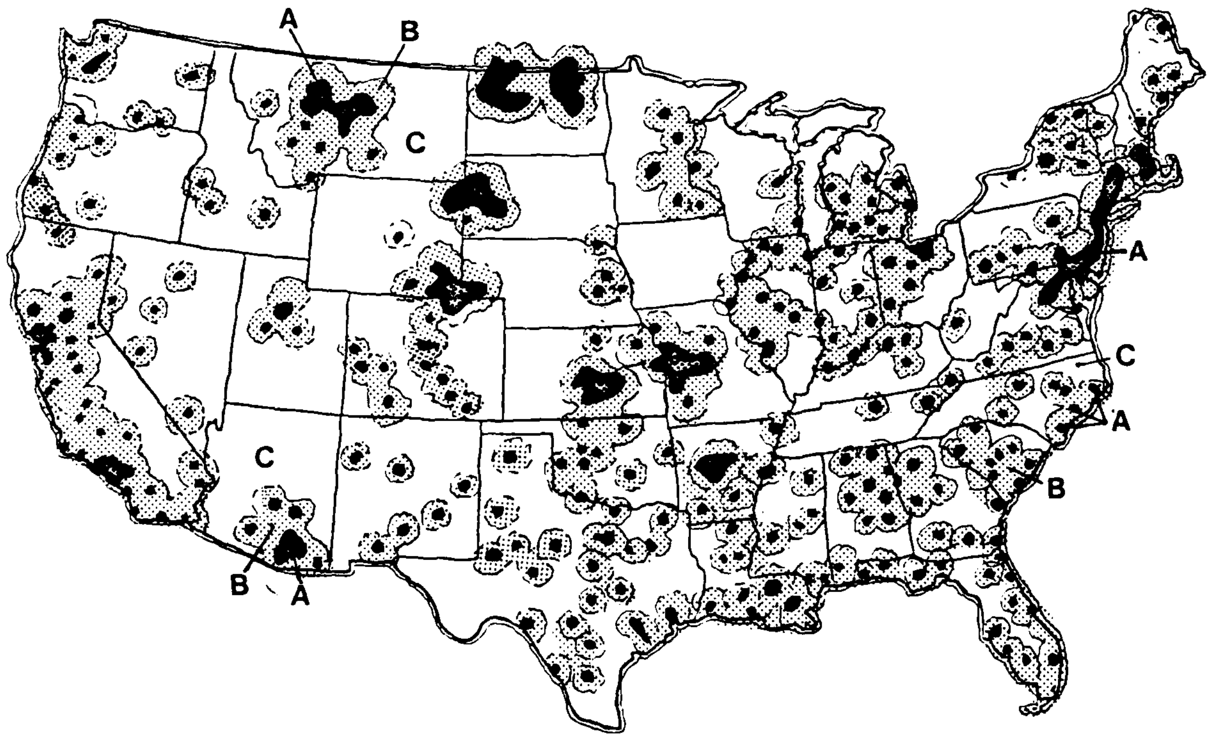
Map 4-1 indicates very approximately a scenario of nuclear weapon effects across the United States, using various assumptions about the number and targeting of enemy weapons. Unlike natural hazards, the actions of humans are involved in causing the disaster, and hence maps such as Map 4-1 are valid for planning purposes but are not literally predictions.

The first step is to determine the location of the site on Map 4-1 and record the result on Form 4. Risk areas are defined by the Federal Emergency Management Agency as areas where, given the assumptions mentioned above, it is extremely difficult to protect people from the high levels of radiation and blast. Present U.S. civil defense planning includes the concept of crisis relocation: moving people out of risk or target areas and into less hazardous territory relatively nearby where the effects of nuclear weapons would be diluted by distance, requiring much less protection.

MAP 4-1: NUCLEAR ATTACK BLAST HAZARD ZONES



Note: Fallout hazard not shown on this map.



Zone A: Federal Emergency Management Agency risk areas

Zone B: within 50 miles of risk areas

Zone C: farther than 50 miles from risk areas

Source: Defense Civil Preparedness Agency, High Risk Areas, TR-82, April 1975.

Nuclear explosions cause tremendous blast forces on buildings — the pressure in the atmosphere rises to many times normal levels, and winds more extreme than in hurricanes are generated. The pressure is measured in pounds per square inch, psi, of pressure above normal pressure (overpressure), and outside the risk areas (zone A on Map 4-1) the overpressure is estimated to be 2 psi or less. The farther from a risk area, the less the overpressure would probably be, and as a rule of thumb, a site about 50 miles beyond the boundary of a risk area could be presumed to be virtually free of any blast effects of consequence. The areas predicted to be blast-free are called zone C, while the areas outside the risk areas (zone A, where appropriate protective action requires considerable effort), but within the additional 50-mile line are called zone B. Here, appropriate protective action requires only a little effort. The zone applicable for your site is entered on Form 4.

Nuclear explosions also cause radioactivity. Soil particles are rendered radioactive and blasted into the air, and when they fall back to earth they are called fallout. Plots of fallout (based on the same assumptions as underlie Map 4-1) can be obtained from TR-82.* Determine whether the site is in a zone A, B, or C fallout zone and record this information on Form 4.

5. Flooding

Considering the possibility of flooding involves consulting detailed flood maps, rather than a small scale map of the entire United States. One or more of the following methods should be used to determine a site's flood hazard on a localized scale:

1. Ask the city and county emergency services and planning departments if they have maps indicating flood hazards in their jurisdictions.

2. Contact either a local insurance broker or a financial institution such as bank or savings and loan that offers mortgage financing (perhaps the firm that provides your insurance, mortgage, or banking services). They will probably have copies of Federal Insurance

* TR-82, **High Risk Areas for Civil Preparedness Nuclear Defense Planning Purposes**, Defense Civil Preparedness Agency, April 1975.

Administration flood insurance maps for the local area, since insurers and lenders consider flood hazard and availability of federally administered flood insurance for all properties they insure or finance. These maps are at a scale more detailed than a usual street map, so a large collection is required simply to deal with one county-sized area.

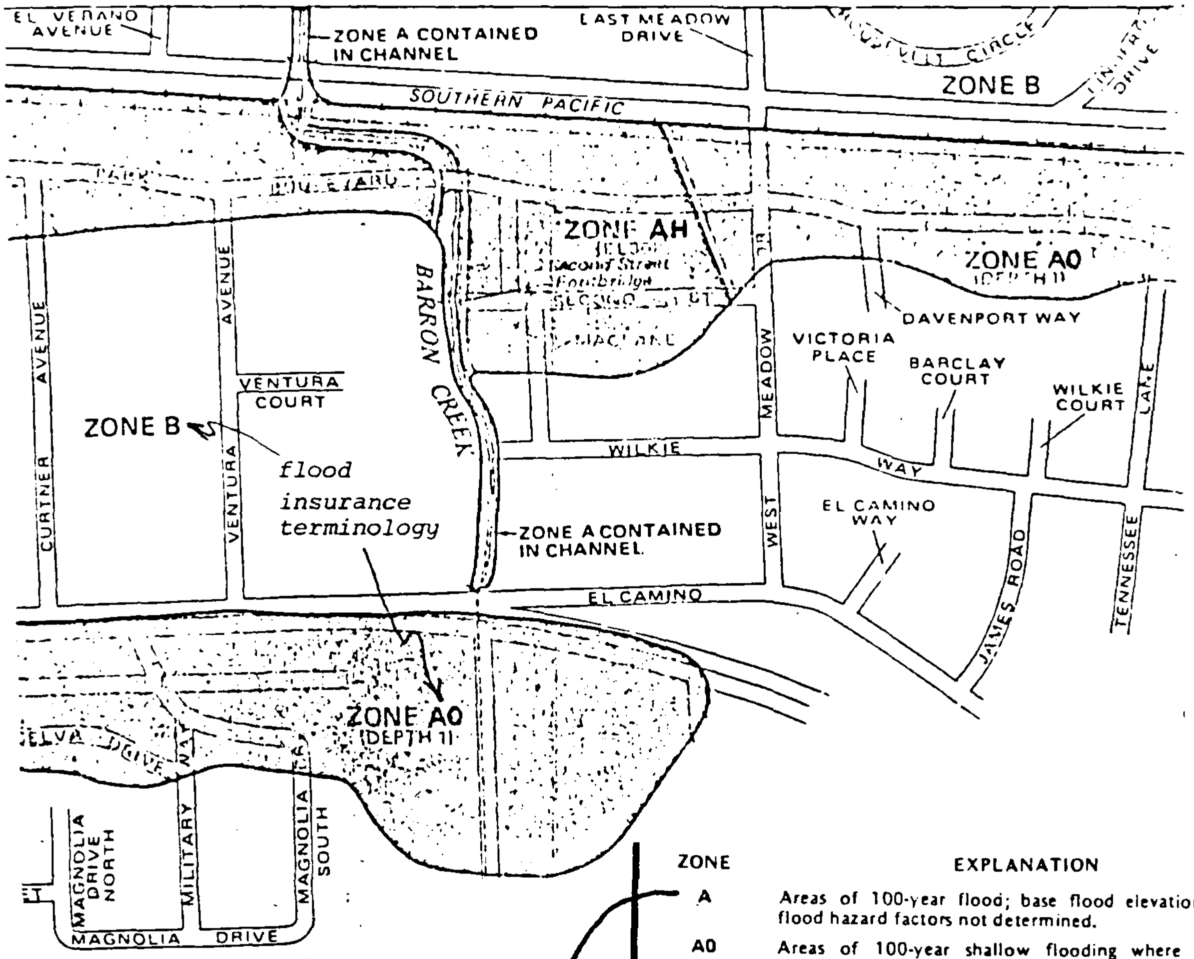
3. Request the flood maps that include your particular site (by name of city and county) from the Flood Insurance Administration directly: (800) 638-6620. If there is essentially no flood hazard at your site, then no further flood disaster planning is required. If flood maps indicate a flood hazard, the degree of hazard must be indicated, preferably in terms of whether the site is in a 100-year or 500-year flood zone. A 100-year flood zone indicates the ground expected to be flooded on average once every 100 years, and similarly for 500-year floods. This information is helpful in evaluating the likelihood of flooding. Map 5 is a sample of a portion of one Federal Insurance Administration flood map.

In addition, information on the potential severity of flooding is required. The predicted depth of flooding can be obtained by either:

1. Consulting the flood insurance map. Shadings on the map may refer to items in the legend such as flood depth between 1 and 3 feet, for example. In addition, the elevation of flood waters may be indicated and the elevation of selected points on the ground plotted; the difference in elevation of water and ground is the depth of flood waters.

2. Using the flood insurance map or other flood map (such as may have been obtained from a local planning department) and comparing the indicated elevation of water with the site's elevation, as obtained from a U.S. Geological Survey topographical map, if topography is not already plotted in detail on the flood map.

If any information is available on the specific type of flooding, that should be recorded on Form 5 as well. The basic types are: flood plains where relatively flat valley floors will be flooded with water; narrow steep-walled valleys or other areas where flash floods are possible; coastal areas where seismic sea waves may cause



TERMINOLOGY FOR THE PRESENT METHOD

- Zone B (1% annual chance of occurrence) — A, A99
- Zone A (0.2% annual chance of occurrence) — B
- Zone C (outside 0.2% or 500-year flood zone) — C

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

MAP 5

Sample of Use of Flood Insurance Rate Map to Determine Flood Hazard Zones flooding; coastal areas where hurricanes can cause flooding with storm tides. This information may be noted on the maps, available in conversation with an agency, or obvious from local knowledge.

6. Hazardous Materials

Rather than a map, a general description (verbal) of the hazardous materials environment of a site is used to elicit an approximate rating of the degree of hazard present at a facility. Another difference in the analysis of the geographic component of this hazard is that information on the type of activity and type of materials present is required, rather than simply locational information. For the other hazards, information about the contents of buildings or the type of commercial or industrial activities is used at subsequent steps after the geographic factor is separately considered.

There are three basic hazard exposure factors to consider: the presence of hazardous materials on site, the presence of hazardous materials on nearby sites, and the passage of hazardous materials near the site on transportation routes. These are briefly discussed below, and are dealt with in worksheet fashion on Form 6.

1. Hazardous materials onsite: This information may be obvious to anyone familiar with the facility in simple cases, or else a safety or production manager's knowledge may be required to inventory these data if the facility uses considerable quantities and types of chemicals.

2. Hazardous materials on neighboring sites: This information is difficult or impossible to obtain in detail, since privacy is involved. Fortunately, detailed information is not required, and if it were obtained it would require regular updating to prevent obsolescence. This task is accomplished on Form 6 by reference to the general type of industrial activity or company, which associates reasonably accurately with general degree of hazardous material hazard.

3. Hazardous materials passing near the site on transportation routes: This information, as with step 2 above, would be difficult to obtain in

detail, but fortunately, as with step 2, detailed information is not required, and a knowledge of the major types of nearby transportation routes is all that is required.

With any of the above sources of hazardous material incidents, one could also consider the wind factor to predict the movement of any spills that are in gaseous form. While this type of analysis is occasionally done, it is not required in this method. "Prevailing" winds rarely are truly prevailing. If the compass is divided into 16 sectors, often all of the sectors except for one or two will account for the wind direction at least 5% of the time, for example. Combined with the difficulty of obtaining accurate wind data for a specific site (since wind direction varies considerably from one specific site to another depending upon neighboring buildings, street pattern, and other detailed factors), this variability makes it generally infeasible to consider wind direction in assessing a typical facility's exposure to the risk of a hazardous materials spill.

CONSTRUCTION RISK FACTOR

For those hazards assigned a geographic zone factor of A (high risk) or B (moderate risk), the next step is to consider the characteristics of the building. If zone C (low to essentially no risk) applies with regard to a particular hazard, then it is not necessary to consider the hazard further in this simplified approach.

General Level of Construction Risk Factor

Different types of construction can vary considerably in their resistance to the various types of hazards. There have been many cases where buildings designed to resist horizontal forces have withstood an earthquake with virtually no damage while next door a poorly designed structure collapsed. Many buildings with strong connections and strong walls have been exposed to hurricanes without significant damage, while nearby, similar appearing but less carefully constructed buildings have lost their entire roofs.

At a general level, estimates can be made of the resistance of a type of building to the expected intensity of a type of hazard at the site (based on the first step of evaluating the site or geographic risk factor). Such estimates are useful for approximating the severity of a disaster on one's own facility, and focusing attention on the weakest points and the measures that might be employed to lessen these weaknesses.

Specific Level of Construction Risk Factor

More accurate assessments of a given building's resistance to the effects exerted by one of the hazards can usually only be attained with the application of engineering expertise to that specific case, and involves an onsite survey, review of drawings, and calculations. This is beyond the scope of a pre-packaged method, but the general level estimate of construction risk, even if only an estimate, can be useful in pointing out where such further detailed engineering analysis is warranted, and what the benefits of such an analysis might be. Where possible, some more particular indications of degree of hazard resistance of a building are offered, which could be recognized by someone reasonably familiar with construction although not an engineer. In some cases, the consideration of geographic risk factors may indicate a very low exposure to a particular hazard, and the variation in hazard resistance of different buildings in that area, even if brought to light with detailed analysis, might not have any practical significance. In some cases, the site is located where the expected effects are so severe, should the worst occur, that variations in the construction may be completely overshadowed. For example, should a 50-foot tsunami strike a given site, the precise construction characteristics are probably insignificant (though perhaps they may be significant with 8-foot waves crossing the site).

1. Tornadoes

Many people mistakenly believe the folk wisdom that it is merely luck that causes some buildings within the swath of a tornado to survive while others are destroyed. Detailed studies of tornadoes indicate that this is not the case. Although tornado winds can be more severe than hurricane winds, they are not so extreme as to destroy everything in their path. Generally, the larger the tornado the greater the wind speed, and fortunately, the chances of being hit by the rare large one are much less than being hit by the more common smaller one. Especially for small to moderate size tornadoes, variations in construction strength can mean the difference between minor damage and complete destruction.

For the largest and most severe tornadoes, admittedly many of the less substantial construction types (light wood frame buildings, mobile homes, all metal industrial buildings) may have inadequate strength, even if above average in design, to escape destruction. More substantial types of construction, however, can survive even this scale of hazard, if properly designed and built. Hence, a consideration of the type of construction is necessary to adequately describe tornado risk.

The construction factor is also important to evaluate for another reason: tornado resistance can often be greatly improved with relatively minor changes in a building (which is not often the case with regard to floods, for example). In new construction, the contrast between the well-designed, very resistant structure, and the average relatively non-resistant case is striking.

Form 1, on which was noted the geographic tornado factor, contains descriptions of construction types. Select the most appropriate type, and follow the worksheet's instructions.

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FORM 1
TORNADO RISK ANALYSIS WORKSHEET

Geographic Risk Factor: consult Map 1 and enter zone: ___________.
(if in zone C, no further analysis required)

Construction Class: select the most appropriate class(es) from below; for more than one building, tabulate each separately; for basements, tabulate separately from the aboveground portion of the structure:

class 1 (most tornado-resistant)

Underground structures with roof covered with at least 3 feet of earth; if roof or wall areas exposed, they are constructed of reinforced concrete

Basements with reinforced concrete ground floor above, and no aboveground exposure of basement walls

Any structure specifically engineered as a tornado shelter

class 2

Underground structures with exposed roof/wall areas not constructed of reinforced concrete, but engineered for wind load of __ psf or greater (exceeds building codes)

Aboveground structures with reinforced concrete walls and roof, engineered for wind load of __ psf or greater (exceeds building codes)

class 3

No building within class 3 can have walls of masonry (brick, concrete block) unless reinforced with steel bars horizontally and vertically; if not verifiable, assume unreinforced condition; roof may be of any material

Large buildings (but without long span roofs as in class 4) such as multistory office buildings, concrete wall-wood roof one and two story commercial or industrial buildings, large apartment buildings

class 4

Single family residences not known to meet building code provisions for wind (probably lack of metal straps connecting roof framing to walls, lack of anchor bolts connecting walls at sill to foundations

Buildings with long span (over 50 ft) lightweight (non-concrete) roofs

Buildings with unreinforced masonry walls

class 5

Mobile homes without positive connection between superstructure and ground

Sheds or canopies

page 2
Form 1: Tornado Risk Analysis Worksheet

Point System

zone A = 10 points
zone B = 7 points
(if zone C, the risk is disregarded in this simplified analysis)

class 1 = 1 point
class 2 = 3 points
class 3 = 5 points
class 4 = 7 points
class 5 = 10 points

Add the zone points and the class points together, and indicate the resulting overall hazard rating:

11 points or less:	low hazard;
11 to 15 points:	moderate hazard
15 points or more:	high hazard

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INDUSTRIAL HARDENING: 1981 TECHNICAL STATUS–REPORT

Unclassified
Scientific Service, Inc., Redwood City, CA — September 1982
Contract EMW–C–0701, Work Unit 1124D — 185 pages

The report presents progress made over the last year in a continuing program to define, develop, and test options that industry can apply in advance of a disaster to reduce vulnerability and accelerate recovery.

Progress discussed in the report covers a variety of topics where additional work was undertaken in 1981 to augment the self–help procedures in the industrial hardening manual previously developed at Scientific Service, Inc. Among the topics discussed are: approaches taken to foster development of industry interest in emergency preparedness; and investigation into expedient methods an industry might apply to supply onsite utilities when public utilities are not functioning, prevent or reduce toxic materials releases, or reduce damage from rapid shutdown of facilities. In addition, assessments of the production processes and equipment inventories of a number of industries are described which were analyzed to identify the nature of common production elements that critical industries require for their operations. Assessments of other end–users of these or similar production elements were also initiated to establish some non–critical industries among them who could act as sources for substitute elements in emergencies.

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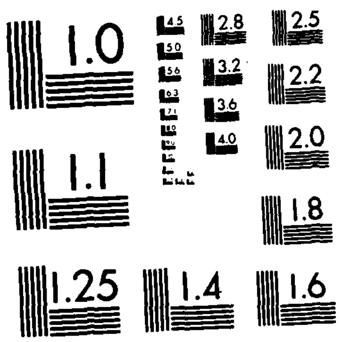

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AD-A119 934

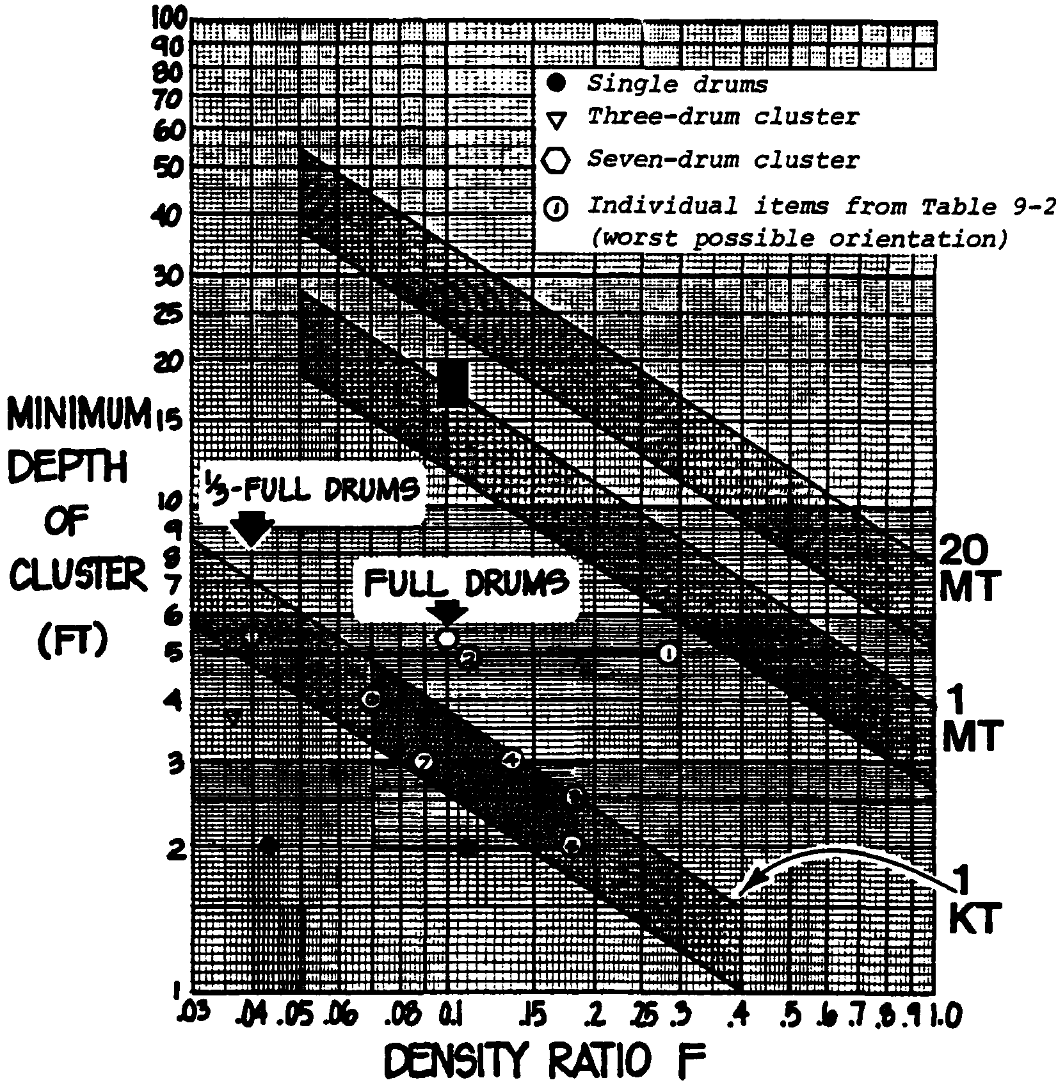
8 November 1982

INDUSTRIAL HARDENING: 1981 TECHNICAL STATUS-REPORT, SSI Report No. 8145-7, prepared for Federal Emergency Management Agency under Contract No. EMW-C-0701, Work Unit 1124D, September 1982.

The attached sheet replaces pages 151/152 of the above referenced report, which was distributed in September 1982.

The replacement material is intended to clarify the symbols in Figure 9-3 (page 151). **Numbered** circles correspond to the worst orientation of the individual items of equipment listed in Table 9-2 (page 152). The **solid** circles represent individual drums. The remaining symbols represent clusters.

Note also the correction to the F value for item 10 in Table 9-2 (the single drum, 1/3 filled), which should have been 0.046 rather than 0.46.



20 PSI SURVIVAL LEVELS OF SINGLE & CLUSTERED EQUIPMENT.

Fig. 9-3. Twenty psi Survival Levels of Single and Clustered Equipment.

TABLE 9-2: KEY INDICATORS FOR EQUIPMENT DAMAGE

Item	Equipment	Width (ft)		Length (ft)		Height (ft)	Weight (lb)	Equivalent ρ (lb/ft³)	F
1	Vertical Mill	5	x	8	x	7	40,000	142	.29
2	Horizontal Mill	5	x	20	x	½@12 ½@ 3	40,000	57	.11
3	Shaper	2½	x	5	x	3½	4,000	91	.18
4	Punch Press	3	x	3-3/4	x	5	3,800	68	.14
5	Turret Lathe	2	x	6	x	4	4,000	83	.17
6	Lathe	4	x	8	x	½@ 4 ½@ 3	4,000	36	.07
7	Compressor with water-filled air tank	3	x	6	x	5	3,960	44	.09
8	Compressor			ditto			400	4.4	.009

	MILLRACE OBJECTS	D (ft)	Height (ft)	Weight (lb)	Equivalent ρ (lb/ft³)	F
9	Single Drum, Filled	1.9	2.8	570	56	.113
10	Single Drum, 1/3 Filled	1.9	2.8	230	23	.046
11	Three Drum Array, Filled	3.7	2.8	1710	45	.09
12	Three Drum Array, 1/3 Filled	3.7	2.8	680	18	.036
13	Seven Drum Array, Filled	5.4	2.8	3990	49	.098
14	Seven Drum Array, 1/3 Filled	5.4	2.8	1610	20	.04