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IMPORTANCE OF PREPARATORY MEASURES IN DISASTER EVACUATIONS*

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I INTRODUCTION

Background

Evacuation of people from an area of danger is a basic protective action both in war and in peacetime disaster. Hardly a week goes by in the United States without some sort of evacuation being performed to avoid possible injuries and death. Many of these evacuations involve only a few people from a few families. They tend to occur "naturally" in response to observation of a threat or instructions from police or other officials. Periodically, however, large numbers of people are evacuated. In these cases, it would seem to be important that preparatory measures of some sort should be made if the evacuation is to be successful in saving lives.

Interest in preparations for evacuation is more-or-less routine in areas subject to certain natural hazards, such as hurricanes and floods. It is more sporadic in other areas although transportation accidents, explosions, and fires can call for evacuation of large numbers of people. The extent to which it is prudent to engage in preparations for such contingencies may be subject to question. One basis for judgement that might be useful is an understanding of the degree to which various preparatory measures have influenced the conduct of the disaster evacuations that have already occurred.

The preparatory measures that can be readily identified as potentially useful are:

(1) Preparing a plan of action.
(2) Acquiring any specialized equipment and communications.
(3) Training and orienting emergency personnel and decision-makers in the actions to be taken.
(4) Informing and instructing the population who may be evacuated in event of need.

One can argue that all of these preparatory measures, and possibly others, are necessary in

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principle. The questions addressed in this paper are to what extent they were taken in advance of past disaster evacuations and what was the effect, if any, of the presence or absence of one or more of the above measures. To address these questions, it was proposed to review the results and conclusions of other scholarly disaster studies and to evaluate directly disaster records in the files of the Federal agencies concerned with emergency operations.* After action reports, analyses and other disaster-related information in the files of the Defence Civil Preparedness Agency, the Federal Disaster Assistance Administration and other agencies were summarized, this data was analyzed with respect to the existence of emergency plans, pre-disaster public information activities, and tests involving either disaster organizations, the public, or both, and their effect on the carrying out of such plans.

Limitations of the Analysis

Every analysis is limited to some degree by the amount of information available and this present study is no exception. The record identifies many more evacuations than it contains data on. And, in many cases, the data is limited to place, date, number of evacuees, and cause. This makes it difficult to perform a rigorous quantitative analysis of the effect of a particular characteristic on the effectiveness of an evacuation. But a number of analyses are available in which trained observers have examined various aspects of the disaster, especially needs that they have seen for better preparation. And finally, the record gives mute testimony to the actions of government officials and agencies and to the results.

Taken all together these bodies of information were found sufficient to draw conclusions as to what is important and what is not important in preparing for emergency operations including evacuation. And while it was not possible to assess the relative value of all alternative preparedness measures related to effectiveness, it was found possible to identify the kinds of data that should be recorded to permit such an assessment in the future.

*The authors acknowledge that the application of their findings to other countries remains an open question.

II DISASTER EVACUATION EXPERIENCE

General

Historically, evacuation has long been adopted as a protective measure against known or perceived hazards – an approaching enemy army or a rising river. Before 1960, most evacuations were of this kind, e.g., Boston in 1775 and Topeka, Lawrence, and Kansas City in 1951. With the development of means for identifying approaching hazards – enemy bombers, hurricanes, etc. – in the 1950's, evacuation came to be seen as an effective defence against a wider spectrum of hazards. Several evacuation tests by civil defense in 1954 and 1955 showed that planned, orderly evacuations could be successful. When Hurricane Audrey struck Cameron Parish in Louisiana in 1957 with great loss of life, impetus was given to evacuation planning and its wider adoption as a defensive measure. As the years have passed, the incidence of evacuation has increased; how much it has increased is difficult to say.

Evacuation Data

In planning this study, it was decided that a rigorous analysis would require the data listed on the Evacuation Study Work Sheet (Fig. 1) and that only those evacuations in which 100 or more people moved would be studied. Data was obtained chiefly from a search of the files of the DCPA Disaster Research Center and from Hans and Sell [11]. Information on major events was obtained from studies by the Defence Civil Preparedness Agency (DCPA), the Office of Emergency Preparedness (OEP), the Disaster Research Group of the National

Incident _____

Place _____

Year _____

I. Incident.

1. Nature: Natural _____ Accident _____ Exercise _____
2. Description: _____
3. Build-up: Instant _____ Hours _____ Days _____
4. Prior Warning: Of Possibility: No _____ Yes _____ When _____ How _____
   Of Approach: No _____ Yes _____ When _____ How _____
   Of Event: No _____ Yes _____ When _____ How _____
5. Time of Event: Date _____ Hour _____

II. The Evacuation.

1. Area Evacuated: _____
2. Reception Area: _____
3. Number of Evacuees: _____ Total Population _____
4. Time of Evacuation: Start: Day _____ Hour _____ ; Finish: Day _____ Hour _____
5. Evacuation Order: By _____ In Name of _____
6. Spontaneous: No _____ Yes _____ Triggered By _____
7. Movement Control: No _____ Yes _____ By _____

III. The Preparation.

1. Plan: No _____ Yes _____ By _____ Date _____
2. Publicized: No _____ Yes _____ By _____ How _____
3. Exercise: Government: No _____ Yes _____ Date _____
   Public: No _____ Yes _____ Date _____
4. Previous Evacuations: No _____ Yes _____ Dates _____

IV. Results: _____

1. Deaths: No _____ Yes _____ Number _____
2. Injured: No _____ Yes _____ Number _____
3. After-Incident Report: No _____ Yes _____ Findings _____

Recommendations _____

V. Documentation: _____

Fig. 1. Evacuation study work sheet.

Academy of Sciences/National Research Council (NAS/NRC), and the Ohio State University Disaster Research Center. Availability of data was discussed with the American National Red Cross, the Bureau of Motor Carrier Safety, and the Federal Railroad Administration. These three organizations advised that their records would not yield the kinds of data being sought.

In all, reports of 228 evacuations of 100 or more people were found. These events are listed in Appendix A in five classes by type of event that posed the hazard. Accidents include events involving the release of – or threat of release of – toxic and corrosive chemicals and explosions – and the threat of explosions. Fires include forest and wild land fires and conflagrations in urban and suburban areas. Flash floods are those in which the warning is measured in a few hours as in the occurrence of torrential rains or the collapse or impending rupture of a dam or reservoir. Floods are those in which the warning is measured in days as when a river crest moves downstream. Hurricanes are tropical storms that produce exceptionally high tides or tidal waves and often produce heavy rainfall. For simplicity, this class also includes – for this study – the two cases of tsunami for which evacuation data was found.

Accidents and fires as well as flash floods tend to have a rapid build up; i.e., only a few hours pass between the first perception of the threat and the onset of the hazard. In these terms, floods and hurricanes have a long build up. And it is worthy of note that there is a rough correlation between length of build up and area involved: the longer the build up, the greater the area.

In only 56 of the cases listed in Appendix A were data found other than place, date, cause, and number of evacuees. Substantial amounts of data were found only in the few instances in which post-disaster studies had been made. The extent of the data, by type of event, is shown in Table I.

TABLE I

Data on Evacuations

Type of Event	Number of Evacuations	Reports with more than Basic Data	Reports Mentioning Plan
Accident	75	12	8
Fire	10	0	0
Flash Flood	22	7	3
Flood	92	15	13
Hurricane	29	22	21

The total numbers of the people evacuated for the evacuations listed in Appendix A are shown in Table II.

TABLE II

Number of Evacuees

Type of Event	Number of Evacuations	Total Number of Evacuees
Accident	75	298,120
Fire	10	11,500
Flash Flood	22	148,380
Flood	92	296,170
Hurricane	29	1,166,310
	228	1,920,480

It should be noted that hurricane evacuations account for the majority of evacuees and that the average hurricane evacuation has involved about 40,000 evacuees as compared with about 4,000 in other types of disasters.

The increase in number of pre-disaster evacuations over the years can be judged roughly from Table III.

The increases shown may exaggerate the real situation because record-keeping has gradually improved and because records of recent years are more readily available. For example, DCPA after-action documents for years before 1973 had been retired to a government document center and were not available for study.

All of these numbers would have been larger if sufficient data had been available. Hans and Sell listed 338 evacuations in 8 states for

TABLE III

Pre-Disaster Evacuations

Period	Accident	Fire	Flash Flood	Flood	Hurricane	Total
Before 1960				5	1	6
1960–1969	30		2	20	21	73
1970–1975	45	10	20	67	7	149
	75	10	22	92	29	228

which the number of evacuees was not found. In the search of the DCPA files, many reports of evacuation were found that did not give number of evacuees. Not all of these would have met the 100-minimum criterion set for this study. But if the data for them had been available, the numbers of evacuations in the above table would have been larger, especially for the periods after 1960.

Evacuation Tests

Tactical evacuation of the central cities was introduced into civil defense planning in the early 1950's as an optional measure for defense against enemy attack. In those days, warning of 4 hours or so of the onset of an attack was expected. Previous evacuation experience was for the most part related to events with a long build-up time, e.g., several days in the case of a flood on a sizeable river. But there were few data on the factors affecting the planning for tactical evacuation.

In 1954 and 1955, about ten cities conducted tests of evacuation plans to obtain data, primarily on traffic flow, organization, and control. Those identified are listed in Appendix B. The tests varied in size from 8,000 evacuees out of 28,000 people in Bremerton, Wa., to 101,000 evacuees out of 372,000 people in Portland, Or. They included a test in Mobile, Al., in which 37,300 out of 38,000 school children were evacuated. Then in 1957, 1,500 volunteers were evacuated from Binghamton, NY to Deposit, NY to test methods for reception and care of evacuees. This evacuation also tested a proposed method of traffic control, which was found unnecessary. In no case were these tests designed to publicize adopted evacuation plans or to train the public.

III EFFECT OF PREPARATORY MEASURES

General

Sources of information bearing on the need for or usefulness of preparations for the evacuation of threatened population groups are of several kinds. First, there is the body of data concerning actual disaster evacuations summarized in Appendix A. Second, there are the perceived needs voiced by officials involved in disaster evacuations as a result of their experiences. Third, there are the observations and conclusions of trained observers who have published analyses of various aspects of disasters. Finally, there is the mute evidence of behavior on the part of public officials and agencies of government. All of these have been consulted in this study.

Some 228 instances of disaster evacuations in which it is known that at least 100 persons were evacuees are tabulated in Appendix A. Other instances have doubtless occurred but records of these evacuations, if they exist, are not readily available. Of the 228 tabulated incidents, only in 56 or 25 percent was the presence or absence of preparatory measures mentioned in the documentation reviewed. This does not mean that preparatory measures

played no role in the 75 percent for which the record is silent. As will be discussed, disaster preparations are more pervasive than some might imagine and are likely to have exerted some influence even though not remarked upon.

In attempting to evaluate the effect of preparatory measures on disaster evacuations, we will follow the organization suggested in the Introduction although it will be found that, in many respects, it is not possible to discuss each measure separately from the others.

Emergency Plans

All of the 56 tabulated incidents in which reference to preparatory measures was found contain references to the existence or lack of specific evacuation plans. In 80 percent of the cases (45 instances), existence of an evacuation plan was mentioned. In 20 percent (11 instances), lack of prior planning was mentioned. Most of the plans mentioned were in connection with flood and hurricane evacuations, as can be seen in Table IV.

TABLE IV

Summary of Disaster Evacuation Data

Disaster Type	Number of Cases	Mention Measures	Had Plan
Accidents	75	12	8
Large Fires	10	0	0
Flash Flood	22	7	3
Flood	92	15	13
Hurricane	29	22	21

Floods and hurricanes are repetitive seasonal threats in many areas. One kind of evidence for the perceived utility of specific evacuation plans is that few communities facing this sort of threat are without such plans, at least in recent years. Of course, hurricane evacuations are usually major operations. Of the approximately two million evacuees accounted for in the incidents tabulated, a majority were caused to evacuate because of the threat of hurricane tides. About ten times as many people are involved in the average hurricane evacuation as are involved in other types of disaster evacuations. Thus, the need for prior planning is most evident for this disaster type.

In the accident and flash flood incidents, 11 of 19 cases in which preparatory measures are discussed were said to be based on an evacuation plan. Several of these plans, however, were devised after the threat to the population was imminent. The chlorine barge incidents at Baton Rouge [7] and Morgan City, Louisiana, [6] and at Louisville, Kentucky [9], are examples. How many other slowly-developing threats motivated the preparation of evacuation plans is not known. There are several instances of plans being prepared in response to a specific threat where an evacuation was not needed. Operation Red Hat, in which military nerve gas was moved by rail in the Pacific Northwest, was a case in which fairly elaborate evacuation plans were laid but never implemented. Although not treated here, these incidents also demonstrate an official recognition that evacuation plans are useful.

With respect to the data summarized in Table IV, however, it does not seem possible to attribute any quantitative improvement in the disaster outcome to the existence of prior evacuation plans. In general, disaster evacuations have been remarkably effective whether they are based on specific evacuation plans or not. For example, 5,700 out of 6,000 residents of Cameron Parish, Louisiana, were evacuated in 1961 on the basis of a written parish evacuation plan brought about by the Hurricane Audrey disaster of 1957 [27]. In 1971, 80,000 out of 81,000 people in Los Angeles threatened by the impending collapse of the Van Norman Dam were evacuated in a period of six hours without benefit of an evacuation plan [30]. Where needless loss of life has occurred, it seems to be attributable to factors other than lack of an evacuation plan, as discussed at a later point.

Despite the failure of the limited data to exhibit a quantitative effect that can be attributed to the existence of evacuation plans, there is a relative abundance of other evidence. Incidents in which preparatory measures are mentioned always discuss the evacuation plan. Moore et al. [16], in a study of the response to Hurricane Carla, concluded, "Civil defense planning was shown to have had high value in meeting the emergency and in keeping the number of casualties at a minimum". Where a plan existed at the time of the evacuation, its value was extolled. For example, the mayor of Lansing, Michigan, is reported as stating during the April 1975 flood, "Years of planning and exercises are paying off". Where no plan existed, preparation of an evacuation plan was proposed as part of the lessons learned. An official review of the Louisville, Kentucky barge incident, for instance, argued that it demonstrated the need for pre-disaster planning. Proposals for improvement are also common in after-action documents; e.g., the after-action report on the 1972 flood evacuation of Wilkes-Barre, Pennsylvania, cites the need for a better, more detailed plan.

One possible explanation for the fact that instances of major evacuation can be found that were successful without the aid of a plan is that few local jurisdictions are without an emergency plan of some sort even though a specific evacuation plan may not exist. This situation is largely the result of a civil defense requirement that must be met by State and local governments to qualify for Federal support in the form of matching funds for staff and equipment and access to surplus property of considerable use to the community. The required plans focus on response to enemy attack but have much in common with responses to peacetime disasters. A field study by System Development Corporation for the Defence Civil Preparedness Agency in 1970 [25] disclosed that while many such plans were pro forma or compliance documents of a too-general character, many others were rated highly. A relatively recent requirement is that these plans must be updated at least every two years, which is intended to correct these kinds of deficiency. Additionally, the Defence Civil Preparedness Agency, within interagency agreements, has broadened its emergency preparedness program to include readiness for all the types of emergencies that are identified in a risk analysis for a locality and has had in operation for a number of years a program of on-site planning assistance to local governments that has tended to emphasize peacetime incidents rather than nuclear war. The Van Norman Dam incident is a clear example of the influence of such emergency planning. It is quite true that a specific evacuation plan for the affected area was not available but a well-developed emergency organization exists in the Los Angeles basin and that could well explain the evacuation success.

It is significant to note that after-action documents on the Van Norman Dam incident stress that the county emergency plan was not sufficiently explicit for this type of incident, that provision should be made for better exclusion control, and that there should be written "Red Cross plans", presumably for reception and care of evacuees [30]. This is characteristic of the support given to the need for evacuation plans.

EQUIPMENT AND INFRASTRUCTURE

The second kind of preparedness measure that should be considered has to do with the facilities, equipment, and supplies that are needed to make an evacuation plan work. For the most part, disaster operations rely on resources normally available to the community and evacuation of people is no exception. Private automobiles or travel by foot are used for most of the actual evacuation, with school buses and other suitable vehicles provided for those in need of transportation. Public safety vehicles and communications are also relied upon. Commercial radio and TV stations are

relied upon to broadcast messages to the affected public. In most cases, however, some specialized facilities, equipment, and supplies are found to be needed in order for an evacuation plan to work efficiently. The nature of these specialized needs tends to vary with the type of threat.

An important distinction among various disaster types is the amount of buildup or advance warning intrinsic in the event. Floods and hurricanes are not only seasonal in occurrence but also are slowly-developing threats on which advance information is obtained through the use of weather forecasts, aerial surveillance, upstream flood stage measurements, and the like. Thus, the public can be alerted to the potential danger well in advance and given instructions relative to evacuation behavior. In a flash flood situation, such as the Rapid City, South Dakota, disaster, the evacuation process involves little warning and great urgency. In the evacuation incidents that we have tabulated, the fires, floods, and hurricanes are generally slowly-developing events whereas the accidents and flash floods are of the rapidly-developing kind.

In slowly-developing events, specialized means of providing warning have not usually been found to be needed since weather warnings and flood measurements are now well developed. The Marysville-Yuba City flood of 1955 is an exception where the need for better upstream measurements was noted in the after-action documents. Rather, the need for coordination of evacuation and other disaster activities from a centralized emergency operations center has been noted since the Midwest floods of 1951. In the data screened during this study there are four cases in which the need for better Emergency Operating Center (EOC) facilities was stressed in after-action documents. An equal number of comments on the inadequacy of communications can also be found. This relatively low incidence of expressions of need is probably the result, in our opinion, of the long-standing emphasis in civil defense programs on the development of an adequate emergency operations center in every political jurisdiction. These EOC's and the communication systems they tie together are routinely of value in a wide variety of peacetime emergencies.

In a rapidly-developing kind of disaster threat, maximum forewarning of existence of the threat and effective means of alerting and advising the affected population are the specialized capabilities of general note. These are found especially in the documentation of flash flood disasters such as in Buffalo Creek, West Virginia, and Rapid City, South Dakota [12]. As a consequence, the National Oceanic and Atmospheric Administration is presently engaged in developing a nationwide flash flood warning network. Having knowledge of the threat, civil defense sirens, public safety vehicle sirens, loud speakers, and door-to-door visits have been used for alerting the population. Broadcast media and door-to-door visits are the main means of instructing the public to evacuate. In the past, these methods have been successful.

Finally, for some threats, such as radiological accidents and transportation accidents and explosions involving the release of hazardous chemicals, specialized instruments and training must be included in the requirements for specialized facilities, equipment, and supplies. These may be needed not only to provide a basis for ordering evacuation but also to define the area at risk and to indicate when the need for evacuation has ended.

While this discussion has emphasized lessons from disaster evacuation experience, it should be understood that careful preparation of an evacuation plan can serve to identify specialized needs and ways to meet them. This is perhaps another reason for asserting the utility of evacuation planning.

TRAINING AND EXERCISING

The third kind of preparatory measure identified in the Introduction is the training and

orienting of emergency personnel and decision-makers in the actions to be taken in the event that an evacuation becomes necessary. In the data tabulated in Appendix A, specific mention of training and orientation is generally confined to the mention of prior exercises, as shown in Table V.

TABLE V

Exercises Related to Disaster Experience

Disaster Type	Mentioned Had Plan	Used Plan	Mentioned Exercise
Accidents	8	7	1
Large Fires	0	0	0
Flash Floods	3	2	0
Flood	13	10	1
Hurricane	21	20	2

There were four such instances. There could, of course, have been more exercises pertinent to a disaster than were mentioned. The data is quite limited in this respect. As one might expect, all of the instances in which a prior exercise was mentioned were instances in which the existence of an evacuation plan had been made known. It would be difficult to conduct a training exercise without a plan on which to base it. Moreover, all of these instances were cases in which the plan was used in the actual emergency. Put another way, in all six instances in which a plan was said to have existed but was not used, no prior exercise of the plan was mentioned (and, most probably, had not occurred). This would suggest that a plan not exercised by the emergency organization may not be useful in an emergency because too many members of the organization may be unaware of its contents.

With regard to the exercises mentioned, they were uniformly noted to have contributed significantly to the successful conduct of the evacuation. We have already noted the comment of the mayor of Lansing, Michigan that "Years of planning and exercises are paying off". In Petal, Mississippi, where ignition of a leak from an LP gas storage area in August, 1974, led to the evacuation of 3,000 people, the after-action report notes that on-site assistance activities (which involve an EOC exercise) and further testing of the plan in spring 1974 floods (no actual evacuation was required) made local operations "run smoothly".

It is in the case of lack of exercising of the emergency organization that the value of such exercises is most apparent. Two or three instances will be described to illustrate. The Rapid City, South Dakota, flash flood in June 1972, in which 226 were killed with 53 missing, is the first example [12]. The Rapid City-Pennington County Civil Defense Director was stranded at his home in the hills by the heavy rains and was unable to reach the city. Officials were deprived of his knowledge of the plan and of specialized capabilities. The city had a well-developed EOC but responsible officials knew little about its capabilities. City officials mobilized several hours before the flood and knew that evacuation of the river area was essential about an hour prior to the crest. Warnings were broadcast by telephoning the radio station and asking the announcer to make the announcement. The station announcer was not as credible to the public as an official might have been. Many phone calls were received berating the station for exaggerating the emergency. Also, many people had turned off television and radio because of the interference and static caused by the electrical storm. The civil defense sirens were not sounded to gain their attention. Officials said that it never occurred to them to sound them. But the radio station was part of the Emergency Broadcast System (EBS) and the transmitter was equipped with emergency power and a remote programming unit located in the EOC that would have permitted the mayor and the county commissioner to broadcast directly to the public. This capability was not used prior to the main disaster. Shorting of a power transformer about 11.47 p.m., said to be about three-quarters of an hour after the deluge, put the radio station

off the air. About 1.00 a.m. it was realized that the remote program unit existed and that both the EOC and the transmitter had emergency power and only then was communication to the public re-established. Despite these problems 8,700 people who might have been lost were evacuated during the short warning period. Nonetheless, the circumstances suggest that if orientation and training of local officials and emergency personnel had occurred, some of the loss of life may well have been prevented.

A second example is the Van Norman Dam incident previously discussed [30]. The earthquake occurred at 6.01 a.m. At 7.10 a.m. the police captain on the scene below the Van Norman Dam began requesting the people to evacuate. At 8.45 a.m. engineers at the dam recommended evacuation. The assistant chief of police ordered evacuation at 9.05 a.m. At 10.00 a.m. the area at risk was expanded and the evacuation order was changed to advice. Finally, at 10.37 a.m. the area at risk was again expanded and the evacuation order reinstated. Two hours later the evacuation was said to be complete. About 80,000 people were involved. The police force had a general emergency plan and organization and had had a number of tactical exercises. A specific plan for evacuation apparently did not exist nor had one been exercised.* Fortunately, the dam did not collapse. Otherwise, the uncertainties exhibited by changes in evacuation instructions over the 5½ hour period might have been disastrous.

A final example may be drawn from Hurricane Carla in 1961 [27]. Although hurricane evacuation plans did not exist, civil defense evacuation plans for the affected jurisdictions had been completed in 1958. Officials in Jefferson County, Texas, were well aware of these plans and had conducted several exercises of the plan earlier in 1961, including a tactical exercise in July in which emergency units actually assumed their planned positions. In the hurricane evacuation, the same units deployed as the plan indicated and the evacuation was highly successful. Officials reported that the only change made from the civil defense plan was that highways were not made one-way outbound. In Galveston, Texas, a similar plan was not used because local officials were unaware of it. All instructions given there left it up to the citizen to decide whether to evacuate or take shelter. Only 95,000 out of 140,000 chose to evacuate before egress routes were closed by the rising tide. Investigators believed that an exercised plan and an evacuation order would have resulted in nearly the whole population being evacuated.

These examples exhibit the value of orientation and training of decision-makers and emergency forces in readiness for disaster evacuation. They also point to the value of exercising the organization for orientation and training. For the training to be effective, an evacuation plan is essential. Given the plan, the exercise can take on some aspects of a test; i.e., the workability of the plan and its organizational arrangements and the sufficiency of the equipment, supplies, and communications called for or provided can be assessed. Tests and exercises also afford the opportunity to evaluate alternative plan provisions. For both testing and exercising, valid scenarios are needed to present the postulated disaster accurately in its dimensions and pace. Such scenarios permit the exercise of the plan, either in decision-making in command centers or in tactical operations involving actual deployment of emergency units.

In addition to accomplishing necessary orientation and training of officials and emergency forces, these exercises usually identify deficiencies in facilities, equipment, and supplies that can be planned for correction. Deficiencies in the plan, in performance, and in equipment are disclosed in post-exercise critiques in which the participants and experi-

*Although a specific plan for evacuation did not exist, both the police department and the water department had a plan specifying how far people would have to be evacuated if the Van Norman Dam were damaged by an earthquake. The police officer in charge in the area obtained the necessary map from downtown and used it in setting the limits of the area that was to be evacuated.

enced observers discuss their observations. Many such exercises have occurred throughout the country in recent years.

PUBLIC INFORMATION, INSTRUCTION AND DRILLS

The fourth kind of preparedness has to do with measures for informing and instructing the public that may have to be evacuated. In this, effectiveness is measured in terms of giving the public knowledge that they can use in a potential disaster situation as well as in terms of its impact on life-saving responses in an actual disaster. The possibility and appropriateness of drills involving public participation also needs to be considered.

In discussions of preparedness for emergency operations, the terms "test", "exercise", and "drill" tend to be used interchangeably. Used strictly, they are not. A test involves the deployment and operation of the emergency organization in simulated conditions for the purpose of discovering deficiencies with a view toward correcting them. An exercise involves the deployment and operation of the emergency organization in simulated conditions for the purpose of training the personnel with a view toward improving their performance in a real emergency. A drill may be either a test or an exercise with the added feature of the participation of the public.

If public information on how to respond to a disaster threat is to be effective at all, the minimum requirement would seem to call for public knowledge of the existence of appropriate plans, if not of their content in behaviorally useful terms – where to go and what to do. However, for the most part, the evidence in the disaster literature [3, 15, 16, 24] does not support a conclusion that the public, even when informed and instructed under normal conditions, will retain such information. For example, after the disaster of Hurricane Audrey in 1957, Cameron Parish developed an evacuation plan and publicized it widely in the media and through organization of neighborhood civil defense groups. But when Hurricane Carla occurred in 1961, 4 out of 10 residents of the Parish were unaware of the plan or asserted that no such plan existed [16]. In Galveston, 58 percent of the people were unaware of the evacuation plan or thought that it did not exist [16].

There is little doubt – no study seems to show otherwise – that information and instructional campaigns under normal conditions fail to prove effective in affecting behavior in a disaster context. If this is so, then such information, regardless of the mode and intensity of its dissemination, cannot have a positive effect on subsequent responses in the disaster situation itself. This, of course, is a result of the selectivity with which people absorb information. Relevancy to their life conditions seems to be among the crucial factors in knowledge acquisition and retention. Thus, information given publicity at the beginning of the hurricane season may have some impact because of its relevancy but the impact would be short of that associated with specific hurricane warnings to a particular area.

Among the many stimuli which bombard us all everywhere at all times, information pertaining to actions in preparation for low-probability and "unscheduled" (time-unpredictable) occurrences must rate as having low saliency. The motivation to learn and to retain what has been learned – and then be able to use the knowledge in the form of appropriate behavior in coping with these occurrences – is correspondingly low. However, information and instructions, if authoritative and unambiguous, given under threat conditions or at the onset of a disaster are assimilated rapidly and produce high levels of compliance. In slowly-developing disasters, there is relatively ample time for the dissemination of even complex information and instructions. In rapidly-developing disasters, reliance must be placed on the dissemination of that minimal information which is required to lead to effective public response.

Thus, it seems important to prepare essential messages to be disseminated to the public as an aspect of overall evacuation planning, especially in regard to rapidly-developing disasters. But the need for authoritativeness and clarity (and, by implication, message standardization, at least in its *core* elements) in emergency communications to the public makes such information content-and-dissemination planning highly desirable regardless of the time trajectory of the disaster agent.

The extent to which the public can develop more effective modes of coping with a disaster situation by participation in drills (perhaps, of course, coupled with dissemination of other information) is open to serious doubt. In the disasters we have surveyed in this study, public participation in drills antecedent to the actual evacuation never occurred. Thus, there is no way to compare evacuation performance in which there had been prior public participation in drills with that in which there was not. Not only were no instances found in which public drills preceded evacuation in an actual disaster, but we also found no case in which the after-action documents mentioned the need for public drills or recommended them.

The closest that we can come to making a comparison on this point is in considering areas of the country which had been affected by prior disasters of a similar nature, especially those that called for evacuation. In this context, one may then consider the antecedent experience (with an actual prior disaster) to be a "drill" for a subsequent disaster. The results, similar though the situations are, show some of the problems. "We've been through all this before, we can handle it again" is, perhaps, a succinct summary of one of the key attitudes exhibited. But, in reality, it does not follow that prior behavior was as effective as it might have been or that it would be as effective under somewhat different circumstances, or that alternative coping actions would not be preferable. Thus, prior experience leads some to ignore official instructions in favor of personal decision. At the same time, most with prior disaster experience are able to respond quickly to comply with instructions and information given at the time they are needed, so that "learning" in this sense does tend to occur [16].

Another comparison that can be made relates to public behavior when civil defense sirens have sounded an alert in the context of previous routine siren tests [15,24]. Such alerts sounded in this country have all been accidental but the public had no way of knowing this. The practice of audible siren testing introduced ambiguity into the alert message and allowed the public to interpret the event not as a warning of dire emergency but rather as "just another test". In rapidly-developing disasters, such ambiguity could be fatal for some. Just the time spent confirming that the emergency was real and not just another drill could be costly.

The several civil defense tests conducted in the 1950's cannot be used easily as data sources to determine how response effectiveness might be enhanced by public participation in drills. These tests involving public participation were carried out largely as research efforts – to gather data and test elements of the emergency organization. These tests were not designed to inform or instruct the public or even to test complete evacuation plans but rather to provide feedback of data to improve the character of civil defense evacuation plans. Testing of the operating system as an important way of determining problems, evaluating alternatives, and yielding data on possible improvements, is, of course, important. But such testing is now known not to require the participation of the public, and the limitations imposed by such participation, compared with the flexibility afforded by simulated problems, may actually lessen their teaching value for the system.

The possible value of public drills, it appears, is also degraded by the fact that highly-unusual circumstances tend to prevail: a drill has to be announced and publicized in some detail well

ahead of time; a great deal of "tooling-up" by the public can, and does, occur. The situation is more like one of a "game" than of an approximation to reality. The members of the public are so removed from being able to conceptualize the real meaning of the "game" that it is highly questionable whether any learning applicable to an actual disaster can, in effect, take place. When, in addition to that, the operating system is learning too – functioning less than adequately, attempting to identify its problems, and critiquing its plans and their performance – the public visibility resulting from public participation is likely to have a negative, rather than a positive impact on the credibility of instructions in an actual disaster situation.

In emergencies that call for a response by the public, credibility of the source of information and instruction is known to be a major factor in how well and how quickly the public responds. This is especially so in emergencies in which the individual cannot perceive the danger through his own senses. A major consideration in planning for emergency public information activities is maintaining and protecting the credibility of the source of the information and this includes avoiding whatever may degrade source credibility. Public participation in evacuation drills and the inevitable discussion in the media and other forums of the deficiencies disclosed would surely contribute to the degradation of the credibility of the information source. In this respect, a public participation drill can be foreseen to have a counterproductive effect.

Furthermore, the evidence from the limited tests of the 1950's suggests that the social situation itself changes when a drill is attempted. In Bremerton and Spokane, for instance, many people simply stayed home to avoid involvement in the test, with the result that there were unusually light traffic loads and concurrent normal activities. Klass, et al. [13] were led to conclude that "the public participation in 'Operation Rideout' was so small as to imply that even a homogeneous population presented with a logical plan by an organization that it respects as a group of persons, if not an institution, will not fully participate in a civil defense exercise".

Last, but not least, the economic costs and intrusiveness of evacuation drills, even if considered alone and apart from other problems already referred to, may be such as to make their "cost/effectiveness" exceptionally problematic. There is, as it were, no compelling reason to believe that public drills would enhance the population's capacity to cope with disasters more effectively or improve planning and there is fair evidence that the results might well be counterproductive.

IV. FINDINGS AND CONCLUSIONS

Findings

On the basis of the data analyzed in this study, the following findings are drawn:

1. Records of disaster evacuations – as well as of other characteristics, especially antecedent preparatory measures – are incomplete and this introduces uncertainty into analyses of specific aspects of disaster experience.
2. Evacuations of people from danger areas have been routinely successful, even when specific plans for them had not been made in advance.
3. Existence or lack of a plan is most often noted in after-action comments on disasters and improvements in a plan are often recommended by officials and observers. Next most common are recommendations for improvements in equipment and infrastructure. Also noted were exercises of the emergency organization, but in no case was public participation in drills noted or recommended.
4. Familiarity of local officials with emergency plans and capabilities appears the most important desideratum in preparing for evacuation.
5. Preparation of specific evacuation plans is

essential for orientation and training, but if not exercised by responsible officials and the emergency organization such plans are often not used in actual disasters.

6. No record was found of public evacuation drills and there is no evidence that large-scale participation in such drills is achievable. There is some evidence that such participation, even if achievable, could be counterproductive in a subsequent disaster evacuation by introducing misinformation and ambiguity, by limiting response flexibility, and by degrading information source credibility.
7. Intensive efforts to inform the public on evacuation plans and procedures have had limited success.

Conclusions

The following conclusions are drawn from the above findings and from the data analyzed in this study.

1. Responsible agencies of government, such as the Defense Civil Preparedness Agency, should use a standard data sheet similar to that in Fig. 1 of this paper in recording disaster-related characteristics in order to obtain a better basis for improving the ability of government to protect life and property in disasters.
2. A broad and vigorous program of planning, investment in infrastructure and specialized equipment, and orientation and training of local officials and emergency personnel for disaster preparedness, including tests and exercises of emergency plans, is well justified and should be supported.
3. Public participation in practice drills would produce no benefit, may tend to degrade effectiveness, and should be de-emphasized.
4. Efforts on preparedness for disaster should emphasize advance preparation of message content and means of dissemination of authoritative and unambiguous information and instructions in time of need; public information on disaster preparedness in normal times should be limited to that needed to enhance source credibility in the emergency.

APPENDIX A: HISTORICAL INCIDENTS OF PRE-DISASTER EVACUATION

The tables in this Appendix present the applicable data that could be found. These data were obtained for the most part from:

1. Files of the DCPA Disaster Information Center.
2. Hans, J.M., and Sells, T.C. (1974) *Evacuation Risks – An Evaluation*, EPA National Environmental Research Center, Las Vegas, Nevada.
3. Reports of post-disaster studies by DCPA and OEP.
4. Reports of disaster studies by the NAS/NRC Disaster Research Committee and its successors.
5. Reports of disaster studies by the Ohio State University Disaster Research Center.

The data is assembled in this Appendix by type of event that was the proximate cause of the evacuation. The types used are:

Accident. These events are "man-made". They include transportation accidents – water, rail, and highway – explosions in pipelines, buildings, storage facilities, and so on, and such events as leaking storage tanks, etc. Their common feature is that they pose a present or a possible danger of physical harm to people. The dangers include missiles from explosions and the emission of poisonous and corrosive substances.

Fire. These events are either "man-made" or natural. They include conflagrations in urban and suburban areas. They do not include fires in one or a very few buildings. They include forest and other wild land fires.

Flash Flood. Again these events are either "man-made" or natural. Man-made flash floods are those in which a flash flood is – or can be – the result of the failure of a man-made structure such as in the Baldwin Hills Reservoir and Van Norman Dam events in Los Angeles and the Buffalo Run event in West Virginia. Natural flash floods are the result of torrential rains on a relatively small watershed. The two kinds have in common a short build-up and warning time – measured, at most, in a few hours.

Flood. These are natural events. They occur ordinarily on rivers as the result of relatively long periods of rainfall sometimes accompanied by melting of the snowpack. The build-up is slow; it can be perceived in rising river stages; and warning usually comes from observations of the times of the flood crest at upstream points.

Hurricane. These are natural events. They are severe tropical storms whose chief hazards in these days are from the high tides and tidal waves they cause although some hazards still exist from building collapse and wind-borne missiles. These again have slow build-up and the warning time is relatively long. Their location and path are watched by "hurricane

hunters" and well publicized in the media. However, the prediction of the location and timing of the onset of the "eye" of the storm is not as precise as for floods. To avoid unnecessary complication, the two cases of tsunami – tidal wave caused by earthquake – for which data were found are included with the hurricane data.

Where available, data is also included on the following:

Number evacuated: The number of people who moved out of the area at risk by any mode – walking or by auto, public transport, or boat -- and whether spontaneously or in response to advice or direction of the government.

Population: The population reported in the record from which data was extracted. This can be either the total population in the area or the population at risk. Whenever a choice was possible between total population and population at risk, the number at risk is given.

Evacuation Time: The evacuation time given is the total elapsed time, in hours, from the first beginning to the end of the outward movement. In some cases, spontaneous evacuation or "advised" evacuation went on for some time before an evacuation was ordered.

Plan: This refers to the existence and use of an evacuation plan applicable to the evacuated area. In this, we followed Hans and Sells:

P – Plan available, not used

PU – Plan available and used

NP – No plan available

Government Exercise: This refers to an exercise of the organization to test a plan or its readiness to execute the plan or to train it in the execution of the plan. In some cases, it involves activation of the government's Emergency Operations Center (EOC) and simulation of an event. This is similar to a military Command Post Exercise (CPX). In others, it involves actual deployment of the field units of the organization to their assigned posts and the exercise of their operations.

Public Drill: this refers to an exercise of an evacuation plan involving the participation of the public to the extent of evacuating the area. The purpose of such a drill is to educate the public in the detailed requirements of the plan and their proper response to them.

Accident

1961: Aug. 1, Creve Coeur, Illinois (Number evacuated: 7,500), Evacuation time: 1 hr., Plan: PU.

1965: Sept. 9, Baton Rouge, Louisiana (150,000), 2 hr., PU: Sept. 26, Westfire, Oregon (300): Dec. 4, Camden, Arkansas (1,000).

1966: Richland Co., South Carolina (200).

1967: Aug. 27, Texarkana, Texas (5,000), 4 hrs., NP: Oct. 28, Danbury, Texas (1,200): Nov. 18, Waterford, Alabama (2,800).

1968: Jan. 1, Dunreith, Indiana (240): Jan. 13, Chadbourne, North Carolina (1,500), 5 hrs., NP: Feb. 27, Hagerstown, Maryland (2,500), NP: Apr. 21, Kelley, Iowa (240): Aug. 13, Urbana, Ohio (4,000),.3.5 hrs: Aug. 19, Beattie, Kansas (300).

1969: Jan. 13, Lima, Ohio (2,000): Jan. 25, Laurel, Mississippi (1,000): Feb. 18, Crete, Nebraska (400): Apr. 4, Wetamka, Oklahoma (2,000), 8 hrs., PU: Apr. 15, Allentown, Wisconsin (400): Apr. 16, Allentown, Louisiana (150): Apr. 25, Persling, Indiana (400): May 16, Logansport, Louisiana (1,800), NP: Aug. 24, Piedmont, West Virginia (150): Sept. 3, Wellington, Alabama (200): Sept. 10, Butler, Illinois (700): Sept. 11, Glendora, Mississippi (35,000), 4 hrs., P: Oct. 18, Troup, Texas (100): Nov. 26, Rockwell, Texas (200): Nov. 30, Crew Lake, Louisiana (250): Dec. 29, Carlisle, South Carolina (450).

1970: March 3, Danbury, Texas (300): Apr. 9, New Athens, Illinois (1,500): May 24, Jasper, Alabama (500): June 21, Crescent City, Illinois (600): Oct. 25, Farmers, Kentucky (1,000): Dec. 2, Clay City, Illinois (100).

1971: Feb. 10, Ashkum, Illinois (2,500): Mar. 27, Panther Burn, Mississippi (250): May 2, Eden, Mississippi (200): Aug. 16, Rock Hill, South Carolina (1,000): Sept. 18, Weston, Illinois (150): Nov. 2, Sumter Co., South Carolina (180): Dec. 3, Wheatfield, Indiana (700): Dec. 3, Thomasville Alabama (100): Dec. 11, Corbin, Louisiana (500).

1972: Mar. 19, Louisville, Kentucky (4,400), 3 hrs., PU: May 14, Isleta, Ohio (1,100): May 16, Cashocton, Ohio (350): June 1, Dallas Texas (100).

1973: Jan. 4, Harrod, Ohio (100): Jan. 19, Morgan City, Louisiana (3,000), 4 hrs., PU: Feb. 5, Downingtown, Pennsylvania (700), 2 hrs., PU: Feb. 19, Charleston, South Carolina (2,000): Apr. 20, Williamsburg, Michigan (450): Apr. 28, Roseville, California (20,000): July 17, Superior, Arizona (300): July 20, Superior, Arizona (200): July 30, Markle, Indiana (900): Sept. 13, Adrian, Michigan (1,000): Oct. 30, Edmonton, Canada (5,000).

1974. Jan. 10, W. St. Paul, Minnesota (200): Apr. 23, New York, New York (300): Apr. 26, Chicago, Illinois (400): May 28, New Britain, Connecticut (2,000): June 12, Moore, Oklahoma (5,200): July 11, Leland, Mississippi (200): July 19, Decatur, Illinois (10,000): Aug. 5, Plotona, Illinois (500): Aug. 6, Bluford, Illinois (400): Aug. 25, Petal, Mississippi (3,000), PU.

1975: May 6, Omaha, Nebraska (1,000): May 13, Vierton, Louisiana (1,500): June 23, Calipatric, California (1,200): July 18, Tiller, Arkansas (100): Oct. 23, Fertile, Minnesota (950).

Fire

1970: Sept. 26, San Diego, California (5,000).

1973: Aug. 21, Klamath Falls, Oregon (350): Sept. 10, Whale Gulch, California (200): Oct. 14, Chelsea, Massachusetts (2,500): Oct. 28, San Diego Area, California (350): Oct. 30, Topanga Canyon, California (700).

1974: July 8, Walker, California (400): Aug. 29, Soboba, California (1,000): Aug. 29, Pine Cove, California (1,000).

Flash Flood

1963: Dec. 14, Los Angeles, California (9,000), 1.5 hrs., NP.

1968: July 7, Anderson, South Carolina (210), 2 hrs., NP.

1970: Sept. Payson, Arizona (160), 12 hrs., PU.

1971: Feb. 9, Los Angeles, California (80,000), 5.5 hrs., NP: July 20, Cane Run, Kentucky (1,500), 36 hrs., NP.

1972: Feb. 26, Buffalo Creek, West Virginia (700): June 9, Rapid City, North Dakota (8,700), 1 hr., P: Sept. 13, Hicksville, Ohio (280).

1973: Conway, South Carolina (180): Apr. 12, Greeley, Colorado (1,000), 3.5 hrs., PU: May 7, Denver, Colorado (5,300): May 24, Payson, Utah (5,000): Oct. 28, Ketchikan, Arkansas (350).

1974: June 10, Calion, Arkansas (800): Dec. 1, Mineral Co., West Virginia (100).

1975: Jan. 31, Nacogdoches, Texas (500): May 18, SE Kentucky (1,000): Sept. 22, Rock Hill, South Carolina (250): Sept. 23, Dothan, Alabama (12,000): Sept. 25, Susquehanna Basin, Pennsylvania (20,000): Sept. 26, Alexandria and Arlington, Virginia (250): Sept. 26, Elmira, New York (1,100).

Flood

1951: July, Topeka, Kansas (20,000): July, Laurence, Kansas (2,000): July, Kansas City, Kansas (12,000).

1955: Dec. 23, Yuba City, Marysville, California (30,000).

1959: Mar., King Co., Washington (500), 18 hrs., PU.

1961: June 16, Port Angeles, Washington (100), 2 hrs., P.

1962: Velva, North Dakota (400).

1964: Dec. 22, Humboldt Co., California (180), P.

1965: Apr., Grand Forks, North Dakota (200), NP: June, Littleton, Colorado (250): June, Sheriden, Colorado (200): June, Denver, Colorado (125): June, Newton, Kansas (550): July 24, Middlesboro, Kentucky (700).

1966: Grand Forks, North Dakota (300): Apr., Jamestown, North Dakota (280).

1967: Mar. 7, Harlan, Kentucky (500): July 25, Middlesboro, Kentucky (200): Apr., E. Dubuque, Iowa (200), PU: Aug. 14, Fairbanks, Alaska (14,000), P.

1968: Apr. 4, Russellville, Kentucky (700).

1969: Apr., Jamestown, North Dakota (360), 24 hrs., NP: May, Minoti, North Dakota (12,000), PU: May, Jefferson Co., Colorado (125): Dec. 30, Harlan Co., Kentucky (360).

1971: Jan. 8, Ferndale, Washington (225), 4 hrs., PU.

1972: Apr. 15, Frankfort, Kentucky (8,000): May, Okanogan Co., Washington (1,240), 1.25 hrs., PU: June 21, Isleton, California (1,200), 11 hrs., PU: June 23, Wilkes Barre, Pennsylvania (75,000), 5 hrs., PU.

1973: Feb. 3, Florence Co., South Carolina (100), 8 hrs., PU: Apr. 23, Quincy, Illinois (3,800): Apr. 23, Erie, Illinois (1,500): Apr. 23, Rockford, Illinois (300): Apr. 24, North Coast, Puerto Rico (310): Apr. 24, St. Louis, Missouri (10,000): Apr. 24, Keithsburg, Illinois (700): Apr. 24, Rolling Fork, Mississippi (200): Apr. 25 No. Little Rock, Arkansas (350): Apr. 25, Avoyelles Par., Louisiana (1,110): Apr. 25, Broindette, Louisiana (350): Apr. 25, Bordelonville, Louisiana (210: Apr. 26, St. Charles Co., Maryland (7,050): Apr. 26, Basketown, Missouri (600): Apr. 27, Livingston, Louisiana (880): Apr. 27, Des Allemonds, Louisiana (320): Apr. 27, Point Coupe Parish, Louisiana (310): Apr. 27, Ascension Parish, Louisiana (700): May 1, Jonesville, Louisiana (2,500): May 1, Hannibal, Missouri (35,000): May 4, Penobscot, and Aroostock, Maine (1,700): May 10, Wiggins, Colorado (450): May 10, Atwood, Colorado (280): June 15, Houston Area, Texas (700): June 18, Toledo, Ohio (400): July 3, Delaware Co., New York (500): Aug. 1, No. New Jersey Area (800): Sept. 28 New Cambria, Kansas (280): Oct. 21, Graffon and Cheshire Cos., New Hampshire (200): Nov. 27, Overton Co., Tennessee (200).

1974: Jan. 13, Libby, Montana (1,300): Jan. 15, Siskiyou, California (250): Jan. 15, Ferndale Valley, California (425): Jan. 17, St. Maries, Idaho (200): Jan. 17, Kellogg, Idaho (2,800): Jan. 17, Mossy Brac, Oregon (200): Jan. 17, White Swan, Washington (3,500): Jan. 17, Ebey Island, Washington (520): Jan. 17, Klickatal, Washington (280): Jan. 21, Kankatee Co., Illinois (120): Apr. 8, Monroe Co., Louisiana (700): Apr. 12, Hattiesburg, Mississippi (10,000): Apr. 19, Minot, North Dakota (950): Apr. 19, Koloa and Lani, Hawaii (360): May 15, Philips Co., Oklahoma (420): May 18, Plattee and Clay Cos., Missouri (1,000): May 22, Henry Co., Illinois (170): May 22, Kane Co., Illinois (150): May 22, Kendall Co., Illinois (120): Sept. 2, Prichardsville, Kentucky (180): Nov. 1, Oklahoma City, Oklahoma (10,000): Nov. 2, Yukon, Oklahoma (200): Nov. 4, Tulsa, Oklahoma (630).

1975: Jan. 12, Nome, Alaska (100): Mar. 14, W. Memphis, Arkansas (700): Mar. 23, Rockford, Illinois (2,000): Mar. 25, Paducah and McCraken Cos., Kentucky (700): Mar. 31, Warren Co., Mississippi (2,000), PU: Apr. 19, Lansing, Michigan (1,800), PU: Apr. 29, Minot, North Dakota (4,200): May 8, Minot, North Dakota (250): June 18, W. Great Falls, Montana (4,000), 18 hrs.

Hurricane/Tsunami

1959: Sept. 19, Seabrook, Is., South Carolina (210), 4 hrs., PU.

1961: Sept. 11, Plaquemines Par., Louisiana (21,000), 2 hrs: Sept. 11, LaFourche Par., Louisiana (23,000), 9 hrs., PU: Sept. 11, Grand Isle, Louisiana (2,100), 3.5 hrs., NP: Sept. 11, Cameron Pan., Louisiana (5,700), PU: Sept. 11, Biloxi, Mississippi (15,000), 5 hrs., PU: Sept. 11, Jefferson Co., Texas (108,600), 7.5 hrs., PU: Sept. 11, Chambers Co., Texas (10,000), 7.5 hrs., PU: Sept. 11, Galveston Co., Texas (95,000), 23 hrs., P: Sept. 11, Calhoun Co., Texas (15,100), PU: Sept. 11, Port Aransas, Texas (3,900), 2 hrs., PU.

1964: Mar. 28, Shoreline, Washington (900), 1 hr., PU: Cannon Beach, Oregon (3,100), 1.5 hrs: Aug. 27, Duval Co.,

Florida (12,500), PU: Sept., St. Marys Par., Louisiana (40,500), 8 hrs., PU.

1965: Sept. 7, Florida Keys (8,300), 25 hrs., PU: Sept. 8, Par. near New Orleans (250,000): Sept. 8, Pascagoula and Jackson Cos., Mississippi (21,000).

1969: Aug. 17, Coastal Areas Louisiana and Mississippi (100,000), 12 hrs., PU: Aug., Gulfport, Mississippi (10,000), 7.5 hrs., PU: Sept. 9, Cape Cod, Mass. (250), PU: Sept. 20, Corpus Christi, Texas (135,000), PU.

1970: July 3, Robestown, Texas (450), 1.5 hrs., PU.

1974: Sept. 8, Ploquemine and Cameron Brs., Louisiana (200,000), PU: Sept. 8, Coastal Areas, Mississippi (45,000), PU: Dec. 1, Wildwood, New Jersey (200): Dec. 1, Beach Areas, Delaware (500).

1975: Sept. 15, Puerto Rico (7,000): Sept. 22, Coastal Areas, Louisiana (32,000), PU.

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